The Yagi-Uda antenna is mostly used for domestic purpose. However, for commercial purpose and to tune over a range of frequencies, we need to have another antenna known as the **Log-periodic antenna**. A Log-periodic antenna is that whose impedance is a logarithamically periodic function of frequency.

Frequency range

The frequency range, in which the log-periodic antennas operate is around **30 MHz to 3GHz** which belong to the **VHF** and **UHF** bands.

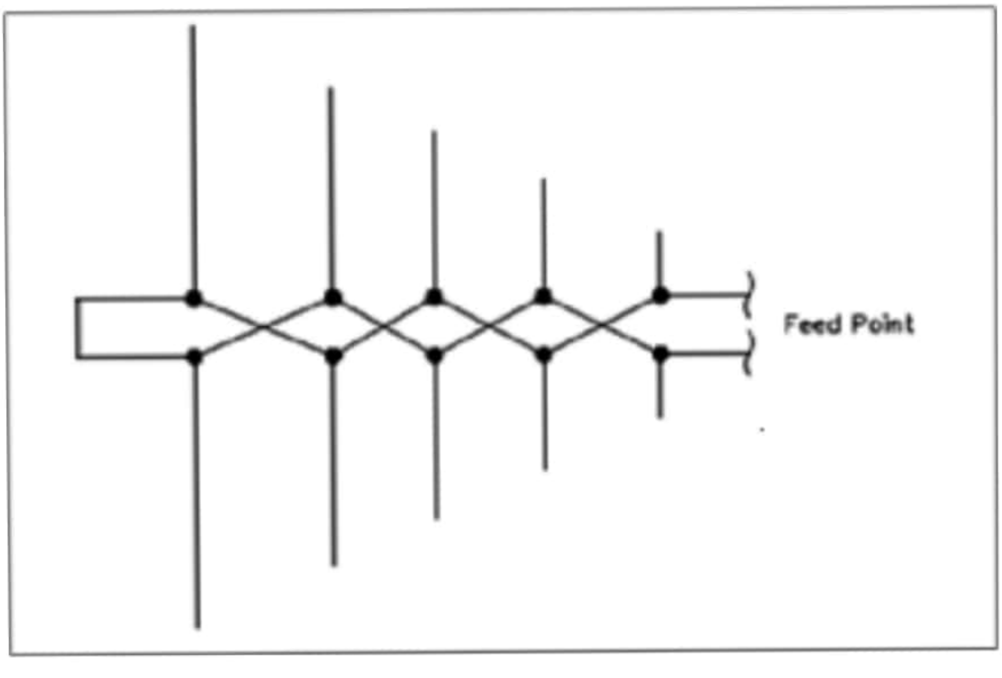
Construction & Working of Log-periodic Antenna

