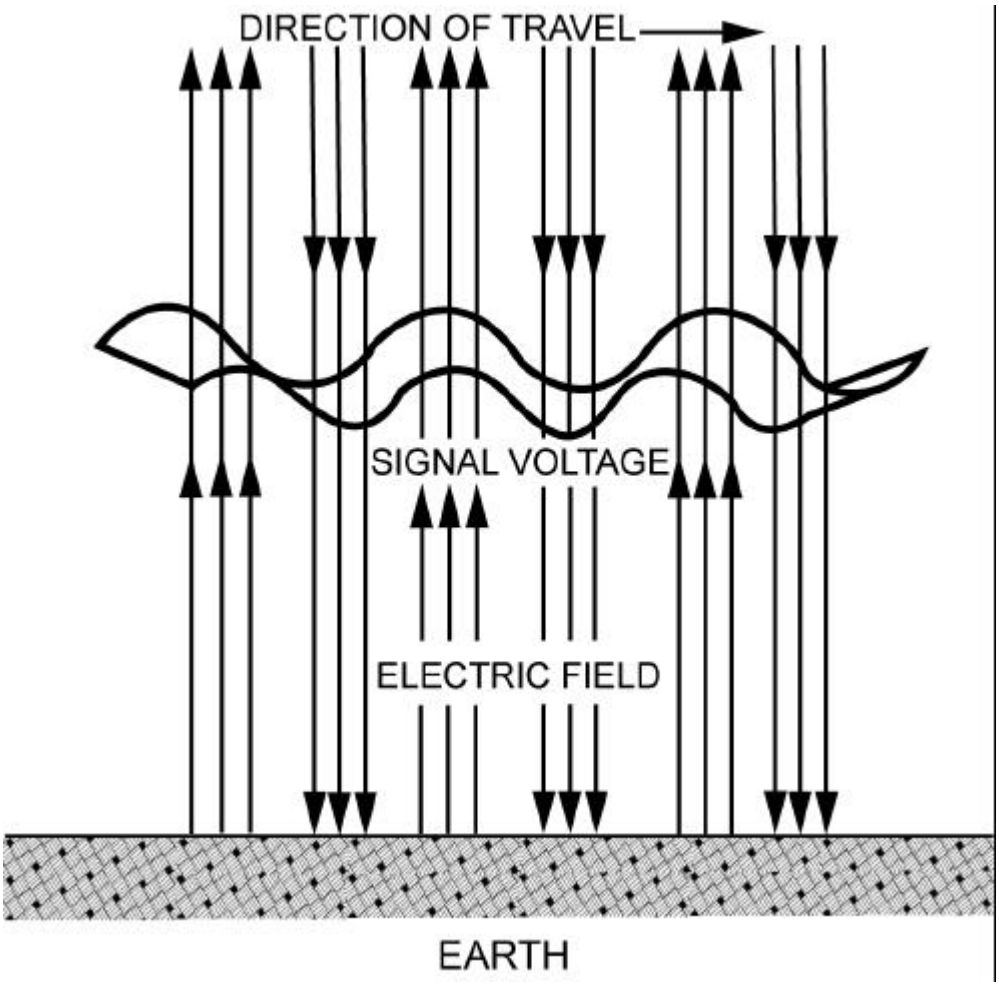
Polarization

Definition

Polarization of a radiated wave is determined by the direction of the electric field lines of force. The two types of polarization are vertical and horizontal.

Vertical Polarization

If the electric field lines of force are at right angles to the surface of the earth, the wave is vertically polarized. This concept is illustrated in the diagram below:



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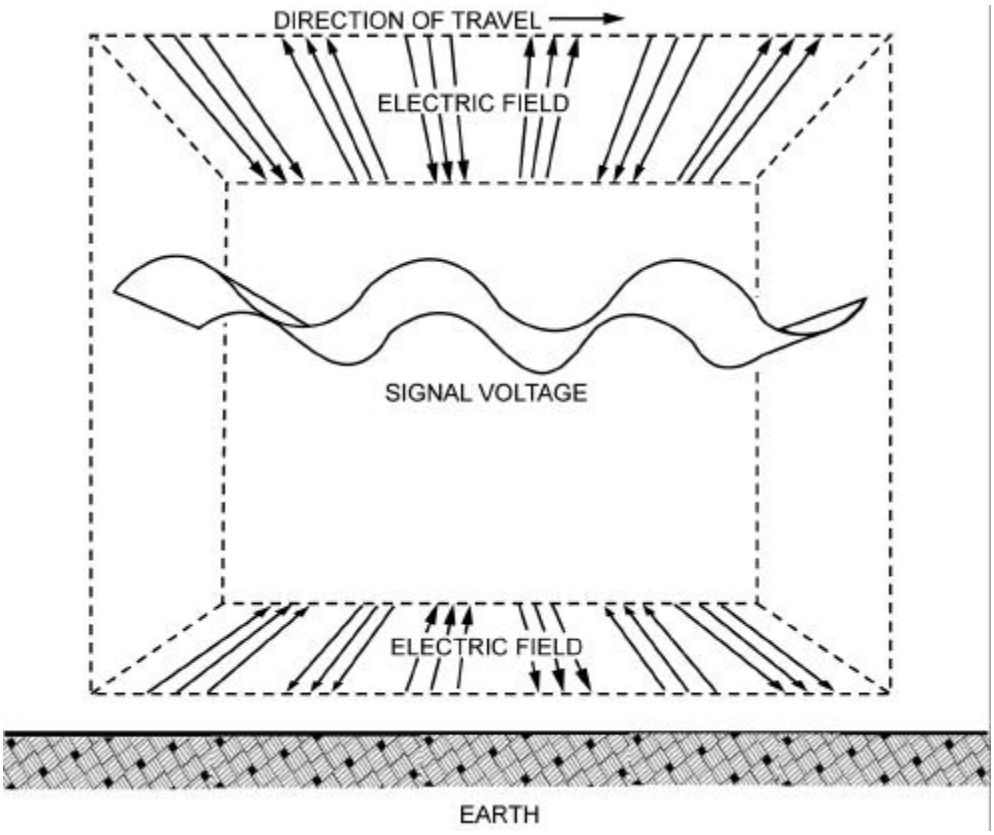
Polarization, Continued

