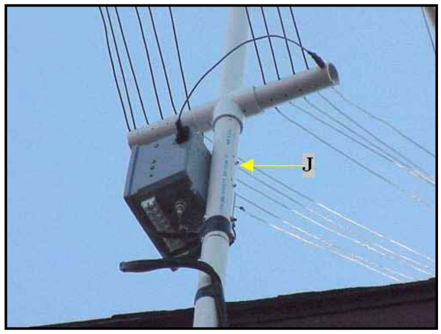
By Dick Goodman, WA3USG

The Monster Loop



High-performance LF receiving loops are frequently small enough to sit comfortably on your desktop. But if you believe that size matters, here's a loop antenna that is physically commensurate with its performance—big, big, big!

Since I've become involved with low-frequency (LF) experimenting I've spent a disproportionate amount of my time in the shack with 136.745-kHz AMRAD beacons droning in the background. As I type this, my wife and daughter are upstairs napping on this lazy Saturday afternoon, and I'm wide awake and looking forward to spending the night checking out the action on LF. My family thinks I'm crazy! After a full day of working in the yard I feel even more ambitious. Just yesterday I completed my "Monster Loop," which is now bracketed to the side of my house.

At 6:18 PM I can easily copy both AMRAD beacons from a distance of more than 200 miles. Throughout the day, taking breaks from my yard work, I periodically poked my head into the shack to check on the strength of the beacons. At about 1 PM, the S-meter on my Ten Tec RX-320 showed RF from WA2XTF/6 and /12. The audio from both was strong enough to pump the receiver's AGC. I switched to the 160-meter sloper, which also works pretty well as an LF receiving antenna. The beacons were both readable on the sloper, but they were nowhere near as strong as on the loop.

At the suggestion of my friend Bob Riese, K3DJC, I've built several loops. The first, a 20-foot shielded loop for 160 meters, didn't work too well, although Bob's version seemed to work just fine.

As a follow-up I tried building a multiturn loop with a 20-foot circumference. I wound about 16 turns of No. 22 wire on the same PVC form that once held the 160-meter shielded loop. I also mounted nine capacitors in a weatherproof box so I could switch one or more of them across the loop with remote-controlled relays, thus changing the antenna's resonant frequency. The loop worked reasonably well from about 100 to 380 kHz, but my160-meter sloper still outperformed it. Not good.

It was time to pull out all the stops and give loop antennas a final chance to perform. How big could I make a loop that I could still turn with a small Radio Shack TV rotator? I started with plans for a loop that was 15 feet from corner to corner (more than 42 feet in circumference). I built the PVC frame and tried to stand it up—wrong! It was way too big and too unstable to rotate. I decided to chop 18 inches from each of the PVC pipes that made up the frame. This produced a more reasonable 12-foot loop (34 feet in circumference).

Taking Bob's advice, I made the loop from No. 14 stranded, insulated wire. I also spaced each of the 10 turns one inch apart to maximize the antenna Q. I used the same relay-switched capacitor scheme but added varactor tuning diodes that worked in conjunction with the switchable capacitors. This lets me remotely tune the loop to resonance anywhere from 90 to 450 kHz.

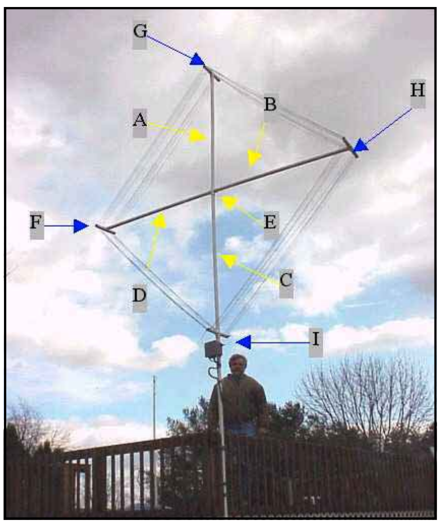


Figure 1—Assembling the loop frame. Cut four pieces of PVC pipe to a length of 5 feet 6 inches (A, B, C and D). These will be inserted into the center-mounted PVC cross fitting (E). Three-way PVC T fittings will be installed at locations F, G and H. The last PVC cross fitting will be attached at location I.

