RADCOM TECHNICAL FEATURE

Top Band Loop for Low Noise Reception

by Richard Q Marris, G2BZQ

TOP BAND (1.81 TO 2.0MHz) is undoubtedly very noisy. Much of the high ambient noise is man-made or atmospheric, to which must be added the usual QRM. This is all very well-known to users of Top Band, which is the only amateur radio band in the MF Spectrum (300-3000kHz). It can be most frustrating to hear others working DX when at your QTH the DX signals are lost in the ambient noise.

Few have the real estate to erect a Beverage antenna [1] to solve the problem. Most either give up Top Band altogether, or resort to a multi-turn small frame loop, usually indoors, either of the 'box' type or 'Spiral' type. The 'Spiral' produces superior nulling to the 'Box' but is more difficult to construct. Such a small frame loop can be anything from 24in x 24in to in excess of 60in x 60in if it is square; or the equivalent in size if octagonal, diamond or round. If properly designed it will enable DX to be heard, where previously it was lost in the ambient noise. However such an indoor loop can be somewhat cumbersome and unwieldy. The answer could well be a small ferrite loop, which if properly designed will give excellent results. The Top Band experimental loop described here has been designed to meet this requirement.

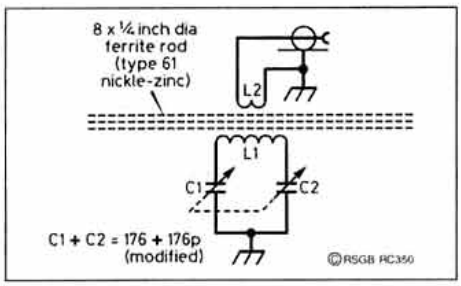

Fig 1: Loop antenna circuit diagram.

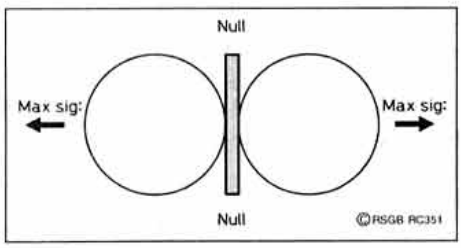

Fig 2: Loop antenna signal pattern.

DESCRIPTION

THE EXPERIMENTAL FERRITE LOOP is shown in **Fig 1**. It comprises of an 8in long x 0.25in diameter, nickel-zinc ferrite rod (u=125) on to which is wound L1 resonated in a balanced circuit by a 2-gang variable capacitor C1 + C2. L2 is a small winding which couples the loop to the receiver via a length of 50Ω coaxial feedline.

Experiments have shown that, by a careful selection from the several different ferrite materials available, it is possible to produce useful ferrite loops from VLF to lower VHF. Also that by careful permutation of rod lengths and rod diameters; turns and turns spacing; and the gap between windings and core, it is possible to tailor-make a desired directivity, or degree of nulling, or sensitivity.

It has been found that a long thin ferrite rod with a centre winding can be made to produce the sharp and deep nulling needed for Top Band noise reduction and elimination as shown in **Fig 2**. Such long thin ferrite rods have to be treated with respect, and carefully protected against damage. A sharp tap or dropping it on the floor will probably result in a fracture or chipping; or it may possibly change the permeability of the core material. The ferrite rod is protected by encapsulating it in a tight-fitting plastic tube, which also acts as the coil former and provides the gap between winding and core. The device is assembled on an 8in wide single sided copper clad base board. This width offers additional rod protection.

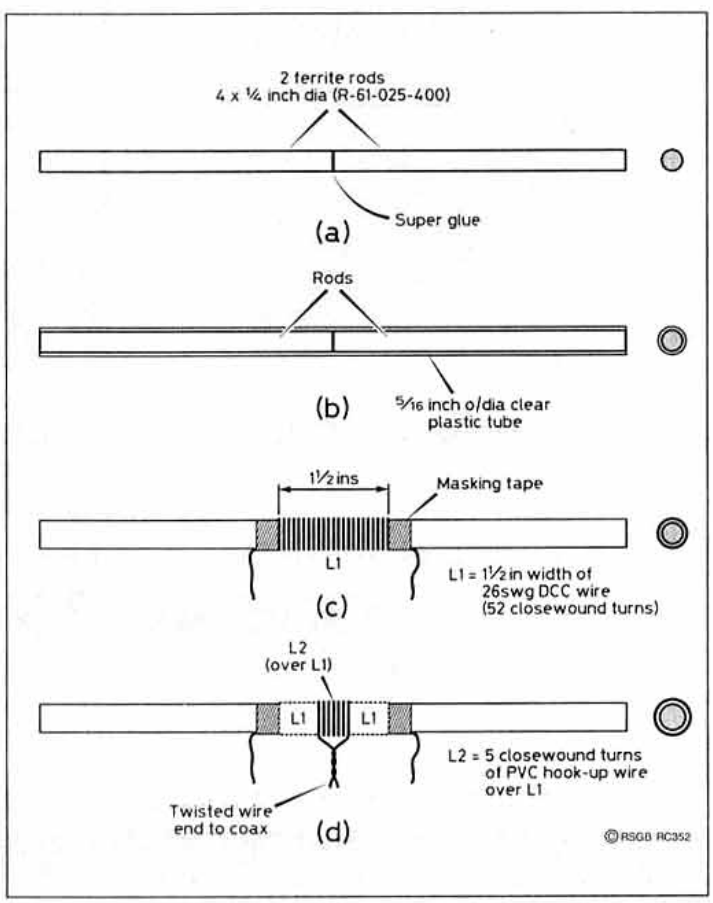

Fig 3: Construction of loop coils.

