Five-Band Magnetic Loop Antenna

Build a loop for QRP, and tune it up just right!

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The magnetic loop has been used successfully worldwide for many years, but one of the problems faced by builders today is the acquisition of suitable variable capacitors. Having tried ARCO trimmer caps which overheated on the higher frequencies, I decided to use coaxial cable, since it has the inherent capacity and voltage protection needed for a 5 W-plus QRP signal. All coaxial cable has a specific capacitance per foot value, so it's a simple matter to calculate the length needed for a given capacitance. Also, its light weight maintains the loop's integrity.

With propagation conditions getting better by the day, this little device should lend itself quite well to the QRP purist, or to the person who just wants to SWL or listen to his favorite net. Supplemented with a long wire antenna for the 3.5, 7.0 MHz bands, its noise-canceling ability should make for a good copy.

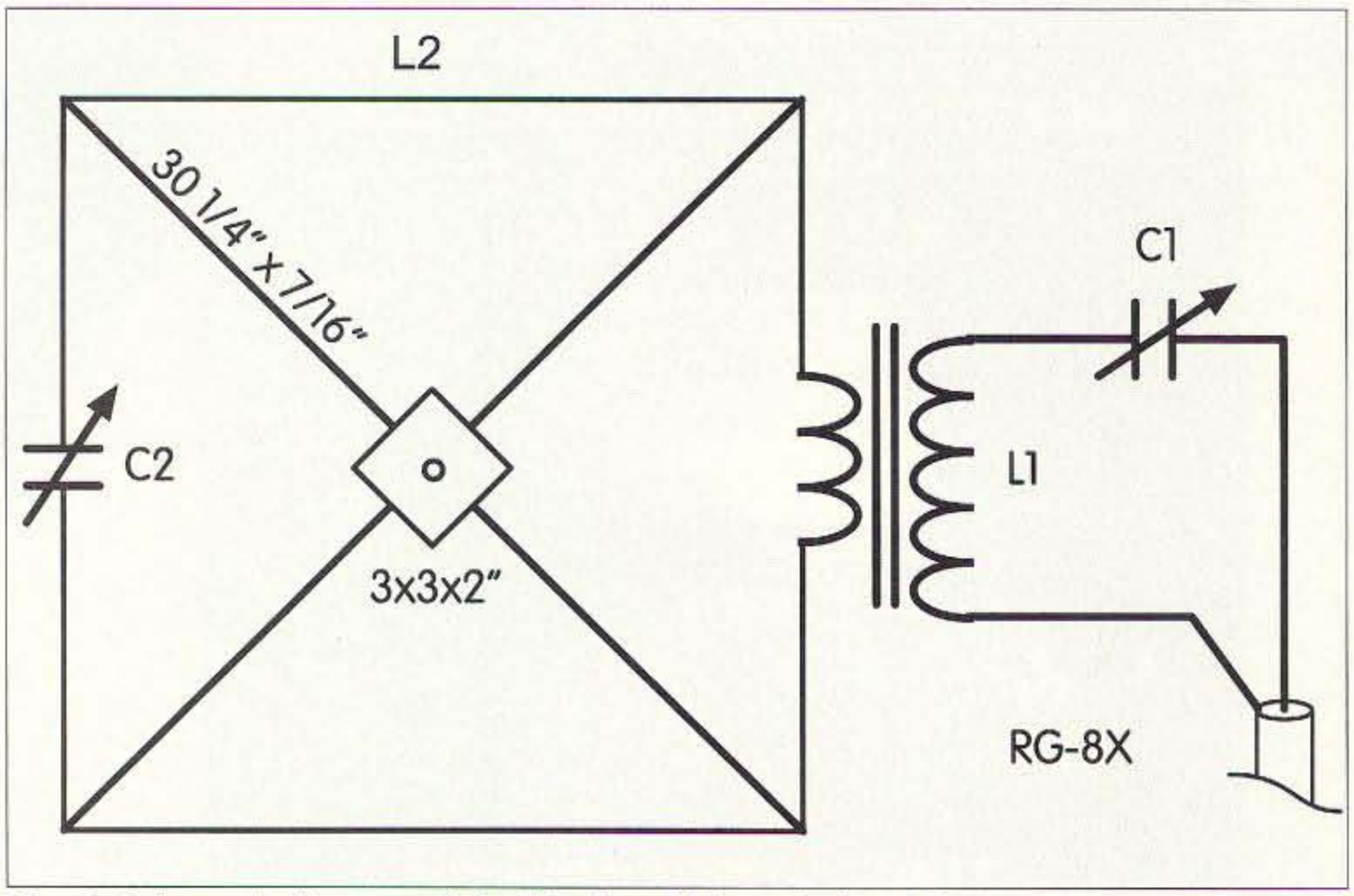

Fig. 1. Schematic diagram of the Five-Band Magnetic Loop Antenna.

Construction

The loop consists of three parts. Printed circuit board 1 (PCB1) tunes the loop to the coaxial input. PCB2 mounts the desired capacitance on the other side of the loop. The loop itself (L2) is supported on a framework of crossed dowels.

Cut four 7/16-inch dowels to 31.5 inches each, and make a 1/16-inch slot in one end of each dowel. Shellac the dowels and set them aside to dry.

You'll need a block of wood for the hub, three inches square and two inches thick. Drill a 7/16-inch-diameter hole into the middle of each side of the block, to a depth of 1-1/4 inches. I also drilled a 1/4-inch hole through the center of the block for mounting. Shellac the block and set it aside to dry.

When the unslotted ends of the dowels are inserted into the hub, they should measure 30-1/4 inches from the hub's outer edge to the dowel tips.

