Work-Ready Electronics

Synchronizing Curriculum to the Rapidly Changing Workplace

Module: Introduction to Wireless Technology

WORKREADY ELECTRONICS

Modern Wireless Technology

Wireless is just another name for radio. And of course, wireless is certainly not new. It was discovered in the late 1800s and quickly developed in the early 1900s by Marconi and others. Radio has many uses which include radio broadcasting (AM, FM, digital and satellite), 2-way radio (public service, aircraft, marine, etc.), personal and hobby (CB, FRS, ham radio, RC, etc.), and telemetry. Cell phones are two way radios as are wireless local area networks. TV, radar, satellites, and navigation systems like GPS are radio.

Today radio is mostly taken for granted. However over the past decades, radio has changed our lives. The developments with the greatest impact are cell phones, wireless local area networks (WLANs) for computers, and short range radios for a variety of applications. These applications are today referred to as wireless.

This module introduces you to basic radio concepts.

Prerequisites For This Module

This module is designed primarily to be used after the completion of basic electronic DC and AC Circuits courses or their equivalent.

Prerequisite knowledge for this module includes the following:

- Electric and magnetic fields and how they are produced
- Difference between analog and digital (binary) signals
- Serial and parallel digital signals

What Technicians Need to Know

- Basic components of any wireless system
- How radio works
- The electromagnetic spectrum
- Radio waves and propagation
- Basic modulation and multiplexing methods
- Radio components

Wireless Operation

Wireless Applications

The first use of wireless in the early 1900's was wireless telegraphy, sending short messages country wide and world wide. Wireless was the savior of many ships at sea.

The development of radio languished in these applications until the development of the vacuum tube in 1907. After that, the wireless boom continued.

Then came radio broadcasting. Two-way radio was next.

Radio was actually the beginning of the electronics industry.

You already know about most wireless applications. See how many applications you can name and at the same time, designate the ones you have or use regularly. Write down as many as you can before going on to the next slide. A list of applications is available under the Learning Resources Tab.

New Applications

How many did you guess? How many do you own or use? Probably more than you thought. Like most other wireless applications, they are common and mostly taken for granted. Imagine there was no radio. Think about it.

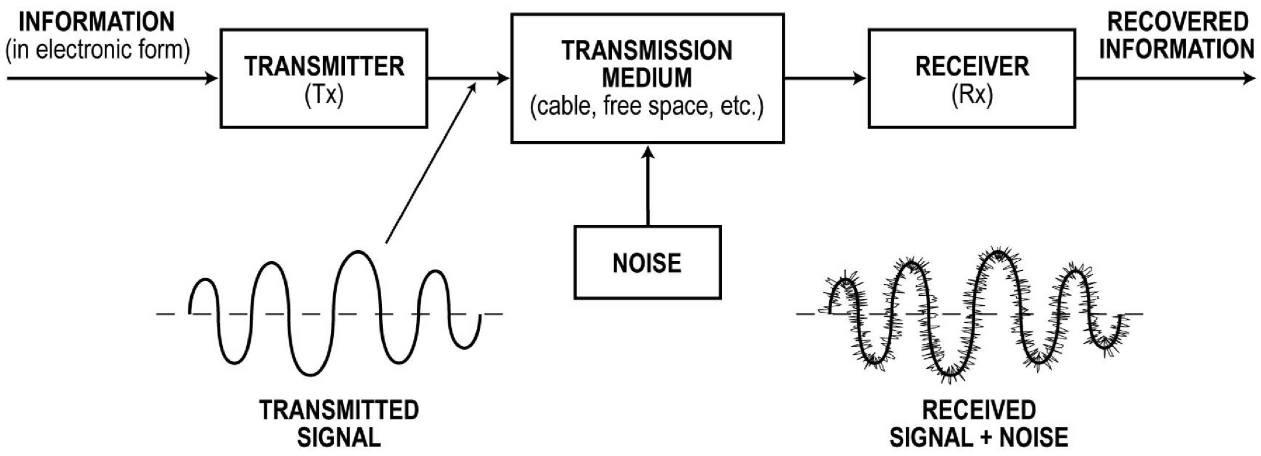
Thanks to semiconductor technology, it is now possible to package a complete radio into a single tiny chip. This makes it possible, practical, and economical to make virtually anything wireless.

