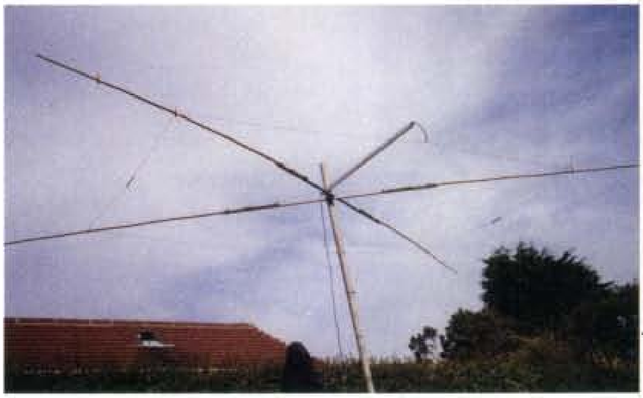
Antenna Workshop

THE MOXON RECTANGLE REVISITED

Peter Dodd G3LDO says the 'Moxon Rectangle' is an antenna that could be put up in almost any 'back-yard' and could improve your signals.



The 'wingspan' of a conventional Yagi antenna can often be a problem for many locations. A problem that's often addressed by shortening the antenna with loading coils, introducing additional complexity into the design. A simpler method is to reduce the area needed for the elements by bending them to fit it into a smaller space. But can a beam shortened in this way still retain its beam characteristics?

With antennas there is very little that is actually new! An antenna configuration, where the elements of a two-element beam were bent so that the 'wingspan' was halved, was first suggested by **John Reinartz W1QP**, way back in October 1937. **Burton Simson W8CPC**, constructed such an antenna, the elements of which were supported on a wooden frame, allowing the element ends to be folded towards each other. The 14MHz antenna was constructed from copper tubing with brass tuning rods that fitted snugly into the ends of the elements for tuning.

A wire edition of the W1QP/W8CPC two-element antenna was described in 1973 by **VK2ABQ**. In this configuration, the tips of the parasitic and driven elements support each other in the horizontal plane as shown in **Fig. 1**. The insulators are constructed so that the tips of the elements are 6mm apart. According to the VK2ABQ, this capacitive end, coupling the reflector from the driven element although the gap between the tips of the elements, is described as 'not critical'.

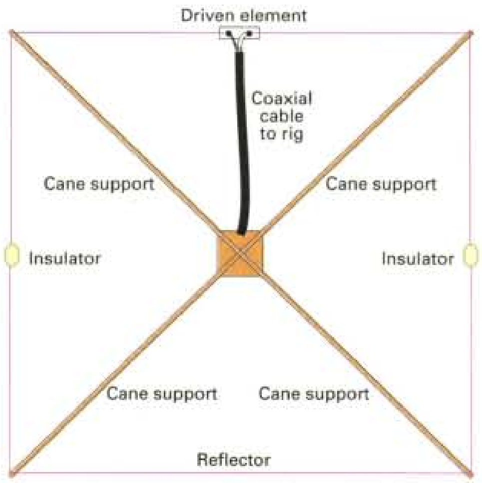


Fig. 1: The basic layout of the W1QP/VK2ABQ antenna.

The Moxon Rectangle

Les Moxon G6XN, did a lot of experimental work with the two-element Yagi antennas with bent elements, particularly in optimising the element spacing. However, some of these structures are complex and difficult to reproduce. A simplified structure devised by **L. B. Cebik W4RNL** (which he has named the Moxon Rectangle) is shown in **Fig. 2**.

The remarkable characteristic of this Moxon rectangle is a very high front-to-back ratio. With a calculated feedpoint impedance between 56-58Ω, it's close to 50Ω of the ubiquitous coaxial cable. The dimensions for Moxon rectangles for 7-28MHz are given in **Table 1**.

