Increasing Side Suppression with Loop-Fed Directional Antennas

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Within this article we will look at the possibilities to increase Front to Side ratio (F/S) by the use of opposing-fed driven elements with loop Yagi and quad antennas.

In more recent times I have been experimenting with rigid quads having see the development of YU1XL on VHF/UHF using tubes rather than wires. It is long known that the larger diameter of the radiator, the higher any potential gain will be and potentially increase bandwidth too. With loop or quad style Yagis being generally able to deliver higher levels of gain (per metre of boom) than Yagi antennas, the combination of thicker elements on a loop directional array such as a quad could deliver excellent results if optimised correctly.

My experiments extended to utilising twin booms on the quad style antenna using one at the top of the elements and one at the bottom on a horizontally polarised array. Several benefits which includes higher gain per metre of boom (when parameters such as SWR bandwidth and Front to Back (F/B) are matched between the models) greater rigidity and wider beam width/gain combinations for any given length.

The next important parameter for me was optimisation of these quads ensuring a direct 50-Ω feed and no matching devices. The next step was to build a few to test which resulted in the installation of a short (53cms) 2el rigid quad at GØKSC this past summer and a scaled version for 4m also.

I have been very impressed with the performance. In addition to an incredible gain level for such a short boom (7.55dBi), the beam width is extremely wide meaning this gain is achieved over a very wide area and virtually no rotation of the antenna is ever needed during an opening. Pointing South East from GØKSC I have manged DL to EA8 with ease on 6m on the same afternoon or operation with good report levels. The next step for me was to increase the gain, maintain the beam width and if possible, reduce noise pick up form noise sources below and either side of the antenna.

Therefore, the next step was to stack a pair of these quads and measure the results. Two antennas stacked 4m apart gave good results in model with around 10.8dBi for the pair. Looking at the sizes of the loops and the distances for any coax to travel, I decided to mode with the quads being fed in different places in order to reduce coax feedline. The 6m quads have a height of 1.5m and therefore, if I fed the top quad at the bottom and bottom quad at the top, the feed points would be 1.5m closer together and thus requiring less feedline between the antennas and any power divider.

Comparing results showed a rather interesting by-product; a large increase in F/S. Below in **Fig 1** and **Fig 2**, the resulting azimuth plots of the two configurations are shown. With the antennas fed in the traditional way, F/S is around 32dB with F/B being 13.77dB and forward gain 10.79dBi. Switching the opposing feed positions results in; F/S infinite 99.99dB, F/B 13.83dB and forward gain 10.83dBi. Therefore, in addition to a rather useful increase of F/S, both F/B and forward gain have seen a marginal increase too.

