A Portable, Collapsible QFH Antenna

for the 137 MHz Band

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Background

In the past, many articles have appeared in a number of publications singing the praises of Quadrafilar Helix (QFH) antennas. Those of us who have had an opportunity to try such an antenna will agree that this device appears to be optimum for APT, since it is truly circularly polarised, with more gain as compared to the classical turnstile or lindenblad types. Often these articles are accompanied by construction details to allow the home constructor to build a suitable device themselves. The majority of these articles, however, employ an infinite balun matching-scheme, which is not exactly constructor-friendly to the average home experimenter.

These antennas rely on using copper tubing filars together with a hard-line co-ax filar to form the balun. In some locations hard-line co-ax is difficult to obtain and expensive. QFH antennas using this construction method require that the filars be insulated from the support and often PVC piping is used for this purpose. Since the filars have to be shaped into the desired helical form, they have to be self-supporting and some means of anchoring them to the support mast has to be devised. This is not an easy feat, in addition to which the shaping of ¼-inch tubing is not as simple as it seems. The interconnection of the filars has to be done carefully or the antenna will not work. Construction details which I have seen so far are rather confusing and they have put me off building a QFH of the infinite matching balun type.

Ever since arriving in Hong Kong I have been plagued by pager interference. Hong Kong uses the 137-138 MHz frequency bands for paging applications as well as various others. In fact there is a pager transmission on 137.95 MHz. This has made reception of certain APT frequencies a misery and I can not get acceptable results on the 137.50 MHz and 137.85 MHz transmissions. After having tried numerous ideas to overcome the problem, including narrow band-pass filtering, I have decided that the only practical solution is to change location. This is of course easier said than done. It is not practical to relocate from my present abode for a number a reasons, not least of which is the fact that another residential area will not necessarily offer relief from the interference. The only areas where one could expect to get interference-free reception would be the more remote and less populated areas on the south eastern part of Hong Kong Island and this would require some form of mobile set-up. Having convinced myself that the best possible APT antenna must be the QFH, I set my sights on constructing a portable version.

Description

I claim no originality for the antenna I am about to describe. As mentioned before, there are numerous descriptions in circulation at the moment. A fundamental deviation from classical QFH antennas is the fact that in this design the filars are not supported directly by the mast but by PVC arms. This relatively simple but nevertheless brilliant idea came from Eugene Buck W3KH, who also provided the dimensions. My contribution lies in the idea of using removable arms and conventional flexible co-axial cable for the filars and matching line alike, which allows the filars to be folded against the support mast when not in use.

This antenna is a ½-turn, half wavelength device using a self-phasing big/small loop configuration. Impedance matching is achieved by an infinite balun arrangement in which one of the four elements is a length of co-ax to produce a characteristic impedance of approximately 40 Ω. The antenna is constructed from standard 20 mm PVC electrical conduit tubing for the support arms and a length of 32 mm PVC tube for the support mast. To accommodate the support arms I used six PVC 2-way junction boxes. The relevant dimensions can be noted from figure 1. The dimensions for individual arms are always half the total width when measured from the centre of the support mast. QFH antennas of this type use a big and a small loop and this is the reason why, instead of 4-way, two 2-way junction boxes were used, mounted at 90° one above the other. This procedure creates a (B)ig and (S)mall loop.

Each loop splits into two filars, which are supported by removable PVC arms B1, B2, S1 and S2. Figure 2 shows the connection of the filars in relation to each other. Note that the smaller loop is not connected at the bottom and for this reason filars S1 and S2 may be left joined so that a single length of co-axial cable 221.6 mm in length is used. The diagram shows connection details as viewed from the top of the mast, connections at the bottom and the joining of the feed cable.

Only one filar (one half of the big loop) is used as a co-axial conductor and those filars which do not require use as a co-axial cable have the centre conductors soldered to the braid at both ends. I used RG-6U co-axial cable, not because of its low loss, which is not particularly relevant at these frequencies, but because it has a continuous aluminium shield in addition to the braid: this gives the cable extra rigidity which is useful for shaping the filars once the arms are fitted. Since the APT satellites in which we are interested transmit their signals using right-hand circular polarisation

(RHCP), the filars must be wound in an anti-clockwise direction when viewing the antenna from the top down its vertical axis.

