A Small, Portable HF Loop Antenna

John Wagner, N8CD – September 2014

While doing a little Internet surfing looking for portable antenna ideas, I ran across several designs for small magnetic loop antennas. STL's (Small Transmitting Loops) are a type of antenna that I had never experimented with in all my years of hamming, and I decided it was time to change that. I certainly don't claim to be an expert on loop antennas, or any type of antennas for that matter. But since I've had good results with this project, I thought I'd share them.

The idea behind the small transmitting loop is a small diameter loop that is about 10% of a wavelength of the operating frequency in circumference, with a tuning capacitor in series with the loop. There are various ways to couple the transmitter to this radiating loop, but one of the more common methods is using a smaller inner loop that is about 20% of the size of the outer loop.

A great quote from AA5TB's web page on loops (http://www.aa5tb.com/loop.html) is that when designing a small antenna, you must choose two of these parameters and will sacrifice the third:

- small size
- efficiency
- bandwidth

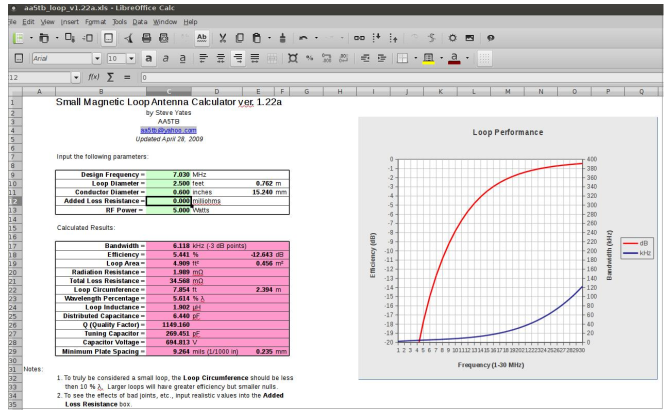
The small transmitting loop's weak spot is bandwidth, and possibly efficiency depending on how small the loop is relative to the wavelength of operation. Changing operating frequency, even by 20KHz or less, will require tweaking the tuning capacitor. More on this later.

There are literally hundreds of web pages on the Internet dedicated to small loop antennas for the radio amateur. In my quest to put a usable portable loop together, I found three pages that led me to what I built.

The first was a commercial offering, known as the “AlexLoop Walkham” (http://alexloop.com) by Alex, PY1AHD. The AlexLoop antenna has very good reviews, and is unique from many other loop designs in that it disassembles into a easy-to-carry portable package. One downside to this antenna is the price, which runs around $370 delivered to the U.S either directly from Alex or from HRO.

Next, I ran across G4ILO's take on the portable loop, with a design he calls the “Wonder Loop” (http://www.g4ilo.com/wonder-loop.html). It's design is very similar to the AlexLoop Walkham antenna.

Finally, I ran across Steve, AA5TB's page which is packed full of useful information on small loop antennas, and also has a spreadsheet you can download that will calculate most of the values you will be interested in when designing a loop.
http://www.aa5tb.com/aa5tb_loop_v1.22a.xls



AA5TB's Loop Calculator spreadsheet

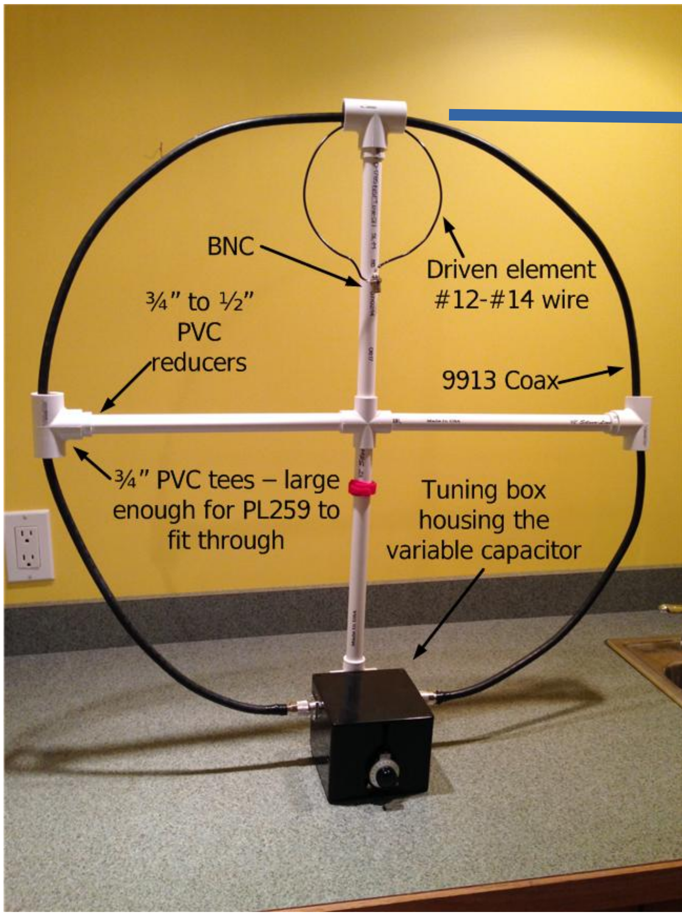
Armed with this information, I began gathering my parts and assembling the antenna shown in this article. For my version of this loop, my parts list was comprised of:

