A Loop Antenna for the Micro HeyPhone

The Micro HeyPhone is designed to use an earth electrode antenna. However, in some circumstances, a loop antenna may be more practical. ***Chris Ross*** *describes a 1 metre loop design for use on those occasions.*

For small caves, or where there is no room for earth electrodes, loop antennas are easier to deploy and work well up to depths of about 80 to 100 m or more, depending on the rock structure of the cave.

As a number of our local caves fall into this category, we were motivated to construct loops for our Micro HeyPhones (Cooper, 2017).

This is not a new idea and has been described in the CREG Journal (Bedford, 2002) for the standard HeyPhone, which had suitable connections for a loop antenna. However, the Micro HeyPhone has only earth electrode connections, which require a different method for connecting the loop. I believe that loops may have been tried on the Micro HeyPhone already, but I have not been able to get any information on this.

Loop Construction

The original HeyPhone loop design used a multi-turn ribbon cable, but it is generally agreed that it is better to have more copper, even with fewer turns. We had based our construction on this premise for the very successful loops we made for our standard Ogofone radios. (The Ogofone is similar to the HeyPhone – 87 MHz USB with approximately the same power) and with our loops, we get a depth range of about 120 m.

- Cable type: H05VV-F
- Conductor cross-section: 2.5mm
- Current: 24A
- Voltage: 500V
- Number of conductors: 5
- Outer diameter: 12.4mm
- DIN 57821/VDE 03281

Figure 1 – Cable Specification

Available from ***uk.farnell.com*** *in black with product number 1387705.*

Also available in white from ***edwardes.co.uk/products/cut-to-required-metre-of-2-5mm-3185y-5-core-white-circular-pvc-flex***

General information on constructing our Ogophone loops was described in an earlier article by me (Ross, 2004), so the following describes only the specifics for the Micro HeyPhone loop; however, I recommend referring to the earlier article for some of the basic construction details.

The design is based on five turns, using a length of 5-core 2.5 mm per core power cable, the sort used to connect stoves to a 3-phase power network, see *Figure 1*.

At this point, I also wish to express my gratitude to Brian Pease who has helped me immensely through this to get it right.

I have found that a loop diameter of 1 m, or for a square loop, 1 m each side, is the most convenient size and the description here is based on this.

Figure 2 shows the basic connection scheme for the cable. The capacitor is connected across all five turns and the Micro HeyPhone earth electrode connections to a one turn centre-tap.

Tuning

The tuning is very critical, and low-loss high quality polystyrene (MKS) or polypropylene capacitors must be used.

These capacitors must have a rating of 500 V or more, because of the high voltages developed across them.

The following values are useful: 1 nF, 2.2 nF, 10 nF and 15 nF. These values are normally sufficient to be able to find suitable combinations for excellent tuning.

The following describes the tuning for a round loop of 1 m in diameter or a square loop with 1 m each side.

Whether round or square doesn't make much difference in practice, but for tuning, you should decide on which layout you will be using most often and tune with that layout. Square loops require spreaders, of course.

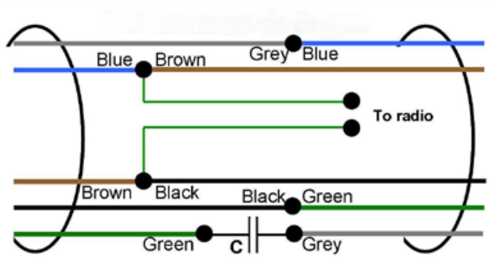

Figure 2 – Connection Arrangement

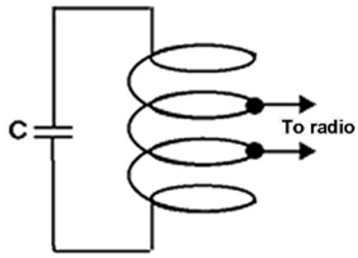

Figure 3 – Circuit

I tuned the antenna while it was lying on a normal earthy ground as normal earth does not seem to change the tuning. Do not try to tune it near any large metallic objects, or on reinforced concrete.

The setup for tuning is shown below:

To tune the antenna, you set up the radio to produce a continuous tone. This can be achieved by feeding a loud audio signal of somewhere around 1 – 1.5 kHz into the microphone or using the beacon of the HeyPhone.

If you use the HeyPhone beacon as a signal, you will find that, within the signal

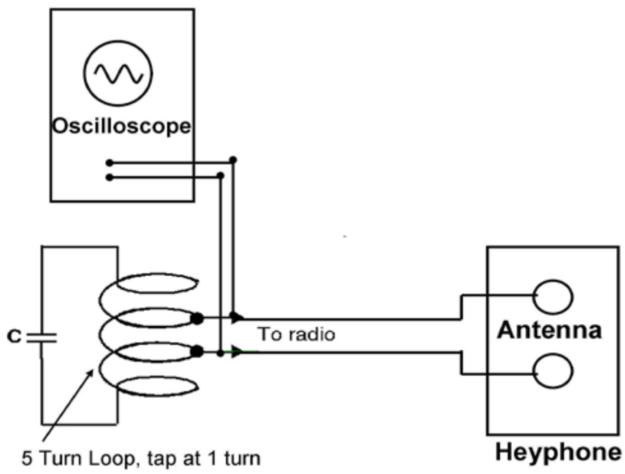

Figure 4 – Tuning Setup

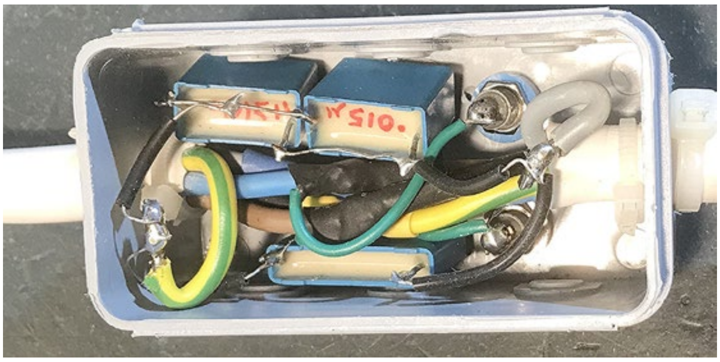

Figure 5 – Connection Box after Tuning
Shown prior to potting with epoxy resin

Figure 6 – 1 m Square Version of the Loop
Showing the location of the connection box