Communications Systems

Wireless is just one of several methods of electronic communications. The first electrical communication system was the telegraph which came about in 1845. The telephone was invented in 1876. Electric lights came in the 1880’s.

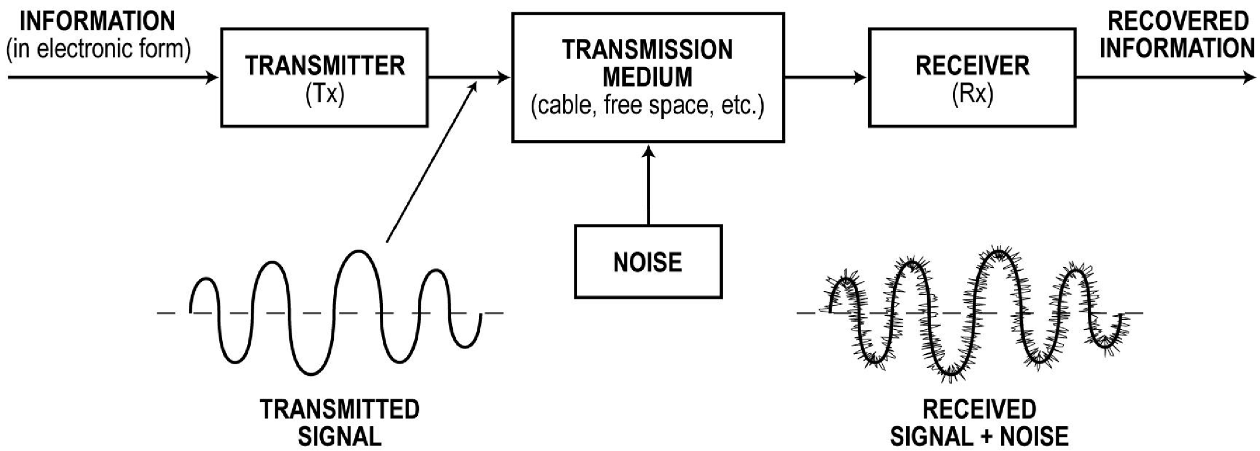
Electronic communications systems were developed to facilitate and speed up long range communications between humans.

Transmission



In the general form of any electronic communications system shown here, the transmitter (TX) on one end of the system accepts and sends information to the receiver (RX). The information is transmitted over some medium such as a cable or free space.

Communications Systems: Data



The message to be sent is called information or data. It must first be put into the form of an electrical signal. A microphone converts voice or music to an audio signal. A video camera converts scenes to a video signal. A telegraph key develops coded pulses. Computers generate electrical codes representing data. Anything that can be converted to an electrical signal can be communicated.

Communications Systems: Signal

The original information signal is often referred to as the baseband signal.

The signal is then usually conditioned, that is, enhanced or modified in some way. Amplification and filtering are common signal conditioning methods. The conditioning may involve converting the analog information signal to digital.

In some communications systems, the conditioned signal is then placed right on the communications medium. The medium is the path or channel that carries the information from the transmitting end to the receiving end. It may be a wire or cable as it was with telegraphy or the telephone, a coax cable as used in cable TV, a twisted pair as in a computer network, or fiber optic cable as in many cable TV systems and the Internet.

In radio, the medium is free space. It is also called the electromagnetic frequency spectrum, or the ether.

