PA3FG Magnetic loop antenna page

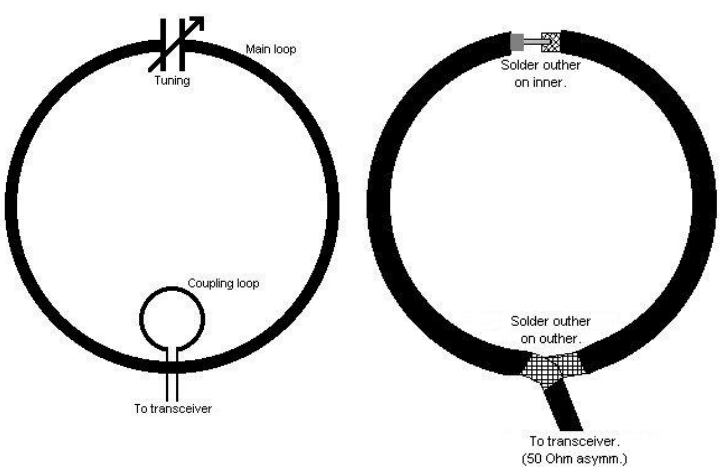
A homemade magnetic loop for 10-17 meters

Introduction

Magnetic loop antennas are very compact HF antennas. If properly build they can be used for transmitting. There are already many good theories published about magnetic loops so I will keep this part of the story short. Information can be found in the ARRL Antennabook, Rothammels Antennenbuch (German) and on the internet. (See links section)

Schematic diagram

The main loop is an LC circuit where L has just 1 big turn. The coil acts as a radiator and the capacitor brings the circuit into resonance. The current distribution is equal in the whole loop. The main loop is inductively coupled to the transceiver with a smaller loop. This coupling loop can be made in various ways but always has a diameter which is five times smaller than the main loop and is coupled to the transceiver directly with 50 ohm coax. The type of coupling loop shown right here is a so called shielded- or Faraday loop. The radiation resistance of the antenna is very low and therefore it's very important to keep the DC losses in the range of milliOhms. Therefore always use thick copper tubing preferably made of one piece, aluminium is less suitable.



The experiment

The loop I have build has a diameter of 75 cm and is made of 12 mm Copper tubing obtained from the local Do-It-Yourself shop. The main loop is made of 1 piece to keep the DC resistance very low. The split stator capacitor was obtained from a militairy dump store and has 2 sections of 100pF - 1mm spacing in series, resulting in 50 pF - 2mm spacing. The loop is soldered to the fixed plates on both ends. Never use rotor contacts because the voltage at the capacitor will be several kV's and there will flow high RF currents even at low power level!
The shielded coupling loop has a diameter of 15 cm and is made of RG58 coax. It is not connected to the main loop and placed opposite of the tuning capacitor. The loop is coupled directly to the transceiver, no antennatuner is needed.
Tuning needs to be done carefully and the practical bandwidth varies from 20 kHz on 17m to 100 kHz on 10m. Coarse tuning is done by searching a noise peak while receiving. Next tune for the lowest swr with a low power carrier. At last increase transmitting power to the desired level. The SWR is below 1:1.5 on all bands.

Vertical or horizontal mounting ?

According to the theory you can mount the antenna vertically at very low heights above the ground (minimum of 2 meters for the lowest part). It results in a somewhat bi-directional behaviour and equal radiation at angles between 5 and 90 degrees. With horizontal mounting the antenna will radiate omnidirectional and the radiation angle will depend on the height above the ground. The same rules like the half wave dipole can be used. In short we can say that if you can mount the antenna at more than a half wavelength above the ground use horizontal mounting for DX results, otherwise use vertical mounting. Directivity is about the same as a dipole.

The results

The antenna works properly up to 50 watt RF without sparks at the tuning capacitor. According to calculations made with the RJELOOP1 software the efficiency will be 53% at 17m, 66% at 15m, 78% at 12m and 84% at 10m, all compared to an ideal loop. In the worst case this is 0.5 S-point loss only! Within 2 weeks I made some qso's on 12 and 17 m CW with 50 watts. Distances up to 10000 km (several times) were no problem and reports varied from 559 to 599. The antenna is still inside the house just under the rooftop at 8 meters above the ground. Propagation was moderate to good. With 50 watt CW there is no BCI or TVI at all!

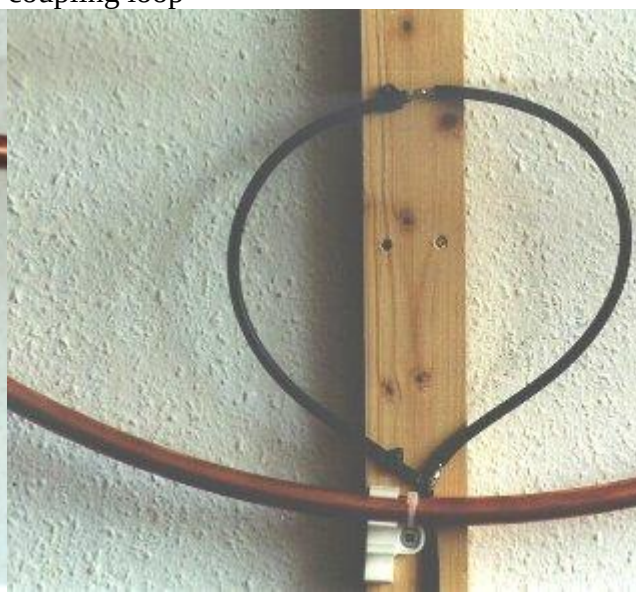
The first qso's I made with vertical mounting. Next I changed to horizontal mounting which appears to work a little better at longer distances because the antenna is mounted more than a half wavelength above the ground.

Photographs of the loop (Click on them to enlarge)

The 10-17m magnetic loop

The split-stator tuning capacitor

The shielded coupling loop



Advantages and disadvantages

Advantages
Small size
Easy to build
Results comparable to a dipole

Good RX preselection (High Q)
Direct match to 50 ohm coax, no tuner needed
Can be mounted low above the ground (2 meters or higher for lowest part)
No radials needed
Low BCI / TVI risk
Strong reduction of manmade noise

Disadvantages
Small bandwidth (High Q)
High voltage on capacitor
Precision remote tuning needed (for outdoor use)

Magnetic loop design software

RJELOOP1	Transceiving, single-turn, loop aerials of various regular shapes	by Reg, G4FGQ (SK)
RJELOOP2	Transceiving, single-turn, loop aerials of rectangular shape	by Reg, G4FGQ (SK)
Loopcalculator	Transceiving, single-turn, loop aerials of round shape	by Matti, OH7SV

RJELOOP 1 and 2 will run on all 32 bit MS Windows versions. For other systems use the freeware DOS Box
The Loopcalculator will run in MS Excel 2003 or higher and the freeware Open Office or Libre Office.