NEWSLETTER ARCHIVES

Antenna Jottings
by G3JKF

In Autumn 1994 I volunteered to give up my salt mine activities at MEL/Thorn EMI in favour of early retirement and my search for a congenial new QTH began.

I had been using a Mustang 3-element Tribander at 45 feet, supplemented by an 80m Inverted V dipole for 30 years or so at my QTH in Furnace Green and I hoped to achieve an equally effective antenna system at the new QTH. In Spring 1998 we finally settled on a bungalow at Seaford which offered me one large spare bedroom for a combined shack and computer room. A 100 foot long garden and 40 foot long loft provided good scope for aerial experimentation.

By Summer 1998 my deep-rooted antennas in Crawley had been dismantled and after several months delay we finally went QRT in November 1998 moving to a rather windier south coast location. The garden, on the slope of Blatchington Hill at a height of 180 feet ASL, offered a superb take-off to W and long path VK/ZL with a clear path, through houses, down to the sea less than a mile away.

I had seen a few tower-mounted Tribanders in Seaford so assumed that planning permission would be readily forthcoming for any similar installation. Being surrounded by bungalows, and spotting some limiting covenants in my Property Deeds, I decided to start with a low profile beam for 20m and extend it when the locals were used to the idea. Initial conversations with my immediate neighbours showed that they would be fairly happy with contraptions in the garden but I was sure that with ridge tiles at only 19 feet any conventional HF Yagi antennas would stick out like a sore thumb above the roof tops and cause raised eyebrows all round.

Our first year was spent settling in and doing essential works on the house, and during this period I concentrated on design, using the EZNEC Antenna Modelling software, of a switchable 5-element vertical beam array for 20m. I finally came up with 23 feet high, top and bottom loaded verticals, arranged as a centre driven half wave element, surrounded by a square of 4 parasitic verticals at a spacing of 16 feet from the centre, relay-switchable as directors, reflectors or side reflectors. EZNEC indicated that this antenna would provide useful gain and directivity at low elevation angles with 8 selectable directions, plus an omnidirectional mode. Just the job for DX!

During the late Summer of 1999 I constructed the elements and switching boxes, using Metapost fence hardware to mount the elements on 9 feet high wooden fence posts to allow easy demounting for adjustment purposes. This lot was erected in November 1999 to check out the mechanical construction and looked reasonable except for the combined guys and top-loading wires, and associated egg insulators, which even I was forced to admit looked like a huge spiders web in the sky. Within 24 hours, alerted by a neighbour 60 yards away, a Planning Officer from Lewes was knocking on the door to warn me that planning permission was needed for the antenna, and further, that I was most unlikely to get it anyway due to loss of visual amenity! I temporarily demounted the structure and investigated my options. The best compromise seemed to be to lose the guys and wire top loads, by reducing the height to 19 feet and using thin wire top radials. This modelled as a fairly good antenna but with a higher vertical angle of radiation and lower gain.

We were now into the Winter so I decided to concentrate on experiments with indoor antennas using the generous dimensions of the 1973-built floored loft. Again EZNEC was used to investigate a 3-element array of verticals and after much optimisation I wound up with three 8 foot nearly-vertical wire elements spaced 16 feet apart and heavily end-loaded to keep the current maximum in the centre of each short vertical radiator.

EZNEC predicted that the parasitic array could readily be switched to fire East or West but tuning would be critical with a high Q giving a narrow SWR bandwidth. I therefore resurrected an old home brewed motorised Antenna Tuner with two

servo-controlled capacitors and a roller coaster. Surprisingly this unit still worked correctly after a 20 year sojourn in the Crawley loft, and I rebuilt it into three separate capacitors, one per vertical, to provide variable tuning on 20m.
I also pulled out of retirement an Antenna Bug which I had last used in 1980 to develop a Vector Processor System for enhancement and control of Yagi antenna reception directivity patterns. After replacement of one tantalum capacitor this unit also functioned correctly and I was delighted to hear it radiating reference signals into a vertical antenna from the end of the garden, at 5 remotely controllable frequencies within each of the 7, 14, 21 and 28MHz bands. Although located well into the near field of any antenna it provides excellent signals for measuring relative gain and front-to-back ratio of various aerial configurations.

The weeks of modelling and servo modification were followed by a few days work in the relatively warm loft to produce the antenna, held up with a multitude of nails and much string. The servos allowed the antenna elements to be tuned over a wide band so finding 20m was easy. It was rapidly apparent that the widely-spaced parasitic wire elements produced a much lower front-to-back ratio than the model suggested, giving only 2dB instead of the 12-14dB expected. Also the tuning was much flatter than EZNEC predicted.

