Antennas

Terminology

When discussing radio communications and antenna it is vital to understand a few basic terms and expressions. The first basic formula to remember relates frequency (f) to wavelength (l) by the equation: l [m] = 300 / f [MHz].

The radiation pattern is the three dimensional radiation characteristics of an antenna in 2 planes, the electric field (E) and magnetic field (H). The gain of the antenna is its capability to force radiation in a specific direction in space at the expense of other directions. Gain is expressed in dB compared to some reference: for example dBi refers to gain compared to an isotropic antenna and dBd to a dipole antenna. The polarization is defined as the plane of antenna's electric field E and can be vertical, horizontal, slanted or circular. Typically the antenna's physical orientation equals the antenna's polarization. Orthogonal polarization's have a cross polarization loss of 21 dB. In practice all the antennas in one system should use the same polarization.

The Impedance of an antenna is its AC-resistance and reactance within the operating band. Nominal impedance of 50 ohms is a standard. The bandwidth is the frequency range where the antenna's characteristics like impedance, gain and radiation pattern remain within the specifications. The commonly used term attenuation is mainly related to feeders and radio propagation and is also expressed in dB.

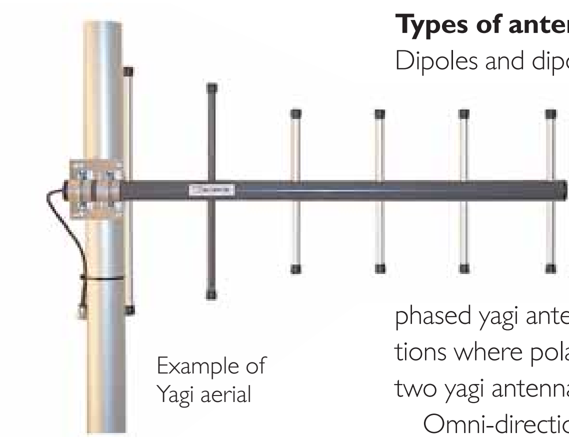
The antenna and its components

An antenna is an electromechanical device whose purpose is to radiate as effectively as possible the power from the feeder in a specific manner.

A power splitter matches and combines multiple loads or sources and equally splits the power between them without disturbing the characteristic impedance of the system. Splitters are used in antenna arrays to combine multiple antennas or in RF distribution harnesses. A feed-line is an interconnecting cable between radio equipment and antenna. Feeders tend to be lossy components so the type has to be carefully selected depending on the required length and operating frequency. Lightning protectors can be inserted between the radio equipment and feeder to help protect the radio against a lightning strike. Typically a lightning protector is a DC short-circuited quarter wave stub. When interconnecting antenna circuit components, impedance match has to be maintained in order to provide ideal flow of power without additional losses due to reflections. Impedance match is commonly measured as VSWR (**V**oltage **S**tanding **W**ave **R**atio) where a VSWR of 1:1 is ideal and 1:1.5 is more realistic in practice.

BACK

Types of antennas



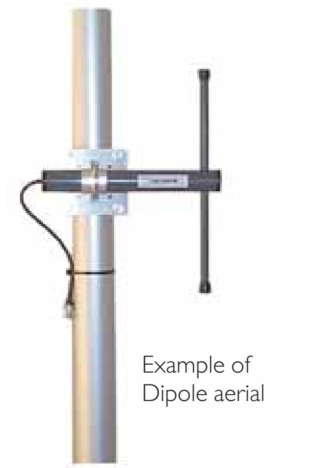
Example of Yagi aerial

Dipoles and dipole arrays are constructed of one or multiple dipole antennas and power splitters combining the antennas. These are typically omni-directional or off-set pattern antennas.

Yagi and Yagi arrays are constructed of one or multiple yagi antennas and power splitters combining the antennas. These are always directional antennas. Cross-polarized yagis are a combination of two independently fed, orthogonally polarized and physically quarter wave phased yagi antennas on the same boom. Cross-polarized yagis are used in applications where polarization diversity is required or in a circular polarization mode when two yagi antennas are combined with a power splitter.

Omni-directionals can be either end fed half wave antennas, collinear antennas or ground plane antennas. These antennas radiate in all directions equally.

Portables are typically flexible quarter wave antennas with specific feeding methods for proper impedance match with small sized portable radio equipment.

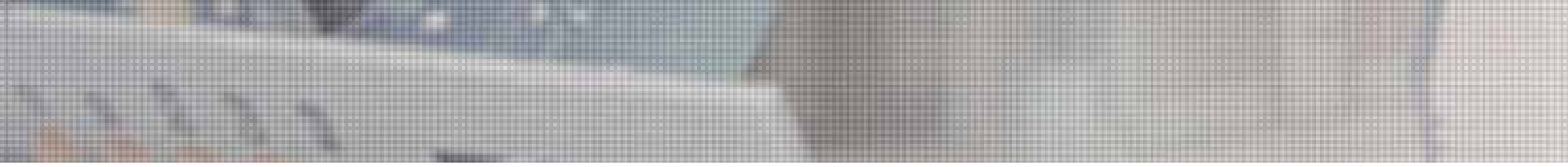


Example of Dipole aerial

Signal propagation

Radio waves propagate mainly along line of the sight but there will also be bending, reflection and diffraction occurring. Typically, radio waves propagate simultaneously in many different modes and paths. This multi-path propagation causes some signal instability as a function of time due to the summing of multiple incoming signals, which have different phases. This also explains why a small physical movement of the antenna can have influence on indicated signal strength.

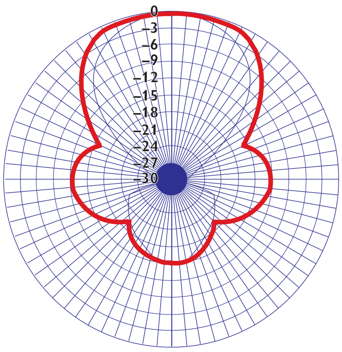
The radio horizon is about 15% further than the optical horizon due to radio waves tendency to bend.



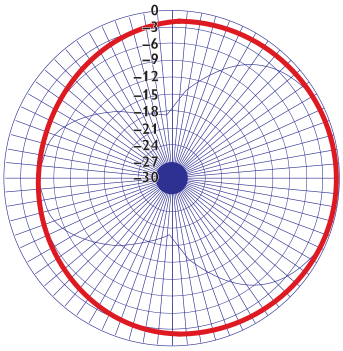
Radio network

A radio link budget calculation should be performed to see if enough power and margin is left at the receiver end of the radio link after propagation. In radio link calculations everything is expressed in dB, plus or minus, and added together. Radio link budget calculation parameters are distance, frequency, terrain, antenna height, transmitter output power, receiver sensitivity, feeder loss, antenna gain and propagation loss. A radio link budget calculation gives the same result in both directions.

Radio network coverage can be improved by using repeaters, which can be located in suitable positions and chained to expand the coverage area.



Yagi
attenuation diagram



Dipole
attenuation diagram