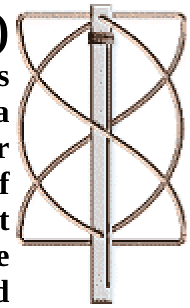
Larger Views may be seen by Clicking on the side index or the pictures

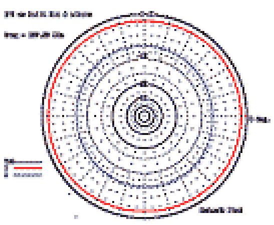


QFH Antenna (The Quadrifilar Helical antenna)

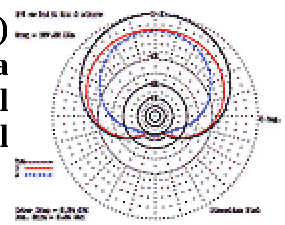
provides circular polarization and complete hemispherical reception, which is precisely what is needed to receive the polar orbiting weather satellites, and as a 2 meter antenna it will receive horizontal, vertical and clockwise circular polarization's from all directions. Fig 1. illustrates the antenna which consists of two vertical loops at right angles to each other, resonant at slightly different frequencies, twisted into a half turn helix. Correctly made it will provide true all round coverage with circular polarization at all angles. The usual crossed dipoles and reflectors used for satellite reception only provide circular polarization directly upwards when the signal strength is high anyway, at low angles when maximum sensitivity is required the polarization is linear, losing 3 dB on the circularly polarized satellite signal. In addition Quadrature feed of crossed dipoles to achieve circular polarization is beautiful in theory and almost impossible to achieve in practice.

Bob Cobey G0HPO an avid weather satellite fan first made one in this area and reported phenomenal results, even inside the roof space of his bungalow. Good noise free pictures were received from Greenland through to Algeria.

The R.I.G articles by Mark Pepper Rig 37 and Chris Van Lint (Rig 44) and also in QST are based on the original work by NASA featured in the ARRL Antenna handbook. There are a number of practical problems in the design which have been addressed and solved over many weeks of computer modelling and prototype construction.

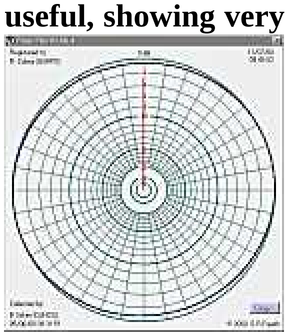


The computer generated (Azimuth & Elevation) polar diagrams are of course perfection and a series of actual measurements of the horizontal and vertical patterns were undertaken on the final design to confirm the computer results.

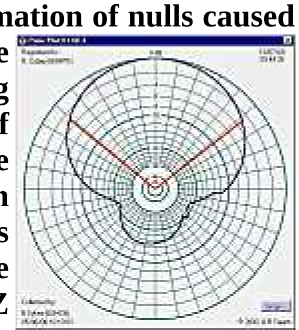


The measured vertical and horizontal polar diagrams using clockwise polarization, were produced using the latest version of a program by Bob Freeth (G4HFQ) called PolarPlot. The Windows 95/98 & 2000 version of the program is now available for download by visiting his page using the links in the right hand column.

Vertical and horizontal polarization's are 3dB down on clockwise as expected and the horizontal pattern is still circular. The polar diagram in the vertical plane is particularly useful, showing very little reception from below, thus reducing the formation of nulls caused

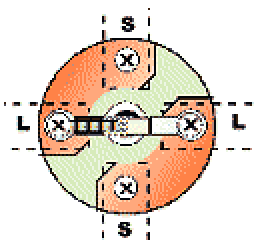


by ground reflections. There are no nulls in the horizontal pattern at any polarization. Allowing for slight distortion in actual measurement of antenna performance, caused by the usual site problems the measured plots and measured gain were identical to the computer generated plots which was particularly satisfying, given the inherent difficulty in modelling a helix in XYZ format for the computer.