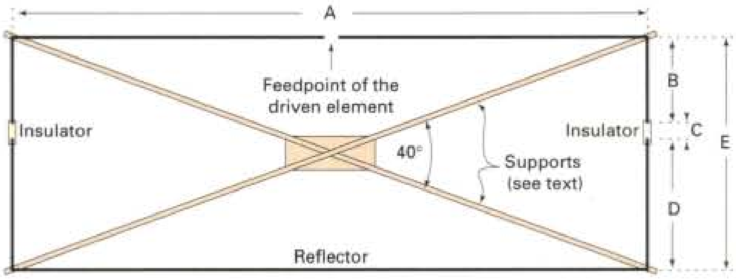


Fig. 2: A single band version of the Moxon Rectangle showing the general construction. The angle of the two element supports is around 40° rather than the 80° often shown elsewhere. See Table 1 for dimensions.

The dimensions are not perfect scaling because the length-to-wire-diameter ratio changes for each band. Free space gain and front-to-back ratio are consistent for all the models, averaging 5.8dBi and greater than 30dB respectively (in free space). The computer model of the W1QP/W8CPC/VK2ABQ arrangement suggests that the driven element/parasitic element coupling is the same as for a wide-spaced two-element Yagi and its performance is shown in **Fig. 3**, where I've compared it to the Moxon Rectangle.

The Moxon Rectangle can be made into a multi-band antenna by interlacing the elements for the different bands on to a common support structure. Unlike the quad, the geometry of the support system ensures optimum spacing on all bands. The dimensions of this antenna are given in Table 1. Though I constructed a single band variant to check out the performance of the antenna, to see

Table 1

MHz	A (m)	B (m)	C (mm)	D (m)	E (m)
29.50	3.79	0.59	125	0.74	1.45
24.94	4.33	0.67	140	0.84	1.66
21.20	5.00	0.80	158	0.99	1.95
18.12	5.96	0.94	180	1.16	2.28
14.17	7.62	1.22	219	1.48	2.92
10.12	10.66	1.71	305	2.07	4.08
7.05	15.10	2.75	405	2.93	5.73

Table 1: (Left) Dimensions for the W4RNL designed Moxon Rectangle beam, which has been calculated using EZNEC for a non-critical design. Refer to Fig. 2. Allow extra 'wrap-back' wire for fixing to insulators; say, 80mm at each insulator.

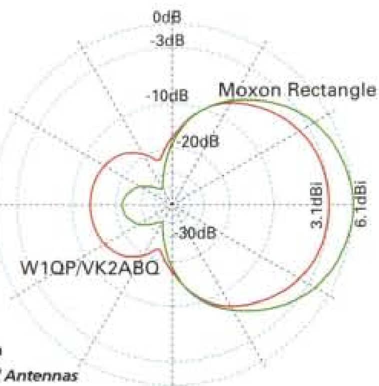


Fig. 3: (Right) Computer analysis comparing the performance of the W1QP/VK2ABQ and Moxon Rectangle. (Both antennas have been optimised).

Diagram taken from *Backyard Antennas*

how they compared with the computer model.

Construction Of Spreaders

The construction of the spreaders for the Moxon Rectangle antenna may be from cane (lightweight bamboo) or fibreglass rod. I chose to use cane because it is easily obtainable from Garden centres and is cheap. The main drawback of cane is that, although it's strong and light, it will deteriorate within a couple of years due to the weather. A view of a single band version of the Moxon Rectangle showing the general construction is shown in the heading photograph.

Most antenna books suggest just using varnish to protect the cane, which is fine provided it does not chip. But if water finds its way under the varnish it cannot evaporate very easily and does its worst. I treat wire antenna cane supports with Cuprinol wood treatment, which displaces water in the cane.

The next problem is fixing the cane to the mast. I use angle section aluminium for this purpose. Two sections, each a little under a metre long, of this aluminium section are required for this antenna. Drill two holes at the centre of each section, their distance apart will depend on the size of the mast or boom and hence the size of the U-bolts. The method of fixing the aluminium angle to the mast is shown in **Fig. 4**

The support rods are fixed to the ends of the aluminium angle using hose clamps. Rubber or plastic tubing 'cushions' can be used to prevent the clamps damaging the cane or g.r.p. supports. I made the cushions from thin plastic garden hose, cut (100mm long) and sliced longitudinally, making a small plastic rectangle. This is wrapped around the cane and fixed in position with plastic insulating tape.