I managed to get the whole thing up on my roof and discovered that, yes, it could be turned with a small rotator as long as I mounted the rotator at the bottom of the mast.

How does it work? Let's just say that "I've gone loopie for loops!"

I was thinking about calling this project "The Lowes Loop" because virtually everything can be procured at your local Lowes (building supply) store. Here's your shopping list:

- Five (5) sections of 10-foot, 1 1/4-inch schedule 40 PVC pipe
- Two (2) 1 1/4-inch four-way PVC cross fittings (join four pipes)
- Three (3) 1 1/4-inch PVC "T" fittings (join 3 pipes)
- One (1) 500-foot roll of no. 14 stranded, insulated wire
- One (1) bottle of PVC glue
- Five (5) 4-inch TV mast-mount standoff insulators
- One (1) 10-foot section of TV mast
- One (1) 5-foot section of TV mast

Building the Frame

As shown in Figure 1, cut four pieces of PVC pipe to a length of 5 feet 6 inches (**A**, **B**, **C** and **D**). These will be inserted into the center-mounted PVC cross fitting (**E**). Three-way PVC **T** fittings will be installed at locations **F**, **G**, and **H**. The last PVC cross fitting will be attached at location I. From this point, the loop mast and support assembly will be attached.

Now that you understand the configuration of the frame, take the remaining PVC pipe and cut eight sections, each eight inches long. See Figure 2. Measure a half-inch from one end and drill a hole large enough to pass the no. 14 wire. Drill five more holes, each one-inch apart.

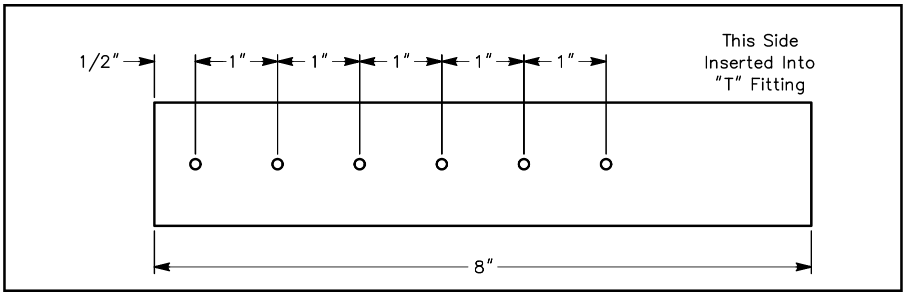


Figure 2—This short PVC pipe is what will actually support your loop wires. Two of these will go into each of the three T fittings on the ends of each pipe. Two more will go into the cross fitting at location I in Figure 1. Measure a half-inch from one end and drill a hole all the way through the pipe that is large enough to pass the No. 14 wire. Drill five more holes through the pipe, each one-inch apart.

Assembling the Loop

Take the eight pieces of drilled PVC pipe and insert them into their appropriate places in the three **T** fittings on the sides, top and in the single cross fitting on the bottom. The holes in the top and bottom (**G** and **I**) pieces should be parallel to the ground. The holes in the side pieces (**F** and **H**) should be perpendicular to the ground.

Place the entire frame on its back (or front) and start stringing the no. 14 wire. It took me about 45 minutes to lace all 10 turns. I started with about 100 feet of wire stretched out on the ground. I threaded it through the holes, keeping everything tight. When I ran out of wire, I soldered another 100-foot piece to the end of the first and continued. When you're finished, you will have 10 turns of wire in place and the framework will be much stiffer then it was before the wire was added.

Cut a piece of PVC pipe 18 to 22 inches long. Insert it into the bottom of the cross fitting. This is where you will fasten the relay box. Insert the five-foot section of mast into this section from the bottom. Leave about nine inches of mast protruding. This will join with an additional 10-foot mast section later in the assembly.