Construction

Start by cutting a suitable length of support mast. In my case I cut the mast just long enough to allow a socket to be fitted inside the lowest 2-way junction box. This allows the mast to be extended by inserting another length of 32 mm pipe. Cut holes in the undersides of the junction boxes. The two junction boxes are cemented together at a 90° offset angle to form a cross and a total of three sets of such assemblies are required.

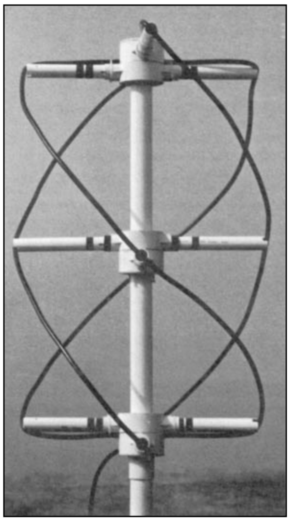


Figure 3
The completed QFH antenna.

Slide the centre assembly on to the mast, followed by the top and bottom ones. For the centre assembly, a suitable hole may be cut in one of the junction box lids which is than slid over the mast to cover the centre assembly. Note that no dimensions are given for positioning the centre assembly, as this is not critical and should simply be near the centre. Cement the assemblies into place, initially with solvent-based PVC cement. I find that this adhesive, once a little dry, allows some level of adjustment before it sets completely. Once you are satisfied that the assemblies are correctly aligned and the adhesive is dry, apply generous amounts of an epoxy-based adhesive to complete the mast assembly.

Now cut the support arms. The actual length will depend on the physical dimensions of the junction boxes used. Make sure that you adjust the final length on the basis of the arms having been tightly fitted into the junction box sockets. Remember that the loop dimensions shown in figure 1 constitute the total width of each of the two loops, and the width of the corresponding arms should therefore be half this, and measured from the centre of the mast. Allow a little extra length to accommodate two slots in the support arms into which the co-axial cable filars can be snugly pressed.

Each junction box assembly will have one pair of short and one pair of long support arms. Drill holes big enough to accommodate the co-axial cable on top of, and as close as possible to, the topmost arms. For the bottom set of arms do the same, but below the arms. Once completed, insert and twist the arms so that the slot slopes from top left down 45° to bottom right. The arms may now be removed and put aside. It may be helpful to put marks on the sockets and arms to indicate in which position the 45° angle is achieved. If the marks on both the sockets and arms are in exactly the same position there should be no need to put identifying marks on individual arms and sockets; i.e. the position marks should be sufficient.

Insert the co-axial cable which forms the smaller loop into the hole below one of the short arms all the way so that the cable exits on the opposite side. Ensure that the length of cable at both sides is the same. Join the centre conductors to the braid. Cut two equal lengths of co-ax which will form the big loop. On one piece only, join the inner conductor to the braid and insert one end in the hole above one of the longer arms. Do the same with the second half-length of co-axial cable, but in the opposite hole. Solder the four cables in the top junction box according to the instructions in figure 2. Insert the opposite ends of the co-axial cables in the holes situated ½-turn anti-clockwise on the bottom assembly.