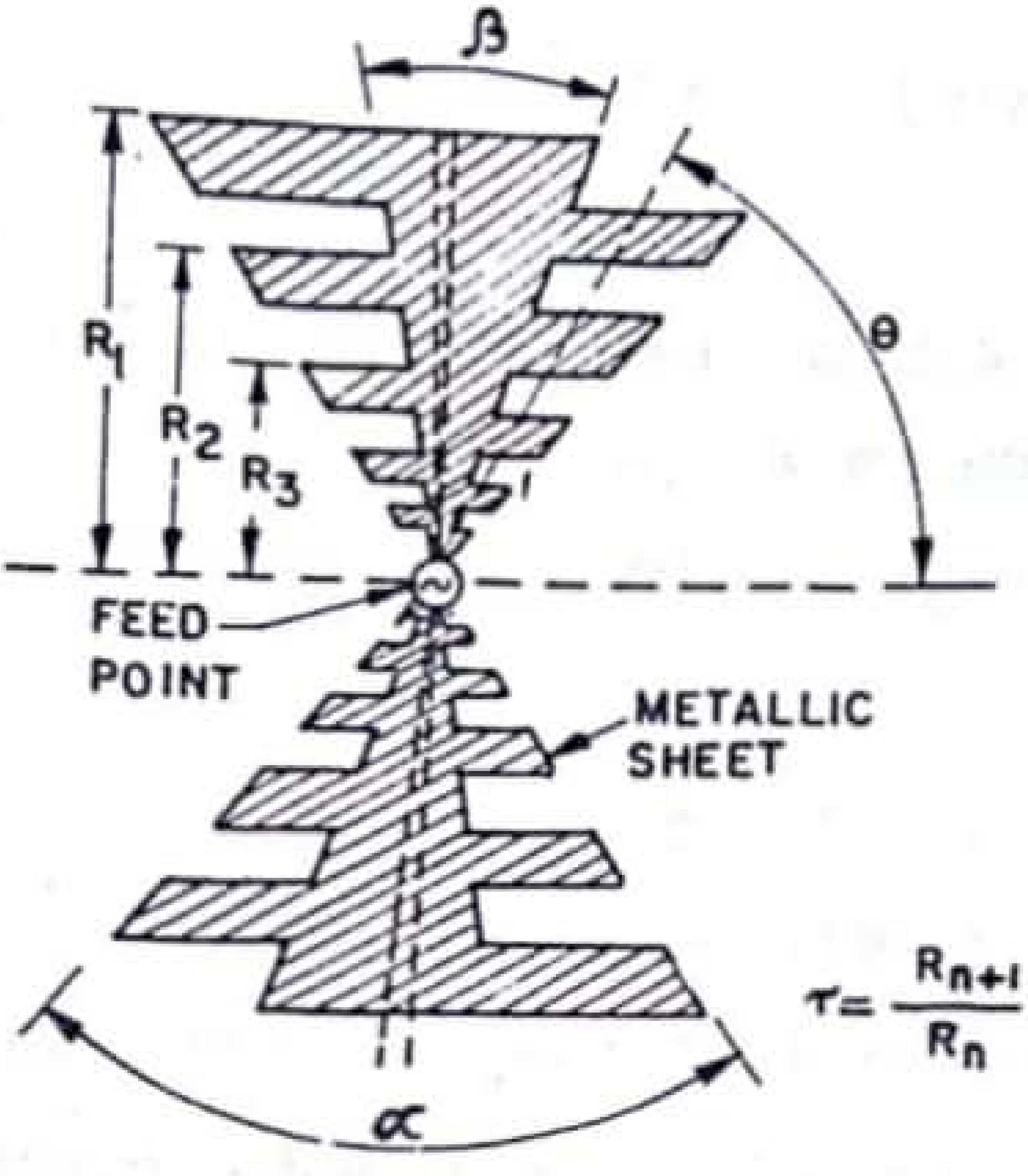
The construction and operation of a log-periodic antenna is similar to that of a Yagi-Uda antenna. The main advantage of this antenna is that it exhibits constant characteristics over a desired frequency range of operation. It has the same radiation resistance and therefore the same SWR. The gain and front-to-back ratio are also the same.

The image shows a log-periodic antenna.

With the change in operation frequency, the active region shifts among the elements and hence all the elements will not be active only on a single frequency. This is its **special characteristic**.

There are several type of log-periodic antennas such as the planar, trapezoidal, zig-zag, V-type, slot and the dipole. The mostly used one is log-periodic dipole array, in short, LPDA.




β
θ
R1
R2
R3
FEED POINT
METALLIC SHEET
α
τ = Rn+1 / Rn

as

$$\frac{R_1}{R_2} = \frac{R_2}{R_3} = \frac{R_3}{R_4} = \ldots\ldots = \frac{R_n}{R_{n+1}} = \tau = \frac{L_1}{L_2} = \frac{L_2}{L_3} = \frac{L_3}{L_4} = \ldots\ldots = \frac{L_n}{L_{n+1}}$$

$$\boxed{\frac{R_n}{R_{n+1}} = \frac{L_n}{L_{n+1}} = \tau} \qquad \ldots 9.1$$

The physical structure and electrical characteristics, when observed, are repetitive in nature. The array consists of dipoles of different lengths and spacing, which are fed from a two-wire transmission line. This line is transposed between each adjacent pair of dipoles.

