# Half Wave Dipole and Yagi-Uda Antenna - Study Material

## HALF WAVE DIPOLE

The dipole antenna is cut and bent for effective radiation. The length of the total wire, which is being used as a dipole, equals half of the wavelength (i.e., $l = \lambda/2$). Such an antenna is called as **half-wave dipole antenna**. This is the most widely used antenna because of its advantages. It is also known as **Hertz antenna**.

### Frequency range

The range of frequency in which half-wave dipole operates is around 3KHz to 300GHz. This is mostly used in radio receivers.

### Construction & Working of Half-wave Dipole

It is a normal dipole antenna, where the frequency of its operation is **half of its wavelength**. Hence, it is called as half-wave dipole antenna.

The edge of the dipole has maximum voltage. This voltage is alternating (AC) in nature. At the positive peak of the voltage, the electrons tend to move in one direction and at the negative peak, the electrons move in the other direction. This can be explained by the figures given below.

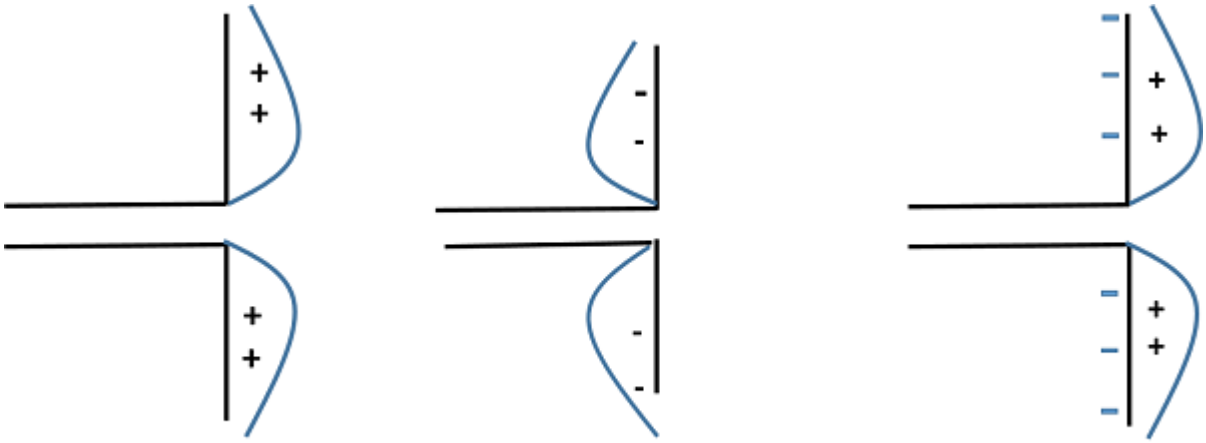
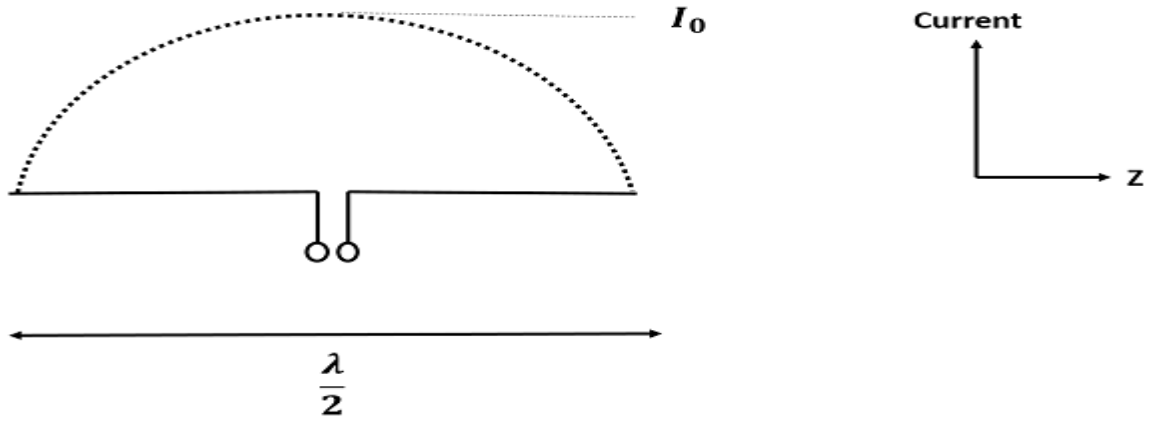


Fig 1 Fig 2 Fig 3

The figures given above show the working of a half-wave dipole.

