Double the bands for the cubical quad loop antenna.

Antenna Workshop

Peter Dodd G3LDO continues his discussion of the quad loop beam antenna by describing how to add additional band elements

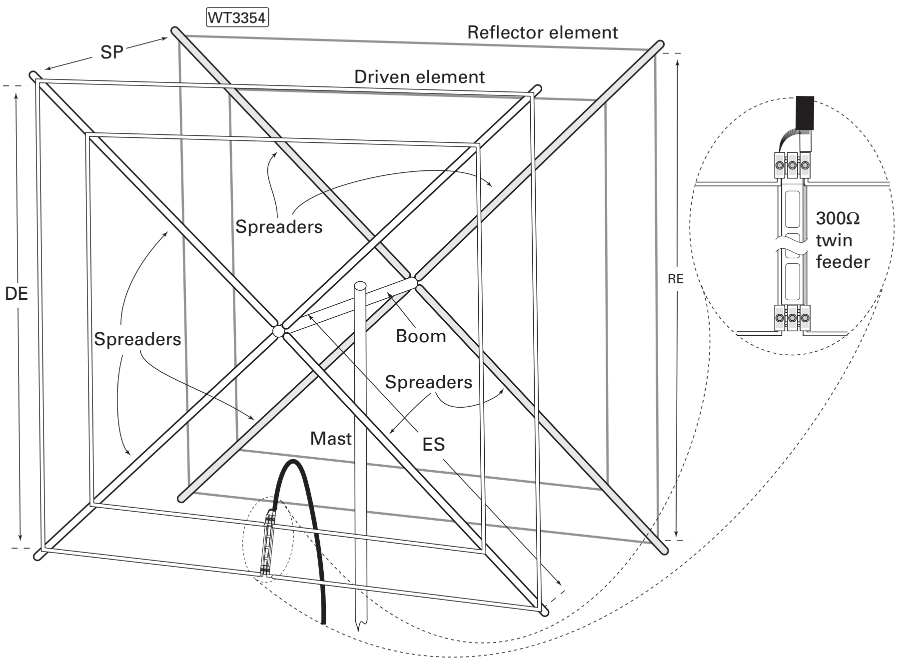

Fig. 1: Adding another band to a mono-band loop antenna. Dimensions are given in Table 1. The two separate band sections of the antenna are fed using 300Ω ladder line with the highest frequency band nearest to the feeder termination.

In the Antenna Workshops in the June 2007 issue of *PW,* I gave a description of the quad loop beam antenna and some ideas on how to construct one. This time I'll describe how additional bands can be added to our single-band version and suggest some simple ways of feeding it.

The advantage of the quad loop antenna is that it can be made into an excellent multi-band antenna simply by nesting elements for the different bands onto a common support structure. I have added an extra band, shown in **Fig. 1**, to the single band antenna of the June issue. The total area is no larger than that required by the largest beam of the group.

My first real DX antenna was a two-band quad loop antenna for 21 and 28MHz, that I constructed in 1959. That antenna was fed with the driven elements connected in parallel from a single length of 75Ω television coaxial cable. The antenna loaded without any problem on each band and the directional characteristics were also very satisfactory.

Because my experiments were so successful I formed the opinion that, for a multi-band quad loop antenna, all I had to do was connect all the driven elements in parallel and use a single feeder. However, this assumption, according to **W4RNL**, is incorrect if any one of the band elements on the antenna is harmonically related to any one other.

Frequency (MHz)		14.1	18.1	21.2	24.9	28.5
Driven Element length (DE)	(m)*	5.33	4.18	3.57	3.04	2.65
	(in)*	210	164	140	120	105
Reflector length (RE)	(m)*	5.56	4.38	3.73	3.17	2.77
	(in)*	219	172	147	125	109
Element Spacing (SP)	(m)	2.98	2.34	1.99	1.70	1.49
	(in)	117	92	79	67	59
Element support length (ES)	(m)	3.93	3.1	2.64	2.24	1.96
	(in)	155	122	104	89	77

* **Note:** These dimension are for one side of the quad. The total length of the element is four times the above figures.

