Antenna Workshop

Geoff Cottrell G3XGC needed a low visual impact antenna for the 50MHz band. His antenna of choice? A Moxon Rectangle.

A Moxon Rectangle for Six Metres

I live in a crowded suburban area where the erection of masts and big beam antennas would definitely be frowned upon by the neighbours. With the up and coming spring DX season, I needed an antenna that could deliver good performance on the 'Magic Band' and have low visual impact. For the past couple of years, my simple rotatable dipole has antenna worked reasonably well, except the noise pick-up that came off the 'back' of the antenna.

I found the very attractive antenna designs based on **Fred Caton VK2ABQ**'s design which **Les Moxon G6XN** developed into the 2-element beam known as the Moxon Rectangle. Compared with a conventional two-element Yagi, the Moxon rectangle, **Fig. 1**, has a marginally lower forward gain, a better front-to-back ratio and smaller dimensions. The antenna described here provides a good match to 50Ω coaxial cable, should handle at least 100W and was built in a day with a total cost less than £25.

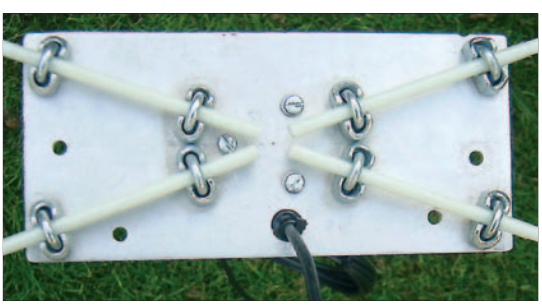
For simplicity, low cost and low visual impact, the wire antenna was designed for 50.15MHz, the centre of the DX end of the band. The wires are supported by four springy glass-fibre (g.r.p.) rods, their springiness keeps the wires in tension and so maintains the rectangular shape. With the minimum amount of the structure held aloft in the sky, weight and wind loading is also kept to a minimum.

I hit on the idea of using 1.5 metre long, 6mm diameter solid g.r.p. rods from cycle safety flags. They're cheap and once the dayglow orange plastic sheath has been carefully removed using a Stanley knife, are exactly what is needed. Carbon fibre rods, often used for kite stiffeners, should **not be used** as their electrical conductivity may affect the antenna pattern.

The assembled wire Moxon Rectangle for 50MHz on its stub-mast, about to be installed 10m up on the roof. Note the upward tensioning curve of the g.r.p. spreaders and the location of the feeder together with its six-turn choke balun. The whole assembly weighs about 1.5kg.

Aluminium Base Plate

Start by cutting the rectangular 3mm thick aluminium base plate. Accurately mark the centre and lines to be followed by the spreaders. The included angle between the spreader pairs is 43° on the narrow side of the plate. The main thing at this stage is to get this angle right so that the rods do not bend out of the vertical plane when the antenna wires are tensioned. Drill 4mm holes as shown for the clamp-down U-bolts.



Top view of the 200mm x 95mm x 3mm thick aluminium base plate. The all-important angle between the spreaders on each of the narrow sides of the beam is 43°. The 50Ω RG58 coaxial cable passes through a hole (+ grommet) in the plate, and is supported by a cable tie. The three bolts near the centre support the mast flange underneath.

The inner four are positioned 35mm and the outer four are 97mm from the centre. Three extra holes are also drilled around the centre of the mounting plate to take a flange for the support pole. In my case, I used a spare piece of 25mm diameter aluminium tube that was in the junk box. Using a hack-saw, the glass-fibre rods are each carefully cut to a length of 1200mm. Before cutting or drilling g.r.p., first wind pvc tape around the area to be cut.

To hold the wires in place, I drilled 2mm holes through the rods, 25mm from the outer ends. Drilling through the centre of the rods is eased by first filing a shallow flat on the rod's surface. Any rough edges around these holes should be removed with a needle file. The holes are just large enough to accept the Teflon-covered wire. Four 50mm lengths of plastic tubing are then heat-shrunk on the ends of the rods and the pre-drilled holes opened up. The heat-shrink is there to prevent any chafing of the wire and de-lamination of the rod.