The aerial pulled in VK, ZL and W nicely, and a few DX QSOs were achieved with 100Watts from the FT902DM. After a few days I bit the bullet and switched on the 400W Linear. I immediately got R5 S9 from a VK6 who alerted Alan and Ron VK6PG and VK6RV, and we had a quick SSB QSO before the band dropped out.

Although I intended to use a Vector Processor to improve the received signal/QRM performance I wanted to improve the basic gain and directivity of the array so I converted it into 3 driven elements with 0, 90 and 180 degree phasing to match the quarter wave spacing. Measurements with the Bug showed that the gain was similar to the parasitic arrangement but that front-to-back ratios up to 30dB were readily achievable by careful tuning of the servo capacitors. This array enabled me to work about 50 W's in the year 2000 ARRL SSB and CW contests. Later I was heard by Bryce ZL1ABB (ex-CARC G3UOV) on CW at RST 539 whilst using 400W. He was using a trap dipole and I heard nothing from his 100W at that time though I later got him at RST 559 when his VK2ABQ beam was in use.
I introduced ferrite rod baluns at each element, and another in the shack to allow West to East switching, and followed this by progressively removing the servo-capacitors one at a time, adjusting each element for resonance by changing the capacitive end loadings. The final antenna provided a low VSWR over a large chunk of 20m, although the matching of the outer elements themselves is far from optimum, and it has allowed me to work both Eu and DX with ease. Front-to-back ratio has not been optimised so it offers only 6 to 12dB over the band at present. Naturally working DX has been harder during the Summer when the indoor antenna performance shows as being well down on that of big, high external beam antennas.

Up to the time of the CARC Dinner in May 2000 my plans were to refine the design of the array, improve the matching and verify the performance over a long period. Then I had a chat with Mike Underhill and Stewart Bryant who extolled the virtues of small loop aerials. These had been convincingly demonstrated at the CARC Meeting that week and the notion of getting an efficient multiband antenna in my loft suddenly became very appealing.

I already had the servo-controlled capacitors needed for loop tuning, and all the kit needed to allow low-power experimentation, and the Antenna Bug would permit some useful gain comparisons to be made. Further I was anxious to check the feasibility of using two or three loops to provide not only gain but directivity against European QRM on 20 metres.

A rapid visit to B&Q procured several 2m lengths of 22mm copper tubing, and the associated accessories for producing octagonal or square loops. I also read up on small loops in the various radio amateur handbooks, and at the antennex.com internet site. I had already bought the $50 antennex CDROM covering all previous articles, so I perused this source at length. Finally $12.95 bought a download of the Loop Book from antennex.com and this can be used as a complete data source for all small loop experimentation.

In the June/July period I assembled and erected three 5ft x 5ft gamma- matched vertical square loops in place of the earlier wire verticals, and these were fed with the original feeders. The loops could be resonated to 7, 10, or 14MHz by the servo controlled ex-T1154 split stator variable capacitors and unity SWR easily achieved for individual loops. Tuning was incredibly sharp on 20m, per the book, and even sharper on 7 MHz. The response was more like an old-fashioned crystal filter. My servo control was inadequately precise to give easy tuning with repeatability so one early prospective task was to build new simpler servo-amplifiers and not have the complication of digital position memories available in the existing Control Unit. The present capacitors did not flash over at 100Watts of RF but would not take 400Watts so big motorised wide spaced variable capacitors made of single-sided epoxy PCB material were considered as a later development.

On-air low power QSOs around Europe were made on 20m and 40m, and 5H3 was worked on CW on 40m. A PY2 on 40m CW was heard at 20dB over S9 in a contest! DX conditions on 20m were poor during the Summer so I concentrated on getting the aerial finished for the Autumn. Both on-air and local measurements with 2 loops showed that very useful directivity patterns could be obtained, but with very critical tuning, as would be expected. Patterns with three loops had not been checked at this stage. The next addition was to be radials below each loop to improve the efficiency and gain, and reduce the Q to make tuning less critical.

Initial results indicate that these loops hold great promise for providing very effective small multiband aerials, provided they are properly built to minimise losses, and I look forward to reporting improved results as the above changes are implemented. If, at the end of the day, I am able to put out a big signal on multiple bands, without bothering the planning officials, I will be a very happy bunny indeed. Incidentally I have not yet attempted to model small loops on EZNEC. Primarily this is because there is a already a good base of practical and theoretical knowledge available, and the size/attributes of the loops, including the servo-controlled variables, enable a large amount of practical experimentation ground to be covered rapidly. So modelling will come later, hopefully to verify practical results that have already been achieved!