Horizontal Polarization

If the electric field lines of force are parallel to the surface of the earth, the wave is said to be horizontally polarized as shown in the diagram below:



Proper Orientation

A single-wire antenna is used to extract energy from a passing radio wave. Therefore, maximum reception results when the antenna is oriented so that it lies in the same direction as the transmitting antenna, which subsequently orients it to the electric-field component. Thus, a vertical antenna is used for efficient reception of vertically polarized waves and a horizontal antenna is used for the reception of horizontally polarized waves. In some cases, the field rotates as the wave travels through space. Under these conditions, both horizontal and vertical components of the field exist and the wave is said to have elliptical polarization.

Polarization Selection

Medium and Low Frequencies

At medium and low frequencies, ground wave transmission is used extensively. For this reason, it is necessary to use vertical polarization. Vertical lines of force are perpendicular to the ground, and the radio wave can travel a considerable distance along the ground surface with a minimum amount of attenuation (loss). Because the earth acts as a fairly good conductor at low frequencies, horizontal lines of force are shorted out—limiting the useful range of horizontally polarized waves.

High Frequencies

At high frequencies with sky wave transmission, it makes little difference whether horizontal or vertical polarization is used. The sky wave reflected by the ionosphere, arrives at the receiving antenna elliptically polarized. Therefore, the transmitting and receiving antennas can be mounted either horizontally or vertically. Horizontal antennas are preferred because they can be made to radiate effectively at high angles and have inherent directional properties.

Very- and Ultra-High Frequencies

With frequencies in the very-high or ultra-high range, either horizontal or vertical polarization is satisfactory. Since the radio wave travels directly from the transmitting antenna to the receiving antenna, the original polarization produced at the transmitting antenna is maintained throughout the travel of the wave to the receiving antenna. Therefore, if a horizontal half-wave antenna is used for transmitting, a horizontal antenna must be used for receiving. If a vertical half-wave antenna is used for transmitting, a vertical antenna must be used for receiving.

Benefits of Vertical Polarization

Vehicular Applications

Simple, vertical half-wave antennas can be used to provide omni-directional communication that has the ability to communicate with a moving vehicle. When antenna heights are limited to 10 feet or less, as in vehicular installation, vertical polarization provides a stronger received signal at frequencies up to about 50 MHz. From approximately 50 to 100 MHz, there is only a slight improvement over horizontal polarization with antennas of the same height. The difference in signal strength above 1100 MHz is negligible.

Over Water

For transmission over large bodies of water, vertical polarization is decidedly better than horizontal when antennas are below approximately 300 feet at 30 MHz. You would only need 50 feet at 85 MHz and still lower at higher frequencies. Therefore, an ordinary antenna at mast heights, such as 40 feet, vertical polarization is advantageous for frequencies less than about 100 MHz.

Aircraft Interference

Radiation using vertical polarization is less effected by reflections from aircraft flying over the transmission path. With horizontal polarization, such reflections cause variations in the received signal strength. This factor is important in locations where aircraft traffic is heavy.

Broadcast Interference

With vertical polarization, less interference is produced or picked up because of strong VHF and UHF broadcast transmission and reception (television and frequency modulation), all of which use horizontal polarization. This factor is important when an antenna must be located in an urban area having several television and commercial FM broadcast stations.

Benefits of Horizontal Polarization

Bi-Directional

A simple horizontal half-wave antenna is bi-directional. This characteristic can help minimize interference from certain directions. Additionally, horizontal antennas are less apt to pick up man-made interference that is polarized vertically.

Heavy Foliage

When antennas are located near dense forest, horizontally polarized waves suffer lower losses than vertically polarized waves, especially above about 100 MHz.

Flexibility

Small changes in antenna location do not cause large variations in the field intensity of horizontally polarized waves when antennas are located among trees or buildings. When vertical polarization is used, a change of only a few feet in the antenna location may have a considerable effect on the received signal strength. This is the result of interference patterns that produce standing waves in space when spurious reflections from trees or buildings occur.

Since the interference patterns will vary even when the frequency is changed by only a small amount, considerable distortion may occur when complex types of modulation are used, as with television signals or with certain types of pulse-modulation systems. Under these conditions, horizontal polarization is preferred.

Compatibility With Transmission Line

When simple half-wave antennas are used, the transmission line (usually vertical) is less effected by a horizontally mounted antenna. Keeping the antenna at right angles to the transmission line and using horizontal polarization keep the line out of the direct field of the antenna. As a result, the radiation pattern and electrical characteristics of the antenna are practically not effected by the presence of the vertical transmission line.