ANTENNA AND WAVE PROPAGATION

TYPES OF ANTENNAS

- According to their applications and technology available, antennas generally fall in one of two categories:

1. Omnidirectional or only weakly directional antennas which receive or radiate more or less in all directions. These are employed when the relative position of the other station is unknown or arbitrary. They are also used at lower frequencies where a directional antenna would be too large, or simply to cut costs in applications where a directional antenna isn't required.
2. Directional or *beam* antennas which are intended to preferentially radiate or receive in a particular direction or directional pattern.

- According to length of transmission lines available, antennas generally fall in one of two categories:

1. Resonant Antennas – is a transmission line, the length of which is exactly equal to multiples of half wavelength and it is open at both ends.

2. Non-resonant Antennas – the length of these antennas is not equal to exact multiples of half wavelength. In these antennas standing waves are not present as antennas are terminated in correct impedance which avoid reflections. The waves travel only in forward direction .Non-resonant antenna is a unidirectional antenna.

Directivity and Gain

Directivity and gain

Directivity $$D = \frac{P(\theta,\phi)_{\max}}{P(\theta,\phi)_{average}}$$

From pattern $$D = \frac{4\pi}{\iint\limits_{4\pi} P_n(\theta,\phi)d\Omega} = \frac{4\pi}{\Omega_A}$$

From aperture $$D = 4\pi\frac{A_e}{\lambda^2}$$

Isotropic antenna: $\Omega_A = 4\pi \quad D = 1$

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k_g = efficiency factor $(0 < k_g < 1)$

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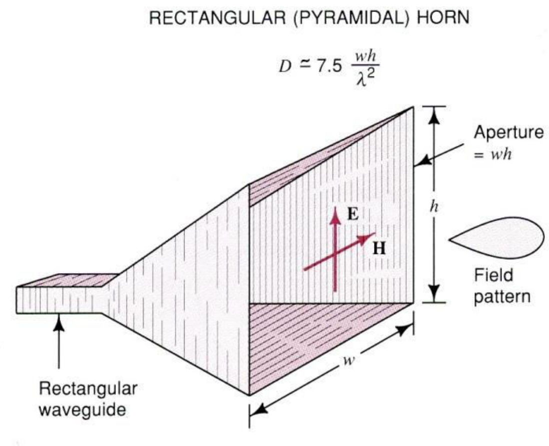
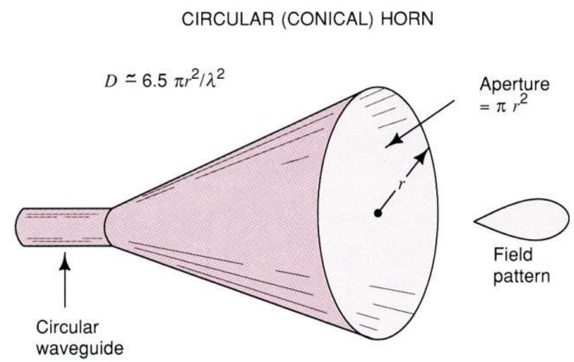
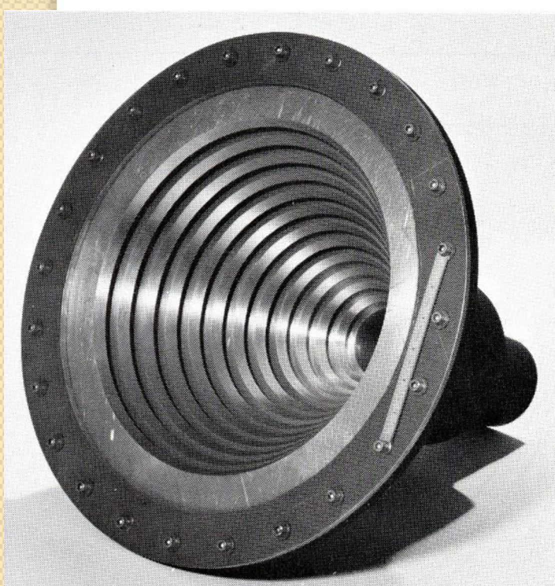
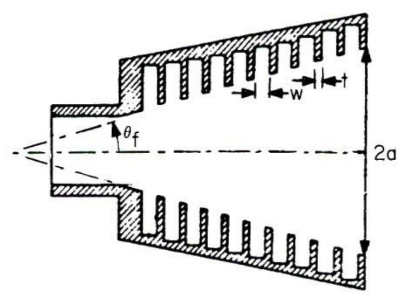
Horn antenna

- Rectangular or circular waveguide flared up
- Spherical wave fronts from phase centre
- Flare angle and aperture determine gain