The antenna wires are cut somewhat over-length to the dimensions given in Fig. 1 and then trimmed them down slightly during tests. A 'chocolate-block' connector is used to physically join the two driven-element wires (and later serves as the 50Ω coaxial cable feed-point connector). It's helpful to carefully measure and mark the positions on the wires where they will pass through the spreader rods. The two insulators were made from the clear plastic barrels of old ball-point pens, cut to 80mm, with 2mm diameter holes drilled through some 5mm in from the ends.

The antenna can now be assembled. Four pieces of heat-shrink tubing, about 80mm long, are slipped over the inner ends of the rods. These are there to spread the load of the U-bolts. The rods are then trial-clamped in position and rotated to align the holes at the far ends in the plane of the base plate. The inner ends of the rods should each be about 10mm from the centre of the plate. The U-bolts can now be tightened to grip the rods, do not to overtighten these clamps.

Flat Surface

With the assembly lying on a flat surface, the antenna wires are next fed through the four holes in the spreaders, following the layout of Fig. 1. One end of each of the plastic insulators is first attached to two free wire ends. The over length is stripped back 50mm and fed through the holes and the end is simply bent back and wound round itself to secure. By bringing together a wire and its corresponding insulator, it will then be possible to join them to complete the rectangle. Note that the spreaders will bend up slightly.

As the second insulator is joined to the wire, the spreaders will lift up to a final height of about 200–400mm, imparting full tension to the rectangle. During this part of the assembly the spreaders can either flip up or down. As every bit of antenna height counts, make sure they flip upwards! Carefully slide the wires through the holes at the ends of the spreaders to align with the reference marks made earlier.

Next you should check all the measurements accurately against the values given in Fig. 1. With accurate wire dimensions, the spreaders, if correctly positioned on the base plate, will simply lift up in the vertical plane, with no sideways twists. There is enough tension in the system to hold the wires securely with very little sag.

For feeder, I used RG-58 50Ω coaxial cable screwed directly into the feed connector. The joint is covered with a good layer of self-amalgamating tape to keep the weather out. The coaxial cable emerges from below a supporting hole drilled in the base plate with the feed point end being supported by the wire tension. For such a short cable span, this did not cause any significant feed point droop.

For heavier feed cables, it would be easy to include a g.r.p. stub support to carry the cable weight. In the cable run back to the shack, I wound a simple six-turn 150mm diameter choke balun just under the base plate. Held together with cable ties, the balun is more than adequate to remove any if from the outer conductor of the coaxial cable.

Trim To Optimise

I had to trim the dimensions to optimise the antenna at my location and I ended up with: A as 2063, B as 304, C as 70, D as 388 and E as 756mm. With these values the s.w.r. was 1:1 at 50.15MHz and the 2:1 s.w.r. bandwidth was more than adequate to cover the DX window portions of the 50MHz band. The computer generated beam pattern is shown in the illustration of **Fig. 2**.

