1. Introduction to Antenna

A transmitter generates a radio frequency (RF) signal, and then sends the signal through a transmission line to an antenna. The antenna broadcasts the signal in the form of electromagnetic (EM) wave into the space. When the EM wave is received by another antenna at the designated location, a transmission line passes the signal from the antenna to the receiver, and the communication path is completed.

In a word, antenna acts as a main role in wireless communication network. No antenna, no wireless communication. There are many types of antennas that can be classified into different categories under different circumstances.

For example:
- Classify by application: communication antenna, television antenna, radar antenna, etc…
- Classify by frequency: VHF antenna, microwave antenna, UHF antenna, etc…
- Classify by shape: panel antenna, parabolic antenna, Omni-directional antenna, etc…

2. Introduction to EM Wave Propagation

Antenna is a set of conducting wires that allow electric current to pass. When the electric current fluctuates, the lectromagnetic wave radiation occurs. The antenna radiates the wave energy into space or receive energy from the space.

The radiation ability depends the wire's length and shape. For example, if the two wires are very close, the electric and magnetic field are trapped between them and the radiation is very weak (figure 1a). As the two wires are apart further, the radiation becomes stronger, meaning more energy is radiated into the space (figure1b, figure1c)

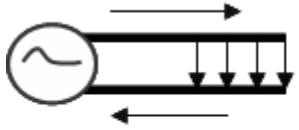


Figure 1a

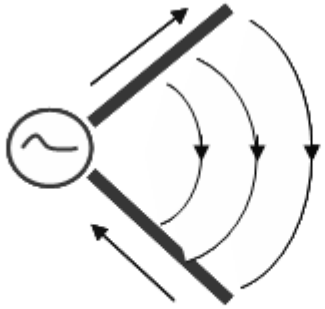


Figure 1b

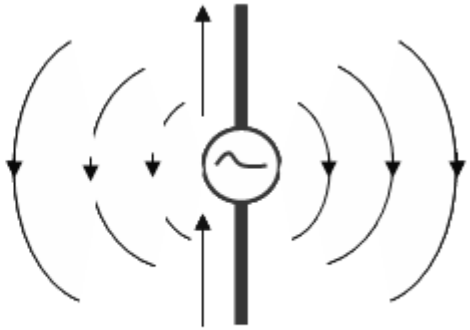


Figure 1c

3. Dipole – The Fundamental Antenna

Dipole–The Fundamental Antenna Dipole antenna is one of the most fundamental antenna that still be widely used today. A single half-wave dipole can work independently, or work as a parabolic antenna's feeder. Several half-wave dipoles can combine to become antenna array.

A dipole antenna with two arms of same length is named symmetrical dipole. If each arm is equal to 1/4 of the wave length and total length is 1/2 of the wave length, such dipole is called half-wave symmetrical dipole (Figure 2a).

In addition, if a full wave length dipole is folded as a rectangular shape, such long, narrow rectangular frame is called folded dipole. Note if a folded dipole is also half wave long, it is called half-wave folded dipole (Figure 2b)