Drill two holes all the way through the PVC pipe, through the mast inside, and out the other side of the pipe. Note the distance between these two holes. You will fasten the capacitor box to this point by running two bolts through the capacitor box, the pipe, and to nuts on the other side. This will also keep the mast from turning.

Now measure how far up into the loop frame the mast goes. About an inch from the upper end, drill a hole through PVC pipe **C** (see Figure 1), the mast inside, and the other side of the pipe. Insert a bolt and fasten tightly with a nut. The mast is now an integral part of the loop structure and offers substantial support.

Turning this mast turns the loop. I used PVC pipe cement to glue the T fittings in place. I also glued the eight-inch PVC pieces in place. I did not glue the PVC pipes where they attached to the cross fitting at location **E** in Figure 1. I did, however, drill small holes where the pipe entered this cross fitting and used self-tapping screws into the fitting to hold the pipes in place.

The Capacitor Box and Control Unit

The capacitor box makes this loop functional. With it you can tune the loop to resonance anywhere between 90 and 450 kHz. And there's no reason you can't modify the circuit to suit your needs. The schematic for the box is shown in Figure 3.

I used a couple of runs of four-conductor rotator cable between my control unit in the shack to the capacitor box. I used five conductors to apply 28 V dc to each relay coil (not shown). Using this method, any number of capacitors (or no extra capacitors) may be switched across the loop. In addition to the switched "bulk" capacitors, three MVAM109 varactor diodes are also connected across the loop in parallel. I used another conductor from the control cable to route tuning voltage from the shack-mounted control box to the varactor diodes in the capacitor box.

The 1:1 toroidal balun is a Palomar FT-50-43 wound with 15 trifilar turns of No. 30 wire wrapping wire I obtained from RadioShack. Use three colors to make it easy to tell which wire goes where. It's an

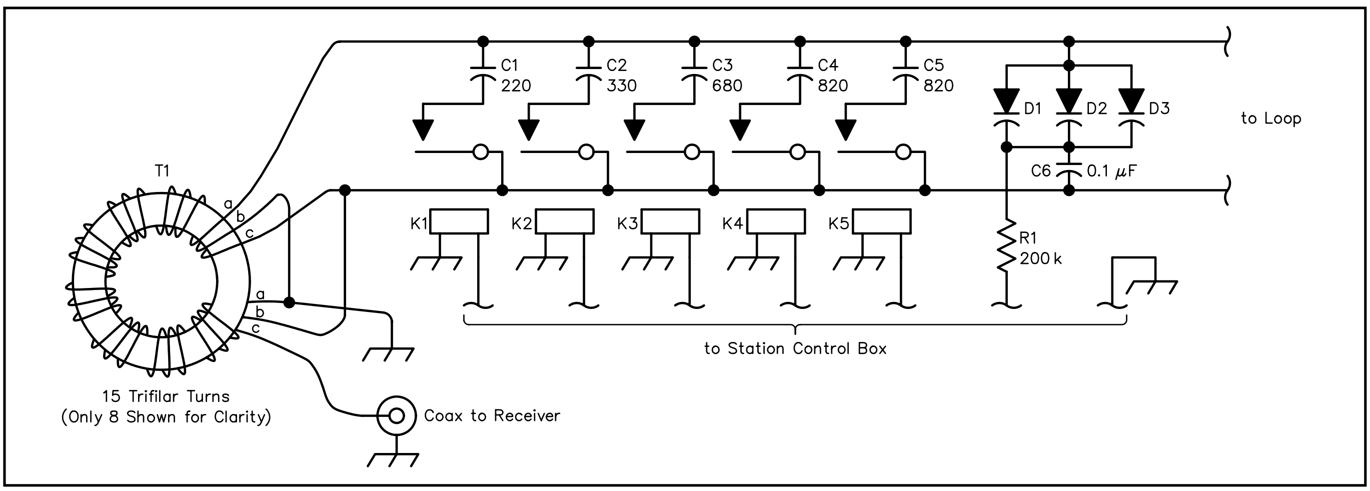


Figure 3—The schematic diagram of the "capacitor box." This circuit must be mounted in a weatherproof enclosure at the base of the loop.

