

An In-Room, 80-Meter Transmitting Multiturn Loop Antenna

A little wood, some wire and a handful of components can make a directional antenna for indoor use where outdoor antennas are not permitted.

By Richard Q. Marris, G2BZQ

See **Feedback**, May 1996 QST for corrections to this article.

In the early 1970s, my employer asked that I move to the USA for a few years. I arrived armed with the correct passport visa plus an FCC permit to operate as G2BZQ/W0.

On arrival in Minneapolis/St Paul, I found the people friendly and hospitable. The work was an interesting challenge with opportunities for travel throughout the US and Canada. Minnesota was delightful—with excellent fishing. Upon moving into my apartment, I had an unpleasant shock.

The “No Antennas Here” Syndrome

I soon learned that a dire punishment would descend on any resident who erected an antenna of any sort or was suspected of causing TVI. This meant that I must either forego transmitting or resign myself to an indoor antenna. The antenna design would be no easy matter, as 80-meter CW is my favorite band and mode.

In the end, the answer to an immediate problem became a continuing obsession that has spanned some 20 years. It has yielded an ongoing series of experimental designs for compact antennas that includes shortened-wire antennas, loops of various shapes and sizes and even experiments with ferrite-rod transmitting antennas (which have produced some interesting results).

The 80-Meter Spiral Miniloop

This loop incorporates an amalgam of the best technical features from many experiments, plus some new ideas. It offers a small, effective 30-inch-diameter indoor spiral loop that takes up very little domestic space. With a minor modification, the loop and support can be separated for vacation or portable operation. The construction permits future experiments or modifications.

The antenna is just 38×30 inches (HW). The 30-inch-diameter octagonal frame clips onto a vertical pole that mounts into a solid wooden base—see **Figure 1**. The loop-framework idea evolved over a decade. I have used it for loops with 18 to 48-inch diameters from VLF to VHF. A TUNING/LOADING meter and a neon “daisy chain” reference indicator make adjustment easy.

How It Works

This antenna is a low-power device; I use it with a 15-W (input) 80-meter CW transmitter. This power level serves the interests of domestic peace (no RFI) and RF safety. The antenna could be scaled up for more powerful transmitters, but it's better to use low power when the antenna is located so near the operator. [1]

Small loops like this one are essentially parallel-resonant circuits with one very long conductor—the loop. In order to reduce loss, small loops must have a very high circuit Q, which limits their bandwidth and multiplies the circulating current and voltage across the circuit. Even at 15 W, there are RF-burn and shock hazards at any exposed conductors in this antenna system. *Be careful!*

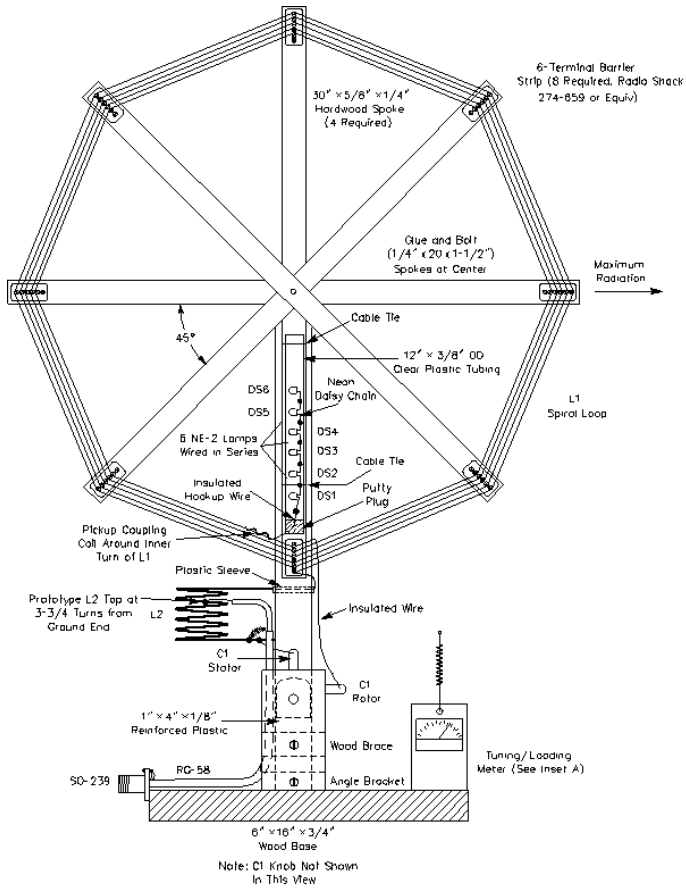
You can reduce RF-burn hazards by insulating or covering any exposed conductors. For example, place a plastic box over L2/C1 and cover L1's connections with electrician's tape. (The C1 end of L1 is a high-voltage point.)