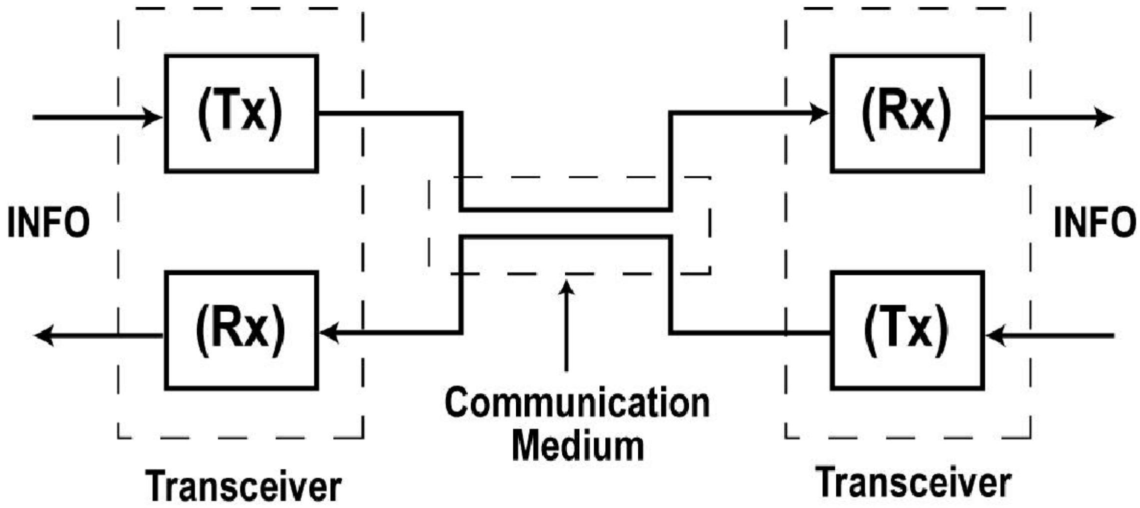
Communications Systems: Reception

Along the communications path, noise is added to the signal. Noise is any unwanted random voltage variation caused by industrial, cosmic, or thermal conditions. Noise is low level but can interfere with the transmitted signal and can even overwhelm it making reception difficult or even impossible.

The receiver (RX) accepts the information signal from the medium and then conditions it and converts it into a form that a human can use. Speakers and headphones recreate voice and music, cathode ray tubes, or LCD screens recreate video or other visual information. Digital data usually goes to a computer.

This system is a one way communication path. It is usually referred to as simplex. An example of a simplex system is radio or TV broadcasting.

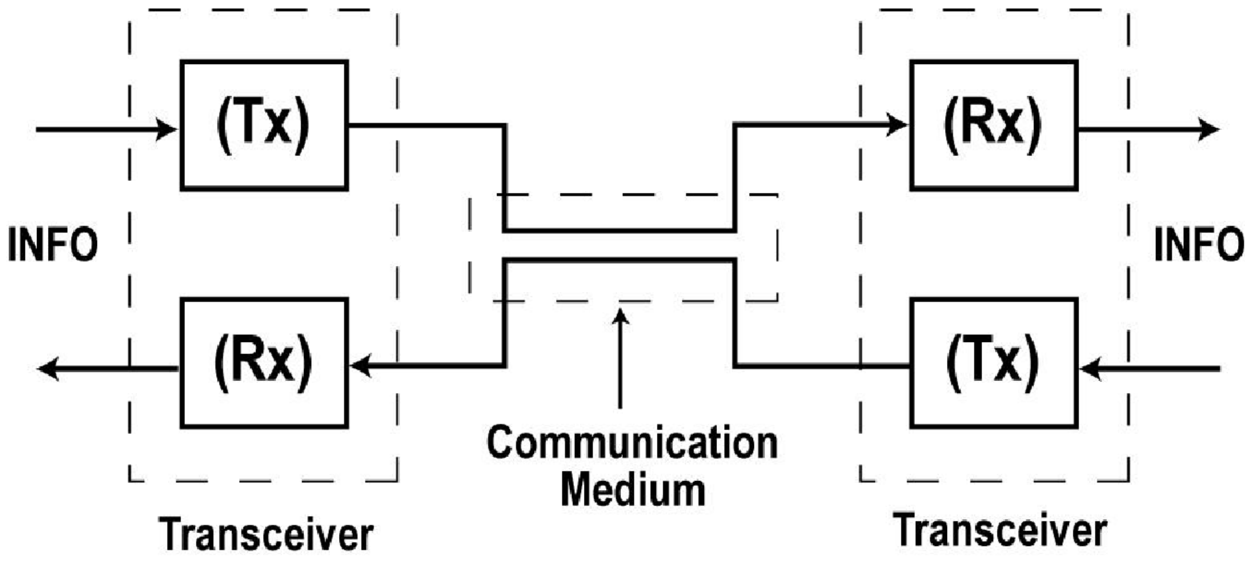
Two-Way Communications



Most communications are two way. There is a transmitter and a receiver at each end of the communications link.

