Work-Ready Electronics

Synchronizing Curriculum to the Rapidly Changing Workplace

Module: How Electronic Circuits and Systems Work

WORKREADY ELECTRONICS

Relating Electrical Fundamentals

The first courses taught in most 2-year technology programs cover DC and AC circuit fundamentals. These courses teach electrical theory, current, voltage sources, Ohm's and Kirchhoff's laws, resistors, capacitors, inductors, transformers, basic circuit theory and analysis techniques.

Question: How does this content fit with the real equipment and systems they will actually work with on the job?

This segment shows two basic models (the input, process, output model and the simple circuit model) to illustrate how basic circuits relate to modern electronic equipment and applications.

What Technicians Need to Know

Difference between analog and digital signals

What a voltage source does

Common sources of input signals

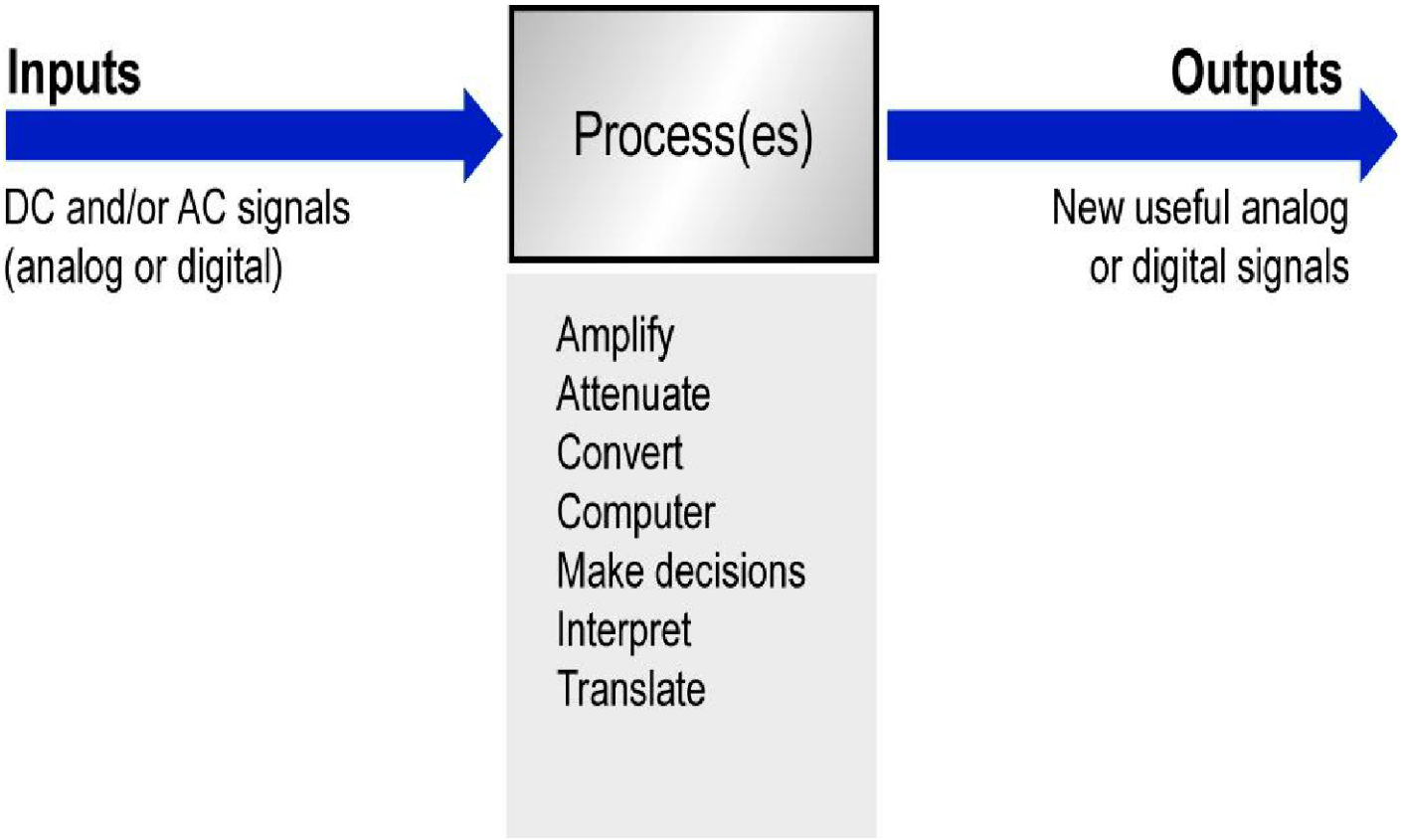
Common types of output devices

Common ways in which electronic signals are processed

Operation of a electronic product using the input-process-output model

Components of the simple circuit model and what they do

The Input/Process/Output Model



Inputs

Electrical signals representing some type of data or information (voice, video, sensor data, computer data, etc.) form the input to electronic circuits or equipment.

