VHF LOG-PERIODIC ANTENNA

by Roger Harrison, VK2ZTB, who swears the prototype is still in use!

WITH THE AVAILABILITY of many imported transistor receivers that cover a variety of VHF bands, many people have discovered the delights of 'VHF Listening'. There are many interesting communications services using channels in the VHF region including taxis, aircraft, courier services — even weather satellites can be heard! From the small transistor 'portable' with auxiliary VHF coverage, many enthusiasts graduate to a more expensive 'general coverage' VHF receiver like the Eddystone 990R for example.

To receive the various transmissions that are spread over a wide range of frequencies, in various bands between 60 and 250 MHz, a wideband antenna is necessary. Most enthusiasts put up a simple dipole or perhaps several. Some make do with a TV antenna. Either system is a compromise. A 'discone' antenna is installed by some enthusiasts and while it is wideband with omnidirectional coverage, it has no gain.

Apart from the general VHF listening aspects, there are many 'TV DX' enthusiasts who seek out long distance reception of TV stations. During the summer months sporadic-E propagation via the ionosphere 'skips' distant TV transmissions many thousands of kilometres and Brisbane channel-O for example may be seen in Adelaide. Certain favourable weather conditions produce atmosphere 'ducts' which propagate VHF signals long distances. Radio amateurs often use TV DX as an indicator to amateur band DX 'openings'. A wideband antenna is worth its weight in QSL cards in these circumstances!

There are also many Hi-Fi enthusiasts using their TV antenna installation in a dual role: adding a splitter and connecting the TV and FM tuner. This situation is also very often a compromise. Many TV antennas, while having reasonable, if not adequate, response on most TV channels, do not have the required sensitivity or directivity over the 88 to 108 MHz FM broadcast band. They have demonstrably poor performance on stereo FM transmissions in many cases, particularly if one lives a fair distance from the transmitters, but not necessarily in a fringe area.

The difficulty in using a readily available TV antenna arises in the fact that it is generally a compromise. Those marketed for use in metropolitan areas are a compromise in several parameters. Response from channel 2 to channel 10, or channel 0 to channel 9, is required in capital cities — a frequency range spanning 60 to 222 MHz in the first case, and 45 to 215 MHz in the second.

A number of antennas are manufactured to respond to channels O or 2 (to cover the low frequency channels) and channels 6 to 11 in the upper range. That leaves a big hole in the middle. Others are cut to have a broad response around channel 2 and a 'peaked' response at three times that frequency, for use in strong signal areas.

The bandwidth response of these antennas on the lower frequency TV channels is often poor, although the effect may go largely unnoticed. When colour TV is installed and perhaps a splitter is added to allow connection of an FM tuner, the existing limitations of the installation become embarrassingly apparent.

Well, here's an antenna to solve all the multifareous problems for the various enthusiasts outlined above.

Log-Periodic Antenna

The antenna described is of the log-periodic type, so called for its physical design and wide frequency response. It has virtually constant gain and directivity pattern across the design frequency range. It uses a number of elements, arranged in this design as a series of dipoles. Only a small group (generally three or four) of these are 'working' on the chosen frequency or across a relatively narrow band within the design frequency range when the antenna is in use. A reflector element has been added to improve the front-to-back ratio, particularly on the lower frequencies.

Construction, although it appears complicated, is quite easy and inexpensive to boot! Most, if not all, the components can be purchased from hardware stores.

There are basically two models: one covering 60 to 250 MHz (TV channels 2 to 11 including the FM band), and the other covering 40 to 250 MHz (TV channels 0 to 11 including the FM band).

The overall construction of the 60 to 250 MHz model is illustrated in Figure 1. The 40 to 250 MHz model requires an additional three-elements of a larger size to accommodate the lower frequency range from 40 to 60 MHz. Construction of the additional elements is illustrated in Figure 6.

The model in Fig. 1 consists of ten dipole elements plus a parasitic reflector. A balun transformer with a 1:1 impedance ratio converts the approximately 70 to 80 ohms antenna feedpoint impedance from a balanced configuration to unbalanced, to suit a 75 ohm coaxial cable feedline.

Construction

Each of the dipole halves must be insulated so an insulated boom is required, along with some convenient method of mounting the dipole elements on it. There are two basic ways of achieving this — using a wooden boom and wooden element support brackets; or using a boom of ABS or PVC water pipe of a suitable diameter and conventional element to boom brackets.

