
Slot and Aperture Antenna - Study Material

SLOT ANTENNA

Slot Antenna is an example of Aperture antenna. A rectangular slot is made on the conducting sheet. These slot antennas can be formed by simply making a cut on the surface, where they are mounted on.

Frequency Range

The frequency range used for the application of Slot antenna is **300 MHz to 30 GHz**. It works in **UHF** and **SHF** frequency ranges.

Construction & Working of Slot Antennas

The use of slot antennas is well understood through its working principle. Let us have a look at the structure of a slot antenna.



When an infinite conducting sheet is made a rectangular cut and the fields are excited in the aperture (which is called as a slot), it is termed as **Slot antenna**. This can be understood by observing the image of a slot antenna. The following image shows the model of a Slot antenna.

The working of Slot Antenna can be easily understood through Babinet's principle of optics. This concept gives an introduction to the slot antennas.

Babinet's Principle

Babinet's principle states that- "When the field behind a screen with an opening is added to the field of a complementary structure, the sum is equal to the field when there is no screen".



Figure 1

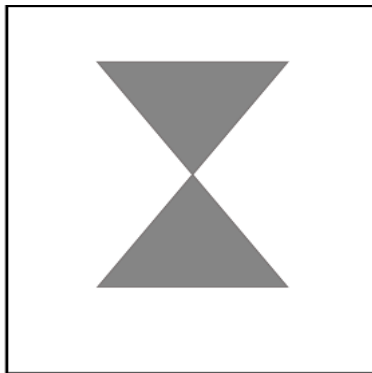


Figure 2

The above images clearly explain the principle. In all the regions, which are non-collinear with the beam, the above two screens, in figures 1 & 2, produce the same diffraction pattern.

Case 1 – Consider a light source and a conducting plane (field) with an aperture before a screen. The light does not pass through the opaque area, but passes through the aperture.

Case 2 – Consider the light source and a conducting plane of the size of the aperture in the previous case, being held against the screen. The light does not pass through the plane but through the remaining portion.

Case 3 – Combine these two conducting planes of both the cases and put before the light source. The screen is not placed to observe the resultant combination. The effect of screen gets nullified.

Working of Slot Antenna

This principle of optics is applied to electromagnetic waves for the wave to get radiated. It is true that when a HF field exists across a narrow slot in a conducting plane, the energy is radiated.



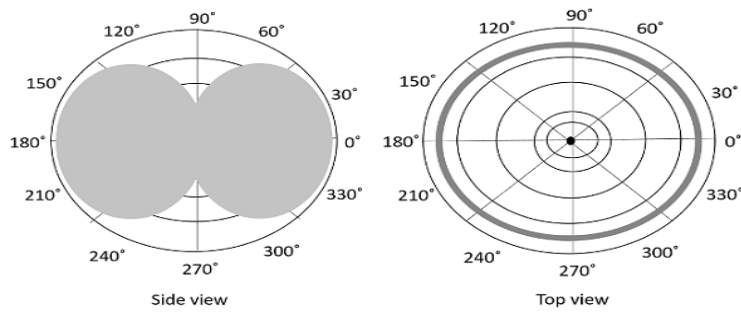
The image shows a slot antenna, which explains well about its working.

Consider an infinite plane conducting screen is taken and pierced with apertures of desired shape and size and this will be the screen of slot antenna. Another screen is considered interchanging the places of aperture and screen area which is the complementary screen.

These two screens are said to be **complementary** as they result in complete infinite metal screen. Now, this becomes the slot antenna. The terminal impedance is quite desirable for the radiation.

Radiation Pattern

The radiation pattern of the Slot antenna is **Omni-directional**, just like a half-wave dipole antenna. Take a look at the following illustration. It shows the radiation pattern of Slot antenna drawn in Horizontal and Vertical planes respectively



Advantages

The following are the advantages of Slot antenna –

- It can be fabricated and concealed within metallic objects
- It can provide covert communications with a small transmitter

Disadvantages

The following are the disadvantages of Slot antenna –

- Higher cross-polarization levels
- Lower radiation efficiency

Applications

The following are the applications of Slot antenna –

- Usually for radar navigational purposes
- Used as an array fed by a wave guide

APERTURE ANTENNA

An Antenna with an aperture at the end can be termed as an **Aperture antenna**. Waveguide is an example of aperture antenna. The edge of a transmission line when terminated with an opening, radiates energy. This opening which is an aperture, makes it an **Aperture** antenna.

The main types of aperture antennas are –

- Wave guide antenna
- Horn antenna
- Slot antenna

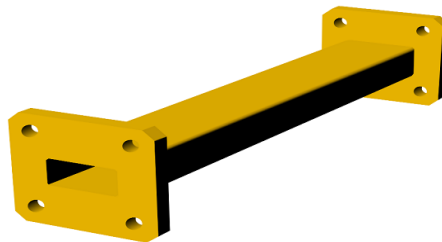
Let us now have a look at these types of aperture antennas.

Waveguide Antenna

A **Waveguide** is capable of radiating energy when excited at one end and opened at the other end. The radiation in wave guide is greater than a two-wire transmission line.

Frequency Range

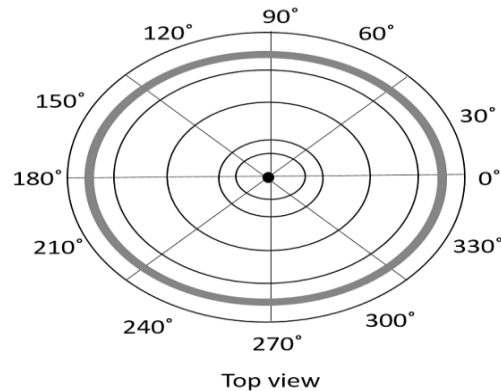
The operational frequency range of a wave guide is around **300MHz to 300GHz**. This antenna works in **UHF** and **EHF** frequency ranges. The following image shows a waveguide.



This waveguide with terminated end, acts as an antenna. But only a small portion of the energy is radiated while a large portion of it gets reflected back in the open circuit. It means **VSWR** (voltage standing wave ratio, discussed in basic parameters chapter) value increases. The diffraction around the waveguide provides poor radiation and non-directive radiation pattern.

Radiation Pattern

The radiation of waveguide antenna is poor and the pattern is non-directive, which means omnidirectional. An **omni-directional** pattern is the one which has no certain directivity but radiates in all directions, hence it is called as **non-directive radiation pattern**.



The above figure shows a top section view of an omni-directional pattern, which is also called as **non-directional pattern**. The two-dimensional view is a figure-of-eight pattern, as we already know.

Advantages

The following are the advantages of Aperture antenna –

- Radiation is greater than two-wire transmission line
- Radiation is Omni-directional

Disadvantages

The following are the disadvantages of Aperture antenna –

- VSWR increases
- Poor radiation



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Applications

The following are the applications of Aperture antenna –

- Micro wave applications
- Surface search radar applications

The waveguide antenna has to be further modified to achieve better performance, which results in the formation of **Horn antenna**.