Table1: Dimensions for a two-element loop beam. The dimensions have been calculated using EZNEC for a design giving a free-space gain around 7.5Bi and a front-to-back ratio greater than 15dB.

For example, for a three-band quad loop antenna for 14, 21 and 28MHz, when the antenna is energised on 28MHz the 14MHz element also presents a near matching impedance to the feeder – being a two-wavelength loop on that band. The effect is to damage the desirable quad loop antenna's directivity pattern on 28MHz. It's probable that this is the reason most multi-band quads, that I've seen, use a separate feeder for each band.

Simply Paralleling

Having mentioned that simply paralleling the driven elements could lead to inter-reaction of the elements, how would such an arrangement work for a simple 18 and 21MHz antenna I was considering? You could be forgiven for asking why I should make a quad loop antenna for 18 and 21MHz when the bulk of the DX on the upper h.f. frequencies is on 14MHz during this period of low sunspot activity. The answer is that there are two reasons for this approach.

One answer to the above question, of why 18/21MHz? is that I suffer insidious QRM on 14MHz, which has defied identification. I have made a recording available on my website if you would like to have a go identifying it. Look at **http://web.ukonline.co.uk/g3ldo** then select QRM Report on the Index page. The other reason is a constructional problem, to utilise the antenna on other bands.

I constructed my proposed 18 and 21MHz multi-band antenna as shown in Fig. 1 – but with the driven elements connected in parallel and fed using a single feeder. The s.w.r. values indicated that the matching on both bands was poor. I then tried connecting the two driven elements via a length of 300Ω ladder line feeder as shown, **Fig. 2**, which resulted in a dramatic improvement.

Recently, I've acquired a new measuring instrument, namely an AIM4170 Antenna Analyser, an instrument that works in conjunction with a computer to produce a graphical analysis of the antenna under test. Furthermore, the analysis can be adjusted to take the feeder's impedance transform effect into account, so the impedance values shown represent the impedance at the feedpoint of the antenna, as shown in the measurements of the 18 and 21MHz quad, see **Fig. 3**.

Not A Small Antenna

From Fig. 1 and **Table 1** you can see that a 14MHz quad loop isn't a small antenna. Each side of the antenna is well over 5m long and each spreader is nearly 4m (13ft) long. The lengths are provided as imperial (feet) because garden canes still seem to be sold in these units. Canes with lengths up to 10ft long seem to be easy to find.

If you are considering constructing an antenna for 14MHz the best type of structure for the fixing the spreaders to the boom is angle aluminium and car exhaust clamps shown in **Fig. 4**. The difference between the cane length and the required length can be made up with longer sections of aluminium angle. The canes, which should be first weather proofed with a couple of coats of outdoor varnish, can be fixed to the angle aluminium using hose clamps.

If you're using insulated wire for the wire elements then they may be fixed to the element supports using several layers

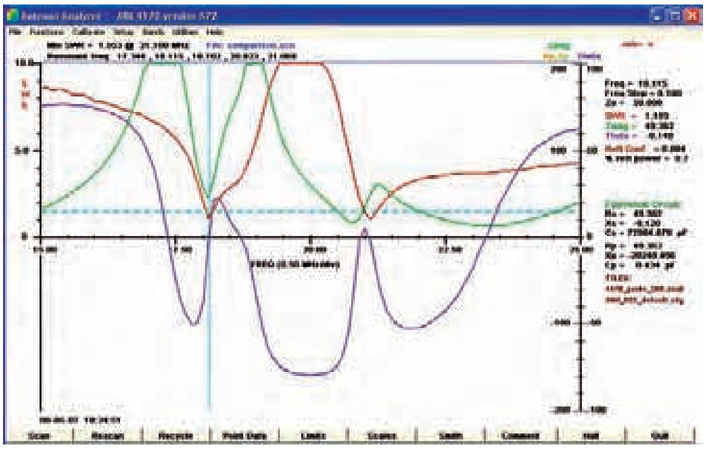

Fig. 3: Analysis for the18 and 21MHz bands, the more familiar s.w.r. plot is shown in red. The impedance at the blue frequency cursor setting is shown in polar form, magnitude and angle. The more familiar R±jX equivalent is also shown labelled 'Rs' and 'Xs' respectively.

of plastic tape. The problem is determining the exact points where the element is attached to the supports. If you add or remove some of the wire from an element during the tuning up phase then, unless the changes are very minor, the points where the elements fix to the supports will also change.