The inputs may be analog or digital, DC or AC.

- Analog signals are smooth and continuous voltages.
- Digital signals are usually voltage levels or pulses that represent numbers, codes, characters, graphics, etc.
- DC signals are fixed or varying voltages that allow current to flow in only one direction.
- AC signals are voltages that cause the direction of current flow to alternate.
- Analog and digital signals may be either DC or AC.

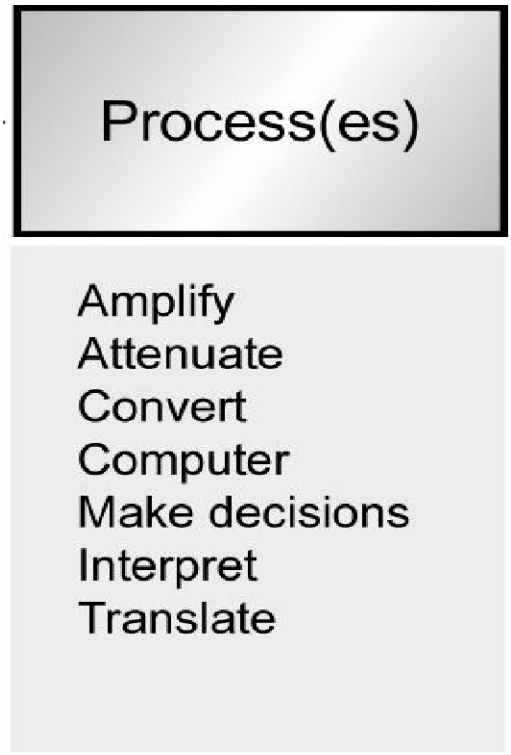
Process

The input signal or signals are applied to a circuit, a collection of circuits or a piece of equipment to be processed. The signals are processed in such a way that some useful application is realized. A desired end result is achieved.

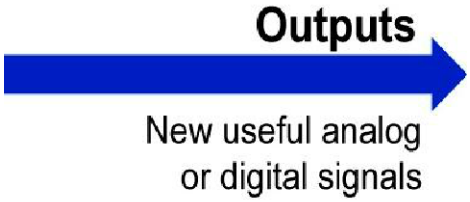
Processing refers to how the signals are manipulated, changed, or otherwise modified to implement some desired outcome.

Some common types of processing include:

- Amplify
- Attenuate
- Compute
- Convert
- Make decisions
- Interpret
- Translate