Additional Metal

An additional piece of metal is required to complete the construction. Although not absolutely necessary, it is useful to be able to support the coaxial cable between the mast and the wire driven element so that the weight of the cable does not distort the element. This support can be made from aluminium angle although the material shown in Fig. 4 is some sort of curtain rail with a channel, in which I laid the coaxial cable.

Fixing wire element supports at the right angle and finding the exact point to fix the wire elements to the supports is always a problem. This applies to all antennas, such as quads, that use this method of construction. My suggestion is to fix the antenna supports so that the angle in dimension E of Fig. 4 is around 40°, then tighten the U-bolts.

Single Band Variant

My single band variant is centred on 28.4MHz. The nearest frequency given in Table 1 is 29.5MHz and the total length of both elements is 10.42m. This does not include the additional wire needed to loop back through the insulators. I made a loop of wire with a total length of 10.8m.

Make up the elements in one complete loop complete with insulators. I used 1.5mm

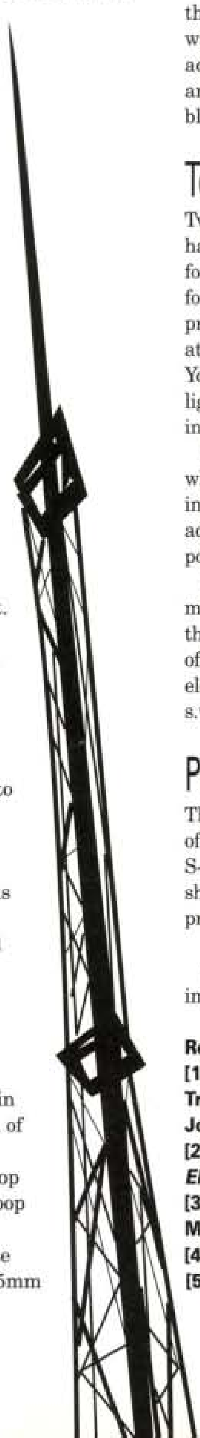


Fig. 4: Method of fixing the element supports and the coaxial cable support to the mast.

plastic covered wire and stripped the insulation from the ends and fixed these ends to a 'choc-block' style connector to connect to the coaxial cable eventually.

Then, using clothes pegs on the cane where I thought the elements should be fixed, the wire loop was then draped over the element supports and adjusted until the loop was reasonably tight. The antenna should be symmetrical with the connector block centralised.

Tooth Brush Handles

Two insulators were then made from tooth brush handles. (Don't snigger - the LF (136kHz) group have found this material will take the thousands of volts found on LF transmitting antennas without any problem!). Cut off the brush bits and drill a small hole at each end of the handle large enough to take the wire. You don't have to use toothbrushes, strips of any lightweight insulating material will do for the insulator.

Mark the point on the wire loop that corresponds to where dimensions B and D meet. Cut the wire and insert your insulators. Allow extra wire for length adjustments. You will also have to slightly adjust the position of the clothes pegs.

Connect the coaxial cable to the terminal block and make some initial s.w.r. measurements, during which the antenna should be at least quarter of a wavelength off the ground. You may have to adjust the driven element wire lengths at the insulator to achieve lowest s.w.r. reading at your favourite operating frequency.

Performs Well

The antenna performs very well with a minimum s.w.r. of around 1.3:1. The front-to-back ratio was around two S-points (12dB). To achieve the front-to-back figures shown in Fig. 2 the antenna needs to be optimised. This procedure is beyond the scope of this article.

Go on! Set up your own Moxon rectangle - it could improve your station! *PW*

References

[1]'Concentrated Directional Antennas for Transmission and Reception', *QST* October 1937, John Reinartz W1QP and Burton Simson W8CPC.
[2]'VK2ABQ Antenna' Fred Caton VK2ABQ *Electronics Australia*, October 1973.
[3] *HF Antennas for all Locations*, 2nd Edn, Les Moxon, G6XN.
[4] L. B. Cebik W4RNL
[5] *Backyard Antennas* by Peter Dodd G3LDO.