

Lowe's Loop for 432 MHz

Your brand-new rig covers 432 MHz, but you don't have an outside antenna for that band? Here's an easily constructed antenna that will get you on 70 cm.

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Introduction

Many of the small modern transceivers on the market today are supplied with 432 MHz capabilities, but often operation on this band is not utilized due to the lack of a suitable antenna. This can be a great band for local contacts, and when propagation is good almost any simple antenna with the right characteristics — horizontal polarization and a low SWR — will permit some long-range contacts.

The purpose of this article is to present an antenna that is easy to construct in a couple of hours and is easy to match. It uses inexpensive material readily available at Lowe's Home Improvement, Home Depot or your local hardware store.¹ After all, putting up a 432 MHz antenna and generating some activity on this band would have to be considered a "home improvement" by any true-blue ham! The antenna described in this article is a *halo* loop with a matching scheme that is easy to implement.

Construction

I fabricated this loop with an emphasis on ease of construction and low cost. To that end, I used standard $\frac{3}{4}$ inch diameter copper water pipe, 5 or 10 feet long for the mast and $\frac{1}{4}$ inch copper tubing, normally used for ice makers on refrigerators, as the radiating element. Icemaker tubing normally comes in a 10 foot roll at Lowe's, but I only use about 1 foot unless I construct a multi-element array. One roll of tubing will be plenty for you and several of your friends to construct antennas.

This project also requires some #6 brass wood screws, some #8 brass wood screws both $\frac{1}{2}$ inches long, and a $\frac{1}{4}$ inch nylon spacer 1 inch long. These parts are also available at Lowe's. Table 1 lists the parts needed.

Fabricating the Pipe

The basic approach to construction is straightforward. Use a tubing cutter to cut the radiating element from the $\frac{1}{4}$ inch tubing

**Figure 1 —
Completed 432 MHz
"Lowe's Loop."**



for a length of 13 inches. Center punch all holes before drilling so that the drill bit does not "walk off" the desired location. Exactly at the center of the element, 6.5 inches from each end, drill a small tap hole using a drill bit of $\frac{3}{32}$ inches. The precise size of this hole isn't critical, since a screw will hold the element in place until it is soldered. Once you've drilled the center hole, the element is bent around a 4 inch form to create the *halo* loop. Keep the tap hole on the inside portion of the circle. That is, place the hole directly against the circular form facing in toward the surface of the form instead of facing out.

The precise diameter of the halo isn't too critical, since the element diameter can later be adjusted by slightly bending it. I shaped the element into a circular form using a piece of 4 inch diameter PVC pipe obtained from

Lowe's and wrapped the 13 inch long, $\frac{1}{4}$ inch diameter, ice maker tubing around the pipe. However, any 4 inch diameter circular form can be used. Figure 1 shows the loop element.

You will be drilling a total of six holes in the $\frac{3}{4}$ inch mast. Using a sharp felt tip pen or a pencil, at a distance of 2 inches from one end of the $\frac{3}{4}$ inch pipe, mark the position of the first hole to be drilled. At this point along the pipe you will gauge the precise circumference using a piece of masking tape. See Figure 2C. Wrap the masking tape around the pipe, offsetting the edge as you wrap just enough so you can see the starting point. Mark the beginning and end points on the tape.

Inserting the Elements

Remove the masking tape and temporarily stick it to a flat surface. Use a ruler to measure

**Table 1
Parts List**

Description	Lowe's Part Number
Round slotted brass wood screw, #6, $\frac{1}{2}$ " long.	490120
Round slotted brass wood screw, #8, $\frac{1}{2}$ " long.	491257
Nylon spacer, $\frac{1}{4}$ " \times 0.140" \times 1".	491257
Copper pipe, $\frac{3}{4}$ " \times 10' long.	23791
Copper ice maker pipe, $\frac{1}{4}$ " \times 5' long.	22100004

¹The author is not related to, nor does he represent, Lowe's Building Supply.

the distance along the masking tape. Calculate $\frac{1}{4}$ of the total circumference distance. Mark points along the tape, each spaced $\frac{1}{4}$ of the circumference around the pipe. Mark the center point in between two marks. This mark will be used to line up with the tap hole you've already marked on the pipe. (The tap hole is for the #6 element screw that will be used to temporarily hold the radiating element in place while it is soldered.) Rewrap the masking tape on the pipe just below the 2 inch circle previously marked on the pipe using the tap center hole as a reference.