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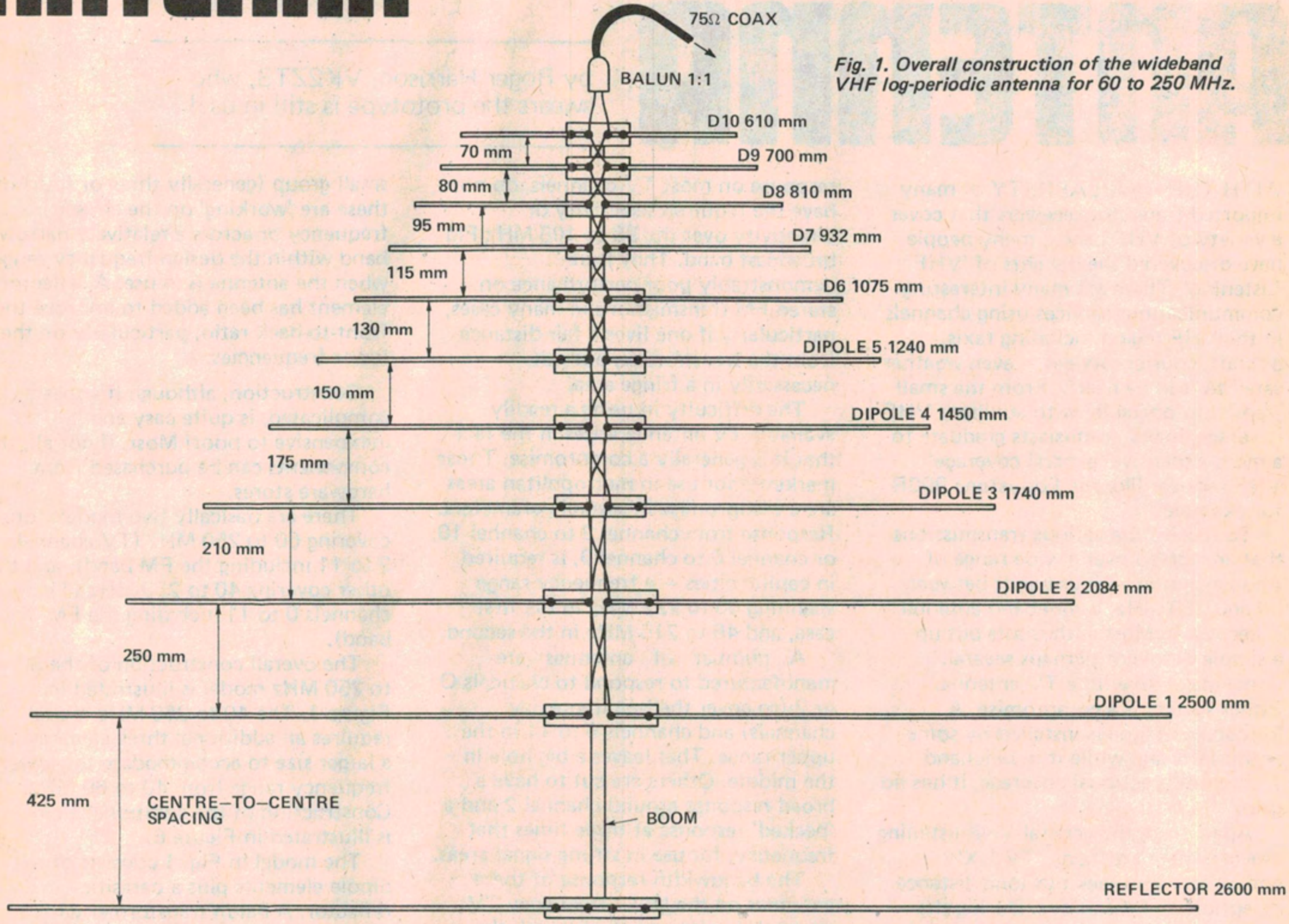


Fig. 1. Overall construction of the wideband VHF log-periodic antenna for 60 to 250 MHz.

Wooden Construction

The boom chosen for the model in Fig. 1 was ordinary rectangular-section 19 by 42 mm dressed size timber. Pine is cheapest, but is subject to warp. Western red cedar, or any close-grained, well-seasoned hardwood, free of warps and knots, would be a better choice. A length a little over 1.7 metres is necessary for the boom alone. A further 1.9 m length will be necessary to make the element to boom brackets.