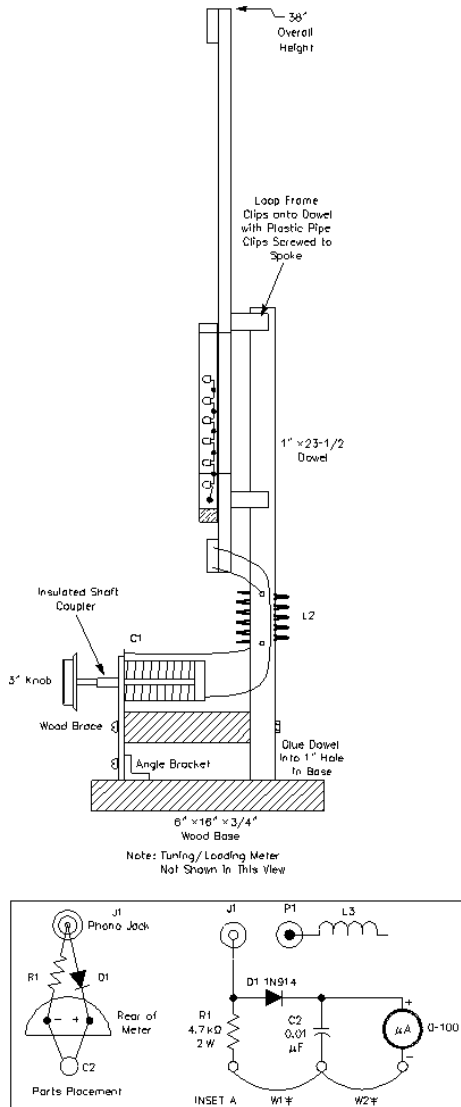
Small antennas like this are not very efficient (about 1%), so it's important to maximize their limited efficiency by reducing losses wherever possible. This antenna does so by using a very short feed line, large stranded copper wire (not tinned; that adds loss) for L1, and a high-Q matching coil. (L2 has a large conductor, nearly equal length and diameter and wide turn spacing.) [2]

Figure 1 shows the loop circuit. The loop consists of a 5-turn, 30-inch-OD octagonal spiral loop, L1, which is series tuned by C1. Use heavy-duty wire for L1. We match the antenna circuit to the feed line by connecting the feed line center conductor to L2 at an appropriate spot. A simple TUNING/LOADING meter ensures that the loop is at resonance, with maximum radiation. This is confirmed by illumination of six small neon lamps (coupled to L1's innermost turn) that give a quick visual check after a frequency change.

The loop radiation pattern is directional, with minimum radiation perpendicular to the plane of the loop. Maximum radiation is in the plane of the loop. Although theory says this loop should have a symmetrical radiation pattern, my loop exhibits a 2:1 front-to-back ratio, with the maximum radiation as indicated in **Figure 1**. The receive performance is quiet, with much lower QRN and QRM levels than with my end-fed slinky at 30 feet.

The usable transmit "bandwidth" of the prototype is just over 20 kHz. (I call "bandwidth" the frequency range over which *my* instruments detect no change in the level of radiated output. This is quite different from the common definition of bandwidth.)





* W1 and W2 are the leads of R1 and C2, which serve as current returns for L3. Shorter leads make the circuit less sensitive.

Figure 1—Construction details of the 80-meter indoor loop antenna.

C1—100-pF, 2-kV variable capacitor with ceramic end plates and silver-plated fins, eg Jackson C11

DS1 - DS6—NE2 (no resistor) neon lamps

J1—Panel-mount phono jack

L1—5-turn spiral loop made from one conductor of #18 AWG stranded copper lamp cord. For 15 W input, the wire should be rated at 6 A. Loop current increases as the square of the power increase: 30 W input (2 × power) produces 24 A (2 × 2 × current), etc. See text.

L2—6 turns of #14 AWG tinned copper wire, 2 inches in diameter, with turns spaced 1/4 inch apart. Place the coax center-conductor tap as described in the text. (It is 3-3/4 turns from ground end on the prototype.)

L3—About 10 inches of #16 AWG wire coiled by winding around a pencil. Misc—4x3x1-1/2-inch plastic box for field-strength meter P1—Phono plug

Construction

Figure 1 shows most construction details for the antenna. Assemble the loop-frame spokes as shown. Screw a 6-position, 2-A terminal block to the end of each spoke. These blocks are guides for the spaced coil winding. Clip the assembly to the vertical pole with two PVC standoff wall clips as used for 1-inch water pipes.