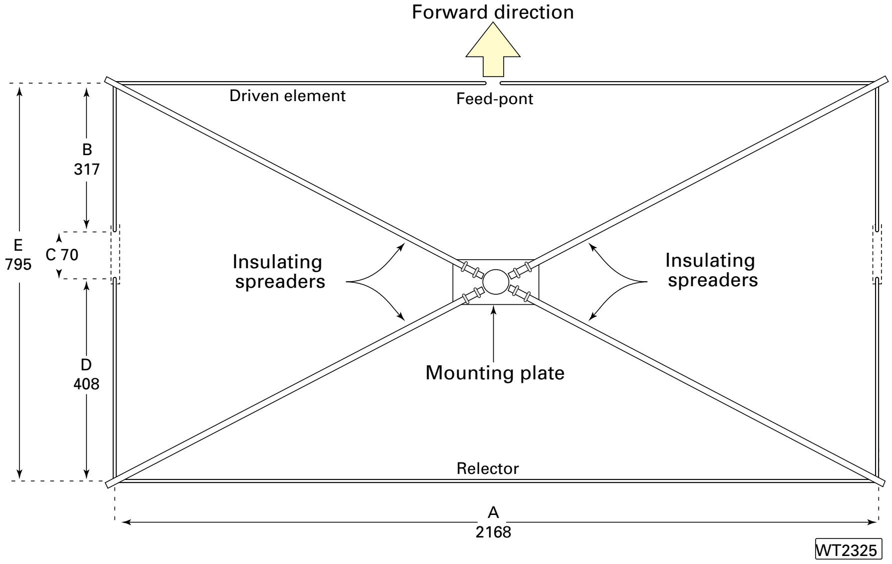


Fig. 1: Plan view of the wire Moxon Rectangle. At the chosen operational frequency of 50.15MHz, the computer model wire dimension may need tweaking to give matching at your location. (See text for my final values).

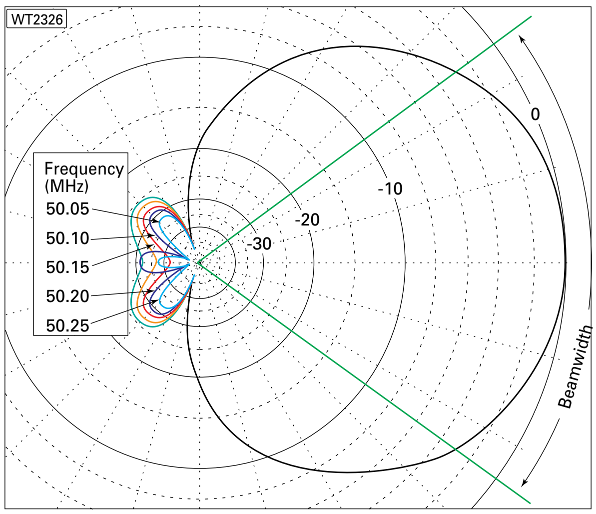


Fig. 2: A graphical representation of the free-space azimuth pattern of the 50MHz Moxon Rectangle. The range of frequencies is shown by the colour legend. The beamwidth at the -3dB points (marked lines) is 78.6°. See p.36 *PW* June 2003 for a description of the EZNEC model used to calculate this pattern.

Depending on a particular installation, you will probably also need to fine tune the lengths to obtain the correct resonance. For higher in the 50MHz band, the dimensions need to be reduced from the optimum values given above. You could use the on-line Moxon rectangle calculator‡ to scale the dimensions accordingly. Note that there is no need to re-drill the spreaders as they will automatically bend to the new dimensions.

For portable operation, you could use short metal tubes attached to the base plate to hold the rods. The longest part of the disassembled antenna structure would then be only 1.2m long. The spreaders could then be quickly inserted to assemble the antenna. For long-term fixed use, it would be a good idea to paint the g.r.p. poles with ultra-violet resistant boat paint to prevent any deterioration.

The antenna described here was first used during a Sporadic E opening to Europe in May 2003. Signals were coming in loudest with the antenna pointing broadly towards the european mainland. Rotating the antenna 180° away from this direction caused the signals to all but disappear into the noise, consistent with the expected large front-to-back ratio. On transmit, and using only 8W c.w. and s.s.b. power, I received excellent signal reports from stations as far away as the Ukraine (a new one for me!).

On reception, I found the Moxon Rectangle to be extremely quiet 'off the back' compared with the dipole. I had planned to include a photo of the erected beam on the roof of my house. However, owing to the designed-in low visual impact, the photo I took hardly showed the antenna at all! Let's hope my neighbours agree. **PW**

References:

HF Antennas for All Locations RSGB - Les Moxon G6XN p.197

Weblinks

www.cebik.com/moxpage.html
www.qsl.net/ac6la/moxgen.html