RADCOM CONSTRUCTION FEATURE

Double Delta for 80m DX

by Tony Preedy, A45ZZ

FEW AMATEURS HAVE the opportunity to construct an effective beam for the 3.5MHz band, but this design may help you to join the lucky few. The most consistent DX signals which I used to hear on the HF end of the band were those using beams of the Yagi type or multiple monopoles. Initially I got plenty of contacts on the strength of the A4 callsign using an inverted-vee dipole but reports were never very encouraging until I built the antenna illustrated in **Fig 1**. Afterwards I could compete with the best and soon had over 100 countries on 80m. Working the grey-line long path to the West coast USA has almost become a daily event between October and April.

PRINCIPLES OF OPERATION

FOUR DIFFERENT radiation patterns can be obtained from this antenna using a double-pole four position switch (see **Fig 2**) at the operating position. An almost omnidirectional pattern is formed by driving a single loop. The feeder of the second loop is then left unterminated but for some feeder lengths it may be better to short circuit the second feeder. The object is to obtain minimal current in the second loop by avoiding a near resonant condition in this omnidirectional mode. The same pattern can be obtained by driving both loops in phase but this would complicate the switching.

The next mode is a figure-of-eight pattern obtained by driving both loops, out of phase. Because one feeder is twisted relative to the other the loops automatically have currents 180° out of phase when the driven ends are connected in parallel. In this condition horizontally polarised radiation, which could deform the pattern, is minimal because in all planes the significant horizontal components between loops and between sides of loops cancel leaving only vertical polarisation (**Fig 3**). In the unidirectional modes only the horizontal components within each loop cancel, incidentally.

The next two modes are the unidirectional patterns formed by driving one loop and terminating the feeder of the second loop with a reactance which makes the second loop function as a reflector.

CONSTRUCTION DETAILS

FIG 1 SHOWS THE general arrangement of my antenna which is essentially two delta loops insulated from each other. they are suspended from a single mast and connected via independent feeders to the radio through a control unit and tuner. This provides a choice of four radiation patterns which in theory should look like those in **Fig 4**.

In most parts of the world the best 80m DX will be worked via the grey line paths so if possible arrange the longest dimension to run east-west. This will put both morning and evening paths close to the direction of maximum gain (north and south). The switch in the control unit needs to be adequately insulated and should be a ceramic type if possible.

The reflector tuning reactance will depend on the type and length of feeder. Whatever the value at the tuner (ATU), that at the loop will be an inductive reactance of about 100Ω. For example if 75Ω cable is used and the length is electrically a quarter-wave a capacitor of about 400pF will be needed. Initially try using a series L C circuit which is known to resonate at 3.8MHz. Use a variable capacitor and note which way you have to change capacitance when adjusting for minimum back radiation (see later). If it is increased above the capacitance necessary for resonance you will require an inductor in the final arrangement.

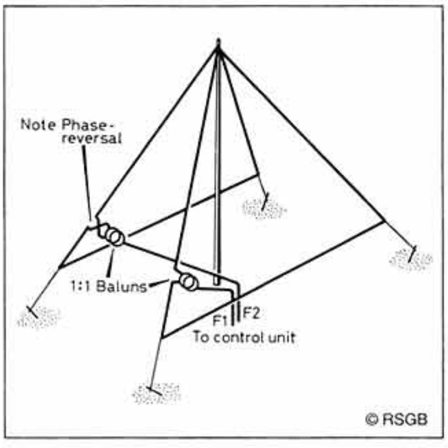

Fig 1: The Double Delta 80m antenna. Two feed lines determine the directional characteristics.

