A QFH antenna for the weather satellite band

This article describes how to make a **quadrifilar helix** (**QFH**) antenna easily, from inexpensive materials: uPVC plumbing pipe and RG-58U co-axial cable. No bending and soldering of copper pipe required. If you have been put off making one of these highly effective antennas because you thought it was difficult, or that the antenna won't work unless the design is reproduced to fractions of a millimetre, don't be. If I can make one of these antennas and it works, then you can! The proof is in the pudding: see my weather satellite images here.

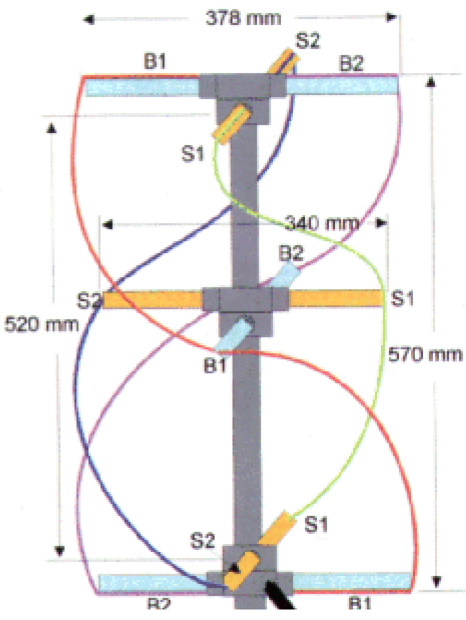
Introduction

When I began receiving weather satellites from my present QTH using a turnstile antenna in the loft, the received images were plagued by noisy fade-outs and pager interference. Many weather satellite receiving enthusiasts recommend using a quadrifilar helix (QFH) antenna. However, most of the designs are made from copper pipe, the construction of which require plumbing tools (and skills) I simply don't possess. Most of the QFH designs also appear to be optimized to receive a good satellite signal from horizon to horizon, something that seems to be an obsession with many enthusiasts, but which is exactly what I did not want, since an antenna that receives signals from the horizon is also going to receive a strong signal from radio pager transmitters.

In searching for a solution, I came across a design for a portable QFH by Chris van Lint. Chris required a portable antenna as he had concluded that the only way to get away from the pager transmissions was to travel away from home. This was not a consideration for me (there probably isn't anywhere in England that is far enough away from the damn things anyway!) What was interesting about Chris's design is that it used materials that are inexpensive, easy to obtain and easy to work with, and that it could easily be constructed. Being shorter and fatter than many QFH designs, it also favors the higher angles at the expense of the lower ones, something that will help to attenuate the dreaded pager signals.

Mast and supports

Chris van Lint used PVC electrical conduit tubing and junction boxes to make a mast with removable support arms for his portable antenna. These materials are not obtainable where I live, and in any case, portability was not a requirement. Instead, I used uPVC plumbing pipe to make a structure that once made, is not intended to be taken apart. The dimensions of the structure are shown in the diagram, taken from Chris's original article.



The main mast was made from a length of uPVC waste pipe left over from a dishwasher installation project. The support arms were made from narrow bore uPVC plumbing pipe, of the sort used for water tank overflow pipes. You'll need more than 2m of this, which will probably mean buying two lengths, and having a lot left over. The actual diameter of the pipe is unimportant, but obviously the smaller it is, the easier it will be to make the holes in the mast. Even the smallest diameter should have adequate strength for this application.

The holes were made by drilling the mast using the largest drill I had available, and then filing out the hole until the pipe would go in with a tight fit. Filing the hole also gave the opportunity to compensate for the inevitable inaccuracies (inevitable when I make anything, anyway!) so that the support arms when installed would be at right angles to the mast, and to each other.

Although not obvious from the diagram, there are notches at the end of each support arm, to help locate and hold the co-ax. The notch at one end is made at 90 degrees to the notch at the other. When the supports are mounted in the mast, the notch facing you must be oriented so that it slopes at 45 degrees from top left to bottom right.

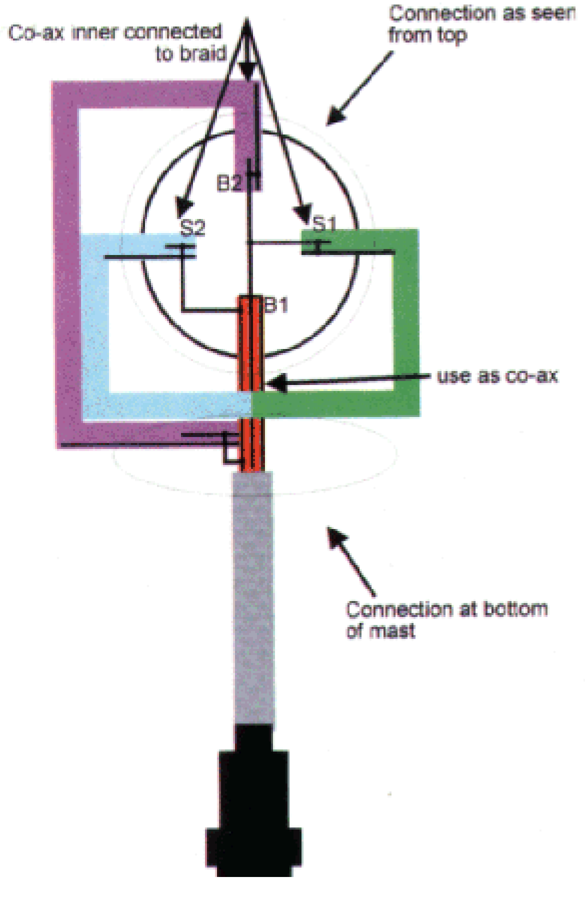
The given lengths of each arm are the length measured to the center of the coaxial cable as it passes through each notch. I made the notches by drilling a hole in the tubing and then cutting through the middle. If you want to make deeper notches, to hold the cable better, you'll want to make the overall length of the supports slightly longer than the dimensions given.