K1-K5—SPST relays, 24-V dc coils
D1-D3—MVAM 109 varactor diodes (Dan's Small Parts, tel 406-258-2782; http://www.fix.net/dans.html)
C1—220-pF 50 V mica capacitor
C2—330-pF 50 V mica capacitor
C3—680-pF 50 V mica capacitor
C4-C5—820-pF 50 V mica capacitors
C6—0.1 μF ceramic disc capacitor
T1—1:1 toroidal balun. Palomar FT-50-43 wound with 15 trifilar turns of no. 30 insulated wire (Palomar, tel 760-747-3343; http://www.Palomar-Engineers.com)
R1—200 kΩ, 1/4-W resistor
One roll no. 30 wire wrapping wire (red)
One roll no. 30 wire wrapping wire (white)
One roll no. 30 wire wrapping wire (blue)
One chassis-mount SO-239 coax connector
Two 10-pin terminal strips
One five-pin terminal strip

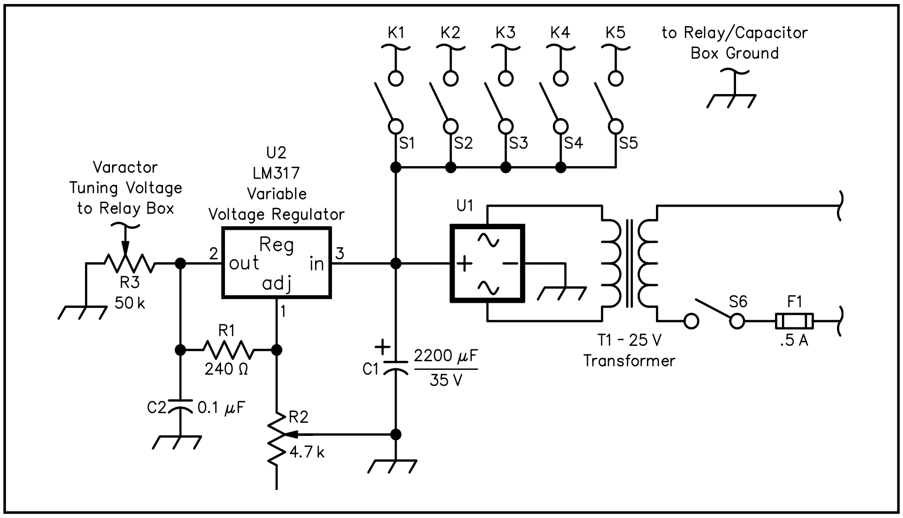


Figure 4—Schematic diagram of the control unit. All parts are available from RadioShack unless otherwise indicated. Layout is not critical. Simply mount the five "capacitor switches" on the front of the enclosure along with the tuning potentiometer (R3). By using various combinations of switches and tuning, you can tweak the loop for maximum received signal strength from the comfort of your shack.

C1—2200µF, 35-V electrolytic capacitor (272-1020)
C2—0.1µF ceramic disk capacitor (272-135)
F1—0.5A, 120 V fuse
R1—240 Ω resistor
R2—4.7 kΩ trimmer potentiometer (271-281)
R3—50 kΩ potentiometer, linear taper (271-1716)
S1-S5—SPST toggle switches (275-624)
S6—SPST switch (275-603)
T1—120/25.2-Vac transformer (273-1366)
U1—Bridge rectifier, 4A, 100 PIV (276-1171)
U2—LM317T adjustable voltage regulator (276-1778)

elegant way to match and interconnect the loop to the coax, and it works perfectly. I ran about 60 feet of RG-58 coax from the SO-239 connector on the capacitor box to the shack-mounted preamp.