The combination of a transmitter and a receiver is called a transceiver.

Two-Way Communications: Duplex

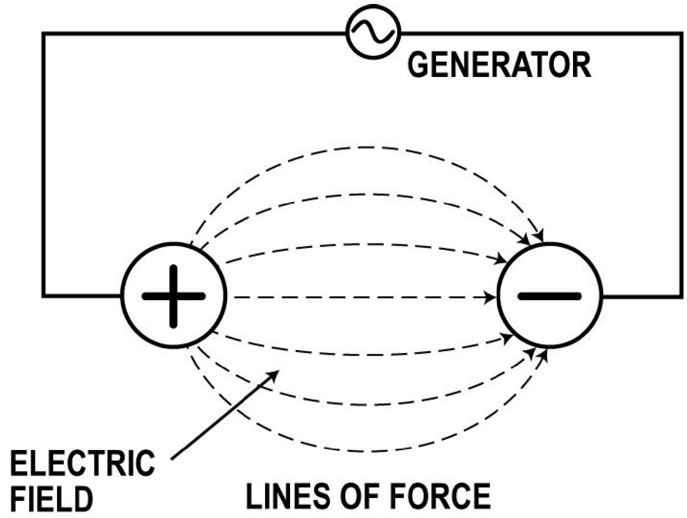


The two way communications may be conducted in two ways, half duplex or full duplex.

In half duplex, the two communicating parties take turns transmitting and receiving. Most two-way radios work like this.

In full duplex, both communicating parties may send and receive simultaneously. An example is any telephone or cell phone.

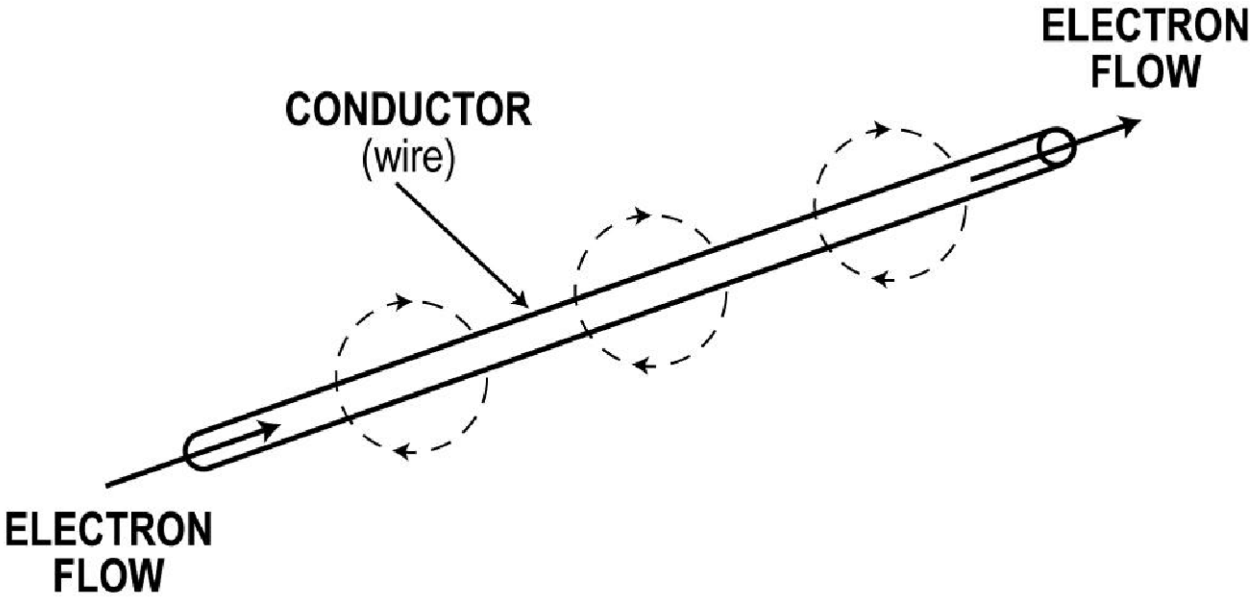
Radio Signal



A radio signal is a combination of an electric field and a magnetic field and is more commonly referred to as an electromagnetic wave.