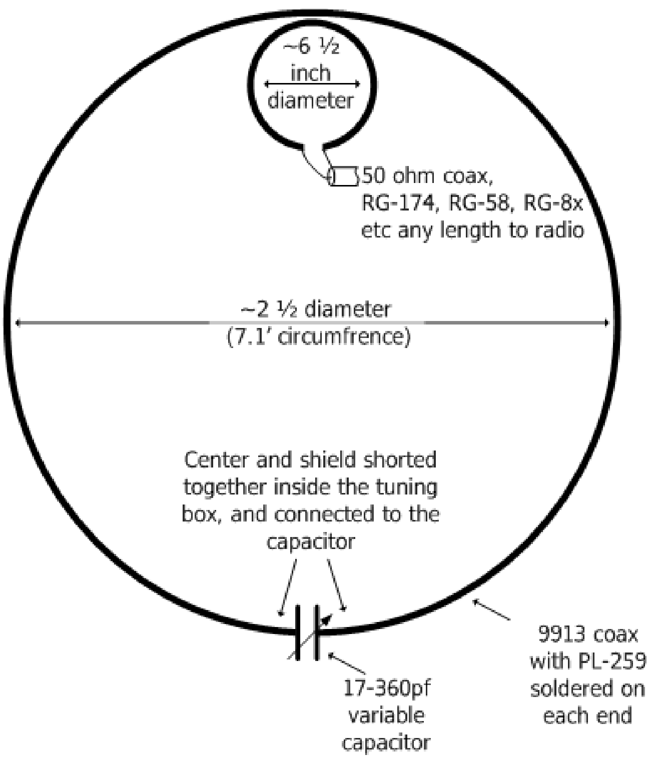
- **1** 17-360 pF variable capacitor, from the Randolph hamfest
- **1** 3:1 reduction vernier drive (Philcap Electronics)
- **1** 4”x4”x4” plastic project enclosure (just big enough for the capacitor you choose) from Mouser electronics
- Misc ½“ and ¾” PVC fittings from Lowes
- **2** SO-239 panel mount connectors
- **2** PL259 connectors
- **86”** of scrap Belden 9913 coax cable (length determined experimentally)
- **19”** of 14 guage general purpose wire (about 20% of the loop circumference, not critical)
- **1** BNC panel mount connector

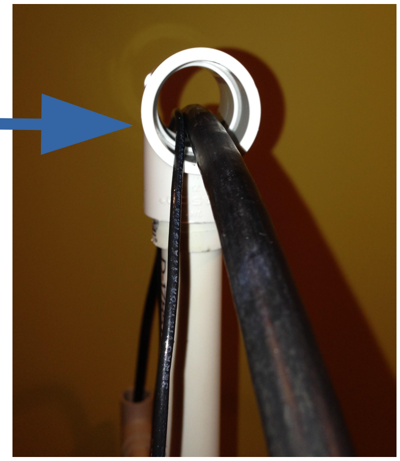
WARNING
Even medium power levels mean high (and lethal) voltages can be present on exposed components of the loop. While transmitting, it is important that people and pets do not come in contact with the main loop or the PL-259 connectors!

With a small transmitting loop the RF voltages across the capacitor can be surprisingly high, even at QRP levels. Even at 5 watts of power, according to AA5TB's spreadsheet there will be **over 600 volts of RF across the capacitor plates**. Note that these voltages are also present on the OUTSIDE of the enclosure that holds the capacitor, on the SHIELD of the PL-259 connectors used to connect the loop.

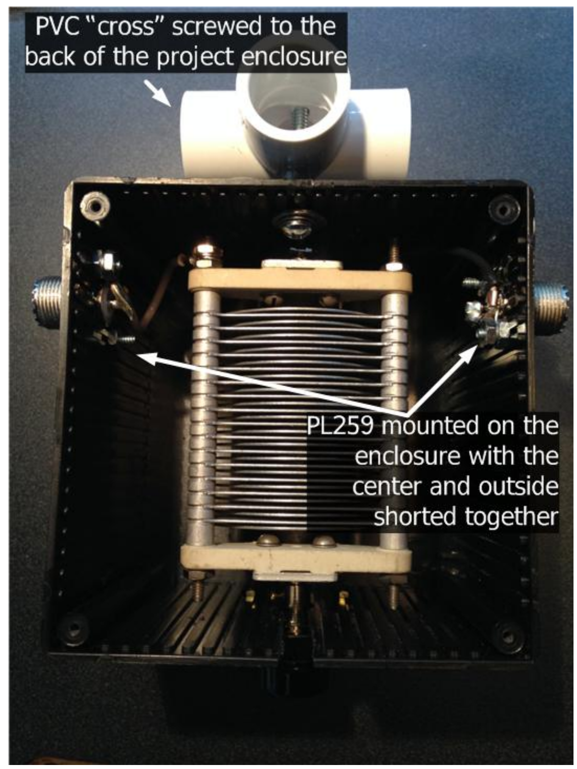
and ANOTHER WARNING
You may tend to be physically close to this portable antenna when operating. Please be aware of potential RF exposure risks! See http://www.arrl.org/rf-exposure for more information