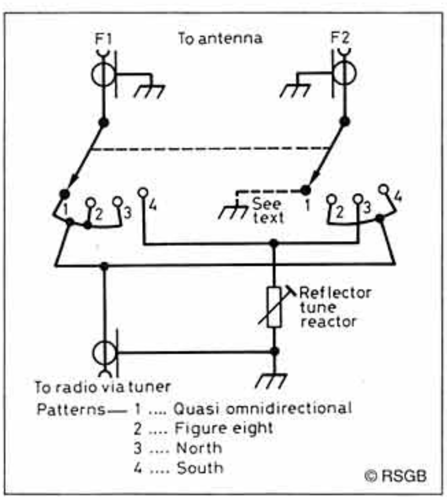

Fig 2: Four different radiation patterns are available from the switched ATU.

LOOP CONFIGURATIONS

BOTH LOOPS ARE identical so they can be interchanged between driven and reflector functions without retuning and also to allow a single reactance to be used to tune either loop as reflector. I did not bother to make the loops exactly resonant, only to make them the same length, because a tuner is always used to obtain unity VSWR at the transmitter.

The type of wire is not critical, bell wire will do, but the ideal material is miniature coaxial cable with a steel core such as UR95. This has the advantage of thickness, for low RF resistance, light weight and minimal stretch under tension. The feeder can be either 50 or 75Ω coaxial cable but it is important to use some form of choke to prevent RF from returning on the outer conductor. A proprietary sleeve balun or a coil of feeder on a ferrite rod is effective. The feeders should be of identical length and of the same type of cable but actual length is not important.

To support the loops I used two separate pulleys and halyards. Alternatively, it would be possible to use a single system and have short insulating lengths of rope fixed to the loop apexes to clear the mast and stays. This does waste valuable mast height, however.

Geometry of the assembly is shown in **Fig 5**. You will need to draw this out to scale if you are not familiar with Pythagoras and you want to adapt the design for another band. If a metal mast is used it must be insulated at the base to minimise current induced from the loops and any stays must also be insulated if the pattern of radiation is not to be corrupted.

At first, the height of mast required to support an equilateral loop one wavelength circumference is daunting but, as Fig 5 shows, this reduces when allowance is made for the loops sloping in two planes. An apex as low as 18m can be used, if the base is extended in order to maintain one wavelength loops. There is no significant performance loss.

WILL IT FIT MY PLOT?

MECHANICAL SIMPLICITY is the big advantage of my antenna – just one mast and some wire plus a simple control system. The only

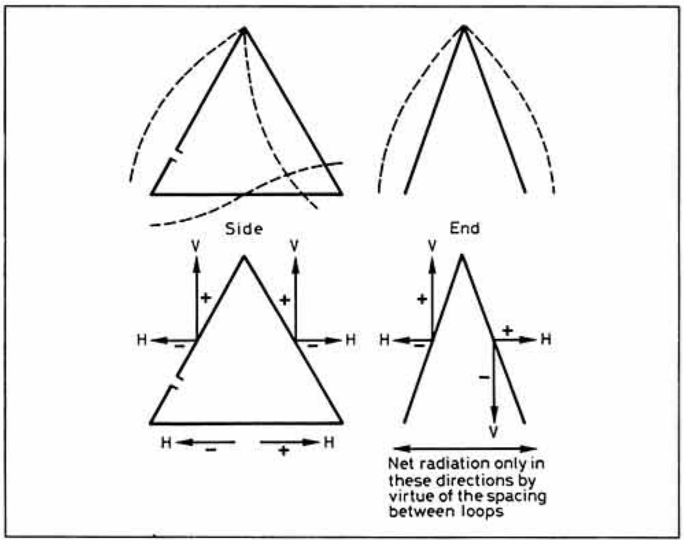

Fig 3; Spacing between the loops and the sides of loops affects polarization as shown.