Cut two segments of #22 audio wire, each 7 feet, 4-1/4 inches long. Strip 1/8 inch of insulation from each of the wires' four ends; tin each end with solder. Solder a Caltern™ ring terminal, common to auto wiring (the #22-18 Red are suitable), to each end of the wires.

Prepare two single-clad PCBs as depicted in **Figs. 2** and **3**. You may use something else, just as long as you keep the separation for L2 the same as shown, or else you may have trouble keeping L2 taut with the dimensions shown.

The coaxial input is L1, toroid T 68-7 White, wound with #24 enamel wire 25 turns, spaced approximately one millimeter apart. The secondary winding is prepared by winding the #24 enamel wire for a total of six turns, encompassing at least three-quarters of the toroid's primary. This will approximate a 75-ohm input, which is easily matched up with the RG-8X coax.

Remove the insulation from the toroids' four leads, and solder to PCB 1 (**Fig. 2**). Solder C1 across the copper traces on PCB1 as shown.

At this time you may want to apply coil dope or clear fingernail polish to coil L1.

Note that the negative PCB trace continues along a path beneath C1, so don't mount C1 flush against the PCB.

Mount the ring terminals of the audio wire to PCB1 and PCB2, using 6-32 x 1" screws, nuts, and washers. Use three nuts on each PCB, so that removal of L2 will be easy later on.

Insert the dowels into the hub, and align the wire on the dowels as shown in **Fig 1**.

You may remark on the fact that, worked out by the formula for determining cross-arm lengths, one quarter of L/7071 = 63.50 inches, but ours is 64 inches. This gives us a slight bow to the loop for rigidity—and it also looks nicer that way.

To build the various capacitors, you will need approximately five feet of RG-174U mini coaxial cable, plus a little extra to play with. Cut all coax as specified by the chart for your frequency of choice.