Outputs

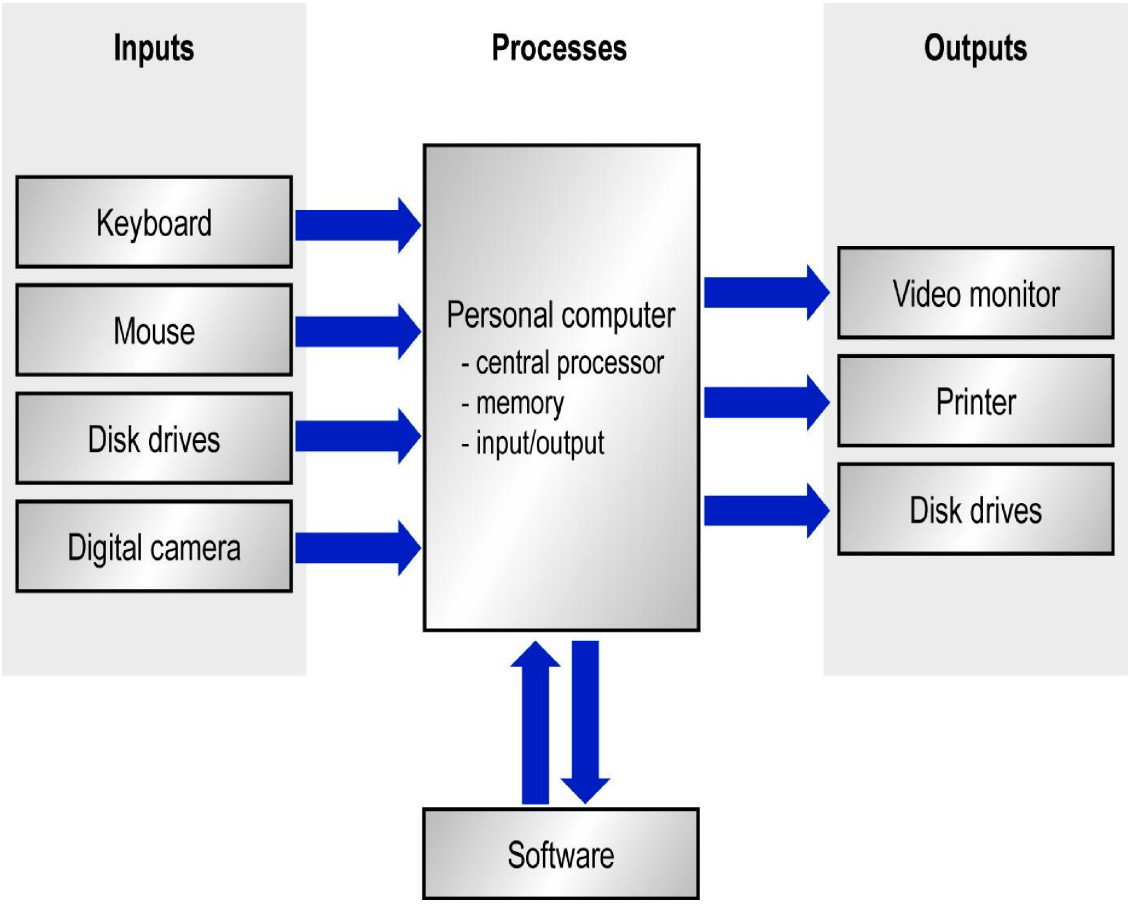


The processing box may represent a single simple circuit or multiple circuits where the signals are repeatedly processed in different ways to achieve the desired outcome. In many cases, the signal is processed several times where the output of one process becomes the input to the next process and so on.

The output from the process circuits or equipment are new analog or digital signals that perform some useful end result. These are usually applied to other components or equipment that translate them into audible, visible or other human sensory inputs or mechanical motion, etc. Outputs are often transmitted to speakers, CRT displays, motors, and antennas.

All electronic applications fit the Input/Process/Output model.