The dipole lengths and seperations are related by the formula –

$$\frac{R_1}{R_2} = \frac{R_2}{R_3} = \frac{R_3}{R_4} = T = \frac{l_1}{l_2} = \frac{l_2}{l_3} = \frac{l_3}{l_4}$$

Where

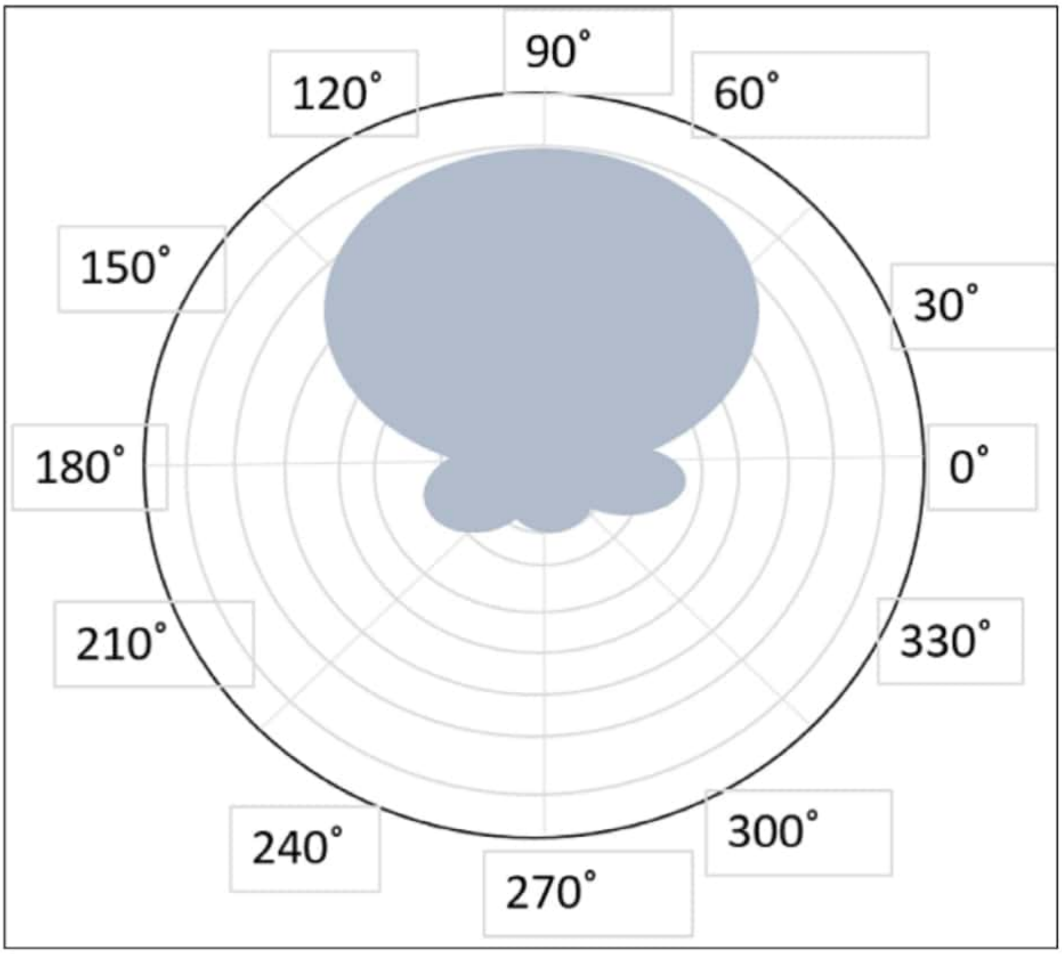
- τ is the design ratio and τ<1
- R is the distance between the feed and the dipole
- l is the length of the dipole.

