

## 22.3: Applications of Induction and EM Waves

### learning objectives

- Discuss the use of inductance in modern devices

Inductors have many uses in modern electronics. In a sound system, sound can be transmitted from a microphone to a speaker (shown in ). The microphone works by induction, as the vibrating membrane induces an emf in a coil. That “signal” is then transmitted to an amplifier and then to a speaker. The speaker is then driven by modulated electrical currents (produced by an amplifier) that pass through and magnetize (by inductance) a speaker coil of copper wire, creating a magnetic field. Thus, the electrical current variations that pass through the speaker are converted to varying magnetic forces, which move the speaker diaphragm, forcing the driver to produce air motion that is similar to the original signal from the amplifier.



**A simple, modern speaker:** A speaker with magnet and coils that is used to produce sound.

Inductance in modern electronics is also used in computer memory. Magnetic storage uses different patterns of magnetization on a magnetically coated surface to store information. Differently magnetized areas on tape (or disk) induce signals on “read-write” heads, from which the information is later accessed.

Another application is the seismograph—an instrument for detecting and recording the intensity, direction and duration of ground movement. It contains a fixed coil and a magnet hung on a spring (or vice versa). These “record” the current induced when the Earth shakes.

A ground fault circuit interrupter (GFCI) provides additional safety (that circuit breakers cannot) by stopping the current in a shorted-out circuit. This is done by inductance. If a GFCI detects that there is a leakage of current, it produces an EMF and a current in the opposite direction of the original current.

### Antennae

An antenna is a device that converts electric power into radio waves, and vice versa.

### learning objectives

- Describe functions and uses of antennae

Maxwell’s equations predicted that all light waves have the same structure, regardless of wavelength and frequency. As a consequence, visible light and radio waves should share common characteristics. Maxwell’s 1865 prediction passed an important test in 1888, when Heinrich Hertz published the results of experiments in which he showed that radio waves could be manipulated in the same ways as visible light waves. To aid in his experiment, Hertz built the first antenna.



**Car Antenna:** A common car antenna that converts electric power in the air into electromagnetic waves.

An antenna (or aerial) is an electrical device that converts electric power into radio waves, and vice versa. Usually, it is used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an oscillating radio frequency electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals. This voltage is applied to a receiver to be amplified.

Antennas are essential components of all types of equipment that utilize radio. These include: radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, and satellite communications; as well as other devices such as garage door openers, wireless microphones, bluetooth enabled devices, wireless computer networks, baby monitors, and RFID tags on merchandise.

Antennas may also include reflective or directive elements or surfaces not connected to the transmitter or receiver, such as parasitic elements, parabolic reflectors, or horns. These serve to direct the radio waves into a beam or other desired radiation pattern. Antennas can be designed to transmit or receive radio waves in all directions equally (omnidirectional antennas), or transmit them in a beam in a particular direction and receive from that one direction only (directional or high gain antennas).

### Key Points

- The microphone works by induction, as the vibrating membrane induces an emf in a coil.
- A speaker produces sound by induction as varying magnetic forces move a speaker diaphragm, producing air motion that produces sound.
- Computer memory is stored by inducing signals on read/write heads.
- GFCIs induce a current to oppose sudden increases in current in a circuit, thus preventing possible electrocution.
- The first antennas were built in 1888 by German physicist Heinrich Hertz.
- Antennas are essential components of all equipment that uses radio.
- Antennas transmit or receive radio waves in all directions equally, or transmit them in a beam in a particular direction.

### Key Terms

- **amplifier:** An appliance or circuit that increases the strength of a weak electrical signal without changing the other characteristics of the signal.
- **wavelength:** The length of a single cycle of a wave, as measured by the distance between one peak or trough of a wave and the next; it is often designated in physics as  $\lambda$ , and corresponds to the velocity of the wave divided by its frequency.
- **frequency:** The quotient of the number of times  $n$  a periodic phenomenon occurs over the time  $t$  in which it occurs:  $f = n / t$ .
- **transmitter:** An electronic device that generates and amplifies a carrier wave, modulates it with a meaningful signal derived from speech, music, TV or other sources, and broadcasts the resulting signal from an antenna.

### LICENSES AND ATTRIBUTIONS

#### CC LICENSED CONTENT, SHARED PREVIOUSLY

- Curation and Revision. **Provided by:** Boundless.com. **License:** [CC BY-SA: Attribution-ShareAlike](#)

#### CC LICENSED CONTENT, SPECIFIC ATTRIBUTION

- Primary memory. **Provided by:** Wikipedia. **Located at:** [http://en.Wikipedia.org/wiki/Primary\\_memory%23Primary\\_storage](http://en.Wikipedia.org/wiki/Primary_memory%23Primary_storage). **License:** [CC BY-SA: Attribution-ShareAlike](#)
- GFCI. **Provided by:** Wikipedia. **Located at:** <http://en.Wikipedia.org/wiki/GFCI>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- Seismograph. **Provided by:** Wikipedia. **Located at:** <http://en.Wikipedia.org/wiki/Seismograph>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- Loudspeaker. **Provided by:** Wikipedia. **Located at:** [en.Wikipedia.org/wiki/Loudspeaker](http://en.Wikipedia.org/wiki/Loudspeaker). **License:** [CC BY-SA: Attribution-ShareAlike](#)
- Microphone. **Provided by:** Wikipedia. **Located at:** [en.Wikipedia.org/wiki/Microphone](http://en.Wikipedia.org/wiki/Microphone). **License:** [CC BY-SA: Attribution-ShareAlike](#)
- amplifier. **Provided by:** Wiktionary. **Located at:** [en.wiktionary.org/wiki/amplifier](http://en.wiktionary.org/wiki/amplifier). **License:** [CC BY-SA: Attribution-ShareAlike](#)

- Fields. **Provided by:** Light and Matter. **Located at:** [http://www.lightandmatter.com/html\\_books/7cp/ch06/ch06.html#Section6.2](http://www.lightandmatter.com/html_books/7cp/ch06/ch06.html#Section6.2). **License:** [CC BY-SA: Attribution-ShareAlike](#)
- Antenna (radio). **Provided by:** Wikipedia. **Located at:** [en.Wikipedia.org/wiki/Antenna\\_\(radio\)](https://en.wikipedia.org/wiki/Antenna_(radio)). **License:** [CC BY-SA: Attribution-ShareAlike](#)
- wavelength. **Provided by:** Wiktionary. **Located at:** [en.wiktionary.org/wiki/wavelength](https://en.wiktionary.org/wiki/wavelength). **License:** [CC BY-SA: Attribution-ShareAlike](#)
- transmitter. **Provided by:** Wiktionary. **Located at:** [en.wiktionary.org/wiki/transmitter](https://en.wiktionary.org/wiki/transmitter). **License:** [CC BY-SA: Attribution-ShareAlike](#)
- frequency. **Provided by:** Wiktionary. **Located at:** [en.wiktionary.org/wiki/frequency](https://en.wiktionary.org/wiki/frequency). **License:** [CC BY-SA: Attribution-ShareAlike](#)
- Antenna (radio). **Provided by:** Wikipedia. **Located at:** [en.Wikipedia.org/wiki/Antenna\\_\(radio\)](https://en.wikipedia.org/wiki/Antenna_(radio)). **License:** [Public Domain: No Known Copyright](#)

---

22.3: Applications of Induction and EM Waves is shared under a [not declared](#) license and was authored, remixed, and/or curated by LibreTexts.