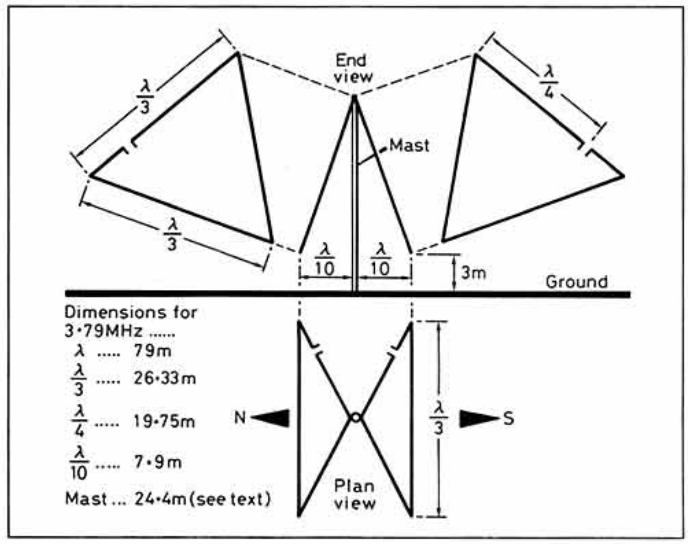

Fig 5: For a loop with a centre frequency of 3.6MHz dimensions should be multiplied by 1.055.

real snag is the space required over the ground. However this is probably no greater than that required for stays supporting an 80m Yagi and certainly less than that required for a phased array of comparable performance. By placing the mast on top of my flat-roofed bungalow and arranging for the loops to terminate on opposite sides it becomes quite manageable.

The minimum space required is a third of a wavelength by a fifth of a wavelength with a short pole at each corner of the rectangle. Alternatively, the four corners can be pulled out to ground spikes or, as in my situation, to large stones if more space is available. The height of the base of each loop is not very important, but 3m is a safe height to avoid contact with people or vehicles.

By mounting the mast on the house and using thin wire you possibly reduce local authority planning problems, but there will probably be a certain incompatibility with the TV. I can transmit, even with a linear, without TVI but I can't hear much with the TV working because of radiation from the TV sitting inside the array.

PERFORMANCE COMPARISONS

A VERTICAL TRIANGULAR loop fed one quarter wavelength from the apex is electrically similar to a pair of quarter wave monopoles spaced a quarter-wave apart and driven in phase. This combination has a gain of about 2dB over a single monopole. A second identical loop suitably spaced from the first and tuned as a reflector forms the equivalent of a four mast array. I measured 4dB gain for two loops compared with a single one. Total gain over a monopole is therefore about 6dB.

This will not equal the performance of a three element Yagi at optimum height unless you are over sea water, but it will be a better antenna than most of the competition will be using. In practice, the various modes provide flexibility in fighting QRM. I obtain a front to back ratio of 30dB or more for local stations, and when listening to DX signals arriving via the ionosphere the front to back ratio is seldom less than 10dB.