Computing Example



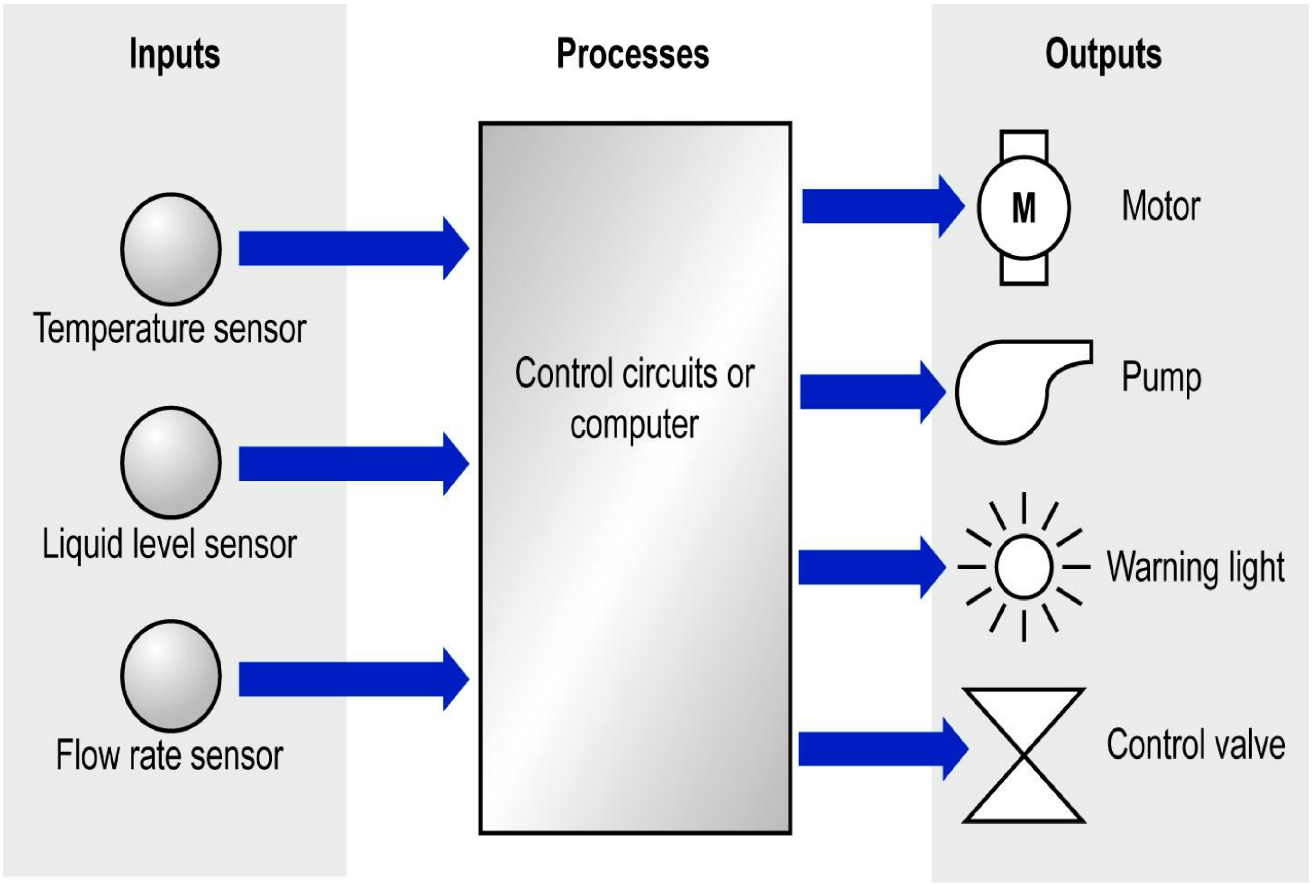
Computing Example Description

Input: Digital inputs come from the keyboard, mouse, disk drives, the Internet via a modem or other sources (scanner, digital camera, etc.)

Process: The computer, consisting of a central processing unit (microprocessor), memory and input/output circuits, processes the inputs according to some software stored in the computer.

Output: The outputs are in the form of video signals on a CRT display, printer, storage on a disk drive, signals to an interface or modem for transmission over a network, or control signals to external devices.