An electric field is the invisible force field between two conductors across which a voltage is applied.

Radio Signal: Magnetic Field

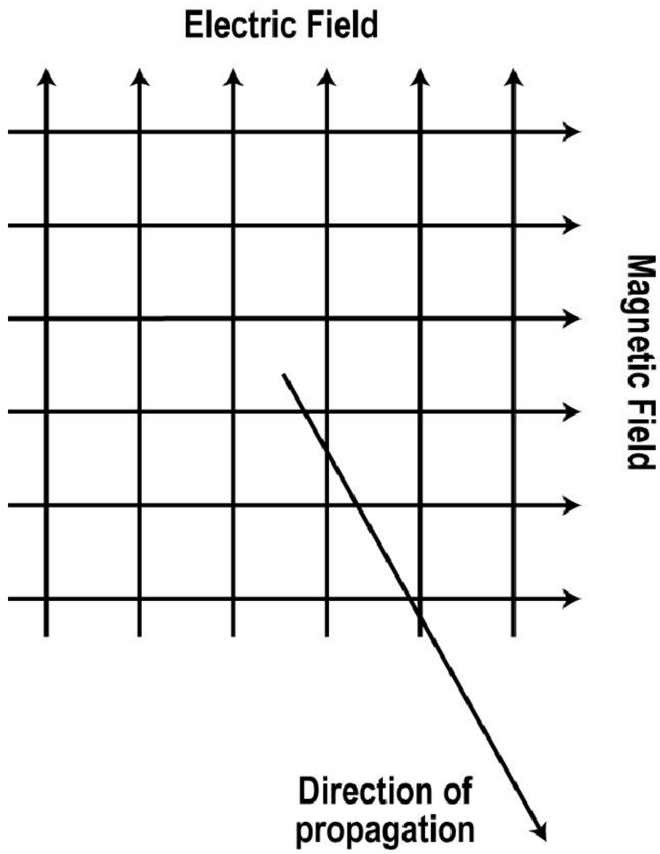


A magnetic field is the invisible force field produced by a current flowing in a wire.

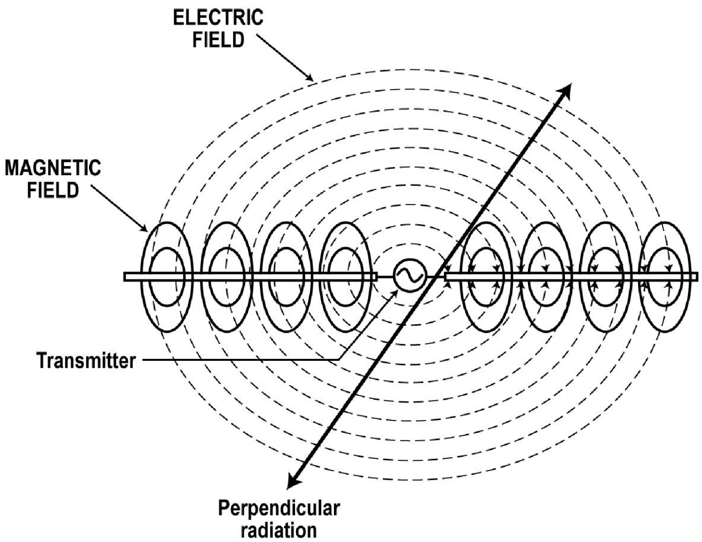
Radio Signal: Polarization

In a radio wave, the two fields are at 90° to one another. These two fields move in a direction perpendicular to both of the fields as shown.

Radio waves are polarized meaning that they are oriented either vertically or horizontally with respect to the earth's surface. Polarization is determined by the electric field. In the figure shown here, the polarization is vertical.



