Antenna Basics

Antenna Fundamentals

Let's get right down to the study of antennas and **Antenna Basics**. Suppose one day you're walking down the street and a kind but impatient person runs up and asks you to design an antenna for them. "Sure", you quickly reply, adding "what is the desired frequency, gain, bandwidth, impedance, and polarization?"

Or perhaps you have never heard of (or are a little rusty) on the above parameters. Well then, you've come to the right place. Before we can design an antenna or discuss antenna types, we must understand the basics of antennas, which are the fundamental parameters that characterize an antenna.

So let us learn something. We'll start with frequency and step through radiation patterns, directivity and gain, and ultimately close with an explanation on why antennas radiate. Jump ahead if this is already familiar to you.

Frequency

The basics of sinusoids (sine and cosine waves), wavelength, frequency and the speed of light.

More Advanced Frequency Information

A discussion on how all waveforms in the universe are made up of the sum of sinusoids (simple waves) This helps explains why in antenna theory we always discuss wavelength and frequency no matter what signal (information) we want to transmit.

Frequency Bands

No discussion on antenna fundamentals is complete without a real-world list of frequency bands.

Radiation Pattern

The radiation pattern for an antenna is defined on this page. We have 3D graphs of real antenna radiation patterns, with a discussion on isotropic, omnidirectional and directional radiation patterns. Radiation patterns are of the utmost importance in the discussion of antenna basics.

Field Regions

The introduction to antennas continues with a discussion of Field Regions. The Far Field, Near Field and Fresnel Regions for an antenna is presented.

Directivity

Directivity is fundamental to antennas. It is a measure of how "directional" an antenna's radiation pattern is.

Antenna Efficiency

An antenna's efficiency is a measure of how much power is radiated by the antenna relative to the antenna input power.

Antenna Gain

Antenna Gain is a measure of power radiated in a particular direction (typically the peak direction of radiation).

Beamwidths and Sidelobes

An antenna's radiation pattern in the far field is often characterized by it's beamwidth and sidelobe levels. This introduction to antenas illustrates this with an example.

Impedance

Antenna Impedance is presented as the ratio of voltage to current at the antenna's terminals. Low- and High-Frequency models are presented for transmission lines. The fundamentals of antenna theory requires that the antenna be "impedance matched" to the transmission line or the antenna will not radiate. The concept of VSWR is introduced as a measure of how well matched an antenna is.

Bandwidth

The bandwidth of an antenna is the frequency range over which the antenna radiates. The bandwidth can be defined in different ways; this page presents an introduction to antenna bandwidth.

Polarization of Waves

All electromagnetic plane waves have an associated polarization. The antenna concepts of Linear, Circular and elliptical polarization are presented.

Polarization of Antennas

Antennas are also classified by their polarization; this defines the type of plane wave polarization the antenna is most sensitive to. This is a fundamental antenna concept.

Effective Aperture

Effective aperture is a basic antenna concept that is a measure of the power captured by an antenna from a plane wave. Effective aperture can be expressed as a function of the antenna gain and the wavelength of interest.

Friis Transmission Equation

Friis Transmission Formula is the most fundamental equation of antenna theory. This equation relates transmit power, antenna gains, distance and wavelength to received power. This page is a must-read for those interested in antenna theory.

Antenna Temperature

Antenna Temperature is a property of an antenna and the environment it operates in. It is a measure of the noise received by the antenna due to thermal (or temperature) effects.

Why do Antennas Radiate?

The antenna basics section concludes with a discussion of Why Antennas Radiate. The idea here is to explain the physical concepts that produce radiation in terms of electrons flowing on a wire.

After concluding the study of Antenna Fundamentals, the next step in the understanding of antenna theory is to move on to the types of antennas page, where basic antenna types are discussed. You will find that the understanding of the above concepts is crucial for understanding real antennas.

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