On each piece of coax, measure off one inch, and remove the outer insulation. Bend the coax at the point where

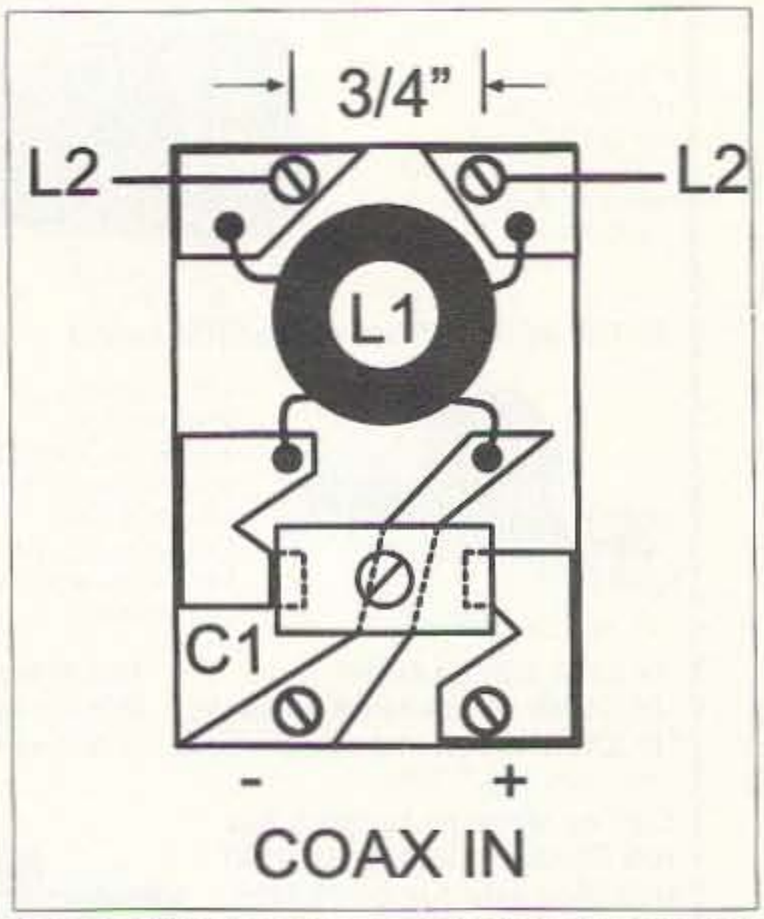

Fig. 2. PCB1 (approximately 2-1/4" x 1-1/2") provides mounting for the input circuit.

the outer insulation now meets the braid. With a sharp-pointed instrument, push aside the braid until the center conductor is exposed; extract it from the braid, leaving two terminal leads each one inch in length. Tin each tip lead, and solder on a ring terminal.

According to **Table 1**, measure off the specified length, from the junction of the braid and center conductor to the coax tip. Hold it!

Despite what the chart specifies, add one inch to each coax. You will use this extra length to compensate for the area density (capacitive effect) in which you will place your loop for operation. I tuned mine in the shack.