The elements on the prototype were cut from nine, 1.83 m long (six foot) lengths of 10 mm (3/8") diameter aluminium tubing. This can be bought in many hardware stores, or from specialist aluminium suppliers (such as Alcan, Parramatta Aluminium Supplies, etc) for around 75 cents per length. Alternatively, the tubing can be bought in any of the standard length sizes, sufficient to make the required number of elements. The total length required is about 15.75 m, although around 700 to 800 mm must be added to this figure to account for wastage in offcuts. Thus, about 16.5 m will be needed altogether.

Each of the dipole halves is cut 5 mm shorter than required. The element lengths indicated on Fig. 1 are tip-to-tip measurements, and a 10 mm gap is allowed in the centre of inter-element feedline connection on each dipole. This is illustrated in Fig. 2.

If you are purchasing the aluminium tubing in 1.83 m lengths, they should be cut in the following way:—

TABLE

ELEMENTS	DIMENSION A
LOW REFLECTOR LOW DIPOLES 1, 2 & 3	400 mm
REFLECTOR (2600 mm) DIPOLES 1 & 2	250 mm
DIPOLES 3, 4, 5 & 6	200 mm
DIPOLES 7, 8, 9 & 10	140 mm

Firstly, the reflector will have to be made from two halves, necessitating a joint at the centre during final construction. All the elements should be cut and then stacked according to size before going on with the next stage of construction.

(a) From one length, cut exactly half the reflector, and half of dipole 7 (5 mm less than 466 mm, or 461 mm as explained). Repeat this with another length. You should end up with two pieces 1.30 m long, and two pieces 461 mm long. You then have the reflector and dipole 7 (or D7).

(b) From one length cut half D1 and half D6. Repeat this with another length.

(c) From one length cut half D2 and half D4. Repeat this with another length.

(d) Cut both halves of D3 from one length of tubing.

(e) Cut both halves of D5 and one half of D8 from one length.

(f) Last of all cut one half of D8 plus both halves of D9 and D10 from one length of tubing.

The wooden element to boom brackets should be cut next. Dimensions are given in the table in Figure 2. Three, 250 mm lengths will be needed for the reflector and dipoles, 1 and 2. Four each of 200 mm and 140 mm lengths will be needed for the other elements. The first line in the table in Fig. 2 refers to the low frequency portion, described later.

Once these are cut and drilled, the element halves should be individually drilled according to Fig. 2, and then screwed to the brackets using 20 or 25 mm screws as in Fig. 3. Solder lugs are placed under the screws holding the centre ends of the dipole halves, as illustrated in the diagram. These provide for the feedline connections.

When the elements and brackets are all assembled, they can be mounted on the boom. Commencing with either dipole 10 or the reflector, mark the position of each bracket on the narrow side of the boom, one by one, and mount them.

Align each bracket and element at right angles to the boom. A pilot hole should be drilled in the boom, to suit the 35 or 40 mm long screws, to avoid splitting the timber.

The spacings between each dipole, given in Figure 1, are centre-to-centre spacings of the elements.

