ANTENNA EFFICIENCY

In antenna theory, radiation efficiency, which is often abbreviated to just efficiency is a figure of merit for an antenna. It is a measure of the electrical losses that occur in the antenna.

Radiation efficiency is defined as "The ratio of the total power radiated by an antenna to the net power accepted by the antenna from the connected transmitter." It is sometimes expressed as a percentage. It will be frequency dependent.

The gain of an antenna is the directivity multiplied by the radiation efficiency.

Antenna efficiency is the ratio between its radiation resistance and its total resistance:

$$E_{radiation} - \frac{P_\Sigma}{P_0} - \frac{P_\Sigma}{P_\Sigma + P_\Pi} - \frac{R_{radiation}}{R_{total}}$$

where, P_0- active power (accepted by the antenna from the connected transmitter),

P_Σ- radiation power,

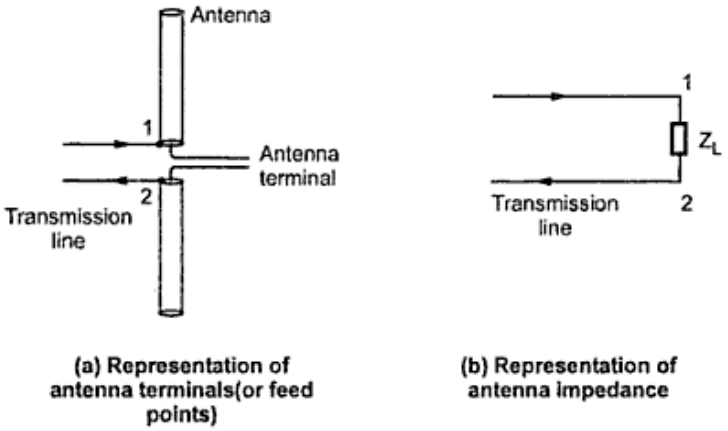
P_Π- power of losses.

Efficiency of a transmitting antenna is the ratio of power actually radiated (in all directions) to the power absorbed by the antenna terminals. The power supplied to the antenna terminals which is not radiated is converted into heat. This is usually through loss resistance in the antenna's conductors. The efficiency of an antenna is equal to

$$\eta = R_r / (R_r + R_{loss})$$

Self Impedance of Antenna

The impedance of antenna measured at the terminals where transmission line carrying R.F. power connected is called antenna input impedance. These terminals are nothing but feed points of the antenna, the impedance is also called feed point impedance or terminal impedance. As the R.F. power carried by the transmission line from the transmitter, excites or drives the antenna, the antenna input impedance can be alternatively called driving point impedance of antenna.



(a) Representation of antenna terminals(or feed points)

(b) Representation of antenna impedance

Fig 6 Representation of antenna impedance

When the antenna is lossless and isolated from ground and other objects, the impedance offered by antenna to the transmission line is represented by two terminal networks with impedance Z_L as shown in the Fig. 6(b). Note that the notation Z_L represents that the antenna impedance acts as load to the transmission line driving antenna. With a lossless and isolated antenna, the antenna terminal impedance is same as the self impedance of the antenna, which is represented by Z_{11}. The self impedance of the antenna is a complex quantity given by,

$$\mathbf{Z_{11} = R_{11} + j\, X_{11}} \qquad \text{...(1)}$$

The real part of Z_{11} i.e. R_{11} is called self resistance or radiation resistance of antenna, while the imaginary part of Z_{11} i.e. X_{11} is called self reactance of antenna.

For half wave dipole, the self impedance is typically given by,

$$\mathbf{Z_{11} = R_{11} + j\, X_{11} = 73 + j\, 42.45} \qquad \text{... (2)}$$

Note: The self impedance of antenna is always positive. The value of self impedance is same for antenna used either as transmitting antenna or receiving antenna. The self impedance of the antenna is nothing but the impedance measured at input terminals of an antenna with all other antennas is isolated from it.