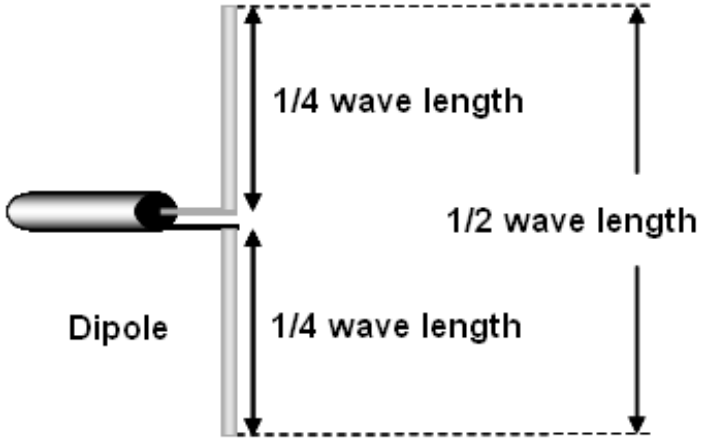


Figure 2a

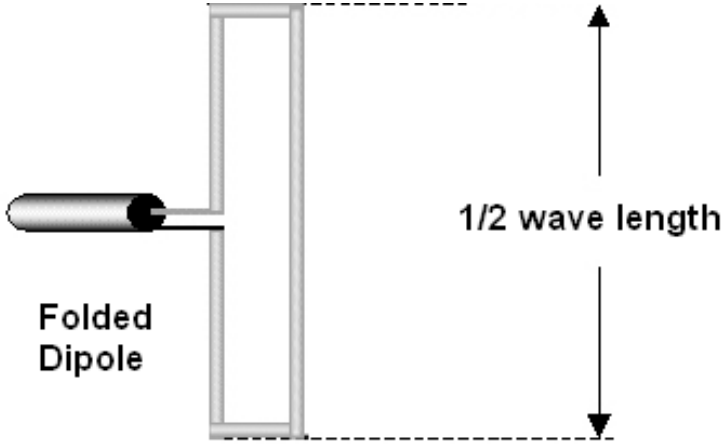


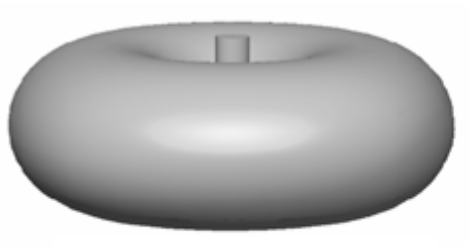
Figure 2b

4. Antenna Radiation Direction

Antenna Direction

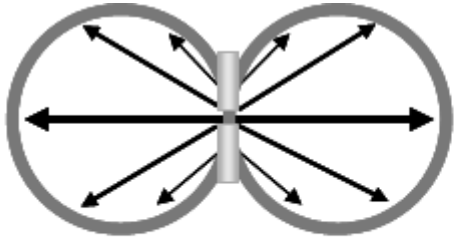
Antenna has two basic functions: 1. radiates the energy into space from the transmission line. 2. radiates most of the energy to the desired direction.

A vertical placed half-wave dipole antenna has a "donut" shape 3-D radiation pattern (Figure 3.1a). From the vertical plane (Figure 3.1b), the maximum radiation is pointing at the horizontal direction. From the horizontal plane (Figure 3.1c), the radiation is equal to all directions.



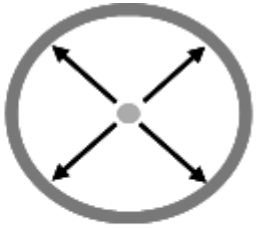
3-D Raidation Pattern

Figure 3.1a



Vertical Plane

Figure 3.1b



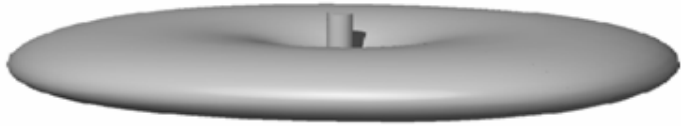
Horizontal Plane

Figure 3.1c

5. Antenna Radiation Enhancement

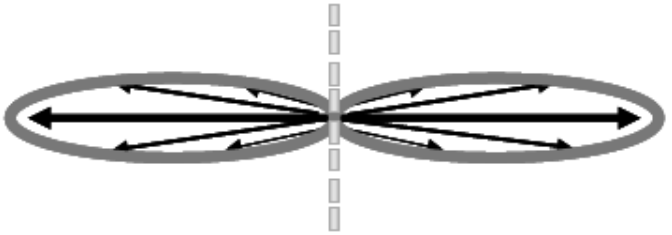
Several symmetrical dipole antennas can form an antenna array to control the radiation direction. The “flat donut” radiation pattern suggests the energy is further converged on the horizontal direction.

The following radiation pattern is formed by four identical dipole antennas placed in the vertical line (Figure 3.2a & Figure 3.2b)



3-D Radiation Pattern

Figure 3.2a

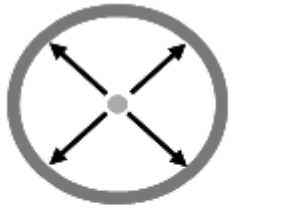


Radiation Pattern in Vertical Plane

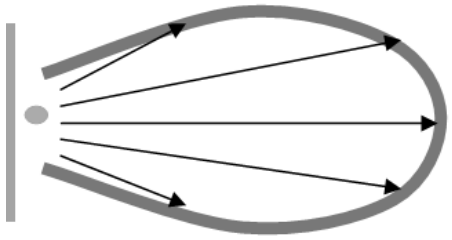
Figure 3.2b

6. Antenna Radiation Enhancement –cont.

- **A reflection panel also works for biasing the radiation to one side.**
- **The following graph shows how the reflector works. By placing the reflector beside the antenna feeder, the radiating power are reflected to one side – thus increases the gain.**
- **The parabolic shape reflector works like a torch which converges the energy to one point, so that the gain dramatically increases at the pointing direction.**



Omni-directional without reflector
Figure 3.2c



The reflector bias the energy to one direction
Figure 3.2d

7. Gain

Under the same input power, gain is the ratio between the highest antenna's radiated power intensity and the standard unit antenna. Antenna gain represents the convergence of the radiation energy at the pointing direction.

If Gain G=13dB=20 , to radiate 100W with the antenna, it only needs 100W / 20 = 5W input power.

A half wave length dipole = 2.15dBi.