On each side of the center hole, at 90° to each other, you will drill two other holes for the radiator to pass through the mast. Mark the positions for these holes on the pipe, along with the holes 1 inch farther down the pipe used for the nylon insulating spacer, and $\frac{1}{4}$ inch farther from that down the pipe for the #6 ground tap screw. See Figure 2 again.

Drill the two mounting holes for the radiator, starting with a small starter bit, following with larger diameter bits. You will need to use a rattail file to open up the holes to the shape of ovals to allow the radiating element to pass through the pipe.

Insert the radiating element through the oblong holes and fasten it temporarily in place with a #6 brass set screw. Then, solder the element into place using a high wattage iron or small propane torch. After the element cools to the touch, the element can be bent to make it exactly horizontal when the mast is vertical.

Insert a $\frac{1}{4}$ inch diameter, 1 inch long, nylon spacer, available from Lowe's, into the spacer hole. This spacer extends approximately $\frac{1}{8}$ inch out each side of the pipe mast, forming a standoff insulator for the balun center conductors that make up the antenna feed system. The matching scheme itself is taken from a well known technique for the delta match using the "plumber's delight" approach. It got this name because the radiating element does not require insulation from the mast and thus can be fabricated from plumbing fixtures.

Wiring it Up

Next, construct the $4:1$ balun from RG-58 coax cable that is $\frac{1}{2}\lambda$ long as shown in Figure 3. While coax with foam insulation exhibits slightly lower loss, the foam can also act like a sponge for water, changing the characteristics of the dielectric and corroding the shield. Therefore, be sure to use RG-58 coax with solid polyethylene insulation, which isn't nearly so susceptible to water. Even though the loss is slightly higher, the length is so short that the difference is negligible.

The RG-58 coax is rated at 70 W at 432 MHz. With SSB or CW operation, the duty cycle is well below 50%, so I wouldn't

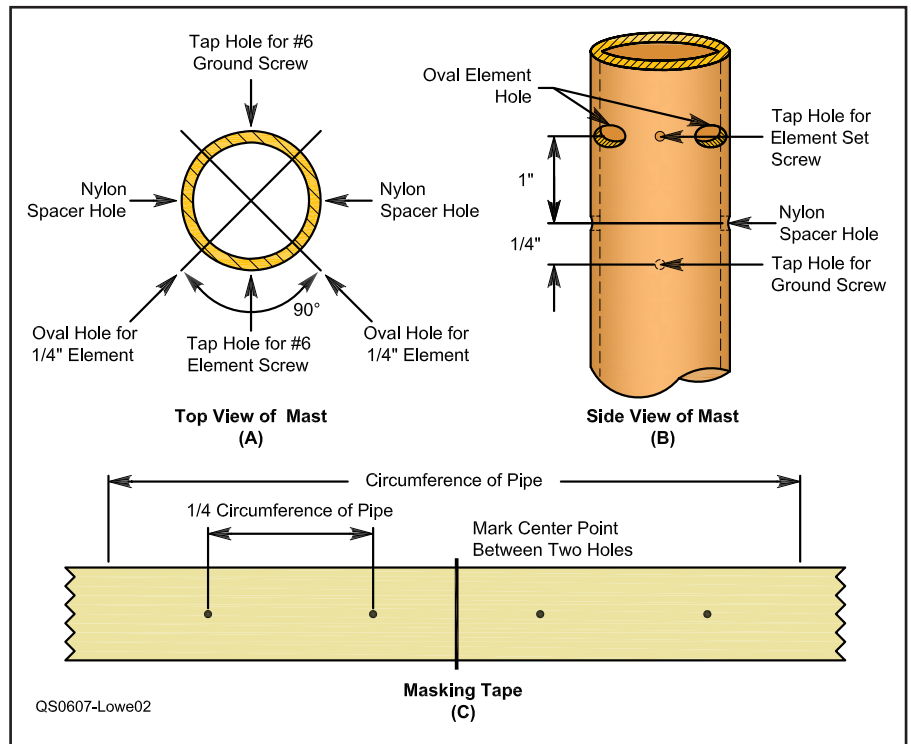


Figure 2 — Hole placement for Lowe's Loop mast. At A, top view of mast. At B, side view of mast. At C, masking tape used to measure exact circumference of mast, and then to mark off four equally spaced hole positions.

