ANTENNA MEASUREMENT TECHNIQUES

Antenna measurement techniques refers to the testing of antennas to ensure that the antenna meets specifications or simply to characterize it. Typical parameters of antennas are gain, radiation pattern, beamwidth, polarization, and impedance.

The antenna pattern is the response of the antenna to a plane wave incident from a given direction or the relative power density of the wave transmitted by the antenna in a given direction. For a reciprocal antenna, these two patterns are identical. A multitude of antenna pattern measurement techniques have been developed. The first technique developed was the far-field range, where the antenna under test (AUT) is placed in the far-field of a range antenna. Due to the size required to create a far-field range for large antennas, near-field techniques were developed, which allow the measurement of the field on a surface close to the antenna (typically 3 to 10 times its wavelength). This measurement is then predicted to be the same at infinity. A third common method is the compact range, which uses a reflector to create a field near the AUT that looks approximately like a plane-wave.

PROPAGATION OF RADIO WAVES

n this chapter, let us go through different interesting topics such as the properties of radio waves, the propagation of radio waves and their types.

Radio Waves

Radio waves are easy to generate and are widely used for both indoor and outdoor communications because of their ability to pass through buildings and travel long distances.

The key features are −

- Since radio transmission is **Omni directional** in nature, the need to physically align the transmitter and receiver does not arise.

- The frequency of the radio wave determines many of the characteristics of the transmission.
- At low frequencies, the waves can pass through obstacles easily. However, their power falls with an inverse-squared relation with respect to the distance.
- The higher frequency waves are more prone to absorption by rain drops and they get reflected by obstacles.
- Due to the long transmission range of the radio waves, interference between transmissions is a problem that needs to be addressed.

In the VLF, LF and MF bands the propagation of waves, also called as **ground waves** follow the curvature of the earth. The maximum transmission ranges of these waves are of the order of a few hundred kilometers. They are used for low bandwidth transmissions such as Amplitude Modulation (AM) radio broadcasting.

The HF and VHF band transmissions are absorbed by the atmosphere, near the Earth's surface. However, a portion of the radiation, called the **sky wave**, is radiated outward and upward to the ionosphere in the upper atmosphere. The ionosphere contains ionized particles formed due to the Sun's radiation. These ionized particles reflect the sky waves back to the Earth. A powerful sky wave may be reflected several times between the Earth and the ionosphere. Sky waves are used by amateur ham radio operators and for military communication.

Radio Wave Propagation

In **Radio communication systems**, we use wireless electromagnetic waves as the channel. The antennas of different specifications can be used for these purposes. The sizes of these antennas depend upon the bandwidth and frequency of the signal to be transmitted.

The mode of propagation of electromagnetic waves in the atmosphere and in free space may be divided in to the following three categories −

- Line of sight (LOS) propagation
- Ground wave propagation
- Sky wave propagation

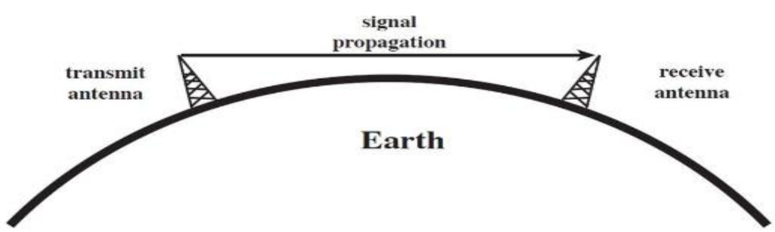
In ELF (Extremely low frequency) and VLF (Very low frequency) frequency bands, the Earth, and the ionosphere act as a wave guide for electromagnetic wave propagation.

In these frequency ranges, communication signals practically propagate around the world. The channel band widths are small. Therefore, the information is transmitted through these channels has slow speed and confined to digital transmission.

Line of Sight (LOS) Propagation

Among the modes of propagation, this line-of-sight propagation is the one, which we commonly notice. In the **line-of-sight communication**, as the name implies, the wave travels a minimum distance of sight. Which means it travels to the distance up to which a naked eye can see. Now what happens after that? We need to employ an amplifier cum transmitter here to amplify the signal and transmit again.

This is better understood with the help of the following diagram.



Line-of-sight (LOS) propagation (above 30 MHz)

The figure depicts this mode of propagation very clearly. The line-of-sight propagation will not be smooth if there occurs any obstacle in its transmission path. As the signal can travel only to lesser distances in this mode, this transmission is used for **infrared** or **microwave transmissions**.

Ground Wave Propagation

Ground wave propagation of the wave follows the contour of earth. Such a wave is called as **direct wave**. The wave sometimes bends due to the Earth's magnetic field and gets reflected to the receiver. Such a wave can be termed as **reflected wave**.

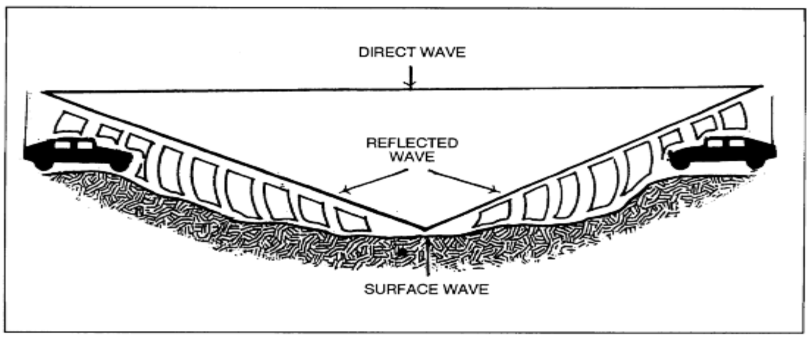
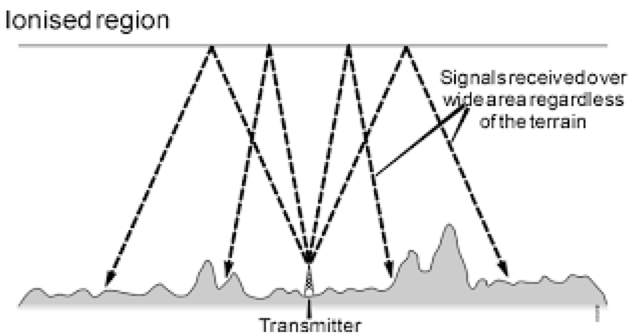


Figure D-2. Components of ground wave.

The above figure depicts ground wave propagation. The wave when propagates through the Earth's atmosphere is known as **ground wave**. The direct wave and reflected wave together contribute the signal at the receiver station. When the wave finally reaches the receiver, the lags are cancelled out. In addition, the signal is filtered to avoid distortion and amplified for clear output.

Sky Wave Propagation

Sky wave propagation is preferred when the wave has to travel a longer distance. Here the wave is projected onto the sky and it is again reflected back onto the earth.



The **sky wave propagation** is well depicted in the above picture. Here the waves are shown to be transmitted from one place and where it is received by many receivers. Hence, it is an example of broadcasting.

The waves, which are transmitted from the transmitter antenna, are reflected from the ionosphere. It consists of several layers of charged particles ranging in altitude from 30- 250 miles above the surface of the earth. Such a travel of the wave from transmitter to the ionosphere and from there to the receiver on Earth is known as **Sky Wave Propagation**. Ionosphere is the ionized layer around the Earth's atmosphere, which is suitable for sky wave propagation.