The major problem is how to make the beast, and particularly how to make it weatherproof. Firstly the dimensions given by the NASA based articles need to be adjusted for weather satellite and 2 meter frequencies. The diameter of tubing used in the ARRL handbook works

out to 19mm at 137 MHz and dimensions show the INSIDE diameter of the helix. Conversion to 8mm tubing which is a much more sensible size at 137 and 145 MHz was not just a question of simple scaling. As stated in the book a quadrature-phase current relationship is required between the two loops. This is achieved by making one loop larger than the desired frequency resonant length and therefore inductive, while the other loop is smaller and therefore capacitive. Correct resonance of each loop means that a circular pattern may be achieved by simply connecting the two loops in parallel. This is confirmed in practice when the SWR dips once only at the required frequency. It is all too easy to get a double hump response which is incorrect, and will show a figure of eight pattern rather than a true circular horizontal polar diagram. The sizes shown have been confirmed by computer modelling and actual measurements on the prototype, and do not conform with the book figures. In particular the helix should be the same diameter throughout its length and therefore the length of the arms forming the helix is important. The formula for this length is $\sqrt{(\pi r)^2+h^2}$ where 'r' is the radius and 'h' the height of the helix.



The major problem was how to make weatherproof the connections at top and bottom of the helix. The connections at the top of the helix in the original design were almost impossible, as the connection had to be made to the ends of four tubes, two of which were 24mm below the top two, with all inside the support mast. Using the computer modelling program, various connection methods were tried to establish a sensible method without compromising the performance. It proved possible to slope the tops of the small loop so that all four tube ends were in a common plane at the top of the mast where they can be reached. The final method uses a small piece of PC board very simply made, shown in Fig 2, which gives good mechanical and electrical connections.

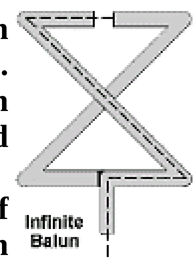
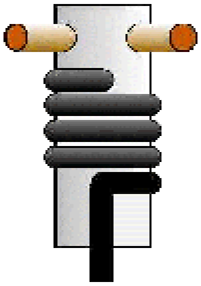


Fig 3 illustrates the original infinite balun arrangement which provides an elegant way of bringing the feeder away from the antenna at a voltage null. This is totally impossible to make if the antenna is made using a central non metallic support mast (as it must be at 137 MHz) when the connections would have to be made inside the mast.
One solution to this was to make the antenna from two continuous lengths of copper tubing with a small diameter coaxial feeder brought through a hole in the feed tube at the null point and connected at the top. This would still be difficult as the feeder entry hole would be inside the support mast. In practice moving the hole a few millimetres to bring the feeder outside the mast solves the mechanical problem and since the current in the lower half of the loop is substantially constant, still provides a good enough voltage null to get the feeder away without affecting the performance of the antenna. The outer braiding of the coax need not be connected to the tube at the point of exit thus preserving the integrity of the coax for weatherproofing. Several antennas were built using this method and were perfectly satisfactory electrically, but construction was extremely difficult. Various methods of actually making the Helix were tried, the use of coaxial cable as in previous designs is acceptable as an indoor antenna but weatherproofing for outside use is almost impossible. 8mm soft copper central heating tube available from the plumbing department of all DIY shops and builders merchants proved to be the easiest to use. Bending tubing by hand is not satisfactory unless the resulting kinks and flattening are acceptable. The elegant way is to use small copper elbows at the corners but it proved totally impossible to insert RG58 coax into the tube after the elbows had been sweated into position and sweating after the coax was inside was not a good idea.
While the original balun design is perfection electrically, it is the main cause of the construction difficulties, and some other type of balun was required. The use of a simple choke balun proved to be the answer and solved all the mechanical problems.
Fig.4 illustrates the feed method where the necessary isolating choke is formed from winding 4 turns of the feeder cable round the support mast. No longer does the antenna have to be



constructed from coaxial cable or have coaxial cable threaded through tubes, and it CAN BE MADE with identical performance to the original NASA design. Performance checks comparing the original design with the new system showed no differences, in particular the feeder was still dead.