Although the efficiency and effectiveness of an indoor antenna can be expected to be inferior to its outdoor cousin, being able to continue experimentation in the relative warmth of the loft in all weathers, and day or night has been a real bonus. It is also possible to use very simple construction and cheap materials since no weather proofing is necessary. This is particularly valuable when building servo-controlled capacitors.

This article was originally written in June/July 2000 and more recent work and current plans will be detailed in a future article. In summary at December 2000 the loop antenna system now uses three octagonal loops each 20 ft in circumference. Copper tubing radials have been fitted below each loop together with a 40ft x 12ft chicken wire netting ground plane.
The tuning has been modified to provide Narrowband tuning. Each element NBC allows 550kHz of the 20m band to be covered giving non-critical tuning, and the Centre loop now also includes broadband servo tuning with 2-plate capacitors made of PCB material and tuning from 3.4 to 15MHz. A cheap B&Q cordless screwdriver provides the essential motor/gearbox shaft drive to rotate a threaded rod coupled to the moving plate. The dual Narrowband and Broadband tuning arrangement gives a 400W power capability on all bands covered.

On 14MHz an array gain of 3 to 3.5dB has been measured against a single octagonal loop. A front-to-back ratio of 12dB with quick casual tuning is readily obtained, improving to 16dB with careful tuning using loop SWRs as tuning indicators on the MFJ Antenna Analyser. Using the Antenna Bug as a source the array can be tuned to give 25dB front-to-back. Direction switching uses a toggle switch to reverse the phase of the East and West feeder currents.

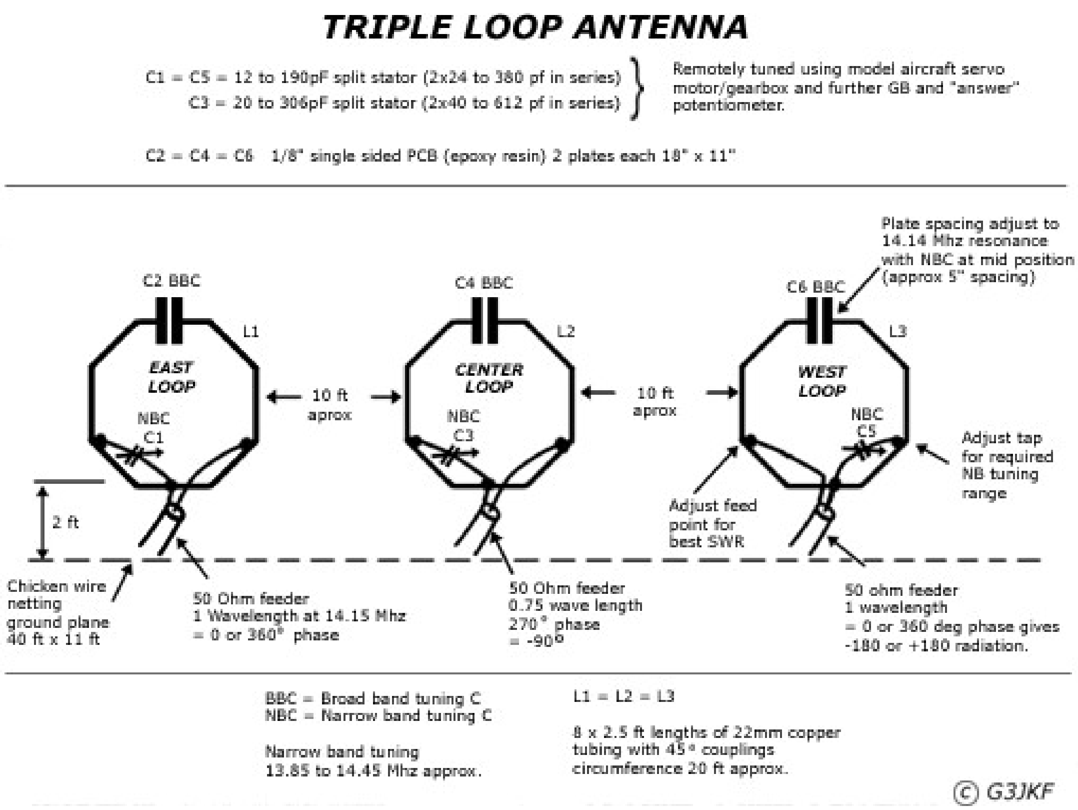
At present the array SWR on 14MHz can be tuned to give between 1.0:1 and 1.5:1 anywhere in the band, depending on the switched direction, with each loop feeder being much better than 2.0:1. SWR of the single centre loop on 3.5, 7.0 and 10MHz varies between 1.0:1 and 1.8:1 at present.