Industrial Control Example



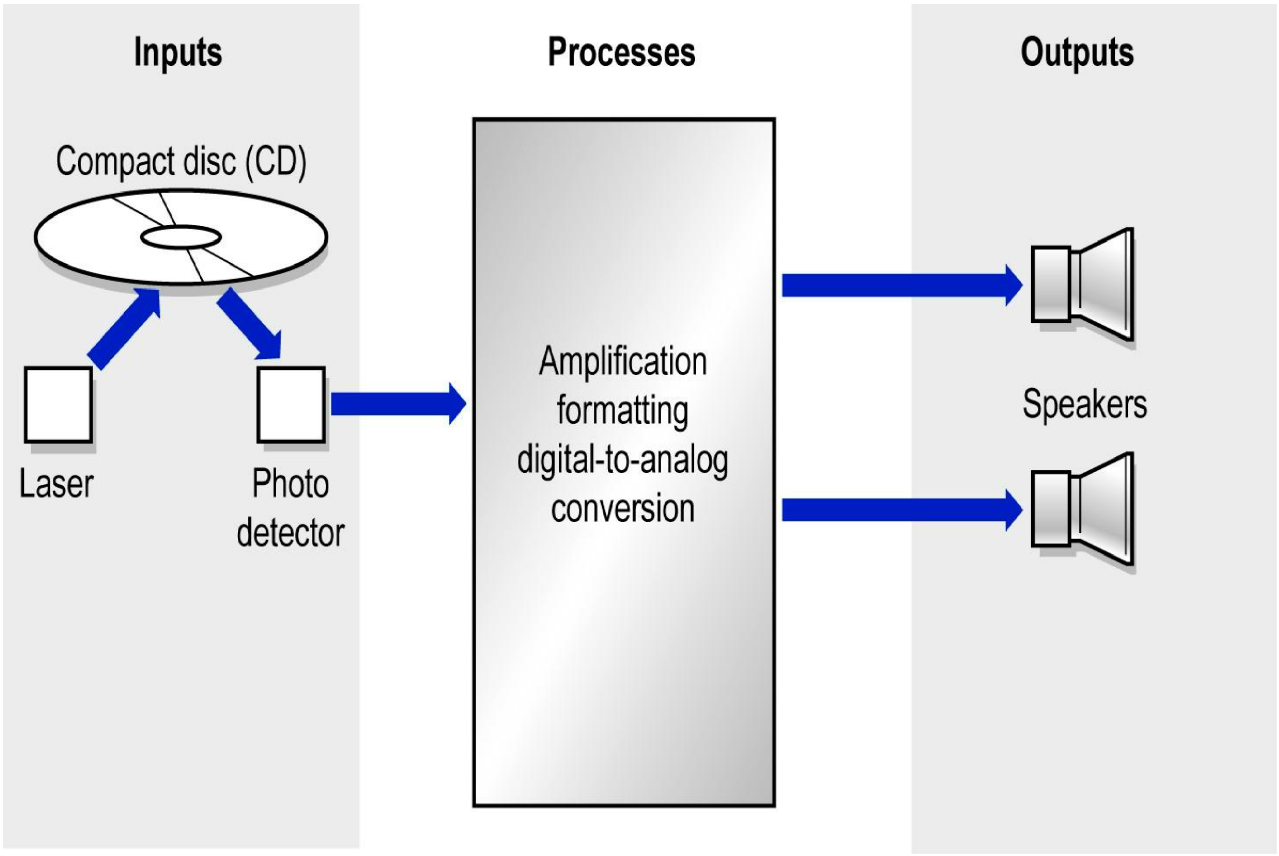
Industrial Control Example Description

Input: Inputs usually come from sensors or transducers that convert physical characteristics (temperature, light, motion, pressure, etc.) into electrical signals. Other inputs may come from manual controls like switches. These signals are conditioned to make them compatible with the process equipment.

Process: A controller or computer performs a variety of processes on the signals such as amplification, decision-making, logic, etc.

Output: The outputs are other signals that perform the desired functions such as turning motors or lights off or on, operating control valves, or recording measurement data.

