

ANTENNA BASICS

Introduction:

Antenna is a source or radiator of Electromagnetic waves or a sensor of Electromagnetic waves. It is a transition device or transducer between a guided wave and a free space wave or vice versa. It is also an electrical conductor or system of conductors that radiates EM energy into or collects EM energy from free space. Antennas function by transmitting or receiving electromagnetic (EM) waves. Examples of these electromagnetic waves include the light from the sun and the waves received by your cell phone or radio. Your eyes are basically "receiving antennas" that pick up electromagnetic waves that are of a particular frequency. The colors that you see (red, green, blue) are each waves of different frequencies that your eyes can detect. All electromagnetic waves propagate at the same speed in air or in space. This speed (the speed of light) is roughly 671 million miles per hour (1 billion kilometers per hour). This is roughly a million times faster than the speed of sound (which is about 761 miles per hour at sea level). The speed of light will be denoted as c in the equations that follow. We like to use "SI" units in science (length measured in meters, time in seconds, mass in kilograms):

$$c = 3 \times 10^8 \text{ meter/second}$$

Some Antenna Types:

Wire Antennas- dipoles, loops and Helical
Aperture Antennas-Horns and reflectors Array
Antennas-Yagi, Log periodic Patch Antennas-
Microstrips, PIFAs

Basic Antenna Parameters:

A radio antenna may be defined as the structure associated with the region of transition between a guided wave and a free space wave or vice versa.

Principle: Under time varying conditions, Maxwell's equations predict the radiation of EM energy from current source (or accelerated charge). This happens at all frequencies, but is insignificant as long as the size of the source region is not comparable to the wavelength. While transmission lines are designed to minimize this radiation loss, radiation into free space becomes main purpose in case of Antennas. The basic principle of radiation is produced by accelerated charge. The basic equation of radiation is

$$I L = Q V \quad (\text{Ams}^{-1})$$

where, I = Time changing current in Amps/sec

L = Length of the current element in meters

Q = Charge in Coulombs

V = Time changing velocity

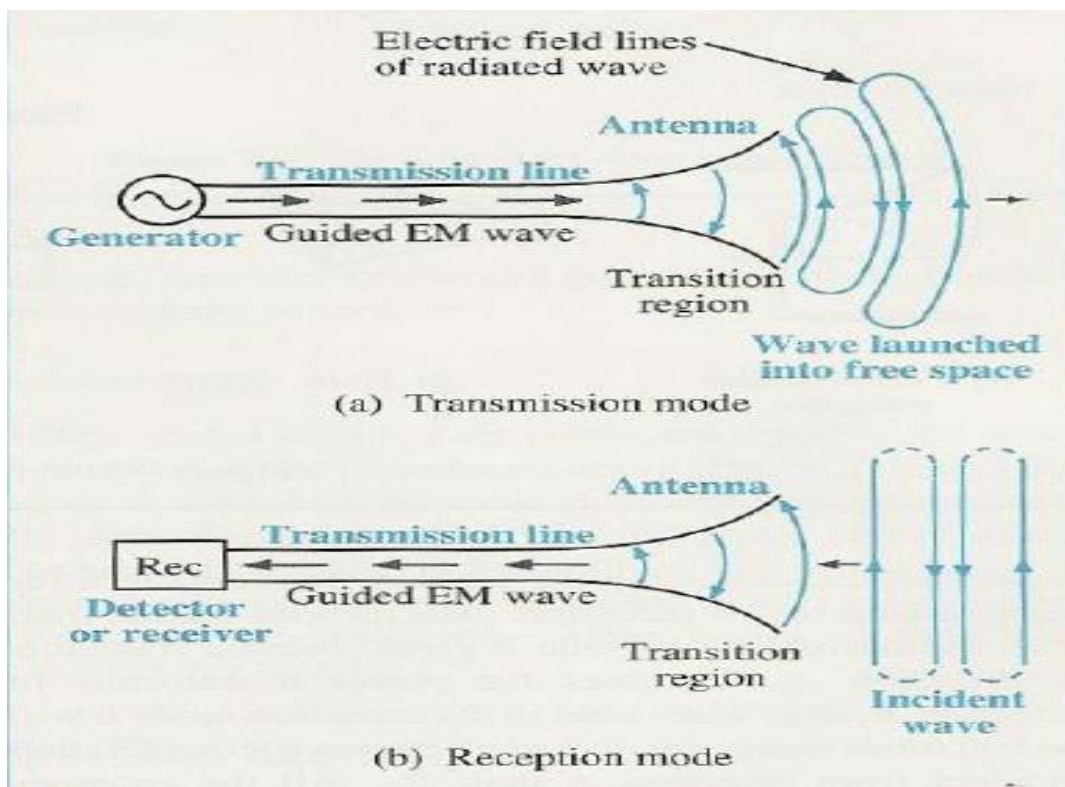
Thus time changing current radiates and accelerated charge radiates. For steady state harmonic variation, usually we focus on time changing current. For transients or pulses, we focus on accelerated charge. The radiation is perpendicular to the acceleration and the radiated power is proportional to the square of IL or QV .

Transmission line opened out in a Tapered fashion as

Antenna:

a). As Transmitting Antenna: Here the Transmission Line is connected to source or generator at one end. Along the uniform part of the line energy is guided as Plane TEM wave with little loss. Spacing between line is a small fraction of λ . As the line is opened out and the separation between the two lines becomes comparable to λ , it acts like an antenna and launches a free space wave since currents on the transmission line flow out on the antenna but fields associated with them keep on going. From the circuit point of view the antennas appear to the transmission lines as a resistance R_r , called Radiation resistance.

b) As Receiving Antenna: Active radiation by other Antenna or Passive radiation from distant objects raises the apparent temperature of R_r . This has nothing to do with the physical temperature of the antenna itself but is related to the temperature of distant objects that the antenna is looking at. R_r may be thought of as virtual resistance that does not exist physically but is a quantity coupling the antenna to distant regions of space via a virtual transmission line.



Thus, an antenna is a transition device, or transducer, between a guided wave and a free space wave or vice versa. The antenna is a device which interfaces a circuit and space.

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