When making element length changes it's often difficult to gauge the correct distance along the support and if these distances are unequal the quad loop looks decidedly lopsided. Although a certain amount of asymmetry can be tolerated, with a multi-band antenna these asymmetries can make it look a mess.

One way around the asymmetry problem is to use a temporary fixing to of the element to the support, which can be easily adjusted until the antenna functions correctly and the structure looks right. You can use plastic clothes pegs provided that the support diameter is no larger than around 20mm.

My favourite temporary clip was bought from one of those emporiums that appear to sell everything. These clips are called mini-clamps and came on a shrink-wrapped card – eight for £1! The method of temporarily fixing the elements to the support is shown in **Fig. 5**.

No matter how carefully you follow an antenna construction plan with regard to dimensions you will be lucky if you get it right first time. It's no surprise that top DXer stations perform well because their owners spend considerable time and effort honing their antennas for maximum performance. This will involve lengthening or shortening wire elements and this is were the temporary element clips come in. When the quad is working satisfactorily the temporary clips can be replaced with a more permanent fixing.

Lower bands

An h.f. quad loop beam antenna, as described can also be used on all the lower h.f. bands, though not in its primary mode of operation. To do this, the quad loop antenna and its feeder are used as 'wire antenna' fed against earth using an a.t.u.

Fig. 2: The feeder support arrangement uses a plastic tube. This arrangement holds the feedpoint in place and holds the feeder clear of the mast when the antenna is used on the lower frequency bands. 'Choc-block' connectors are used as insulators and for fixing the ladder line to the elements.

Obviously, the method will only work if the feedpoint is off the ground and arranged so that it's well clear of the metal structures such as the boom or mast (the second reason for my method of construction). This can be achieved with feeder fixed to a plastic pipe insulated support, which holds the feeder clear of the mast as shown in Fig. 2.

My shack is located some distance from the antenna. The RG213 feeder takes a long convoluted route along the side of the house and along the inside of a hedge where it's connected to a length of RG58A/U to feed the antenna when it's in use on 18 and 21MHz bands. When used on the lower frequencies the RG213 is routed to a nearby garden shed and connected to the socket of an earthed a.t.u.

The RG58 coaxial cable from the antenna (with the inner and screen connected together) is connected to the 'wire antenna' connection of the a.t.u. As this a.t.u is the same distance from the mast as the mast is high, the coaxial feeder section of the antenna system forms a 45° sloping antenna for the lower frequencies.

Fig. 4: Method of constructing a robust spider for a large antenna using angle aluminium and car exhaust clamps.

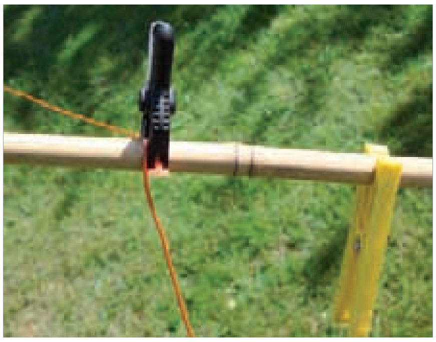

Fig. 5: to variations of the method of temporarily fixing a loop element to the spreaders during the tuning and adjusting phase.

The antenna elements form a considerable top loading 'capacity hat' and the antenna performs quite well on 1.8 and 3.5MHz bands. The performance of such a top loaded sloping antenna is dictated greatly by the quality of the r.f. earth connection. And in this sloping operation, it performs as well as any other wire antenna that I have tried here.

Finally

This simple two-band antenna appears to work very well. It's possible to add all the higher h.f. bands to a quad antenna but the interaction of the elements makes the job of adjusting for the correct performance difficult. I plan to add additional bands to my quad loop beam antenna and I hope to make this the subject of future an Antenna Workshop. ●