8. Beamwidth

- **In the radiation pattern, in most cases there are more than one lobes, which is called the mainlobe with the highest radiated energy and the rest is called sidelobes.**
- **Beamwidth means degree of the gain decrease by 3dB from the maximum gain, or, when the power intensity decreases to its half.**

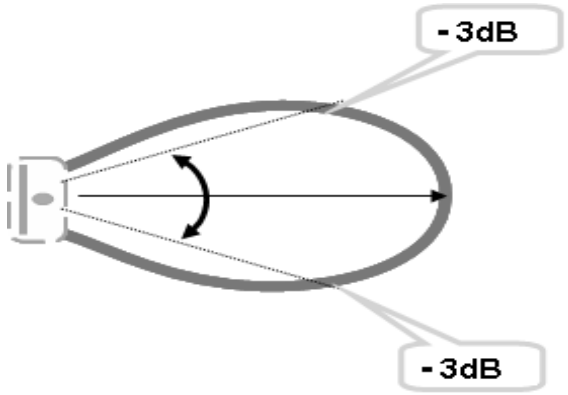


Figure 3.3 Beamwidth

9. Front to Back Ratio

- **In the radiation pattern, the power ratio of the mainlobe's front and back is called Front to Back Ratio (F/B Ratio).**
- **The higher the F/B Ratio value, the more energy is not wasted in the unwanted direction.**

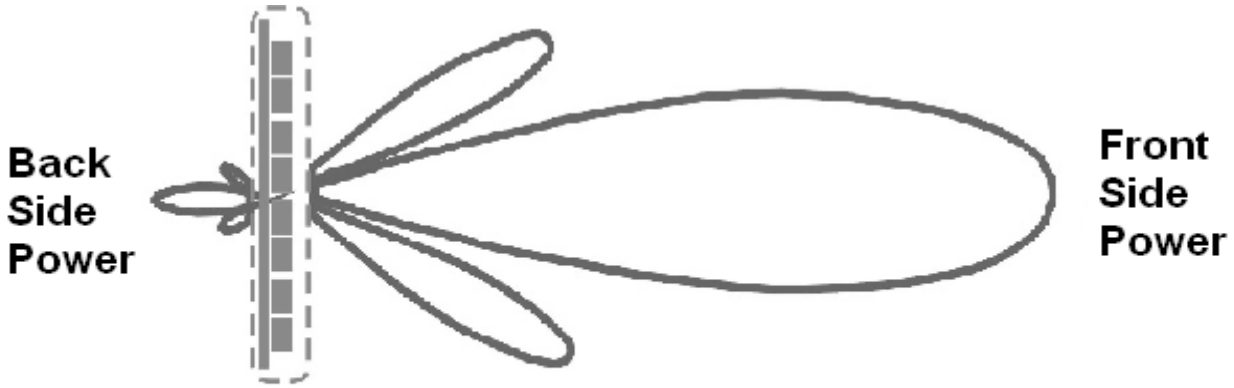


Figure 3.5 Front to Back Ratio

10. Polarization

Antenna radiates energy in electromagnetic wave form. The electromagnetic wave is formed by two perpendicular fields – the electric field and magnetic field.It is defined that the polarization direction is identical to the electric field, or E field.Normally we use vertical polarized antennas, but sometimes we apply horizontal polarized antennas for communications.

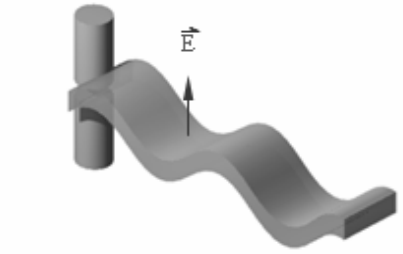


Figure 3.6a
Vertical Polarization

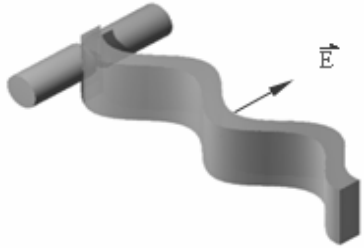


Figure 3.6b
Horizontal Polarization

11. BOBOTO Antennas

11.1 Panel Antennas

Panel antennas are normally installed in base stations. Panel antenna has certain degrees: 60, 90, 120 etc.

- **Usually several antennas group together to form an antenna arrays in order to cover the whole area in 360 degrees.**

11. BOBOTO Antennas

11.2 Parabolic Antennas

- **Parabolic antennas are mostly used for distant communications. The dish shape reflectors highly converges the radiation energy into the pointing direction thus its gain are very high (usually 20 – 30dBi).**
- **Such high gain parabolic antennas are best suited in long distance point-to-point communications.**

11. BOBOTO Antennas

11.3 Yagi Antennas

Yagi Antennas have high gain, light structure, easy installation characteristics. This type of antennas are ideal for point-to-point, point-to-multipoint communications for end users. BOBOTO Yagi antennas are made of stainless steel or aluminum, which protected radome for heavy duty all weather outdoor usage.

11. BOBOTO Antennas

11.4 Ceiling Mount Antennas

Ceiling mount antennas are used for in-building wireless coverage. KBT ceiling mount antennas have nice exterior design and excellent electrical performance. Customization to these low-profile antennas are welcome.

11. BOBOTO Antennas

11.5 Wall Mount Antennas

- **Wall Mount antennas are designed for indoor coverage. Ceiling mount antennas tend to cover the area in 360 degree direction while wall mount antennas tend to provide stronger signal in a particular direction. BOBOTO wall mount antennas have good gain, nice texture, and easy installation characteristics.**