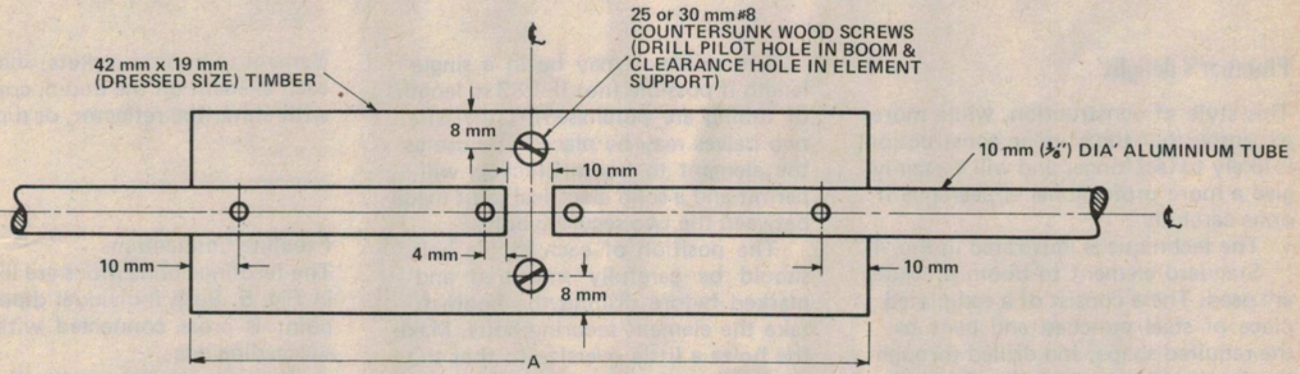
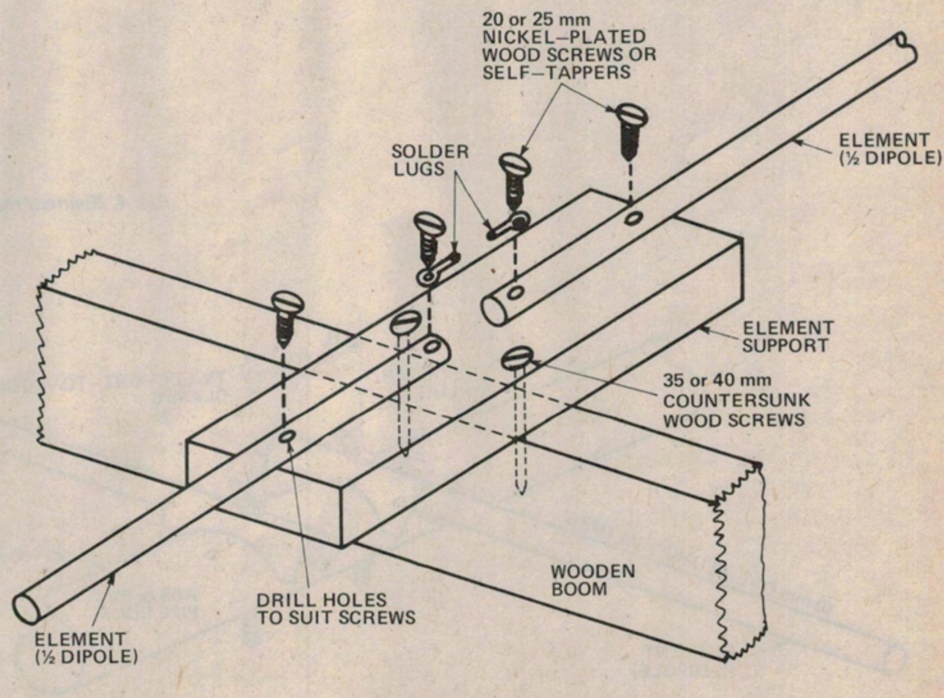


Fig. 2. Dipole boom bracket construction.

Fig. 3. Element mounting using wood construction.



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'Plumber's delight'

This style of construction, while more expensive than the wooden construction, is likely to last longer and will certainly give a more professional appearance if done carefully

The technique is illustrated in Fig. 4.

Standard element to boom brackets are used. These consist of a cad-plated piece of steel punched and bent to the required shape, and drilled through the 'top' centre to take the securing bolt. They are made to accept 10 mm diameter elements and fit 25 to 30 mm diameter booms. Each half of the elements is attached to an insulated boom consisting of a 1.7 m (approximately) length of ABS or PVC plastic pipe, often used these days for domestic plumbing. An offset between the dipole halves of about 15 or 20 mm is used.

The reflector may be in a single length if possible (not if 1.83 m lengths of tubing are purchased). Otherwise, two halves may be placed as close as the element to boom brackets will permit and a solid electrical joint made between the two securing bolts.

The position of each dipole half should be carefully measured and marked before drilling the boom to take the element securing bolts. Make the holes a little oversize so that the elements can be rotated a little to line them up for the sake of appearance.

Cut all the elements to size, more or less in the order given previously. However, with this form of construction, each dipole half will need to be longer by an amount equal to half the length of the element to boom clamps — about 25 mm.

Next drill all the dipole halves according to the requirements of the element to boom brackets, and assemble each element on the boom, commencing with either the reflector, or dipole 10.