- Fig 1 shows the dipole when the charges induced are in positive half cycle. Now the electrons tend to move towards the charge.
- Fig 2 shows the dipole with negative charges induced. The electrons here tend to move away from the dipole.
- Fig 3 shows the dipole with next positive half cycle. Hence, the electrons again move towards the charge.

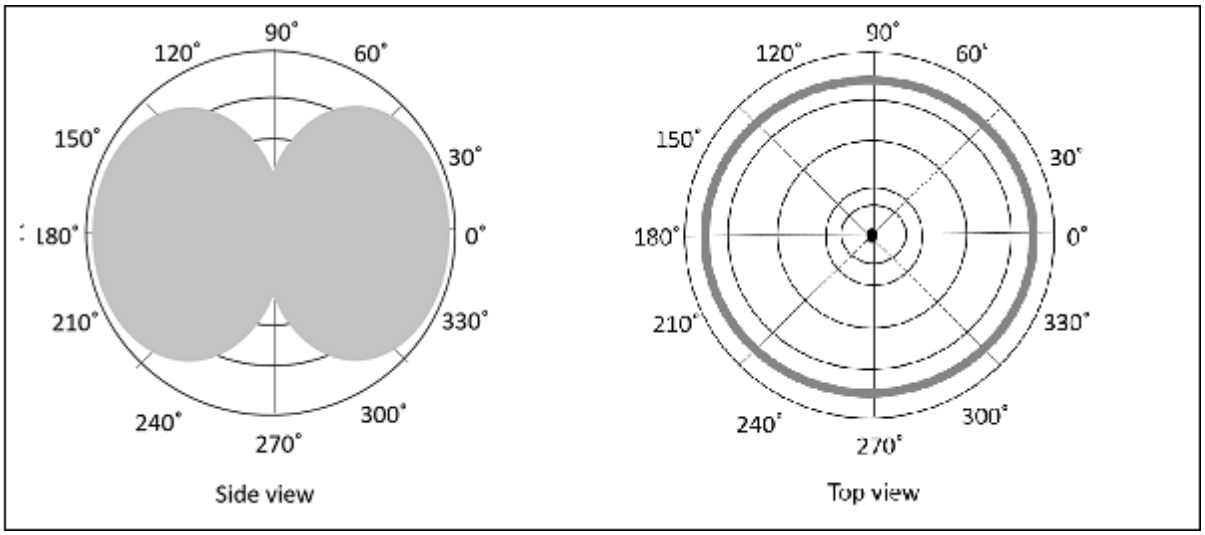
The cumulative effect of this produces a varying field effect which gets radiated in the same pattern produced on it. Hence, the output would be an effective radiation following the cycles of the output voltage pattern. Thus, a half-wave dipole **radiates effectively**.




The above figure shows the current distribution in half wave dipole. The directivity of half wave dipole is 2.15dBi, which is reasonably good. Where, 'i' represents the isotropic radiation.

**Radiation Pattern**

The radiation pattern of this half-wave dipole is **Omni-directional** in the H-plane. It is desirable for many applications such as mobile communications, radio receivers etc.




The above figure indicates the radiation pattern of a half wave dipole in both H-plane and V-plane.

The radius of the dipole does not affect its input impedance in this half wave dipole, because the length of this dipole is half wave and it is the first resonant length. An antenna works effectively at its **resonant frequency**, which occurs at its resonant length.

**Advantages**

The following are the advantages of half-wave dipole antenna −

- Input impedance is not sensitive.
- Matches well with transmission line impedance.
- Has reasonable length.
- Length of the antenna matches with size and directivity.

**Disadvantages**

The following are the disadvantages of half-wave dipole antenna −

- Not much effective due to single element.
- It can work better only with a combination.

**Applications**

The following are the applications of half-wave dipole antenna −

- Used in radio receivers.
- Used in television receivers.
- When employed with others, used for wide variety of applications.