Side view of the top PVC fitting showing the coax and driven element near each other



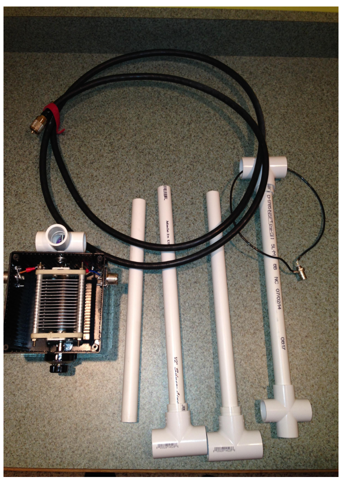
3:1 vernier drive (from Philcap)

Assembly tips and lessons learned:

1) I started with a loop about 12" longer circumference than the 86" I ended up with. I found using an antenna analyzer that the loop would only go slightly above 20 meters. I shortened the loop a few inches at a time until it would comfortably tune from about 6MHz to about 25MHz. If you build a similar antenna, your results may vary depending on the type of coax and capacitor used.

2) The capacitor I found is 17-360 pF, but does not need to have that much capacitance (at least in my case). Most of the tuning takes place in the first half of the capacitor's range. A smaller value capacitor, perhaps 250 pF would allow a better tuning range, and make tuning slightly less sensitive.

3) One of the secrets to a small loop that performs well is using a VERY low resistance conductor for the loop. Using 9913 coax for the main loop material is a compromise, as it has a relatively high resistance compared to copper tubing or other similar material. However, the coax can easily be packed and carried in a portable setup. The beauty of this setup is you can make more than one loop of various materials and interchange them easily. I'll be experimenting with different materials for the main loop.



4) I added a small metal bracket to the plastic enclosure and drilled & tapped a ¼-20 hole so it will fit on a standard camera tripod.

5) I have tested 100 watts of RF into my loop with no arcing in the capacitor, but this will vary widely with the type of capacitor (mainly the spacing between the plates) you choose for the design. **Also if you run more than QRP power levels, keep the earlier warnings about high voltages and RF exposure in mind!**

6) The driven loop and the main loop are not directly connected. I did find that how close they are can affect the ability of the antenna to get below 2:1 where it is tuned. Running the main loop through the driven loop lowered the minimum SWR significantly, and experimenting with the shape of the driven loop between round and football shaped can lead to lower SWR as well.

7) An antenna analyzer isn't absolutely needed to build this loop and experiment with the parameters, but it certainly helps.

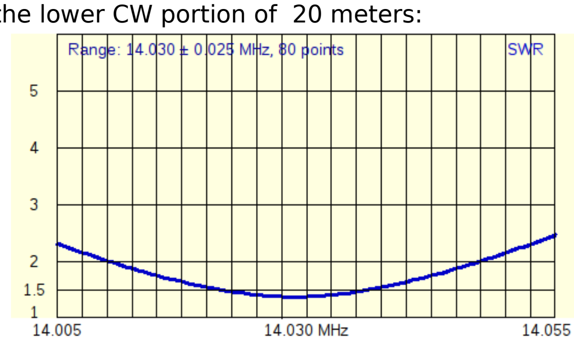
Operation:

1. Connect a radio to the antenna, and slowly tune the capacitor until maximum noise is heard from the receiver. There will be a VERY sharp peak in noise when you get the tuning right. I have found that the SWR is at minimum at the same tuning position as maximum receiver noise. Sometimes the tuning will need to be very slightly adjusted to get minimum SWR, but if care is taken peaking for maximum receiver noise, the SWR is often below 2:1 already.

2. Because tuning is touchy, the capacitance from your finger on the vernier drive can be enough to affect the tuning. You may need to overshoot the tuning slightly one direction or the other to get it spot on.

3. With the dimensions I used, I am able to tune the loop to about 1.2:1 SWR on any frequency between **6MHz and 26MHz**, which covers **40-12 meters**. You're results could be different depending on the exact materials and dimensions you use.

4. Although the antenna will cover a very wide range of frequencies, the tuning is VERY sharp. Here's an example of the 2:1 SWR bandwidth when tuned to the lower CW portion of 20 meters:



Wrap Up

I've made a few contacts with this antenna sitting outside on the deck running 2.5 watts on CW, PSK, and even SSB. While it certainly won't outperform a full size, permanently mounted antenna, it is an easy to build and fast to setup antenna that will get you on the air from hotel rooms, apartments, and other places that would normally be off-limits for HF operation.