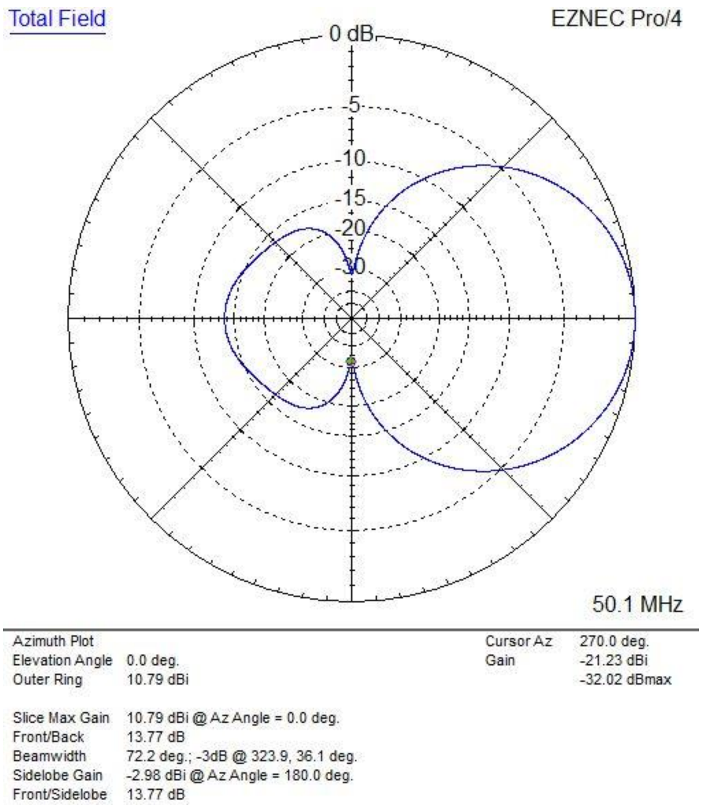


Fig 1 – 2 x 2el Quads stacked 4m apart and both fed at the bottom of the loop

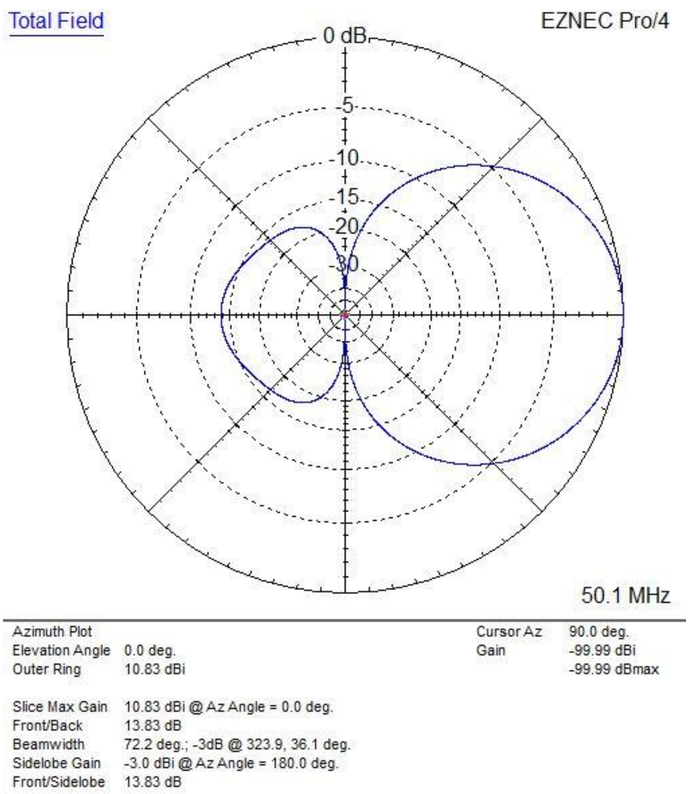


Fig2 – 2 x 2el Quads stacked 4m apart fed opposing sides of the loop

Fig 3 shows the layout of the stacked quads along with their respective feed points shown as a red circle on the driven elements. Note how much closer the feed points are and the reduction in feedline that will result.

