

Antennas

Antenna - a device used to efficiently transmit and/or receive electromagnetic waves.

Example Antenna Applications

Wireless communications

- Personal Communications Systems (PCS)
- Global Positioning Satellite (GPS) Systems
- Wireless Local Area Networks (WLAN)
- Direct Broadcast Satellite (DBS) Television
- Mobile Communications
- Telephone Microwave/Satellite Links
- Broadcast Television and Radio, etc.

Remote Sensing

- Radar [active remote sensing - radiate and receive]
 - Military applications (target search and tracking)
 - Weather radar, Air traffic control
 - Automobile speed detection
 - Traffic control (magnetometer)
 - Ground penetrating radar (GPR)
 - Agricultural applications
- Radiometry [passive remote sensing - receive emissions]
 - Military applications
(threat avoidance, signal interception)

Antenna Types

- Wire antennas (monopoles, dipoles, loops, etc.)
- Aperture antennas (sectoral horn, pyramidal horn, slots, etc.)
- Reflector antennas (parabolic dish, corner reflector, etc.)
- Lens antennas
- Microstrip antennas
- Antenna arrays

Antenna Performance Parameters

Radiation pattern - angular plot of the radiation.

Omnidirectional pattern - uniform radiation in one plane

Directive patterns - narrow beam(s) of high radiation

Directivity - ratio of antenna power density at a distant point relative to that of an isotropic radiator [*isotropic radiator* - an antenna that radiates uniformly in all directions (point source radiator)].

Gain - directivity reduced by losses.

Polarization - trace of the radiated electric field vector (linear, circular, elliptical).

Impedance - antenna input impedance at its terminals.

Bandwidth - range of frequencies over which performance is acceptable (resonant antennas, broadband antennas).

Beam scanning - movement in the direction of maximum radiation by mechanical or electrical means.

Other system design constraints - size, weight, cost, power handling, radar cross section, etc.

Fundamentals of Antenna Radiation

An antenna may be thought of as a matching network between a wave-guiding device (transmission line, waveguide) and the surrounding medium.

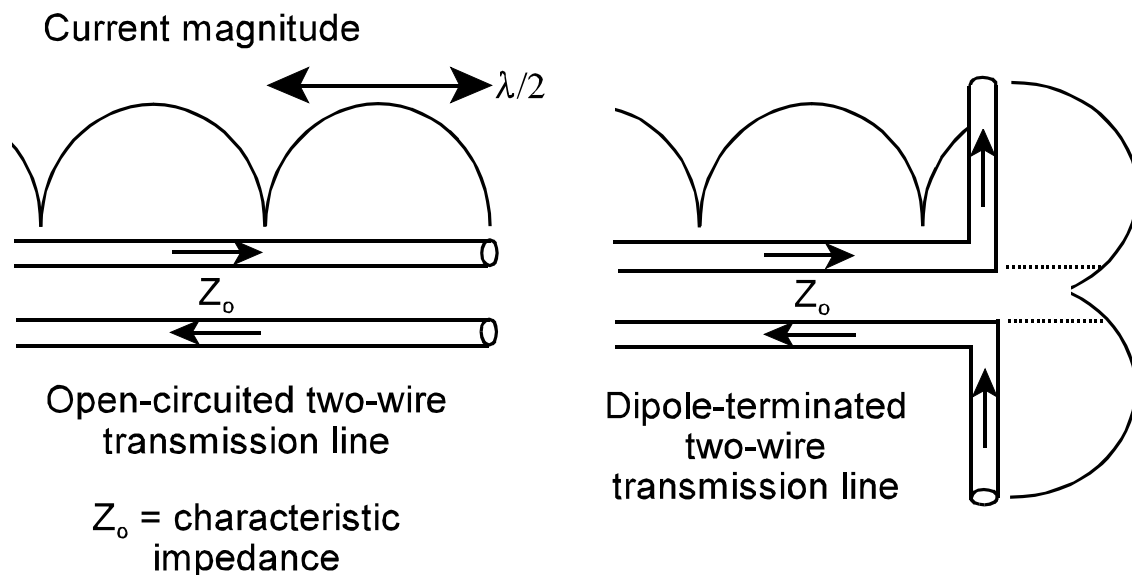
Transmitting antenna

guided wave input \rightarrow antenna \rightarrow unguided wave output

Receiving antenna

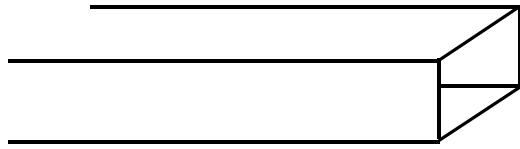
unguided wave input \rightarrow antenna \rightarrow guided wave output

Antenna as the termination of a transmission line

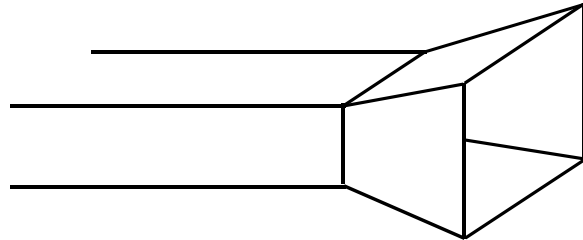


The open-circuited transmission line does not radiate effectively because the transmission line currents are equal and opposite (and very close together). The radiated fields of these currents tend to cancel one another. The current on the arms of the dipole antenna are aligned in the same direction so that these radiated fields tend to add together making the dipole an efficient radiator.

Antenna as the termination of a waveguide



Open-ended
rectangular waveguide



rectangular waveguide
terminated with a
pyramidal horn antenna

The open-ended waveguide will radiate, but not as effectively as the waveguide terminated by the horn antenna. The wave impedance inside the waveguide does not match that of the surrounding medium creating a mismatch at the open end of the waveguide. Thus, a portion of the outgoing wave is reflected back into the waveguide. The horn antenna acts as a matching network, with a gradual transition in the wave impedance from that of the waveguide to that of the surrounding medium. With a matched termination, the reflected wave is minimized and the radiated field is maximized.