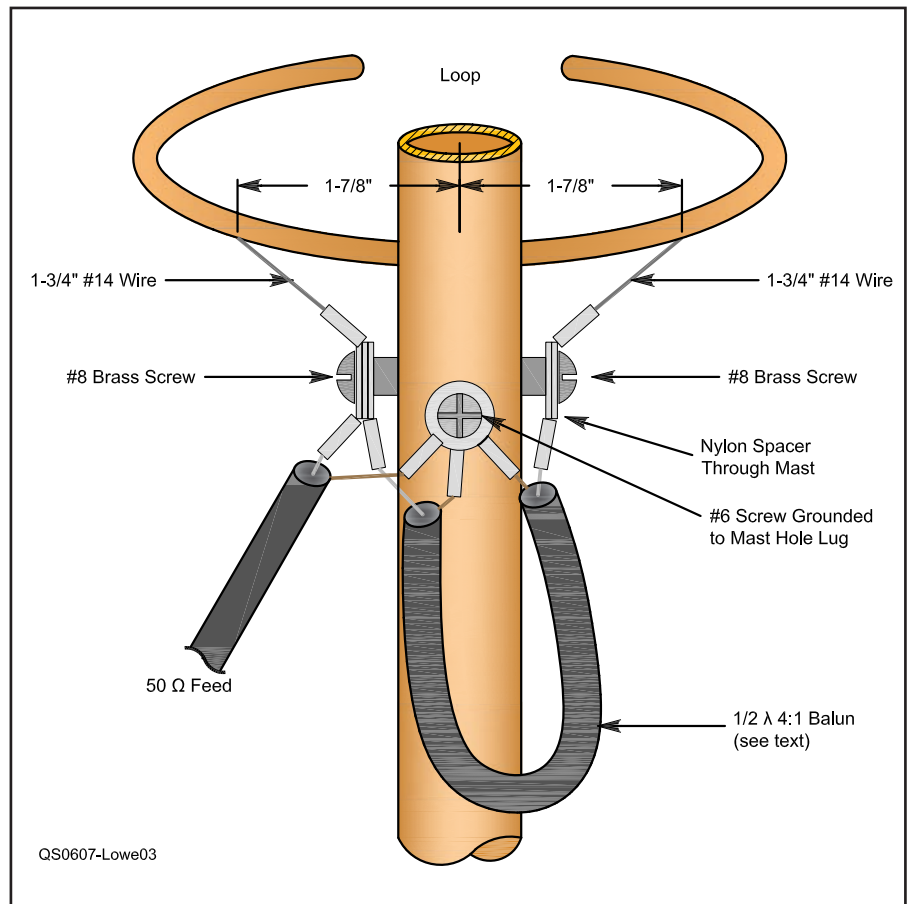


Figure 3 — Feed system, including coaxial 200 to 50 Ω coax balun.

hesitate to run as much as 100 W of RF into this antenna. If you plan to run more than 100 W to the antenna, a larger, higher power coax should be used. Also, with a typical station installation using a nondirectional antenna such as this, most setups will probably have something in the order of 3 dB feed line loss from the shack to the antenna. Therefore, even a transmitter with a couple of hundred watts of output can supply only 100 W to the antenna. As described later, a four-bay array of loops, each at 70 W capability, could take 280 W of average power, or 560 W peak power supplied to the antenna array.

The delta match feed is constructed from the 4:1 balun, two 1¾ inch lengths of 14 gauge copper house wiring and four solder lug terminals. The purpose of the 4:1 balun is to transform the 200 Ω balanced line of the delta match feed point to a 50 Ω unbalanced coax line.

You should mark the elements at the proper distance with a felt tip pen before soldering the delta wires to the element. Attach the 50 Ω feed line's center conductor to one of the lugs at the #8 brass screw that is inserted into the nylon insulator and its shield to the common ground point with the two shield connections from the balun.

The balun uses a piece of RG-58 coax that is 11½ inches long. Carefully remove ¾ inches of the black outside covering from each end of the coax, leaving the black covering on the coax 9½ inches long. Using a scribe or small sharp object, spread the braided shield on each end of the coax, tightly twisting the shield to form a solid conductor, and then carefully remove one half of the polyethylene insulation remaining on each end of the coax. Solder a small terminal lug suitable for a #6 brass wood screw on the twisted shields on each end of the coax. On the center conductor of each end of the coax, solder terminal lugs suitable for a #8 brass wood screw, along with the two 1¾ inch lengths of #14 copper house wiring as shown. Soldering is done before later attaching the lugs to the nylon spacer in order to not melt the nylon spacer. The final coax balun is shown in Figure 3.

After you've completed the coax balun and bent it into a loop, pass #8 brass wood screws through the solder lugs on the center conductors into each end of the nylon spacer on each side of the mast. If the holes for the nylon spacer barely have clearance, the #8 screws spread the nylon spacer just enough to hold the spacer securely in place. This may require a screwdriver on both ends of the nylon spacer at the same time. Then attach the #6 ground lugs on the shields to the tap hole located ¼ inch below the nylon spacer with a screw. The final step is to solder the #14 buss wires to the bottom side of the

element. These wires are attached to the element at a distance of 1¼ inch from the brass set screw used to hold the element in place.