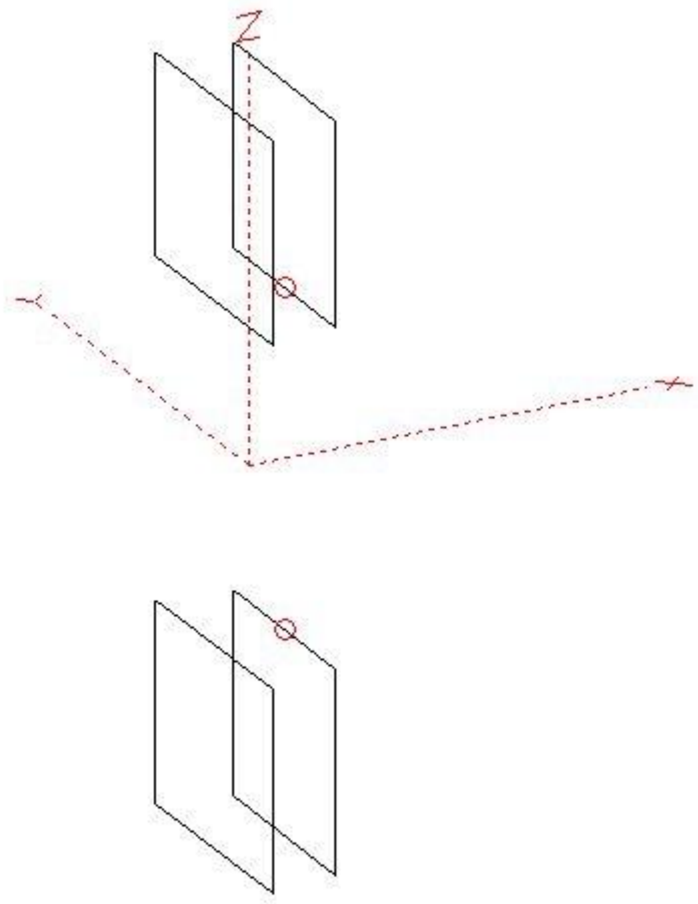


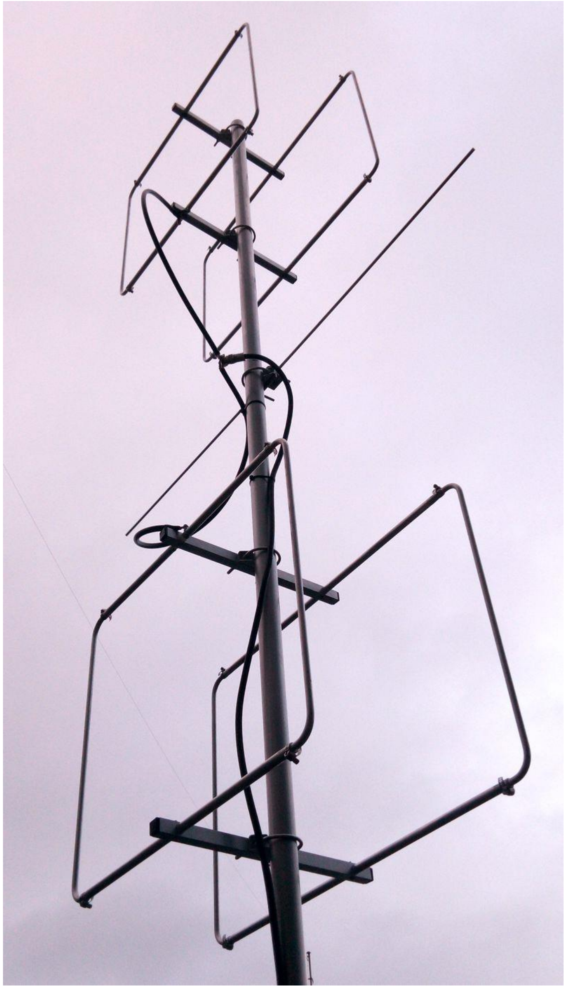
Fig3 – Layout of the 2 quads with feed point on opposing sides of the loop

One point of note with these quads is the lack of F/B. with a stacked pair, enhancement of both gain and F/B can be achieved by placement of a parasitic element between the stacked pair. In order to make building and testing a little simpler, I scaled these models to the 2m band.

In addition to the change of band, I wanted to conduct another stacking experiment. Often quads have bene optimised with a 110/112Ω feed point. With this arrangement, 1/4λ piece of 75Ω coax attached at the feed point, the opposite side of this line would present a 50Ω input.

One method of stacking a pair of 50Ω antennas is to use 2 x 75Ω coaxial lines too. In this case, odd 1/4λ multiples are needed. The problem with this is often, the distance required between antennas leads to the odd 1/4λ lengths being either too long or too short to suit. In this instance, the feed points are closer than usual to one another. If I were to re-optimise these quads for a 110Ω feed impedance, I would lose gain per metre of boom (generally the lower the input impedance of the antenna, the better the overall performance). However, I would be able to extend the distance between the 2 elements by just a few cms to regain performance on the basis this test has now moved to the 2m band.