CONSTRUCTION

THE OVERALL CONSTRUCTION of the loop antenna is shown in **Fig 3**, the Ferrite Rod/Coil Assembly and (**Fig 4**), the Main Assembly. Details are as follows:

The Ferrite Rod/Coil Assembly

The construction of the 8in long x 0.25in diameter rod is shown in **Fig 3a**. It can be constructed by fixing, end to end, a pair of more readily obtainable nickel-zinc 4in x 0.25in diameter Type 61 rods from Amidon (USA). The rod ends should be cleaned and slightly roughened by rubbing on fine sandpaper, and given an application of Superglue, and quickly and firmly pressed together while the Superglue hardens. A simple wood 'V' jig should be made to ensure that the resulting 8in rod is absolutely straight. It is a good idea to use kitchen gloves to keep the adhesive off your fingers.

The rod is pushed into an 8in length of 5/16in outside diameter clear polycarbonate plastic tubing available from Aquarist shops (**Fig 3b**). It may be necessary to apply a film of silicone oil to get the rod into the tube - it will depend on the manufacturing tolerances of the rod and tubing.

L1 is then wound over the centre of the tube covered rod. This coil comprises 52 close-wound turns of 26SWG DCC double cotton covered enamel copper wire. The cotton covering is a simple way of slightly spacing the coil

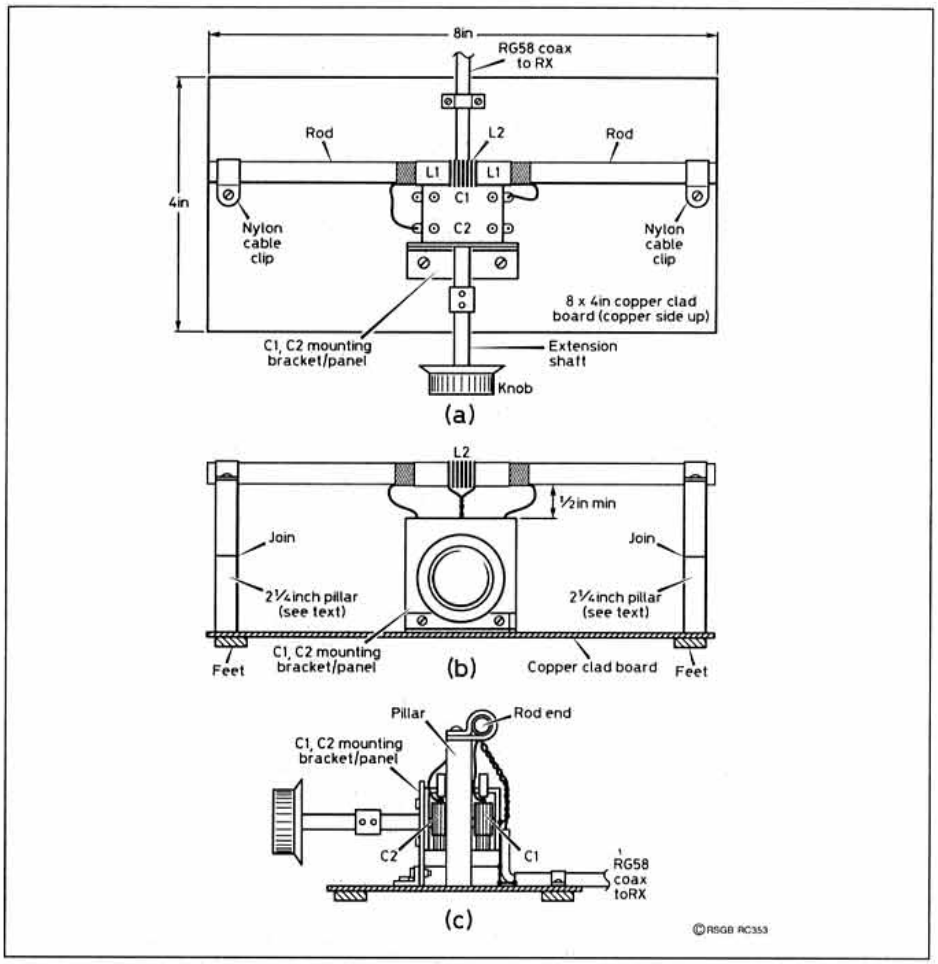

Fig 4: Construction and layout of complete antenna: (a) Plan view (b) Front view (c) Side view.

turns. The winding width is 1.50in (52 turns) - see **Fig 3c**.