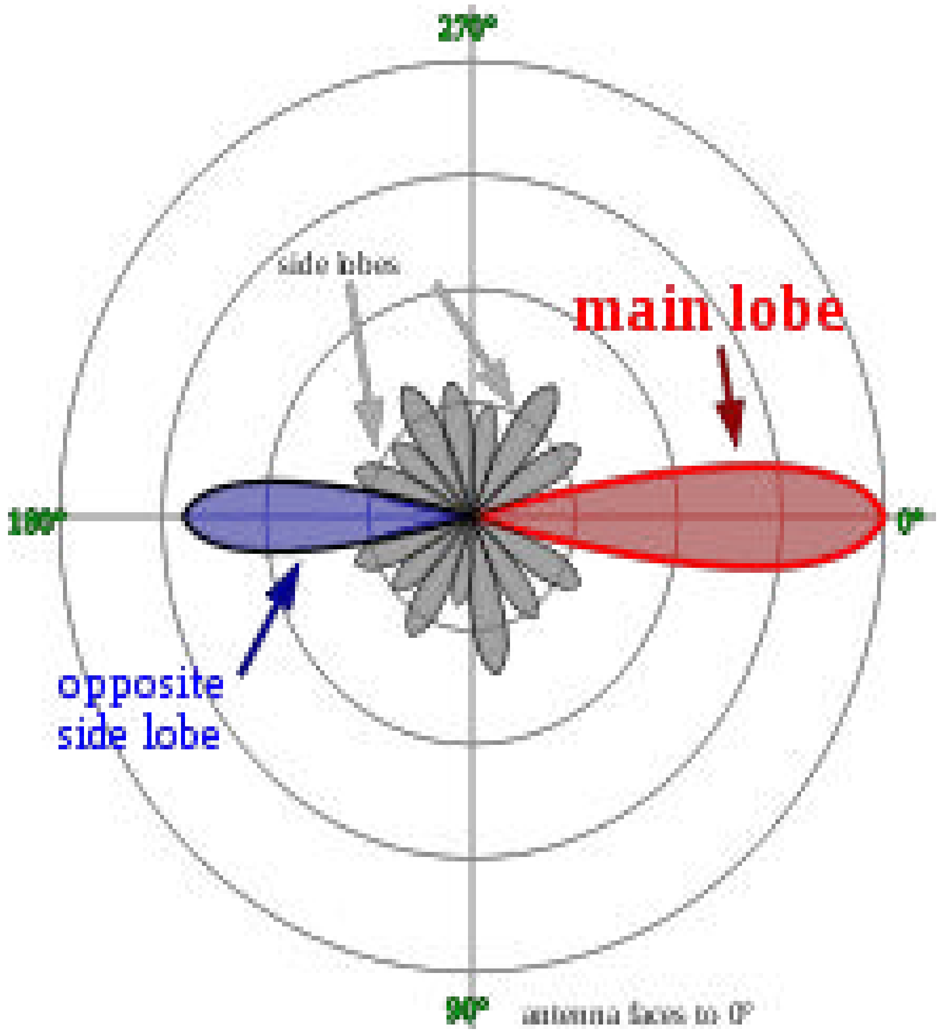








RADIATION PATTERN



- The radiation pattern of an antenna is a plot of the relative field strength of the radio waves emitted by the antenna at different angles.
- It is typically represented by a three dimensional graph, or polar plots of the horizontal and vertical cross sections. It is a plot of field strength in V/m versus the angle in degrees.
- The pattern of an ideal isotropic antenna , which radiates equally in all directions, would look like a sphere.
- Many non-directional antennas, such as dipoles, emit equal power in all horizontal directions, with the power dropping off at higher and lower angles; this is called an omni directional pattern and when plotted looks like a donut.

- The radiation of many antennas shows a pattern of maxima or "*lobes*" at various angles, separated by "*nulls*", angles where the radiation falls to zero.
- This is because the radio waves emitted by different parts of the antenna typically interfere, causing maxima at angles where the radio waves arrive at distant points in phase, and zero radiation at other angles where the radio waves arrive out of phase.
- In a directional antenna designed to project radio waves in a particular direction, the lobe in that direction is designed larger than the others and is called the "*main lobe*".
- The other lobes usually represent unwanted radiation and are called "*sidelobes*". The axis through the main lobe is called the "*principle axis*" or "*boresight axis*".

ANTENNA GAIN

- Gain is a parameter which measures the degree of directivity of the antenna's radiation pattern. A high-gain antenna will preferentially radiate in a particular direction.
- Specifically, the *antenna gain*, or *power gain* of an antenna is defined as the ratio of the intensity (power per unit surface) radiated by the antenna in the direction of its maximum output, at an arbitrary distance, divided by the intensity radiated at the same distance by a hypothetical isotropic antenna.

- The gain of an antenna is a passive phenomenon - power is not added by the antenna, but simply redistributed to provide more radiated power in a certain direction than would be transmitted by an isotropic antenna.
- High-gain antennas have the advantage of longer range and better signal quality, but must be aimed carefully in a particular direction.
- Low-gain antennas have shorter range, but the orientation of the antenna is relatively inconsequential.

- For example, a dish antenna on a spacecraft is a high-gain device that must be pointed at the planet to be effective, whereas a typical Wi-Fi antenna in a laptop computer is low-gain, and as long as the base station is within range, the antenna can be in any orientation in space.
- In practice, the half-wave dipole is taken as a reference instead of the isotropic radiator. The gain is then given in **dBd** (decibels over **d**ipole)