Final Test

If the loop and balun dimensions have been followed precisely, very little tuning should be necessary to obtain a low SWR for the antenna. One factor that could require tuning, however, is a variation in the velocity factor of the particular run of coax used to construct the balun. If this is the case, one way to compensate is to make slight adjustments in the length of the balun. This is easier said than done since it requires cutting and soldering the balun each time an adjustment is made. An easier way to make slight adjustments is to vary the spacing between the ends of the loop. You can make slight tweaks in the resonant frequency of the antenna by slightly changing the diameter of the loop. If the SWR is no more than 1.6:1 or 1.7:1, change this spacing by simply holding both sides of the loop and spreading or squeezing the spacing. This should allow the SWR to be brought down to an acceptable level.

For the test antenna and subsequent models, I easily adjusted the SWR to 1.2:1. Most of the models fabricated did not require any adjustments to achieve this SWR. One model required that the spacing be adjusted to 2 inches to obtain an acceptable SWR.

Quick Fix Four-Bay Array

One useful feature of the Lowe's Loop is the ability to stack these loops vertically to narrow the elevation beamwidth and achieve omnidirectional gain in the azimuth plane. Stacking four of the loops separated by ⅝ λ, or 16 inches between loops at 432 MHz, yields a total height of 48 inches for the four loops shown in Figure 4 and should yield about 6 dB gain, minus any losses in the power divider. While you can fabricate one loop on a ¾ inch copper mast, it isn't much more effort to prepare the mast and cut the elements for three more of the loops. If you pay careful attention during the construction, you can achieve a low SWR for all of the loops. Then, it is necessary to provide four equal-amplitude and in-phase drive signals to the four elements.

If all four loops in the array are fed with equal length feed lines, then each element receives the same amplitude and in-phase signal provided by the four way divider.

Tying four identical 50 Ω feed points in parallel results in a feed impedance of 12.5 Ω. I fed the four loops in my array with equal lengths of 50 Ω, RG-58 coax, each with a BNC connector on its end. This provided an easy mechanism to check each antenna individually before combining them into the four bay array. I drilled four holes



Figure 4 — Four Lowe's Loops mounted in a stacked array for additional horizontally polarized gain.

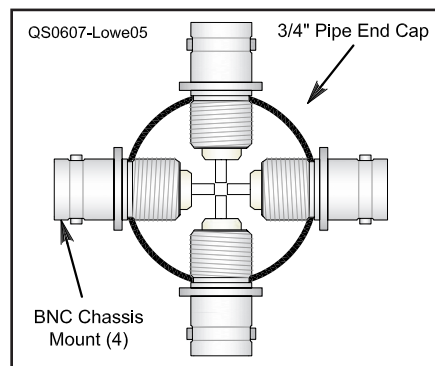


Figure 5 — Four way divider/transformer to feed stacked array of four Lowe's Loops.

in the side walls of a ¾ inch copper end pipe cap to permit insertion of BNC female chassis mount connectors into the pipe cap, as the divider in Figure 5 shows. I sweat soldered the BNC connectors to the copper end cap.

For the particular version of the BNC connectors used, the center conductor pins had to be cut off a slight amount to allow all four connectors to join together at the center point and still have the ground rings of the connectors seat against the sides of the pipe cap. I did this easily with a pair of wire cut-

ters on the soft metal center pins.

I needed to transform the $12.5\ \Omega$ impedance back up to $50\ \Omega$. I decided to use a $\lambda/4$ Q section, which requires a $25\ \Omega$ characteristic impedance line. You can make a line with this impedance simply by paralleling the center conductors and the shields of two $\lambda/4$ lengths of $50\ \Omega$ coax. The photo in Figure 6 shows four BNCs mounted through the bottom pipe end cap, together with the two paralleled Q section coaxes before inserting them into the $3/4$ inch copper pipe and top end cap to finish the final assembly.

I started out by cutting two $5\frac{1}{4}$ inch lengths of RG-58. I removed $3/4$ inches of the outside jacket from each end of each coax. I then removed half of the center insulation at each end to expose the bare center conductors and soldered these center conductors together. After some experimentation, the final length of the paralleled cables was $3\frac{3}{4}$ inches, as shown Figure 7. The difference in length from the calculated value was likely due to the end sections, which act like additional short transmission lines with a different Z_0 .