L2 comprises five close-wound turns of PVC-covered hook-up wire, close wound over the centre of L1, with the ends slightly twisted together for later connection to the coaxial feedline (**Fig 3d**).

Main Assembly

The unit is built onto an 8in x 4in piece of single sided copper clad SRBP board, acting as a baseboard. The copper surface faces upwards so that connections can be soldered to it. A self-adhesive plastic foot is fitted near each corner of the board.

The rod/coil assembly is mounted on two 2.25in vertical insulated pillars, as shown in **Fig 3**, and held in position with two nylon cable clips. The pillars could be fabricated from 5/16in diameter hardwood dowel. On the prototype each pillar consists of two conventional insulated pillars joined together, end to end, with a short length of M3 studding and a spot of Superglue (see parts list).

The two-gang variable capacitor C1, C2 is 176 + 176pf per section, with an integral slow motion drive. An extension shaft is fitted as shown. The two 15pf trimmers on C1 + C2 are removed. The variable capacitor is secured inverted to a small SRBP panel and a bracket as shown in **Fig 4**.

The wire ends of L1 drop down and are soldered to the fixed plates of variable capacitor C1 + C2. The main frame (and variable plates) of C1 + C2 is securely connected to the chassis plate with a short length of 18SWG tinned copper wire. The twisted ends of L2 are taken to the end of a 36in length of RG58 coaxial feedline. The RG58 is cable clipped to the base plate (see **Fig 4a & c**), and brought up the rear of the variable capacitor to meet the ends of L2. The RG58 outer braid is securely soldered to the rear main frame of the variable capacitor (see **Fig 4c**).

TESTING AND OPERATION

TUNE THE RECEIVER for a Top Band signal on the main antenna. Remove the main antenna and connect your mini-loop antenna. Rotate C1, C2 to bring the loop to resonance, indicated by a sharp increase in signal level.

The tuning to resonance of C1, C2 is quite sharp, and tuning to one or other sideband eliminates much QRM. Loop maximum directivity is deliberately not too critical, but the nulling is very deep and very sharp, and will, with practice, eliminate or greatly reduce most man-made interference. Rotating the loop should produce a point where the signal is at maximum clarity and interference at an absolute minimum. It is useful to stand the loop on a simple turn-table, on a wood (not metal) table or bench, well away from electrical wiring and appliances.

A preamplifier may be necessary if the signal levels are low. The pre-amplifier should have a 50Ω input/output and it should be connected in the coax line between the antenna and the receiver. A suitable simple RF amplifier circuit board kit is available for under £10. If the ferrite loop is to be used as the receiving antenna in a transmitting station, then the pre-amplifier should be protected on transmit, (see *Radio Communication Handbook* (RSGB) 'Receiver Protection').

COMPONENTS LIST

The following are the items used on the prototype, and their sources of supply. Most will be available from alternative sources, with the exception of the Amidon Ferrite Rods specified.

2	Nickel Zinc Ferrite Rods - 4in long x 0.25in diameter. Type R - 61 - 025 - 400 from Amidon Associates Inc, 2216 East Gladwick Street, Dominiquez Hills, California 90220, USA.
1	2oz Reel 26SWG Double Cotton Covered Wire. The Scientific Wire Co, Tanaka House, 18 Raven Road, London E18 1HB.
1	8in long x 5/16in o/d clear plastic rigid tub from Aquarist shop.
4	M3 Insulated Spacers - 30mm - Maplin type FS40T.
2	Cable 'P' clips - natural colour nylon to UL 94V-2 5/16in - Maplin type LR46A.
1	8in x 4in single sided copper SRBP board - Maplin HX00A
4	Stick-on Feet - Maplin FW38R
1	2 gang 176 + 176pf variable capacitor with integral SM drive. Jackson Bros type 004 Cat No 5318/4.
1	Extension shaft + 1in diameter knob for above.
1	36in max RG58 coaxial feedline.

Optional suggestion

Low Noise Pre Amplifier Kit (SL560C), Order code = LT42V - Maplin Electronics.

PERFORMANCE

THE FOLLOWING RESULTS may serve to give some idea of performance:

- Using this little loop, CW signals are receivable from East Coast America, and elsewhere, where previously they were lost in the ambient noise.
- A Sunday morning AM Net some 30 miles away (5 watters) can be heard comfortably whereas previously it was lost in the noise.
- It is also interesting to note that during the UK heatwave of July 1994, when twice lightning has been seen in the distance, the resultant QRN obliterating all signals when using the main antenna. However when the loop null was connected and the null pointed towards the lightning source the noise reduction was sufficiently for CW signals to be clearly heard.

REFERENCE

[1] *ARRL Antenna Book*, 17th Edition. Available from RSGB Sales, see pages 94/95.