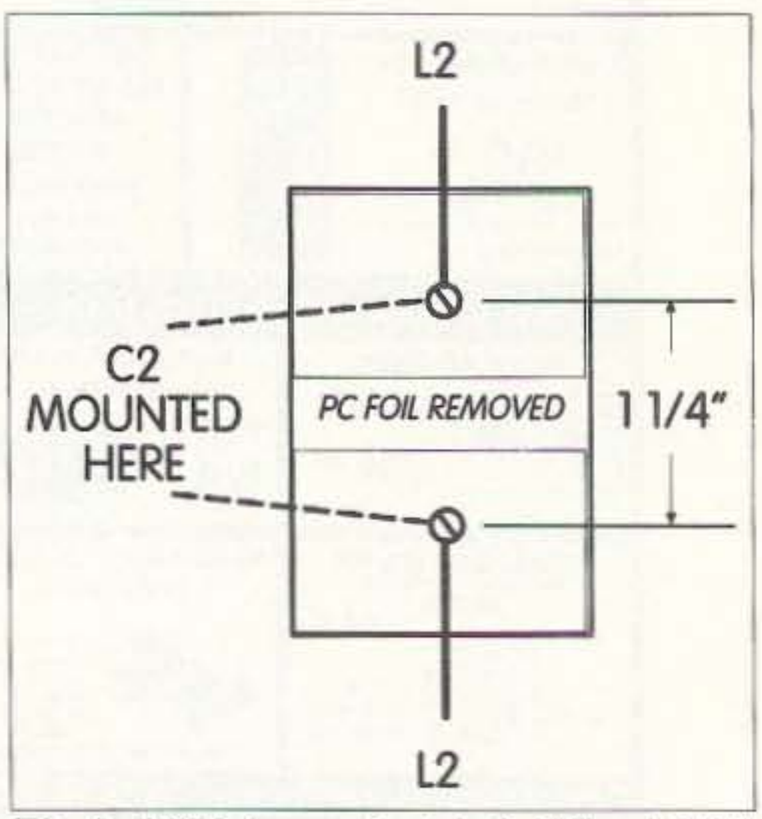

Fig. 3. PCB2 (approximately 2-1/4" x 1-3/4") connects the various capacitors to loop L2.

When I moved it out to the patio there was no change, but this will vary depending on your own surroundings. A 500 pF trimmer was used for the 3.5 MHz band, since the length of coax needed would have been quite long enough. However, this limits the power on this band to only a couple of watts.

If you elect to use the trimmer capacitors for all bands and are going to use two watts or less, just drop me an SASE if you're unsure of values and tuning, and I will be glad to explain it.

Tuning the loop

Connect your RG-8X mini coax to the loop's input as in **Fig 2**. You can use just about any length—I've used 16 to 50 feet in various situations. Connect the free end of this coax to an MFJ-249 SWR Analyzer. At this point you should have the capacitor of choice mounted securely to PCB2.

Search the analyzer for a frequency that obtains a dip. With the added one inch of coax, your frequency should be somewhat lower than expected. Then adjust C1 for the best dip possible. C1 will pull the loop's resonance point a little higher in frequency, so adjust the analyzer a little higher in frequency, and you will note that the SWR is getting lower.

Start to trim your RG-174 coax, about 1/8 of an inch at a time, until you are very close to the frequency selected, and repeat the procedure:

1. Check frequency for a dip.
2. Adjust C1 for a dip.
3. Check frequency again.
4. Trim coax, recheck frequency.

Repeat steps 1 through 4.

Once all your coax caps are resonant, simply roll the larger lengths of coax over two fingers and secure with a rubber band or tie-wrap. The 18 and 21 MHz capacitors are short enough to just hang freely.

Once C1 is optimized, for purity an antenna coupler can be used despite C1 being in series. Since the loop's bandwidth is about 50 kHz, the antenna coupler will allow wider frequency variations.

Desired Frequency	Length of Coaxial Cable
7.0 MHz	26-1/8 inches
14.0 MHz	5-3/4 inches
18 MHz	3-1/8 inches
21 MHz	1-5/8 inches
3.5 MHz	1 each Arco trimmer 500 pF

Table 1. *RG-174U chart.*

A wattmeter or SWR meter placed at the input of the loop should reveal a flat SWR when full power is applied. If it doesn't, retune the coupler and re-touch C1. Proper tuning is the key to success when using an antenna of this type. Use of a field-strength meter or neon lamp is a great help, too.

Qty.	Description
4	7/16" dowels, each at least 31.5 inches long
1	Wooden block for hub, 3 x 3 x 2 inches wide
15	Feet #22 insulated audio wire
5	Feet RG-174U mini coaxial cable
1	PC board, single sided, 3 x 5 inches
12	Caltern ring terminals, Red #22-18
1	Toroid, T 67-7 White
5	Feet #24 enamel wire
1	trimmer var. cap 500 (from Marvac, San Diego, CA)
6	6-32 x 1 inch screws
16	6-32 nuts, plus 12 #6 lockwashers

Table 2. *Parts list.*

For operation outdoors, a couple of plastic pill bottles can be slipped over PCBs 1 and 2.

Seal the coax caps with Shoe Goop™, or cement, at their tips and terminal junctions.

If you cannot beg, borrow, or acquire an MFJ-249 SWR Analyzer, you could use a grid dip meter to acquire resonance, and with the application of very little RF power, obtain a roughly suitable SWR.

I have accomplished QRP DXCC, WAC QRP, and 1,000 miles per watt with Argentina using one watt of power. I also have 40 states confirmed, using mostly wire and loop antennas. 73