On-air good DX and European QSOs are readily achievable on 20m with 100W of CW and SSB and coverage is good to both North and South, whilst switching the primary East and West directions. It is quite apparent that the indoor antenna system is a couple of S points down on a conventional outdoor beam but considering that its maximum height is only 18ft in a radio-unfriendly environment, and it is firing through the roofs of several bungalows the performance is remarkably good and provides more than enough motivation to continue the project.

Immediate plans are to measure the array characteristics more accurately then move the 20ft Centre loop to the East position, and fit 8.5ft circumference loops in the Centre and West positions, with variable broadband tuning. If this configuration still provides good 20m performance it offers scope for coverage of all bands 80 to 10 metres with either a single loop, or double or triple loop array operation.

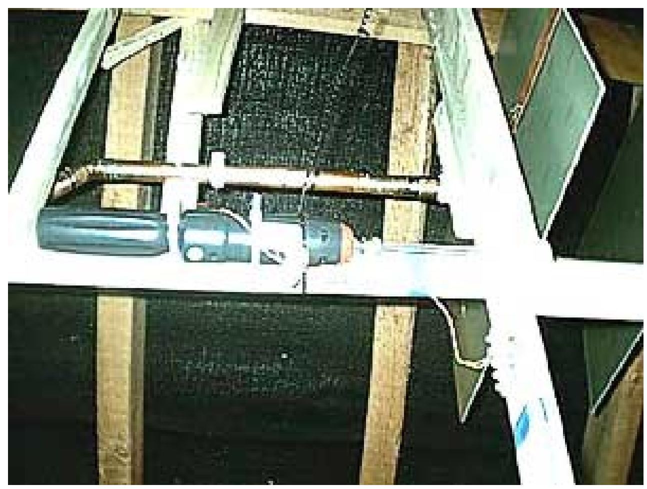
I am currently fitting a broadband tuner to the East Loop using another B&Q screwdriver but moving it physically down to groundplane level to get it out of the immediate loop induction field! On the present Centre Loop about 2A is induced into the motor wires at 400W RF representing yet more losses!

When the project has been completed it will be written up in detail for publication. Anyone with questions or interested in earlier information is invited to email me at g3jkf@onetel.net.uk. I hope the attached photographs and diagrams clarify the general characteristics of the current build standard.

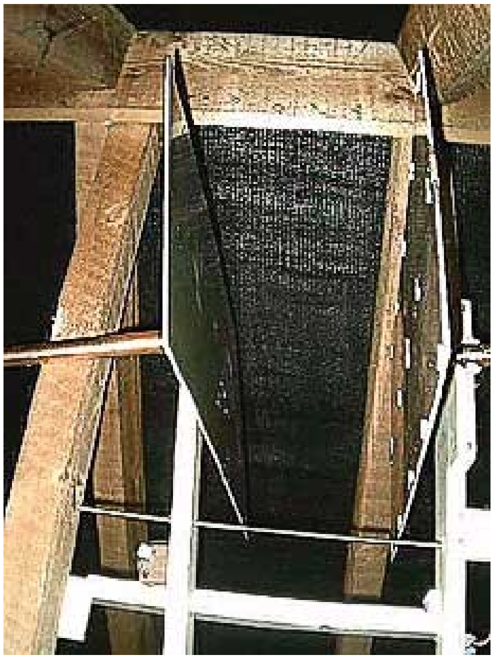


General view of Centre Loop situated 2 feet from the cold water tank (not metal!), in the centre of the 40 ft long bungalow attic cluttered with 50 years worth of radio amateur junk.

Shows the Centre Loop broadband tuning system. A B&Q £5 cordless screwdriver wired down to the shack drives a wooden arm to move one plate over a 3/16" to 6" spacing from the other fixed plate. Plates are shown at maximum spacing (20m tuning position) and are soldered to the extremities of the copper pipe loop.



Another view of the plates at maximum spacing, viewed from the opposite side to loop3.jpg, and showing the 1/4" dia studding rotated the screwdriver (motor-gearbox) which moves the LHS wooden arm. The white attachments to the face of the RHS plate are glued-on pieces of teflon to define the minimum spacing at 3/16".



A view of the broadband tuning plates near to minimum spacing (80m tuning). The moving plate moves in an arc away from the fixed plate rotating up and away via a rotating joint in the copper piping at 3'9" from the plate.

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