CONSTRUCTION

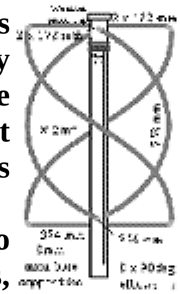
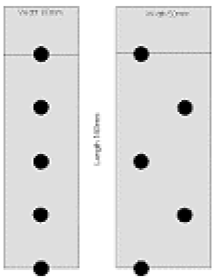


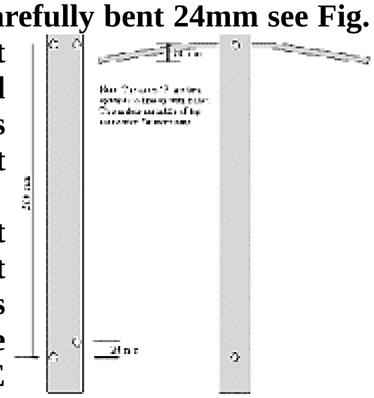
Fig.5 shows the final design using 8mm copper tube with dimensions shown as cut lengths for 137.55 MHz allowing for the length of the copper elbows. Any change in tube size will require different dimensions. Make no mistake, the dimensions are important. This antenna will work after a fashion with almost any slip shod construction but then the polar diagram will not be circular and its a matter of luck whether the maximum lobes are in a useful position.



Mark out the plastic support mast using the template Fig 6 to ensure that the holes are at right angles. Drill the 4 x 8mm holes, two at the top at right angles in the same plane and the two lower down at right angles spaced 24mm. Then drill the 7 mm hole near the top of the mast for the cable entry as shown in fig 4.

Carefully straighten the roll of 8mm tube. This is best done by rolling it out onto the floor keeping the coil vertical. Cut the tube into lengths to the dimensions shown and drill the appropriate holes for the self tapping screws in the ends of the top horizontal sections.

Firstly make the top part of the antenna with the cable and connections. Feed the coax through the hole into the mast and then out of the top threading it through the hole in the centre of the PC board. The top 4 horizontal tubes can then be assembled, the two horizontal tubes forming the top of the smaller of the two loops should be carefully bent 24mm see Fig. 7. The PC board should be mounted copper side down to connect with the copper of the tubes, thus avoiding any dissimilar metal problems with the possible zinc plating of the screws. Four turns of the feeder cable should now be wound around the support mast to form the balun and taped into position.



Next mount the lower 2 horizontal sections through the mast positioning them centrally. The helix can now be formed. First place the copper elbows into position but do not solder at this stage. Carefully bend the appropriate lengths of tube to form the helix. Remember the helix should be wound ANTICLOCKWISE as seen from the top (and the bottom for that matter) to provide clockwise polarization as used on the weather satellites. Final soldering into place can now be done using a small gas torch, the plumbers' trick of applying flux to the copper tubes before fitting onto the elbows will ensure quick and easy flow of solder. The connections at the top require an end cap for weatherproofing and although the appropriate pieces can be obtained from the same source as the plastic tube the user may well find a plastic jar cover of suitable size to do the job.

PLEASE REMEMBER THAT THIS TYPE OF ANTENNA PRESENTS A DC SHORT CIRCUIT AND PRECAUTIONS SHOULD BE TAKEN IF YOUR RECEIVER OUTPUTS A VOLTAGE TO FEED A PRE-AMP.

Cut lengths in mm for 137.55 MHz, using 8mm Central Heating tube & 90 deg elbows.

LOOP	A	B	C	D	E	F	Ht.	PERI
Large	2 x 812	1 x 374	2 x 182				560	2418

Small				2 x 758	1 x 356	2 x 178	512	2284

Parts List (Cost less than £15 from most Hardware Stores)

- **5 mtr x 8 mm Copper Tube (Mini Bore Central Heating Pipe)**
- **8 x 8 mm 90 Deg. End Fed Elbows (Qty. 8 required)**
- **1 meter of 32 mm PVC waste pipe**
- **Etched PC board or Strip board with strips cut to suit.**
- **4 Self start screws to secure PCB and feed.**
- **Suitable length of UR43 or RG58 Coaxial cable for Balun and feed**