## HALF-WAVE FOLDED DIPOLE

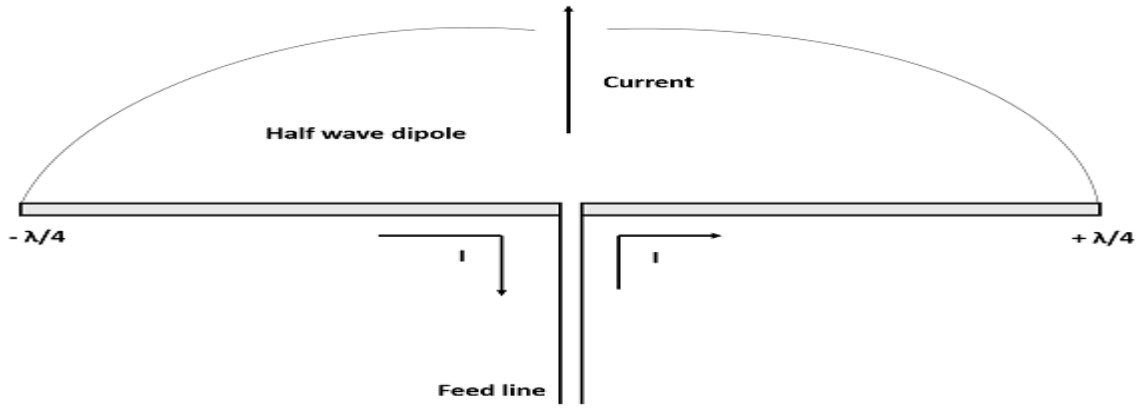
A folded dipole is an antenna, with two conductors connected on both sides, and folded to form a cylindrical closed shape, to which feed is given at the center. The length of the dipole is half of the wavelength. Hence, it is called as **half wave folded dipole antenna**.

### Frequency range

The range of frequency in which half wave folded dipole operates is around 3KHz to 300GHz. This is mostly used in television receivers.

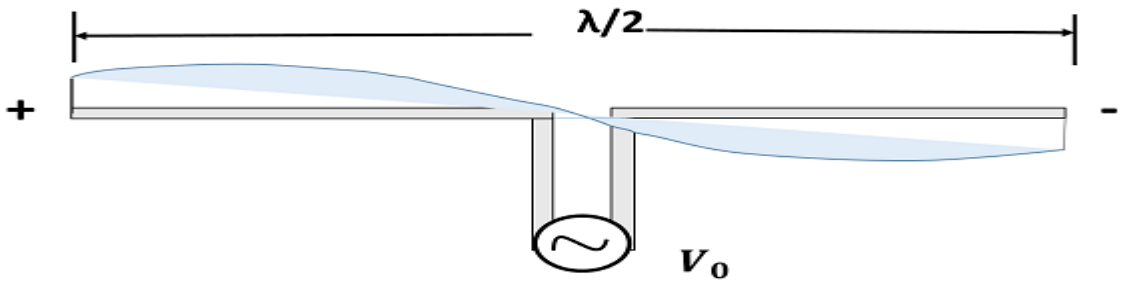
### Construction & Working of Half-wave Folded Dipole

This antenna is commonly used with the array type antennas to increase the feed resistance. The most commonly used one is with Yagi-Uda antenna. The following figure shows a half-wave folded dipole antenna.




This antenna uses an extra conducting element (a wire or a rod) when compared with previous dipole antenna. This is continued by placing few conducting elements in parallel, with insulation in-between, in array type of antennas.