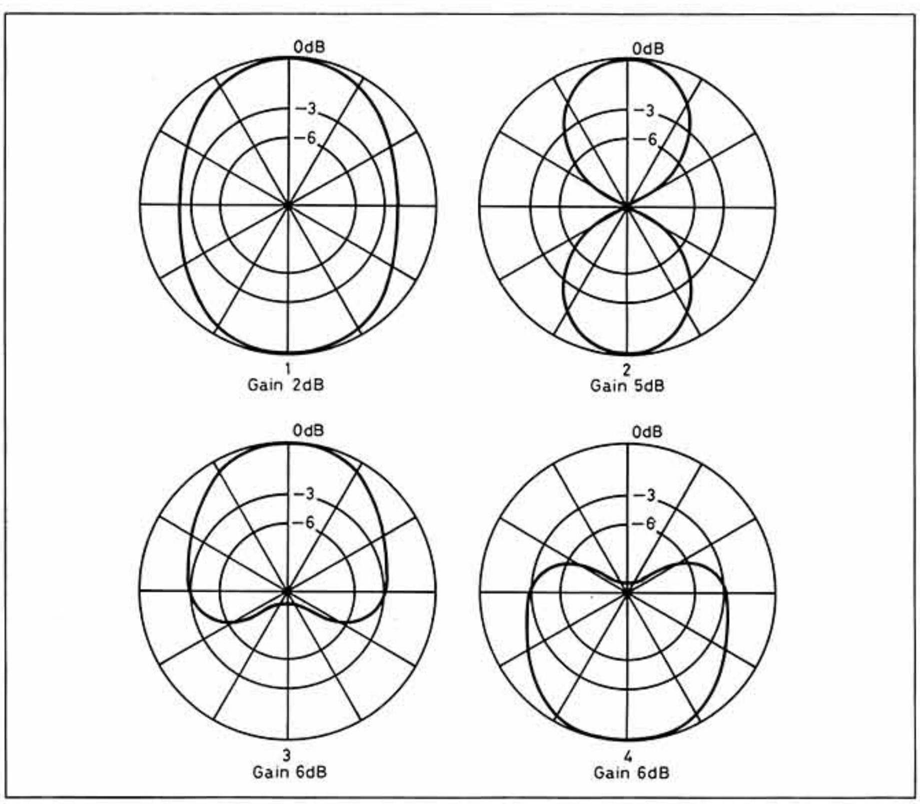

Fig 4: Theoretical radiation patterns for each of the four antenna configurations.

ADJUSTMENTS AND TUNING

TO TUNE THE REFLECTOR, I used a very low power 3.79MHz oscillator, powered by a battery. This was connected to a few metres of wire and hung from a tree about two wavelengths behind the array. The reflector reactance was then adjusted for minimum signal strength on the receiver. After obtaining the optimum tune point, I replaced my series tuned circuit with a single component which in my case was just a piece of wire! This just happened because my feeders were 80ft pieces of low-loss semi-airspaced 75Ω TV cable and the loops were just the right length.

I seldom work CW so my antenna is adjusted to perform best around 3.79MHz. If I go below about 3.60MHz the reflector turns into a director and the pattern reverses. This is a bonus I had not really anticipated, but occurs because directivity is only achieveable over a narrow band.

TUNING AND EARTHING

IT SHOULD NOT BE necessary to reset the tuner when switching between the unidirectional modes, but this may be required when changing from these modes to the omnidirectional pattern. When selecting the bidirectional pattern for maximum side rejection, it will almost certainly be necessary to retune. This is because this mode has quite a narrow bandwidth. In fact it is best to fine-tune the antenna in this mode. Make equal changes to the length of both loops and then optimise the reflector tuning.

Normally, one does not expect to use a ground system with delta loops but since writing the description of the Double Delta I had many requests for QSOs on 160m from A4 (Oman) and needed a good ground system for this band.

After a lot of testing of antennas and ground systems for optimum efficiency with the help of Bob, A45XF, we ended up with an inverted-L hung within the loops from the common mast.

The ground system used almost one thousand metres of 18SWG enamelled wire in the form of radials with their hub at the mast. These run over the house, down to the ground then over the ground out as far as 40 metres from the mast.

Interestingly, this had a beneficial influence on the loops, resulting in a back to front ratio of 18dB on 80m long distance signals. Another bonus was the screening effect which the radials had on the reverse TVI. If we ever need to, we can now watch television and operate on the amateur bands at the same time!

OPERATION ON OTHER BANDS

THIS DESIGN SHOULD be adaptable to operate on either the 7MHz or 10MHz bands by scaling the dimensions. However, when operating above 10MHz it is usually easier to obtain directivity and gain from more conventional antennas.

COMPONENTS LIST

Insulated wire	160 metres of 16 x 0.2mm RS Components (Electromail) No 356-505. Alternatively, 1mm enamelled copper wire could be used.
Coaxial cable	50 metres of 75Ω type CT100, RS Components No 388-782
Self amalgamating tape	1 roll eg RS type 512 317
Switch	2 pole, 4 way heavy duty, eg RS type 327-585
Ferrite Rod	Two required eg Maplin code YG22Y
Insulators	Eight, ribbed polythene eg Moseley
Inductor wire	One reel 16SWG TCW RS type 355-041
Housing for switch	eg RS type 509-709
Variable capacitor	500pF air-spaced type
40mm diameter former for inductor	
PL259 connectors as required	

NEXT MONTH

RSGB 'Codeless Licence Survey' Report