Why go to this trouble? My intensions in this case were to reduce feed line length as much as possible while at the same time, simplifying the phasing/connecting of the two antennas at the same time. By having two quads with a 110Ω feed point that required a 1/4λ 75Ω length of coax to get to 50Ω and at the same time needing 2 x odd 1/4λ length of 75Ω coax connected to each antenna and to each other at the other end to present a 50Ω feed, 2 x 1/2λ lengths of 75Ω coax could be used to achieve the impedance matching requirement of each individual antenna along with providing the shortest possible 2 x 75Ω coax arrangement to stack the pair.



2 x 144MHz rigid Quads with parasitic element enhancement

The above photo shows the built quads for 144MHz. The parasitic elements length has been optimised too resulting in the rather impressive results below.

Stacking distance: 1.5m
Single antenna gain: 7.36dBi
Single antenna F/B: 22.19dB
Single antenna F/S: 26.12dB
Single antenna 3dB beamwidth: 72.6dB
Forward gain stacked pair: 11.01dBi (includes additional parasitic element between quads)
F/B stacked pair: 22.36dB
F/S stacked pair: 99.99dB
3dB beamwidth stacked pair: 72.2 degrees
SWR bandwidth stacked pair: 144MHz to 145MHz better than 1.1:1

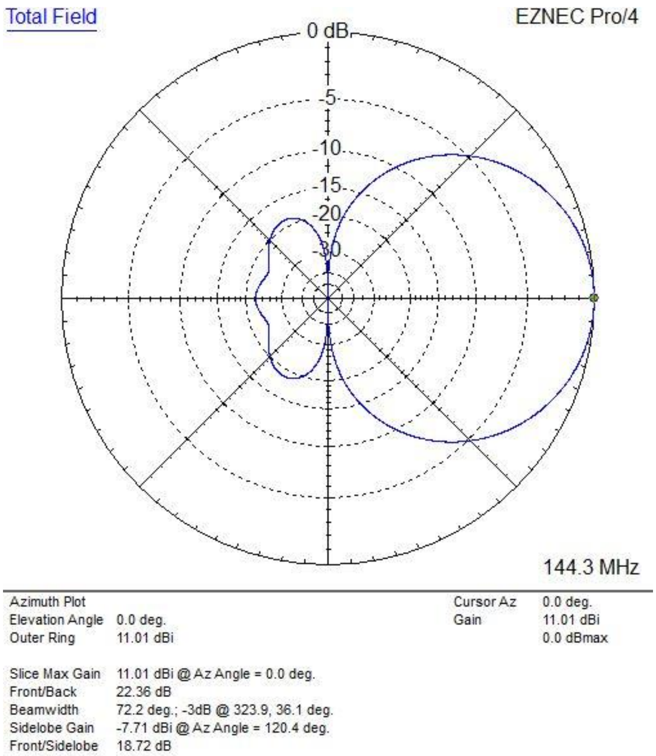


Fig 4 – Azimuth plot of the opposing fed stacked pair including additional parasitic element

Conclusion

The results speak for themselves, for VHF and even UHF bands where gain combined with beamwidth is advantageous, such an arrangement as the above could be most beneficial. With extreme F/S capabilities this as these, the array could be arranged to completely null out a particular loud noise source while still providing a beamwidth in excess of 72 degrees.

Perhaps a contest antenna? Multiple instances of this array could prove successful especially when continuing to stack vertically in multiple of 2 antennas plus parasitic.

The rigid quad has a wide range of benefits which can be used for various applications and perhaps with the opposing feed arrangement in a stacked configuration, its value proposition is increased especially where noise sources in certain directions hamper the ability to receive weak signals.