Zig-Zag Log Periodic

Derek Bundey G3JQQ describes a cheap, compact, wide band antenna covering the 14-28MHz bands.

I first came into contact with log periodic array antennas (l.p.a.) professionally in the mid-1960s. This type of antenna offers, in transmitting terms, the convenience of small v.s.w.r. excursion over several octaves of frequency range. Although the actual v.s.w.r variation does depend on the constants chosen when creating the design.

On reception, an l.p.a. offers useful forward gain and front-to-back ratio, though these parameters are not as good as those of a rhombic antenna. However, the l.p.a. uses less real estate than a rhombic, which is likely to be of greater consideration for most readers.

Multi-Band Coverage

For Amateur applications the main advantage of the l.p.a. is its multi-band coverage, especially on the h.f. bands. Though this is tempered with the need still for a fair amount of space. The other consideration is that only part of the antenna is in use at any one time.

However, if some sacrifice in forward gain and a range of s.w.r. variation is acceptable, it's possible to create a compact design that is small enough to fit into an average garden. The design presented here will achieve that and has an s.w.r. swing of up to 3:1.

The two most significant design constants are the relative spacing, designated by the Greek character σ {sigma} and the geometric constant, the Greek letter τ (tau). I chose a σ factor of 0.06 and a τ of 0.8 for this design, parameters that give an maximum antenna width of 10.36m.

Design Criteria

I won't go deeply into the design criteria, but choosing design constants to reduce the array length has resulted in a reduction of forward gain of around 1.5dB (down to 4.5dB theoretical). There is a very good explanatory chapter on l.p.a. antennas in the *ARRL Antenna Book* and it should be consulted if you are looking for more information about the antenna.

The antenna has five elements within its 3.96m array length, to give a theoretical forward gain of 4.5dBd over the bands 14-30MHz, with a front-to-back ratio that's between 10-20dB over the range. I have since confirmed the front-to-back ratio on DX signals by using two similar antenna mounted pointing in opposite directions.

The basic design may be implemented in various ways, a popular version being a wire dipole form. But this does require a rather more complicated centre feedline, and spacer system with alternate elements transposed.

For this project, I've employed the simpler Zig-Zag configuration, **Fig. 1**, where each

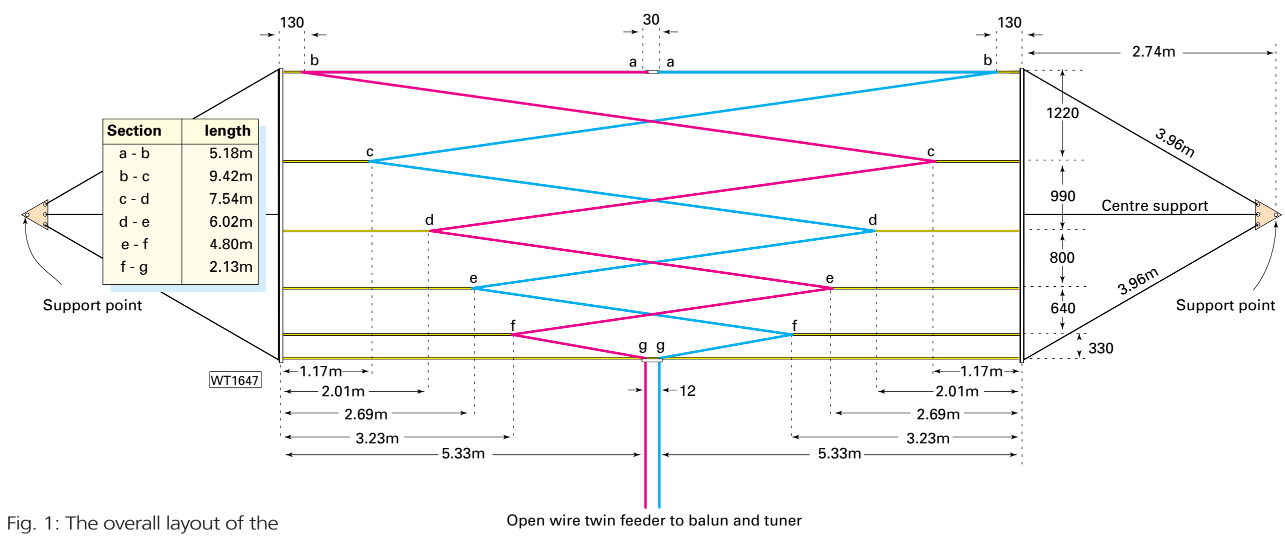

Fig. 1: The overall layout of the Zig-Zag log periodic array.

element is fed from the end. The feeder line carries on to become the elements themselves, resulting in an antenna/feeder arrangement combination free of joints or terminations right down to the balun itself.

More Wire

Although the Zig-Zag arrangement uses more wire than that required for a conventional l.p.a. it benefits from simplicity and the lack of troublesome joints. I use *ptfe* covered silver-plated stranded wire (an extravagance made possible by a visit to the Longleat rally some time ago), but pvc covered stranded wire, of almost any size, may be used to good effect.

The finished antenna could be hung from a non-metallic catenary if three elevated points are available. Alternatively, and this is my preferred method, it may be suspended from two 10mm diameter aluminium tubes to the sides of the array.

Of course you could use other material other than aluminium if it's available. But I've found that the lightweight strength of the tubing, when augmented with a three-point suspension method as shown, holds the array in good shape.

