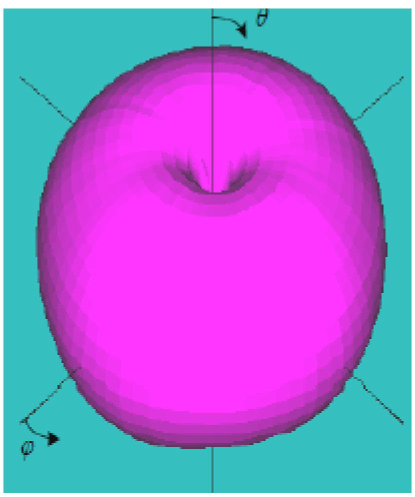
PATTERNS OF ANTENNA

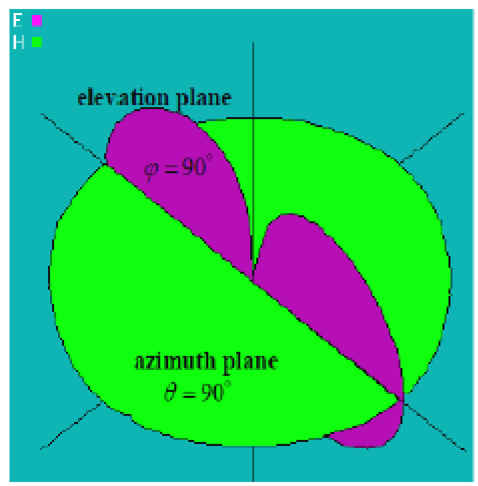
Reciprocity: An antenna exhibits identical impedance during Transmission or Reception, same directional patterns during Transmission or Reception, same effective height while transmitting or receiving**.** Transmission and reception antennas can be used interchangeably. Medium must be linear, passive and isotropic (physical properties are the same in different directions). Antennas are usually optimized for reception or transmission, not both.

Patterns:

The radiation pattern or antenna pattern is the graphical representation of the radiation properties of the antenna as a function of space. That is, the antenna's pattern describes how the antenna radiates energy out into space (or how it receives energy). It is important to state that an antenna can radiate energy in all directions, so the antenna pattern is actually three-dimensional. It is common, however, to describe this 3D pattern with two planar patterns, called the principal plane patterns. These principal plane patterns can be obtained by making two slices through the 3D pattern, through the maximum value of the pattern. It is these principal plane patterns that are commonly referred to as the antenna patterns.

Radiation pattern or Antenna pattern is defined as the spatial distribution of a ‘quantity’ that characterizes the EM field generated by an antenna. The ‘quantity’ may be Power, Radiation Intensity, Field amplitude, Relative Phase etc.





Always the radiation has Main lobe through which radiation is maximum in the z direction and Minor lobe (side and back lobes) in the x and y direction. Any field pattern is presented by 3D spherical coordinates or by plane cuts through main lobe axis. Two plane cuts as right angles are called as principal plane pattern. To specify the radiation pattern with respect to field intensity and polarization requires three patterns:

(i). The θ component of the electric field as a function of the angles θ and Φ or $E_\theta(\theta,\Phi)$ in Vm^{-1}.

(ii).The Φ component of the electric field as a function of the angles θ and Φ or $E_\Phi(\theta,\Phi)$ in Vm^{-1}.

(iii). The phases of these fields as a function of the angles θ and Φ or $\delta_\theta(\theta,\Phi)$ and $\delta_\Phi(\theta,\Phi)$ in radian or degree.

Normalized field pattern: It is obtained by dividing a field component by its maximum value. The normalized field pattern is a dimensionless number with maximum value of unity.

$$E\theta(\theta,\phi)n = \frac{E\theta(\theta,\phi)}{E\theta(\theta,\phi)max}$$

Half power level occurs at those angles $(\theta,\Phi)$for which $E_\theta(\theta,\Phi)_n$ =0.707. At distance $d>>\lambda$ and d>> size of the antenna, the shape of the field pattern is independent of the distance.

Normalized power pattern: Pattern expressed in terms of power per unit area is called power pattern. Normalizing the power with respect to maximum value yields normalized power patterns as a function of angle which is dimensionless and maximum value is unity.

$$Pn(\theta,\phi)n = \frac{S(\theta,\phi)}{S(\theta,\phi)max}$$

Where, $S(\theta,\Phi)$ is the Poynting vector = $[\, E_\theta^2(\theta,\Phi) + E_\Phi^2(\theta,\Phi)\,] / Z_0$ Wm^{-2}

$S(\theta,\Phi)_{max}$ is the maximum value of $S(\theta,\Phi)$, Wm^{-2}

Z_0 is the intrinsic impedance of free space = 376.7Ω.

Decibel level is given by $dB = 10 \log_{10} P_n(\theta,\Phi)$

Half power levels occurs at those angles (θ,Φ) for which $P(\theta,\Phi)_n$ =0.5.