L1 consists of 5 turns (39 feet) of stranded (not tinned), insulated wire with a current rating of 6 A or more. Common lamp (zip) cord (#18 or larger) would be a good substitute. Begin with 20 feet of zip cord, separate the two conductors, solder splice them and cover the splice with heat-shrink tubing or electrician's tape. Secure the wire at the outer hole of the bottom terminal block and proceed counter-clockwise through the terminal blocks, ending at the inside bottom terminal. Tighten one terminal-block screw on each loop turn to tightly hold the wire.

Make the matching coil, L2, as shown. Insulate the upper coil lead with a plastic sleeve, then drill holes through the 1-inch dowel and feed the coil leads through holes in the vertical pole. Connect the top lead of L2 to the outer end of the loop.

C1 is a 100-pF, 2-kV, small (approximately 2×1-1/4×1-1/4 inches) transmitting variable capacitor with ceramic end plates and silver-plated rotor and stator. I used a Jackson C11, but any similar capacitor will do. It is mounted on a 4×1-inch (HW) strip of reinforced plastic, which is fixed vertical to the base board with a small metal angle bracket and braced to the 1-inch dowel just beneath the capacitor. C1 has a shaft coupler, insulated shaft and 3-inch-diameter knob. The fixed plates are connected to the upper end of L2, and the rotor is connected to the lower end of L2 (ground).

An SO-239 jack is fitted to the back left-hand corner of the base board and connected to L2 by a length of RG-58 feed line. The RG-58 shield is soldered to the lower (ground) end of L2, and the inner conductor is tapped onto L2. The cable is fixed to the 1-inch dowel pole with cable ties.

Next, construct the neon lamp daisy chain as shown. Fix it to the bottom spoke of the loop frame with cable ties. The lead will be coupled to L1 later, during initial testing.

The TUNING/LOADING meter is fitted to the base board at the front right-hand corner, by means of a screw and spring washer. This lets it rotate to the best viewing angle. The circuit (**Figure I**, inset) is self explanatory; it's housed in a 4×3×1 1/2-inch plastic box. Mount the meter and phono socket in the box lid. A coil of #16 wire, soldered into a phono plug, forms a short pickup antenna.

Setup, Tests and Operation

Connect the loop to the transceiver with a length of RG-58, not exceeding 6 feet. There is no ground connection at the loop, but my transmitter is grounded.

First, test the loop reception. Set your receiver to some test frequency (about 3550 kHz) and adjust C1 for resonance, as indicated by increased signal strength and noise. If the band is dead, use a pocket calculator near the loop as a noise source.

Set the transmitter to the same frequency, and adjust it while feeding a dummy antenna, if needed. Next, connect the loop to the transmitter. Place a field-strength meter (FSM) near the right-hand side of the loop and transmit; radiation should show on the FSM. Set C1 to midrange and adjust the tap on L2 for maximum field strength.

The TUNING/LOADING meter should also show a reading, but the meter sensitivity may need adjustment. To do so, lengthen or shorten the coiled antenna on the meter. Target a three-quarter-scale reading when the loop and transmitter are matched. If necessary, you can also adjust the meter sensitivity by experimenting with the value of R1.

The neon daisy chain provides a rapid radiation check. Couple a little RF to the neon chain by coiling the end of the PVC hook-up wire lead around the inner end of L1. On the prototype, a 3-turn coupling coil and 15-W transmitter light five of the six bulbs when the loop is fully loaded. As power is reduced, the lamps go out in sequence. When making a quick frequency change, quickly check that five lamps are still lit—if they're not, retune the loop. For lower power levels, increase the number of coupling turns until five of the six lamps are lit.

With a little practice, the loop is easy to use. You'll soon learn to rotate it slightly for maximum signal on receive and quickly adjust C1 for maximum field strength, as shown by the TUNING/LOADING meter and daisy chain.

For vacation or portable use, install small in-line connectors in the leads from L1 to L2 and C1. The loop frame can then be unclipped from the vertical pole and conveniently carried.

Summary

Your results with this little transmitting loop will, as with other antennas, depend on its location and height above ground, transmit power level and operating skill.

This setup won't compete with a kilowatt feeding a Yagi, but it's a good resource for the "no antennas here" syndrome faced by many frustrated hams.

Notes

¹RF safety is a critical concern when hams operate close to their antennas. For more information, look in *The ARRL Antenna Book* (Chapter 1 in the 17th edition) or *The ARRL Handbook* (Chapter 9 in the 1995 and 1996 editions).

²For more information about small transmitting loops, see "Honey, I Shrunk the Antenna," in July 1993 *QST*, page 34.

Feedback

ARRL Technical Information Coordinator, Mike Tracy, KC1SX, has noted corrections for "**An In-Room 80-Meter Transmitting Multiturn Loop Antenna**" that appears on pages 43 to 46 of the February 1996 *QST*. With regard to C1, the text should read "The fixed plates are connected to the upper end of L1 . . ." In **Figure 1**, the words "Stator" and "Rotor" should be transposed.