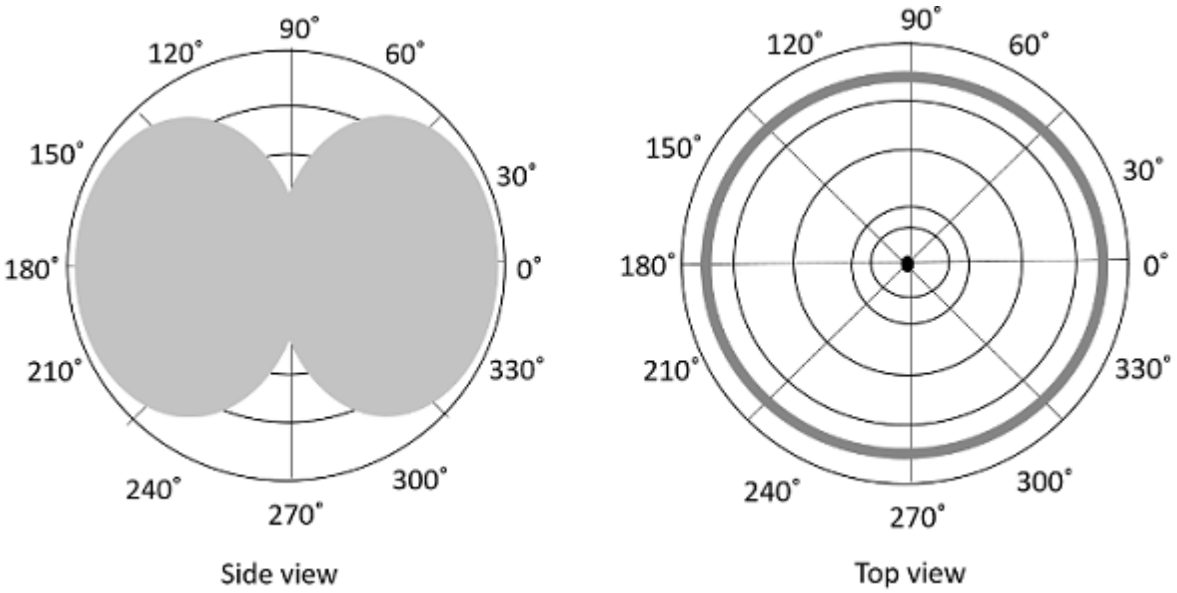
The following figure explains the working of a half-wave folded dipole antenna, when it is provided with excitation.




If the diameter of the main conductor and the folded dipole are same, then there will be four folded (two times of squared one) increase in the feed impedance of the antenna. This increase in feed impedance is the main reason for the popular usage of this folded dipole antenna. Due of the twin-lead, the impedance will be around 300Ω.

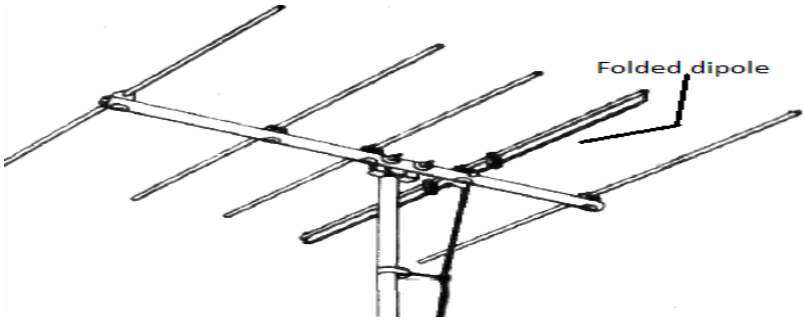
**Radiation Pattern**

The radiation pattern of half-wave folded dipoles is the same as that of the half-wave dipole antennas. The following figure shows the radiation pattern of half-wave folded dipole antenna, which is **Omni-directional** pattern.




Half-wave folded dipole antennas are used where optimum power transfer is needed and where large impedances are needed.

This folded dipole is the main element in **Yagi-Uda antenna**. The following figure shows a **Yagi-Uda antenna**, which we will study later. The main element used here is this folded dipole, to which the antenna feed is given. This antenna has been used extensively for television reception over the last few decades.




**Advantages**

The following are the advantages of half-wave folded dipole antenna −

- Reception of balanced signals.
- Receives a particular signal from a band of frequencies without losing the quality.
- A folded dipole maximizes the signal strength.

**Disadvantages**

The following are the disadvantages of half-wave folded dipole antenna −

- Displacement and adjustment of antenna is a hassle.
- Outdoor management can be difficult when antenna size increases.

**Applications**

The following are the applications of half-wave folded dipole antenna −

- Mainly used as a feeder element in Yagi antenna, Parabolic antenna, turnstile antenna, log periodic antenna, phased and reflector arrays, etc.
- Generally used in radio receivers.
- Most commonly used in TV receiver antennas.

## YAGI-UDA ANTENNA

**Yagi-Uda antenna** is the most commonly used type of antenna for TV reception over the last few decades. It is the most popular and easy-to-use type of antenna with better performance, which is famous for its high gain and directivity

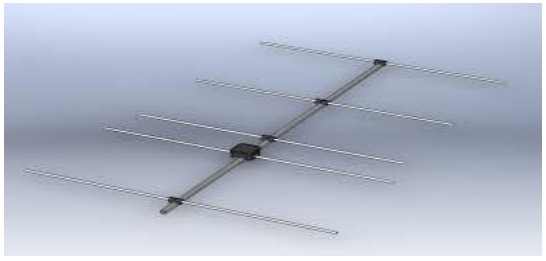
**Frequency range**

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

### Construction of Yagi-Uda Antenna

A Yagi-Uda antenna was seen on top of almost every house during the past decades. The parasitic elements and the dipole together form this Yagi-Uda antenna.