Although the support arms are hollow, the cable does *not* go through the support arms in order to pass through the mast. The purpose of the arms is simply to hold the cable in the correct shape. The electrical connections are all made at the top of the antenna, so the topmost support arm is placed right at the top of the mast. To make the connections, I secured a small square of copper perf board to the center of the topmost support arm, in the center of the hollow mast, and soldered the cables to it.

Where the cable passes through the lower section of the mast, I drilled two pairs of co-ax sized holes, one pair below the lowest short support, and one pair below the lowest long support. So the cable passes through the notches of the support, and then along the bottom of the support itself.

Connecting the cable

The radiating elements of this antenna are made from 50 ohm coaxial cable. Chris van Lint used RG-6U cable for its increased rigidity. As my antenna is used indoors and consequently not exposed to the wind, I used ordinary RG-58U cable. In fact, I used a length of redundant Ethernet network cable, which had the added benefit (for the feeder) of already having a BNC plug soldered on one end!



One thing that put me off trying to make this antenna for a long time was that I didn't understand how the elements were connected up. The connection diagram (right) confused me. I saw one loop (green and blue) and a half loop (purple) and the feeder (red). I didn't understand where the other half loop was. I didn't realize initially that the feeder itself made up half of one loop!

Once I understood that, the simplicity of this antenna became apparent. The inner (small) loop can be made from a single length of co-ax, 221.6cm in length. Remove the insulation from each end of this length of cable, and connect the inner and outer together. One end will be connected at the top of the mast to the shield of the feeder, and the other to the center conductor.

Half the outer (large) loop is made by cutting a length of coax 122.15cm (i.e. half the total loop length) long, and joining the inner and outer at each end. At the top, this will be connected to the center conductor of the feeder.

The second half of the outer loop is formed by the feeder cable itself. Strip away a small section of the outer jacket of the cable, 122.15cm from the end. The lower end of the other half of the loop is soldered to the braid. This is one of the trickiest parts of the whole construction: soldering to the braid of the

feeder cable at this point without melting the inner
insulator and causing a short circuit. After removing a section of insulator I tried pushing the two outer sections together, causing the braid to bunch up a bit. This ensured that when I soldered to the braid, it wasn't in contact with the inner insulator.

You'll probably find it easier to solder the two halves of the outer loop together first, then thread them through the holes in the mast, and then connect them at the top. I removed the lower support arms at this point, so I could push a finger through one of the holes to help thread the ends of the cable through the holes in the mast.

Once the cable is threaded through the holes in the bottom of the mast, it forms a half turn clockwise (when viewed from the top), so that at the top it is connected on the opposite side from the hole it came out of. The photo and the upper diagram shows how the cable should look, and the connection diagram shows how the four cable ends should be connected when viewed from the top. After soldering the connections, arrange the cable so that the elements form nice smooth curves.

Trying it out

The quadrifilar helix antenna is now ready to use. However, you may want to use some electrical tape to secure the cable to the ends of the supports. One point to bear in mind: sharp bends in the cable are to be avoided, and could affect the performance of the antenna. Don't tape the cable tightly to the top and bottom supports. Instead, tape it at the end point so that it doesn't fall out of the notch, and allow the cable to form a natural curve.

Before connecting the antenna to the receiver, check that the receiver is not configured to supply a DC voltage down the center conductor of the feeder to supply a preamp. The quadrifilar helix antenna is a DC short circuit, and attaching this antenna to a receiver configured to supply a preamp will in all probability burn something out.

Now all you have to do is wait for a satellite to pass over. Hopefully you will find that the signal increases steadily from acquisition until the point of highest elevation, and then decreases steadily again, with no dips or nulls.

Chris van Lint wrote that "The QFH produces a higher magnitude of gain on circularly polarised signals as compared to linearly polarised signals. This in effect attenuates linearly radiated signals in relation to the circular ones and reduces interference." This characteristic should help reduce the effect of pager transmissions compared to other antennas such as turnstiles, discones and verticals. Chris also found that during field testing, the QFH seemed to have distinct directivity in relation to linearly polarized signals. By turning the antenna, he was able to find a very distinct reduction or even a null in the strength of an interfering pager signal. I haven't tried this, but if pager signals are still a problem, it's something to explore.

Waterproofing

Because my antenna was intended for attic mounting, I didn't have to bother about waterproofing the connections. If you want to place it out of doors you'll need to think about that. However, the thin RG-58U cable may be unsuitable for outside use, as the elements may not maintain their shape in strong winds.

Theoretically, if you make the antenna from a different thickness of tubing you may need to change the dimensions of the design. I would expect that this would apply to co-ax too. However, I already made an unauthorized change, building this antenna out of RG-58U to dimensions given for a construction using RG-6U, and it works just fine. Conclusion: I really don't think it matters that much!