

Magnetic loop antenna for 160 - 15 metres

All
material
on this
site
(c) [Peter
Parker
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Another item on this website discussed antennas that amateurs use to operate from confined locations. The smallest antenna described for 80 metres was a magnetic loop. This article provides details needed to build your own.

Description

Below is a diagram and some construction details.
Note that the element is continuous except for a gap at the top across which the variable capacitor is wired.
The feedline is connected to the bottom of the loop.
Dimensions are not particularly critical, provided it is possible to bring the loop to resonance on all operating frequencies with the variable capacitor used.

1.8 - 21 MHz Magnetic Loop

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(c) 2003-4

Solder all
connections

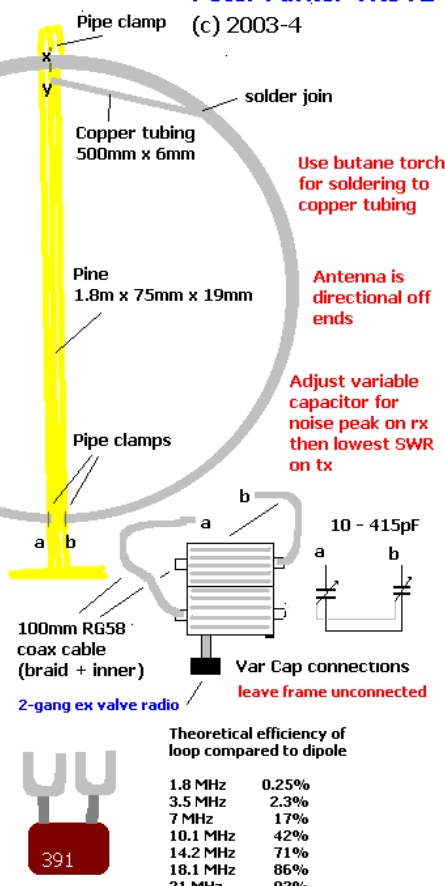
Q is high -
adjust every
few kHz

Do not touch
loop when
transmitting

Connections

- a. variable capacitor
- b. variable capacitor
- x. RG58 coax outer
- y. RG58 coax inner

For 80 & 160m connect capacitors across a & b. Use about 390pF for 80m & 2100pF for 160m. High voltage silver mica capacitors (wired in parallel to obtain the required capacitance) are ideal. Soldered connection is best, but I used self-tapping screws and terminal lugs.



What to expect

Magnetic loops are a compromise antenna and performance will be down on a full-size wire antenna, particularly on the lower HF bands. If built properly, expect the following results at QRP power levels: (i) 80 metres - contacts up to a few hundred kilometres, (ii) 40 & 30 metres - single hop contacts up to about 1000 km, (iii) 20 metres - contacts up to about 3000 kilometres with the occasional DX. The variable capacitor won't spark if transmit power is kept down (10w is fine).

80m: comparison with full-sized wire antenna

During the 80 metre SSB 2004 VK/Trans Tasman contest the indoor loop was compared to an inverted-L approx 30 metres long installed in an RF-quiet suburban park. The results are as follows.

	Inverted-L (outdoors)	Magnetic Loop (indoors)
Operating time	1hr 50 min	2hr 20 min
No contacts	57	36
Avg contacts/hr	31	15
Contacts		
VK2	15	8
VK3	20	17
VK4	1	1
VK5	8	5
VK6	1	1
VK7	2	4
ZL1	2	0
ZL2	4	0
ZL4	4	1
Percent outside VK3	65%	53%
Percent VK6/ZL	19%	6%

Notes: (1) A Yaesu FT-817 transceiver running 5 watts was used in both tests. (2) The inverted-L was 11 metres above the ground at its highest point and had an average height of about 7 metres. (3) The magnetic loop was positioned on a coffee table in a ground floor apartment and had an average height of 1.5 metres above ground. (4) The receive noise level was much higher indoors and some contacts were undoubtedly missed because of this. (5) Band conditions were estimated to be somewhat better than average.

160m experiments

Though its efficiency is a fraction of one percent on 1.8 MHz, results can still be worthwhile. On AM you can expect local AM contacts up to approx 10-30km. On SSB expect more range; 300km is the best DX so far, but interstate contacts may be possible on CW. On receive the antenna is quieter than outside wire antennas and its directionality can be an advantage.

Note: for all these tests the loop was used indoors, inside a ground floor flat in a noisy RF location.