The various feedline and rear element central spacers are made from the lightweight plastic material often used for soffit boards. A friendly builder is the ideal place to start for offcuts to make up the pieces at minimum cost.

An alternative material for the spacers is Perspex, although it does degrade in sunlight over time. I've not tried sections of the grey plastic water pipe, available from builders, but using a little ingenuity you can keep the costs down easily.

The Construction

Now let me turn to the construction of the antenna array, which is best carried out on a large flat space. To minimise problems, I would suggest banning from the area, all household members, friends and pets, unless they are helping directly in the job. I'll deal with the construction in a series of steps, as I feel this technique has much to offer in ensuring success.

Step one:

Measure or estimate the length of the extra wire that will become the twin wire open feeder. This length is added to the overall length of each half antenna array element. As the length needed for array is a little over 35m the lengths involved can be quite long. Accurately measure off the total length needed for each element (perhaps adding a little more to cover errors) and coil each wire onto a separate drum or large cardboard box.

Step two:

Prepare the two suspension tubes by marking the various support points on each tube with a marker pen. I used the rear end as the reference point, but start from one end only when measuring and marking. Tie each string onto its correct point leaving enough free to tie and adjust the lines when completed. Attach the low frequency centre insulator to the ends of the two wires on the drums.

Step three:

Start by carefully measuring the wire forming the rear element and bind a small loop of wire to form the suspension point at the outer end of the element. If possible ask someone else to verify the measurement before making the loop.

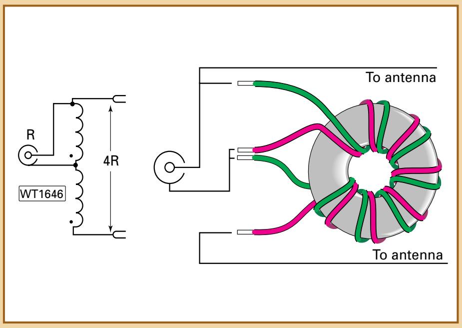

Fig. 2: A typical ferrite cored balun with seven bilfilliar wound turns gives a 4:1 impedance set-up when used in this format.

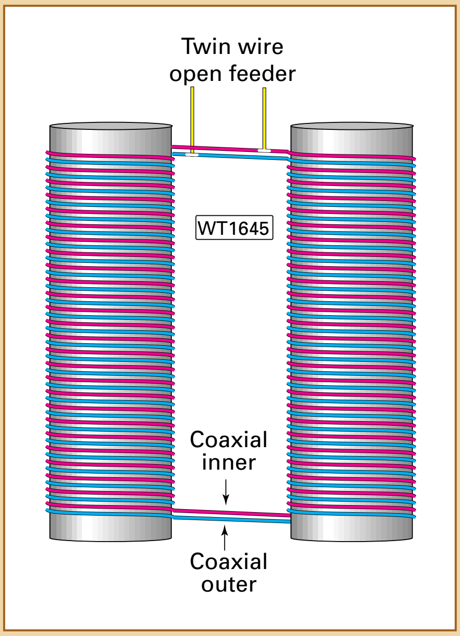

Fig. 3: An alternative balun with two windings of 26 turns wound side-by-side on 30mm diameter plastic waterpipe. The two formers should be separated by about 30mm.

Step four:

Measure the length of the next element forward and make another loop for its suspension point. Again try to have the measurement verified before any action is taken.

Step five:

Repeat step four on each of the smaller elements until you arrive at the feed-point position. Place the drum or cardboard box on the ground. Now repeat steps three to five for the mirror image of the array.

Step six:

Add in the centre support insulator and tie each antenna half to it. Loosely tie each suspension point onto its support line, and suspend the whole antenna at a comfortable height to trim and fix the various lines for equal and even tension in them. Add in the centre support insulators if you are going to use them. Tied in place, they help to keep the antenna in shape, rather better than just simply allowing the wires to float around.

Step seven:

This step is to form the twin wire open feeder from pre-cut plastic spacers to give a wire to wire spacing of 12mm or so. Put spacers about every 300mm along the wires. The end of each slot was sealed using a gas powered soldering iron on medium heat. **DO NOT breath in the fumes**!

Opposite Directions

I actually use two of these antenna mounted, at a height of around six metres, pointing in opposite directions but slightly offset from one another. Each antenna has its own balun, which may be air or ferrite cored, and can be quite near the shack. The pair are fed from a changeover switch mounted in the coaxial cable feeder running back to the shack, the whole arrangement can be quite efficient.

The balun used, **Fig. 2**, should have a nominal step up ratio of 4:1 and may be either seven turns bilfilliar wound on a suitable ferrite toroidal core. Or it could also be double linear wound (26+26 turns) on 30mm diameter formers as shown in **Fig. 3**.

The back-to-back set-up has allowed me to gauge the front to back ratio of the antenna and to guess the forward gain lobe, which seems to be rather broad in use. My reference antenna has been a trapped dipole at around the same height, and the logs show that the Zig-Zag antenna to be several S-points better in signal gain.

We have had some severe storms in this area since I erected the antennas, but no problems or damage have been experienced in the set-up. I do, though have the main suspension point running over a pulley with a counterweight to keep the tension on in normal use, but allow for some movement.

For those of you with more space available, you could extend the antenna coverage down to the 7MHz band, keeping the geometry of the design, as long as the longest element is slightly greater than a half wave long at the lowest frequency. Similarly you could scale the values to extend the values to extend the design higher in frequency. PW