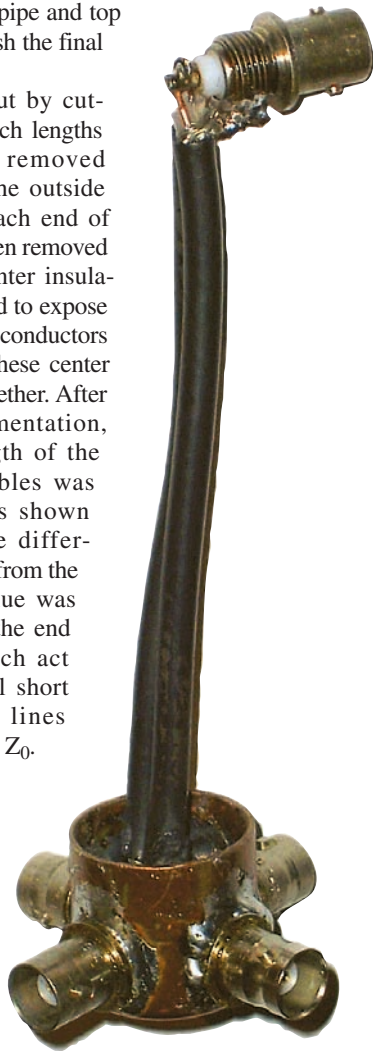


Figure 6 — Photo of four way divider/transformer before mounting in $3/4$ inch copper pipe with end cap.

Incidentally, the same approach should be applicable for building two way dividers using paralleled pieces of $72\ \Omega$ coax. The paralleled coax characteristic impedance should be $35\ \Omega$ to transform the $25\ \Omega$ impedance of two $50\ \Omega$ antennas in parallel to $50\ \Omega$. The required $35\ \Omega$ is very close to two paralleled pieces of $72\ \Omega$ coax cut to $\lambda/4$ in length.

Once I cut the Q section coax lines to length, I soldered their center conductors to the junction of the BNC center pins, and then soldered the four short ground lead pigtails onto the ground of each BNC connector. I soldered another BNC connector to the top end of the transformer at 90° to the coax to



Figure 8 — Completed four way combiner/transformer assembly.

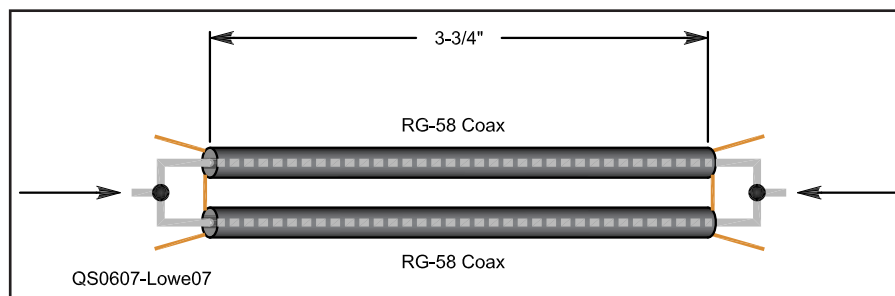


Figure 7 — Making a $25\ \Omega$, $\lambda/4$ transmission line by paralleling two RG-58 lines.

minimize lead lengths.

It was now time to test the divider/transformer assembly. I connected a $50\ \Omega$ termination to each of the four BNC connectors and measured the SWR, which was 1.2:1. After testing, I placed the entire Q section inside a 3 inch long, $3/4$ inch diameter copper water pipe, together with an end cap with a hole in its side for the top BNC connector. Figure 8 shows a photo of the completed divider/transformer assembly.

Conclusion

This antenna is relatively easy to construct and to put into service. The materials are available at almost any building supply or hardware store. While one antenna provides omnidirectional coverage, the four bay array should approach 6 dB gain over a single element in all azimuth directions. This gain comes from compressing the elevation pattern, the same way that TV transmitting stations obtain gain in their omnidirectional antennas.

I've taken the same approach for a 2 meter halo simply by multiplying all dimensions by three. I've also constructed a 6 meter version, but that required capacitive loading to keep the dimensions of the antenna from getting too large. So far, my best DX on 70 cm has been Texas from Alabama. I've used the 2 meter Squalo to log Toronto to the northeast and Houston to the southwest, among the 42 grids that I've worked since putting it into operation a year ago.

I want to express my appreciation to Dieter Schliemann, KX4Y, for the use of his antenna analyzer and SWR meter, and to George Hall, W4BUW, for review of this manuscript.

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