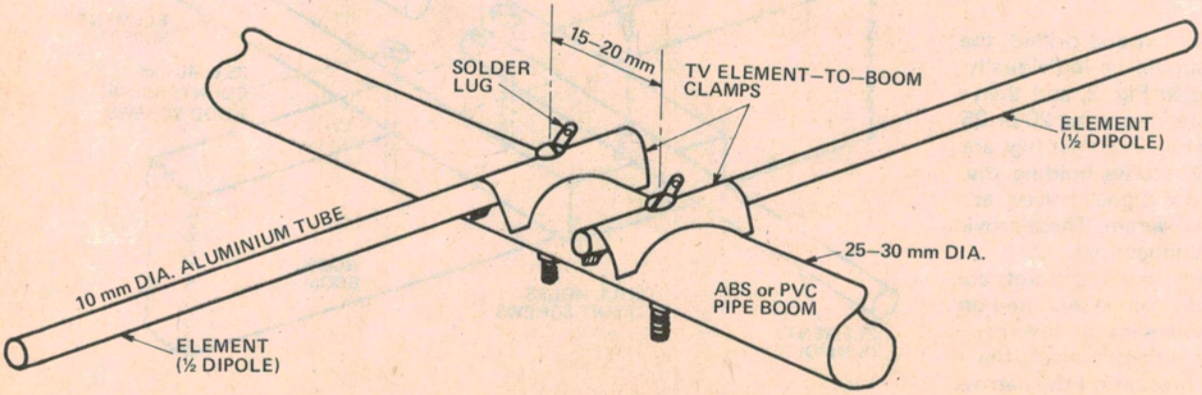
Feedline Connections

The feedline connections are illustrated in Fig. 5. Each individual dipole feedpoint is cross connected with the succeeding one.

The connections can be made with light-gauge hook-up wire, such as PVC covered 7/010, obtainable from most electronic component suppliers. Carefully solder each joint.

The balun transformer is mounted on the end of the boom, adjacent to, or beneath, dipole 10. Short connecting leads run from the balun input connections (balanced) to the feedline connection lugs of dipole 10.

Fig. 4. Element mounting for the 'plumber's delight' version.



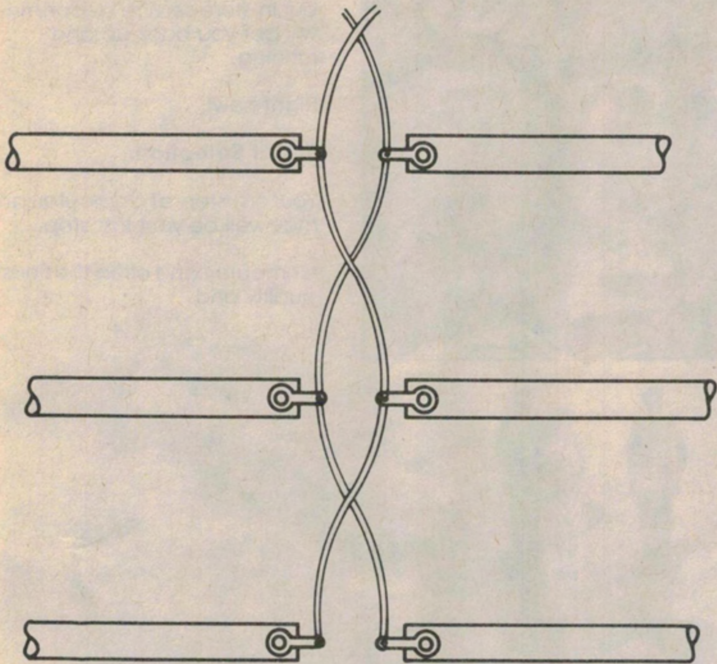


Fig. 5. Feedline connections between the elements.

Low Frequency Coverage

The 40 to 250 MHz model requires a longer boom, of larger cross-section, and has a total of fourteen elements. The dimensions of the extra three elements are given in Figure 6. They are mounted to the rear of dipole 1, and the original reflector is not used.

A boom 3.3 m long and about 25 mm by 50 mm dressed size cross-section is required to support the fourteen elements. The element to boom brackets can be made of 19 by 42 mm dressed size timber as before. A total length of 3.35 m (including cutting allowance) will be needed, as shown in the dimension in the table of Figure 2.

Plumbers delight construction can also be used for this model; construction is the same as described previously.

The longer low frequency elements in this model necessitate obtaining longer lengths of aluminium tubing, otherwise the shorter lengths will need pieces attached to the ends in order to make up the required lengths of the dipole halves. This can be done by slipping a 40 mm length of the next largest size tubing over the two pieces at the joint, and securing with small self-tapping screws. The feedline connections to the dipoles are as described previously.

Next month we shall continue with balun designs and further details on installation.

Fig. 6. Construction of the low frequency extensions to 35 MHz.