CD Player Example



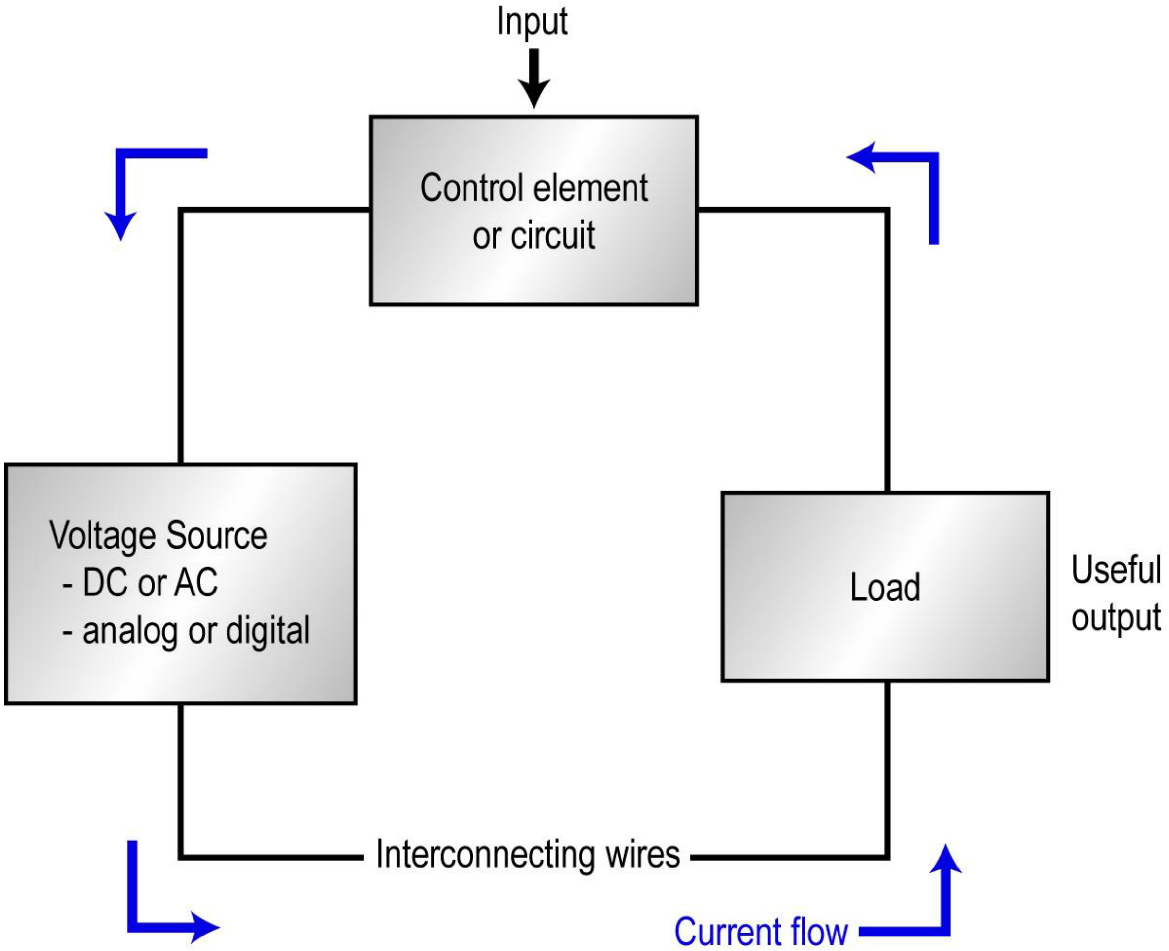
CD Player Example Description

Input: An infrared laser shines a tiny beam of light on the bottom of a compact disk (CD) containing music in the form of digital signals recorded as miniature pits on the disk surface. The reflections from the disk produce digital light pulses representing the music. The light pulses are picked up by a photo detector and converted to electrical signals that are processed by the CD player.

Process: Processing consists of decoding, formatting, digital to analog conversion, and amplification. Control circuits are also used to position the laser source over the correct area of the disk, open and close the disk drive door, control disk speed, and to select the desired music segment.

Output: The outputs are analog music signals applied to the speakers that convert the analog signals into sound.

Simple Circuit Model



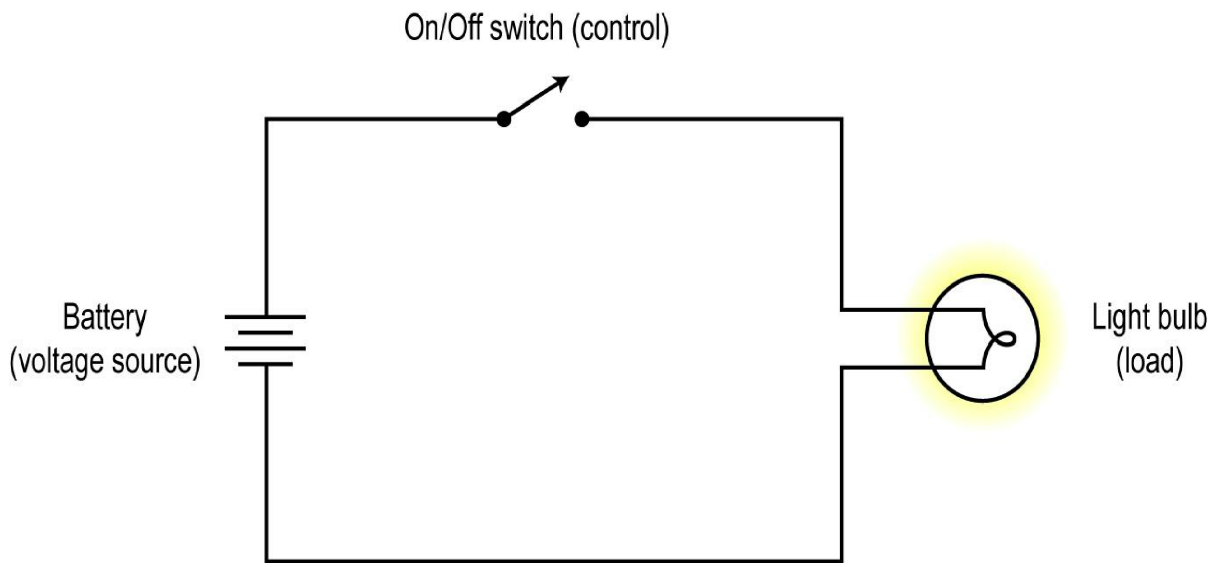
Simple Circuit Model

All electronic applications and circuits can be reduced to the simple circuit model consisting of a voltage source, conductors to connect the voltage source to a load, a control element, and a circuit protection device (e.g., fuse or circuit breaker). The essential goal of electronics is to generate a current flow then control it in a specific way to do something useful.

