ANTENNA TEMPERATURE AND FIELD ZONE

Radiation Efficiency

Total antenna resistance is the sum of 5 components

Rr+Rg+Ri+Rc+Rw

Rr is Radiation resistance

Rg is ground resistance

Ri is equivalent insulation loss

Rc is resistance of tuning inductance

Rw is resistance equivalent of conductor loss

Radiation efficiency=Rr/(Rr+Rg+Ri+Rc+Rw). It is the ratio of power radiated from the antenna to the total power supplied to the antenna

Antenna temperature

The antenna noise can be divided into two types according to its physical source:

- noise due to the loss resistance of the antenna itself; and
- noise, which the antenna picks up from the surrounding environment The noise power per unit bandwidth is proportional to the object's temperature and is given by Nyquist's relation

$$p_h = kT_P, \text{ W/Hz}$$

where

Tp is the physical temperature of the object in K (Kelvin degrees); and k is Boltzmann's constant (1.38×10^{-23} J/K

A resistor is a thermal noise source. The noise voltage(rms value) generated by a resistor R, kept at a temperature T, is given by

$$V_n = \sqrt{4kTBR}$$

Where,

k is Boltzmann's constant (1.38×10^{-23} J/K). And

B is the bandwidth in Hz

Often, we assume that heat energy is evenly distributed in the frequency band Δf . Then, the associated heat power in Δf is

$$P_h = kT_P \Delta f \text{ , W.}$$

For a temperature distribution T(θ,Φ) and radiation pattern R(θ,Φ) of the antenna ,
Then noise temperature T_A is given by

$$T_A = \frac{1}{4\pi} \int_0^{2\pi} \int_0^{\pi} R(\theta,\phi).T(\theta,\phi) \sin\theta d\theta d\phi$$

The noise power P_{TA} received from an antenna at temperature T_A can be expressed in terms of Bandwidth B over which the antenna(and it's Receiver) is operating as $P_{TA} = kT_A B$

The receiver also has a temperature T_R associated with it and the total system noise temperature (i.e., Antenna + Receiver) has combined temperature given b

$$T_{sys} = T_A + T_R$$

And total noise power in the system is

$$P_{Total} = kT_{sys} B$$

Antenna Field Zones:

The space surrounding the antenna is divided into three regions according to the predominant field behaviour. The boundaries between the regions are not distinct and the field behaviour changes gradually as these boundaries are crossed. In this course, we are mostly concerned with the far-field characteristics of the antennas.

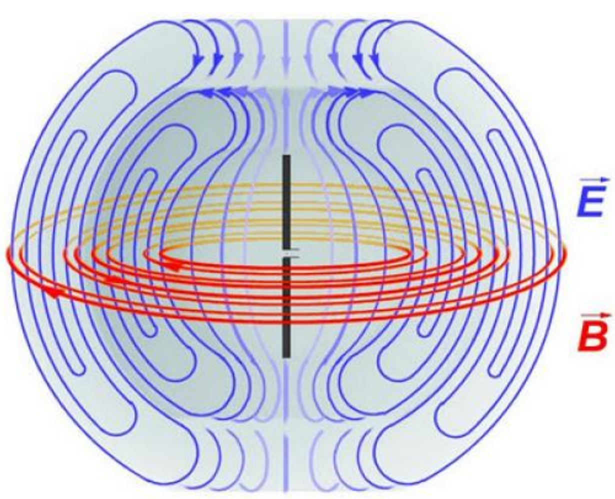

Fig: Radiation from a dipole

1.Reactive near-field region: This is the region immediately surrounding the antenna, where the reactive field dominates. For most antennas, it is assumed that this region is a sphere with the antenna at its centre

2. Radiating near-field (Fresnel) region : This is an intermediate region between the reactive near-field region and the far-field region, where the radiation field is more significant but the angular field distribution is still dependent on the distance from the antenna.

3. Far-field (Fraunhofer) region : Here $r >> D$ and $r >> \lambda$

The angular field distribution does not depend on the distance from the source any more, i.e., the far-field pattern is already well established.