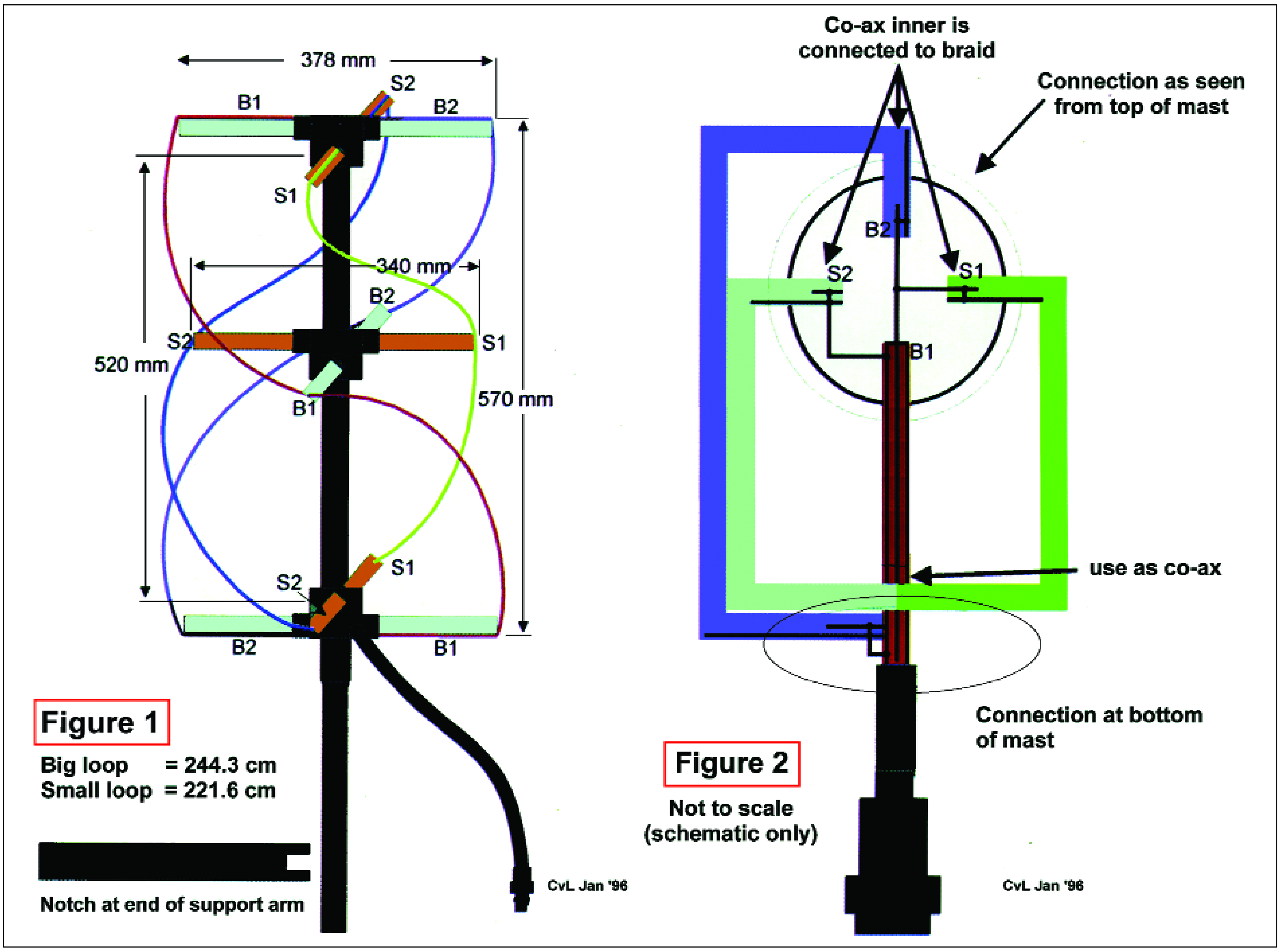
Drill a suitable hole somewhere in the lowest junction box to accommodate one end of the co-axial feed line, which should be fitted with a connector of your choice at the other end. Push this feed-line through and join all cables as shown in Figure 2.

Cement the top junction box cover and the cover for the bottom junction box assembly into place. Now insert the arms in their correct positions and adjust the slot angles. Simply press the co-axial filars into the appropriate slots, moving anti-clockwise from the top, completing a half turn by the time you get to the bottom.

After a little manual shaping of the filars to form the helical shapes, the antenna is finished. If the antenna is to be used as a permanent fixture rather than a mobile device, you can drill a small hole through the arms, behind the slots at 90° to accommodate a nylon tie to secure the filars into the slots.

Performance

I have compared the performance of my prototype against my other QFH antennas, including a commercial version under dynamic conditions, using a co-axial relay to switch from one antenna to the other. I am convinced that the performance of the portable QFH is a good as my other QFH antennas. There are no noticeable nulls and I get usable signals from AOS to LOS (on 137.62 MHz, the only frequency I can receive without interference!).



Figures 1 and 2 - Plan of the QFH antenna, showing dimensions.

If you are plagued by interference from a single source, you may find the QFH more suitable than other types of antenna. 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.

During field testing I noticed that the QFH appears to have distinct directivity in relation to linearly polarised signals. In my case there is a pager transmitter, which makes reception of signals on 137.5 MHz almost impossible. This interference is not intermodulation and it is there when no signal is being received from the satellite.

I found that by turning the antenna when not receiving a satellite signal, it was possible to find a very distinct reduction or sometimes a null in the strength of the interfering signal. This has enabled me, for the first time, to decode NOAA 12 signals on 137.50 MHz. A similar improvement could be obtained when dealing with other forms of linearly polarised interference.