The directive gains obtained are low to moderate. The radiational patterns may be **Unidirectional or Bi-directional**.

Radiation Pattern

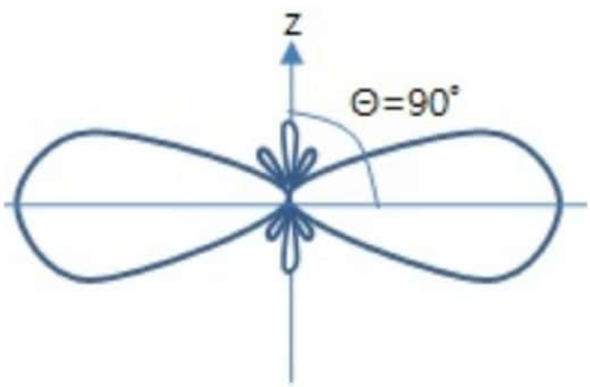
The Radiation pattern of log-periodic antenna can be of uni-directional or bi-directional, depending upon the log periodic structures.

For **uni-directional Log-periodic antenna**, the radiation towards shorter element is of considerable amount, whereas in forward direction, it is small or zero.



The radiational pattern for uni-directional log-periodic antenna is given above.

For **bi-directional Log-periodic antenna**, the maximum radiation is in broad side, which is normal to the surface of the antenna.



The figure given above shows the radiational pattern for a bi-directional log-periodic antenna.

The analysis of a log periodic dipole array can be done by considering three region of the antenna :

(i) Transmission-line region (Inactive region $L < \lambda/2$),

(ii) Active region ($L = \lambda/2$)

(iii) Reflective region (Inactive region $L > \lambda/2$)

(i) ***Inactive transmission line region*** ($L < \lambda/2$). At middle of the operating range, the antenna elements are short with the resonant length *i,e.* $L \leq \lambda/2$, therefore, the elements present a relatively high capacitance impedance. The element current is small and leads the base voltage supplied by transmission line by 90° (approx.). The element spacing in wavelength is also small. By transposition of transmission introduces 180° phase shaft between adjacent dipoles. *Hence currents in elements of these region are small and hence the small radiation in backward direction (towards left).*

(ii) ***Active region*** ($L \simeq \lambda/2$). In this region the dipole lengths are approximately resonant length (*i.e.* $L = \lambda/2$) and hence the impedance offered by the dipoles of this region are resistive appreciably in nature. Hence the element currents are large and in phase with base voltage. The current just below resonance is slightly leading and above resonance slightly lagging. The spacing between two elements are now sufficiently large, causing the phase in a particular element to lead approx. by 90°. For example, by the time field radiated from element I_{n+1} reaches I_n, the phase of I_n advances by 90° and its field add to the field of I_{n+1} elements, in phase producing a large resultant field towards left. Hence there is strong radiation towards left in backward direction and a little radiation towards right.

(iii) ***Inactive reflective region*** ($L > \lambda/2$). The element (dipoles) lengths are longer than the resonant length (*i.e.* $L \geq \lambda/2$) hence the impedance becomes inductive, causing the currents in the elements to lag the base voltage. The base voltage supplied by transmission line is now very much small as almost all the energy transmitted down the line has been attracted and radiated by the active region. This region presents a large reactive impedance to the line and thus, any small amount of incident wave from active region is reflected back towards backward direction.

Advantages

The following are the advantages of Log-periodic antennas –

- The antenna design is compact.
- Gain and radiation pattern are varied according to the requirements.

Disadvantages

The following are the disadvantages of Log-periodic antennas –

- External mount.
- Installation cost is high.

Applications

The following are the applications of Log-periodic antennas –

- Used for HF communications.
- Used for particular sort of TV receptions.
- Used for all round monitoring in higher frequency bands.