Antenna

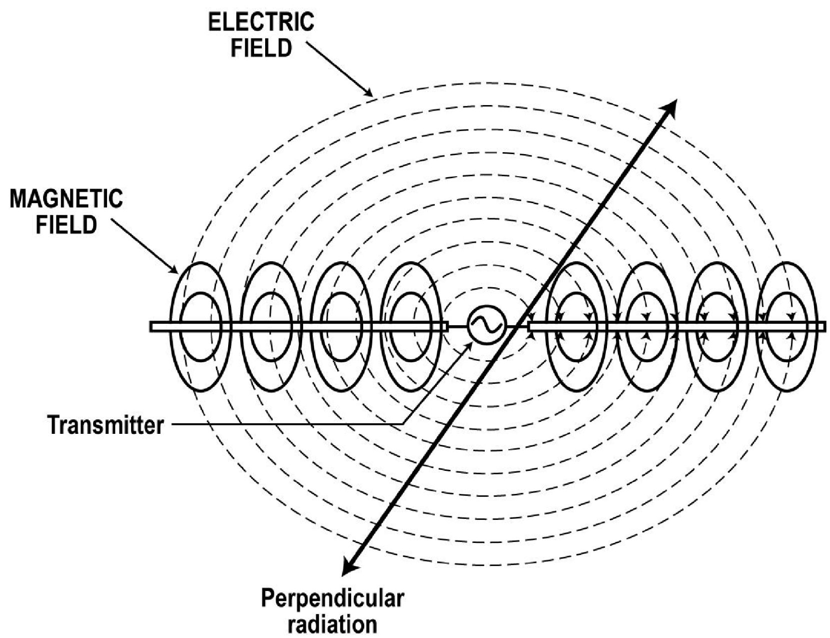


The radio signal is produced by a component known as an antenna or aerial. A transmitter applies an alternating voltage, normally a sine wave, to the antenna. The antenna appears to be a resistance to the transmitter if it is resonant to the frequency of the transmitter AC voltage. But the antenna may also appear to be a complex impedance made up of inductance or capacitance and resistance.

The figure shows a common antenna type consisting of two conductors equal in length. The overall length is determined by the frequency of operation.

Dipole Antenna

This kind of antenna is called a dipole. The transmitter voltage sets up an electric field across the two elements while the voltage produces current flow in the conductors producing a magnetic field. The transmitter voltage is usually a sine wave so the fields vary in strength and polarity as the voltage varies. The fields are perpendicular to one another. The resulting signal is then radiated at a right angle to the antenna.



Radio Signal Transmission

The radio signal radiates into free space. The electric and magnetic fields are varying at the rate determined by the operating frequency. The transmitted signal is a sine wave that reverses its polarity and the electric field polarity every half cycle. The direction of current flow also reverses every half cycle thereby reversing the direction of the magnetic field. These fields, in effect, support and regenerate one another as they travel through space. This effect is expressed by Maxwell's equations, which describe the relationships between the electric and magnetic fields.

The speed of propagation is approximately the speed of light which is about 300,000,000 meters per second or 186,400 miles per second. It is not instantaneous but certainly pretty fast.

Radio Signal Transmission: Travel

The signal travels in a direction as determined by the antenna type and orientation. The distance it travels is determined by the frequency of operation, the power transmitted, and the environment. The signal may travel only a few feet or millions of miles into space.

As the signal travels through space, its strength weakens significantly. The power in the signal is reduced by a factor of the square of the distance between the transmitting antenna and receiving antenna. The received signal is usually only a few microvolts or less.

Antenna Reciprocity

When the electromagnetic wave passes over another antenna, the fields induce a voltage into the antenna. The voltage appearing at the antenna terminals is passed to the receiver where the signal is amplified and otherwise processed to recover the originally transmitted information.

Any antenna may be used for transmitting or receiving. In most wireless applications, a single antenna is shared by both the transmitter and receiver.

Test your knowledge

Introduction to Wireless Knowledge Probe 1

Wireless Operation

Click on Course Materials at the top of the page.

Then choose **Knowledge Probe 1**.