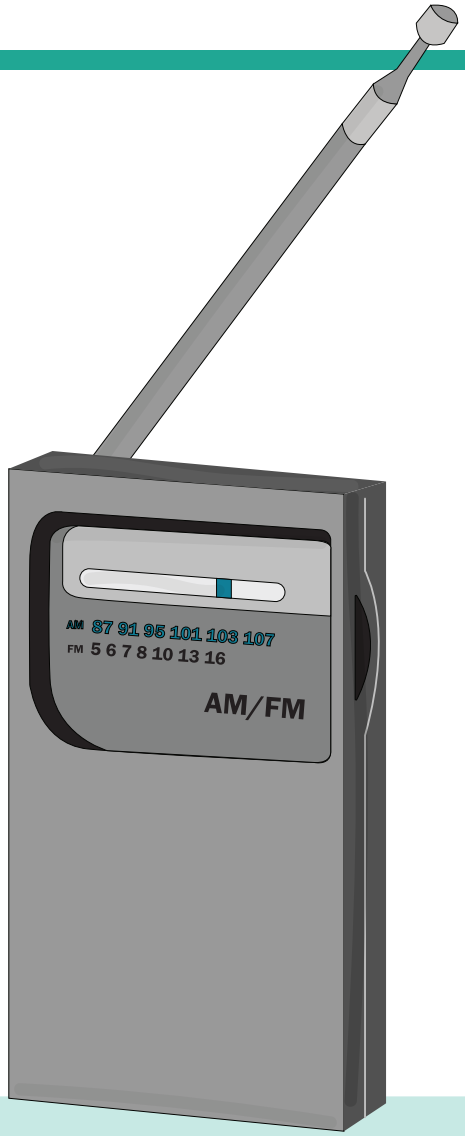
Illuminate NEBRASKA
POWERED BY
NEBRASKA PUBLIC POWER DISTRICT

ELECTROMAGNETIC WAVES

ANTENNA

CONCEPT An antenna is any object that radiates electromagnetic energy into a medium, such as radio waves. While some antennas are built to receive or transmit electromagnetic energy, certain antennas perform both functions. Electromagnetic radiation in the form of radio waves is produced as electrons vibrate up and down the transmitter antenna. These radio waves are emitted from the transmitter antenna at the speed of light. When the waves arrive at the receiver antenna, they make electrons vibrate inside it, which produces an electric current that recreates the original signal.



BACKGROUND

The first electromagnetic experiment was conducted in the 1830s by Michael Faraday, as he explored the relationship between magnetism and electricity, well before the concept of electromagnetic waves was conceived. His experiment began by sliding a magnet around the coils of a wire attached to a galvanometer. He successfully created a time-varying magnetic field by moving the magnet along the coil. The coil operated as a loop antenna and received electromagnetic radiation, which was detected by the galvanometer.

FORMULA

Antenna frequency equals the speed of light divided by the wavelength. For example, if an airband antenna is to receive 125 MHz then it is 300/125 = 2.4 meters full wave length.

EXAMPLES

RECEIVER: An electronic device that receives radio waves (from an antenna) and converts the information carried by them to a usable form, such as a program played on an AM/FM radio.

TRANSMITTER: An electronic device that converts electrical signals into radio waves. These waves can travel around the world and even into space and back.

TIME-VARYING FIELD: In a time-varying field, magnetic and electronic fields are dependent on one another. A changing magnetic field induces an electric field, and vice versa.

Make sure it measures up

REAL WORLD CONNECTIONS

CELL TOWERS: There are multiple antennas attached to a cell tower, typically mounted on a head frame. Some towers have up to 15 antennas per carrier. This number depends on the antenna's performance, coverage and capacity requirements. There are two major types of antenna used in cell towers: omnidirectional and directional. These networks of cell tower antennas transmit a web of RF waves which are received by cell phones, instantly connecting anyone within the network.

APPLICATION

NASA transmits its data from Mars via the Curiosity rover's three receiving and transmitting antennas located on the back of the rover. It has extra antennas for different signals.

Curiosity's most often used antenna is the Ultra-High Frequency Antenna (UHF), which transmits data to Earth through Mars Orbiters (Odyssey and Mars Reconnaissance). The UHF antenna is close range, so the relationship between it and the orbiters is like walkie talkies which chatter back and forth. The use of orbiters as an extension of communication allows for faster communication with Earth.

Curiosity uses its high-gain antenna, the X-Band High-Gain Antenna, to receive communication from the team on Earth. The high-gain antenna can aim any direction in order to send a beam of data directly to a specific antenna on Earth. The ability for the antenna to aim at Earth allows the rover to save energy, instead of turning the entire vehicle around.

The third antenna type Curiosity uses is the X-band Low-Gain Antenna, which is used to receive signals. As an omni-directional antenna, it can receive information from any angle.