The control unit is equally simple (see Figure 4). Because the relays had 24-V coils, I used a RadioShack 24-V transformer and a full-wave bridge for the relay power supply. This pulled in the relays just fine.

For the varactor tuning voltage, I regulated the raw output of the relay supply with an LM-317 three-pin voltage regulator. I set the regulated voltage to 20 V dc and used a 50-kΩ potentiometer to provide 0 to 20 V to the diodes. One side of the potentiometer is connected to ground while the other connects to the 20-V regulated output. A wire from the wiper arm connects to the 200-kΩ resistor that feeds the tuning diodes. A set of five SPST toggle switches activate the relays to select the various capacitor combinations.

To the Roof!

A lot of Old-Timers say loops don't have to be mounted high, but I wanted to get this particular loop as high as possible**.** *Remember that this is a large, unwieldy antenna***.** I first tried to hoist it to the roof myself, with *almost disastrous results*.

Get help erecting this antenna!

If the loop tilts more than 30°, one person probably can't handle it. It's also somewhat heavy and has noticeable wind resistance.

I hoped to be able to rotate the antenna with a small RadioShack rotator, but the sheer size of the loop made it impossible to mount the rotator near the antenna, so I mounted it at the bottom of the antenna mast support assembly.

I took the completed loop assembly, with a five-foot mast sticking out of the bottom, and carefully laid it down on the ground and attached a 10-foot section of mast to the existing five-footer. I slid a nine-foot section of 1¹/₄-inch schedule 40 PVC over the 10-foot mast section, making sure that the PVC pipe was fully contacting the pipe from the completed loop assembly.

Next, I drilled a small hole through the PVC pipe and internal mast about two feet from the bottom of the entire assembly. I ran a small bolt through this hole and fastened it with a nut. Now the PVC pipe couldn't slip off. The whole assembly can be carefully raised by *at least two people* and bracketed to the side of a structure using four TV mast brackets. Make sure the mast brackets are securely anchored to the side of the structure. Once the assembly is bracketed in place, the bolt you installed should be removed, allowing the loop to be rotated from the bottom.

How Does it Work?

I had my doubts about loops before I built this one. The others were poor performers and I had to tweak them incessantly to achieve only marginal performance. After all the adjustments, my short 160-meter sloper would always outperform the loops.

When I finished the Monster Loop, I temporarily strapped it to the deck of our pool (which drew an interesting stare from my wife). I promised her it was only temporary and proceeded to connect the control wires and coax. Back in the shack, I powered up the RX-320, which was tuned to the AMRAD LF beacon frequency on 136.745 kHz. The receiver came to life and DCU (a commercial data station somewhere in Nova Scotia) blared from the speaker!

The Canadian signal was quite strong. I switched to the 160-meter sloper. Yes! The signal was there, but nowhere near as strong as the loop. I flipped the switch on the control box that inserted a 1640-pF capacitor across the loop. The signal from DCU increased markedly. With that particular capacitor in parallel with the loop, the Varactor diodes allowed me to tune the loop to resonance.

Later that day, WA2XTF/6 and /12 moved my S-meter for the first time! And every time I compared the loop to the sloper, the loop won hands down. By rotating the loop I could effectively eliminate about 80% of the line noise that was giving me trouble. The big loop has an incredibly deep null. Being able to null unwanted noise sometimes makes the difference between hearing a signal well and not hearing it at all.

I experimented with the loop's switchable capacitors and found that the loop can be made to resonate anywhere from slightly below 90 kHz to just above 450 kHz.

Remote tuning diodes are the only way to go. The resonance peaks are quite sharp, and you have to retune every couple of kHz, but the incredible performance makes it all worthwhile.

If you build a version of this loop for yourself, please remember to be careful during installation. Although it performs well, it's awkward to install. I also have my finger crossed as to its survivability. We've had a few strong winds since I've installed the "Monster." It swayed back and forth, but no harm was done.

Last but not least—building this big loop was a lot of fun. It had been a while since I'd brought back a load of hardware and turned it into something useful *and* attractive.

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