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Parts

Many of the above items (including the bendable copper tubing) can be bought at hardware shops. The main exception is the wide-spaced variable capacitor. Try Jackson Bros (advertise in Amateur Radio magazine) or eBay. Other possible sources include old high power transmitting equipment, hamfests and deceased estates. If your attempts to obtain a suitable capacitor fail, there is always the possibility of making one.

Construction

It doesn't matter which way you build the loop. I tried it with the feedpoint at the top (as per the diagram) and then inverted it with the feedpoint at the bottom (as per the photo). Both worked well, though I prefer to keep the feedline out of the way, so went for bottom feed.

If the capacitor has two gangs you have some flexibility with how you connect it. Connecting both gangs in parallel increases maximum capacitance, so allows coverage of the low end of the HF spectrum. But it is more lossy and has lower power handling capacity. In contrast, connecting them both in series (done by leaving the capacitor's frame unconnected and connecting the stator plates to each side of the loop) reduces contact losses and arc-over, but may mean that 80 metres is missed. I went for series connection, adding parallel capacitors for 80 and 160 metres.



Adjustment

The object of the adjustment process is to adjust the position of the 500mm copper tubing along the loop so that the feedpoint impedance equal 50 ohms when the loop is brought to resonance. I should mention that other loop designs sometimes use a smaller inner loop for coupling, but I have found that these are harder to get a good match on all bands.

The first step is to connect the antenna to an HF receiver tuned to 7 MHz. Set the receiver's RF and AF gain controls to near maximum and the antenna's capacitor to minimum capacitance (plates fully unmeshed). Then gradually increase the capacitance. Not much will happen at first, but the noise from the receiver should gradually start to increase. Further adjustment of the capacitor will result in the received noise falling. Turn the capacitor back to the position where the noise peaks. Try this for other bands and frequencies across the HF range - you will find noise can be peaked within an HF frequency range of approximately 3:1 (as mentioned above high voltage capacitors are wired in parallel with the tuning capacitor to cover lower bands like 80 and 160 metres).

A resistive antenna bride is quite useful so adjustments can be made without causing interference. It's also useful to experiment with applying a carrier and seeing

how far you can move frequency without SWR increasing by too much - if the loop is working properly the bandwidth should be much narrower than the wire antennas we're used to. If not the loop is likely to be lossy - possibly due to resistance introduced by bad connections or an inefficient tuning capacitor.

When making these adjustments, there is a temptation to leave the transmitter keyed while making changes to the antenna or adjusting the variable capacitor. This should not be done for two reasons.

The first is that the voltages at the top of the antenna element can be quite high (hundreds or even thousands of volts) even with quite low transmitting powers. The second is that the loop is detuned when people are near it. Thus any adjustment made when you are near the loop will not be optimum when you move away. This effect is particularly pronounced on higher frequencies, and applies to metal objects as well as humans.

Operation

The Q of this antenna is very high. This means that it can only operate efficiently over a narrow frequency range. Almost every time you change frequency, you will have to change the setting of the variable capacitor.

As mentioned before, this is done by peaking the capacitor for maximum received noise at the desired operating frequency. If the reflected power is high, make further adjustments until it is acceptable. Again the use of a resistive-type bridge (rather than a conventional SWR meter) is preferred because of the ability to tune up without causing interference. If you have one add a vernier reduction drive or some other method to allow finer adjustment as this will make tuning the loop easier.

Note that the loop is directional, with a sharp null when the element is facing the direction of the incoming signal. This makes its behaviour different to that of full-sized quad elements, where the null is off

the sides of the loop. This directivity can be useful when nulling out interference. It is also useful to remember when other stations report difficulty in hearing you - turning the loop may improve your signal.

Results

This loop has been used extensively on various HF bands, mainly 40 metres. Most contacts have been made with the antenna indoors. Though performance is well down on a dipole, contacts into Western Australia and New Zealand have been made with it. Powers of between 5 and 50 watts have been used.

Contests are always good events to test the effectiveness of new antennas. During July 1997's hour-long 3.5 MHz Australasian CW Sprint, twelve contacts were made with the loop. This was despite the added handicap of having to retune the antenna with every significant frequency shift.

As would be expected, the loop's disadvantage when compared to full-sized antennas falls with increasing frequency. The loop works well for contacts up to about 1000km on 40 metres, while Europeans have been worked on 20 metres.

Conclusion

The magnetic loop is an ideal HF antenna for units, flats or apartments where only a small courtyard or balcony is available. They will also work well indoors. Apart from their small size, other loop advantages include relatively easy construction and the ability to cover several bands.

The antenna described is a compromise, built from available parts. Improvements to the tuning capacitor and connections to it will improve radiated signals. And some sort of remote tuning mechanism will allow operation without leaving your seat.