bursts, the amplitude varies. To make it easier see whether adding or subtracting a capacitor increases or decreases the overall amplitude, it is helpful to use a slow time base on the oscilloscope to display many bursts at once.

Then, with the setup shown, vary the value of capacitance across the open ends of the antenna to give the largest amplitude on the oscilloscope.

The best procedure is to start off by paralleling either two 15 nF or a 15 nF and a 10 nF capacitor and then fine tuning with a 2.2 nF or 1 nF capacitor, all in parallel, so that you end up with a block of capacitors, which can normally be easily squeezed into the junction box.

I found that a 1 metre diameter round loop (4 metres of cable) needs about 28 – 32 nF of capacitance, which you can make up from a series/parallel combination of the above-mentioned capacitors.

A 2 m loop needs only about 11 nF.

When you are absolutely sure you have correctly tuned the antenna as best you can and all connections are OK, you should then encapsulate the connections and capacitors by filling up the junction box with a hard setting epoxy resin. This does not normally change any of the electrical characteristics and makes the whole thing stable and waterproof.

Results

So far, most of the testing has been above ground.

Figure 7 below shows the test setup with about 112 m distance between the HeyPhones.

Setup 1: Loops both horizontal flat on the ground (coplanar):

Result: mediocre. Volume had to be set to 3 – 4 (maximum).

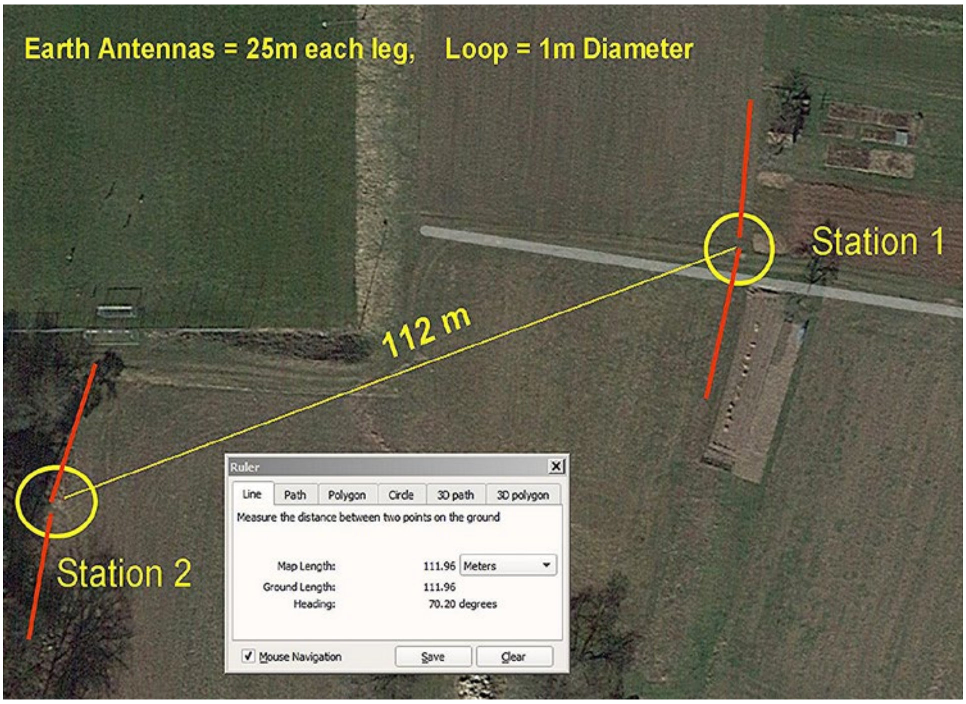

Figure 7 – Test Area
Red lines show electrode arrays, circles show location of loops

Setup 2: Loops both vertical - facing each other (coaxial):

Result: Extremely good communication. Volume set to 2

Setup 3: Earth electrodes (25 m each leg):

Result: Excellent, but no better than setup 2.

Setup 4: HeyPhone 2 using earth electrodes, HeyPhone 1 using a vertical loop with the opening facing the earth electrodes:

Result: Excellent, just as good as setups 2 & 3.

Interference, consisting of annoying pulses like the Loran signal, was about the same with the earth electrodes and the loops, but caused no problems with reception.

Limited underground tests have been carried out to date, but good results have been achieved in a 30 m deep cave with a horizontal offset between loops of 184 m. We will report further results in due course.

References

Cooper, Ian (2017) *The Micro HeyPhone Project: a Conventional Cave Radio for a New Generation*, CREGJ **100**, pp5-10.

Bedford, Mike (2002) *A Loop Antenna for the HeyPhone,* CREGJ **50**, pp 8-10.

Ross, Christopher (2004) *An Alternative Loop Antenna for the Ogofone,*
CREGJ **55**, p26.

Contact

Chris Ross can be contacted at:
Email: ***chrsross@t-online.de***
Tel: +49 (0) 7071-969011