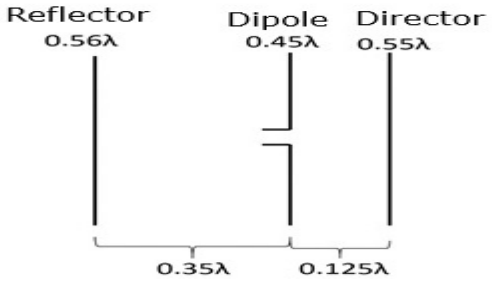
The figure shows a **Yagi-Uda antenna**. It is seen that there are many directors placed to increase the directivity of the antenna. The feeder is the folded dipole. The reflector is the lengthy element, which is at the end of the structure.



The figure depicts a clear form of the Yagi-Uda antenna. The center rod like structure on which the elements are mounted is called as **boom**. The element to which a thick black head is connected is the **driven element** to which the transmission line is connected internally, through that black stud. The single element present at the back of the driven element is the **reflector**, which reflects all the energy towards the direction of the radiation pattern. The other elements, before the driven element, are the **directors**, which direct the beam towards the desired angle.

**Designing**

For this antenna to be designed, the following design specifications should be followed.



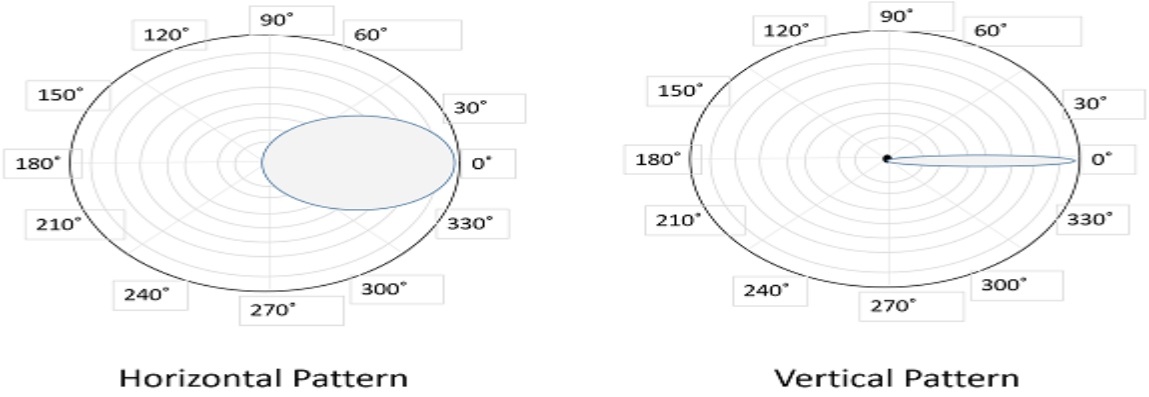

They are −

| ELEMENT | SPECIFICATION |
|---|---|
| Length of the Driven Element | 0.458λ to 0.5λ |
| Length of the Reflector | 0.55λ to 0.58λ |
| Length of the Director 1 | 0.45λ |
| Length of the Director 2 | 0.40λ |
| Length of the Director 3 | 0.35λ |
| Spacing between Directors | 0.2λ |
| Reflector to dipole spacing | 0.35λ |
| Dipole to Director spacing | 0.125λ |

If the specifications given above are followed, one can design an Yagi-Uda antenna.

**Radiation Pattern**

The directional pattern of the Yagi-Uda antenna is **highly directive** as shown in the figure given below.




Horizontal Pattern

Vertical Pattern

The minor lobes are suppressed and the directivity of the major lobe is increased by the addition of directors to the antenna.

**Advantages**

The following are the advantages of Yagi-Uda antennas −

- High gain is achieved.
- High directivity is achieved.
- Ease of handling and maintenance.
- Less amount of power is wasted.
- Broader coverage of frequencies.

**Disadvantages**

The following are the disadvantages of Yagi-Uda antennas −

- Prone to noise.
- Prone to atmospheric effects.

**Applications**

The following are the applications of Yagi-Uda antennas −

- Mostly used for TV reception.
- Used where a single-frequency application is needed.