The voltage source may be DC or AC, analog or digital. It may be a battery, a 60 Hz power line, an electronic oscillator, a sensor, or the output of an amplifier. The voltage source generates the energy to cause current to flow in the circuit.

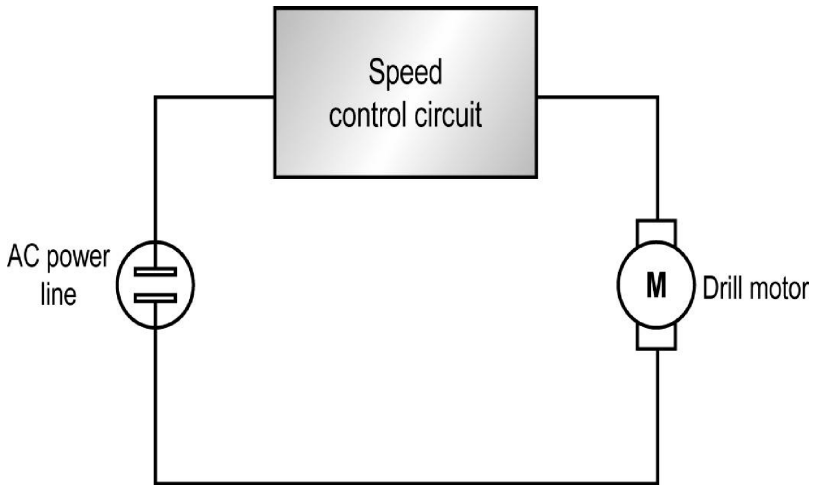
The load is the output that produces the useful end result. It may be a motor, a speaker, a light, an antenna, or heating element. It can also be a simple switch, resistor, transistor, other component, or a complete electronic circuit.

Flashlight Example



The battery is the voltage source.
The control element is an off-on switch.
The light bulb is the load.

Electric Drill Example

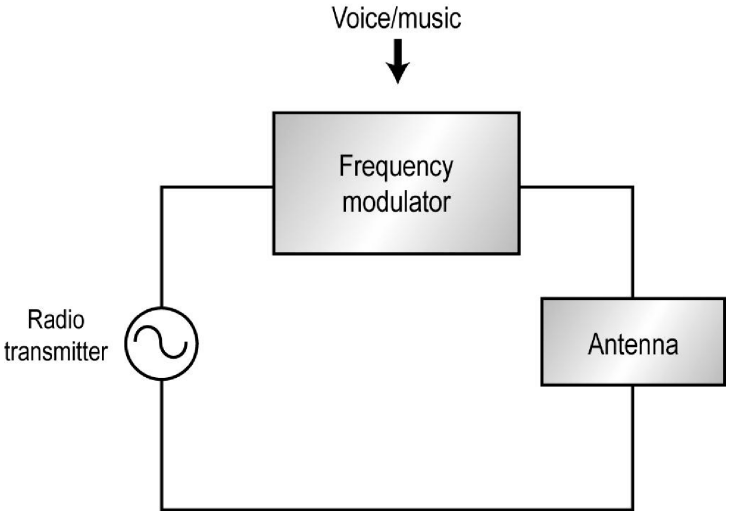


The 120 volt 60 Hz power line is the voltage source.

The control element is an electronic circuit that varies the current in such a way that the motor speed can be varied as desired by some input to the control element.

The load is a motor that rotates a drill or screwdriver.

Radio Transmitter Example



The voltage source is a radio transmitter consisting of a sine wave signal source and a power amplifier.

The control element is a modulator circuit that modifies the sine wave in such a way that the information (voice, video, data, etc.) such that it can be transmitted via radio. Amplitude, frequency and phase modulation are the control methods.

The load is an antenna.

ADDITIONAL RESOURCES

Please see the Practice and Resources section of this module for Web References on modern electronic equipment and applications.

Test your knowledge

How Electronic Circuits and Systems Work Knowledge Probe

Click on Course Materials at the top of the page.
Then choose **Knowledge Probe**.