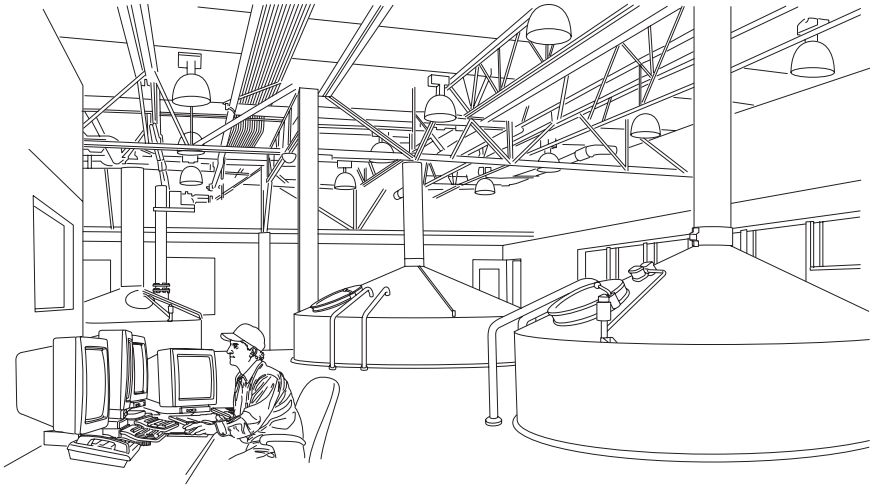
Batch and Continuous Processes

Thus far, we have discussed equipment used in discrete parts manufacturing or assembly applications. In addition to these types of manufacturing processes, electrical equipment is also used to manufacture a variety of products using batch or continuous processes.

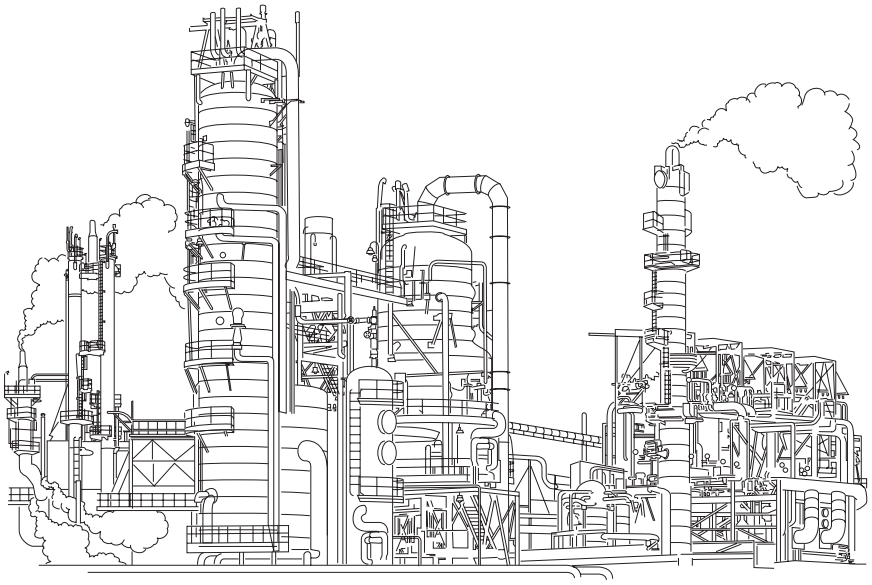
Batch Processes

Batch processes are familiar to most people since we use them in everyday life. For instance, when we bake a cake, we follow a recipe that involves adding ingredients, stirring the mixture, pouring it into baking pans, putting the pans into the oven for a specific time at a specific temperature, etc. Industrial batch processes are similar to the process of baking a cake but scaled up to produce a larger quantity of material. A variety of products are produced using batch processes. Food, beverages, pharmaceutical products, paint, fertilizer, and cement are a few of the categories of products produced using batch processes. Some products such as food, beverages, and pharmaceuticals require precise tracking of batch information for safety and regulatory purposes.



Continuous Processes

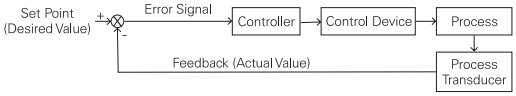
Continuous processes are less understood by most people; however, they have some similarities to batch processes. Ingredients must be combined in precise ways at precise points in the process. Precise control of process conditions must be maintained to ensure product quality and safety of operations. Some industries, such as chemical and petrochemical industries, use continuous processes extensively. Many other industries, however, use continuous processes as some part of their operations, purifying air and water, treating waste products, etc.



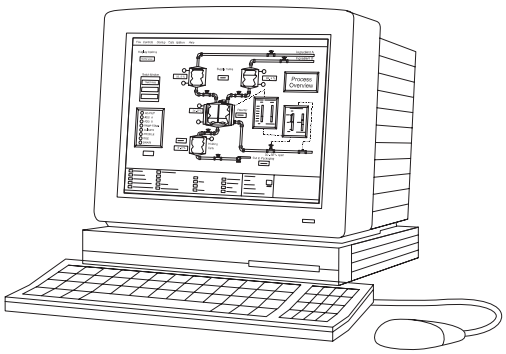
Both batch and continuous processes use many of the products discussed thus far. However, there are some unique characteristics of batch and continuous processes that either require the use of additional types of equipment or require some of the equipment previously discussed to be applied differently.

Closed-Loop Control

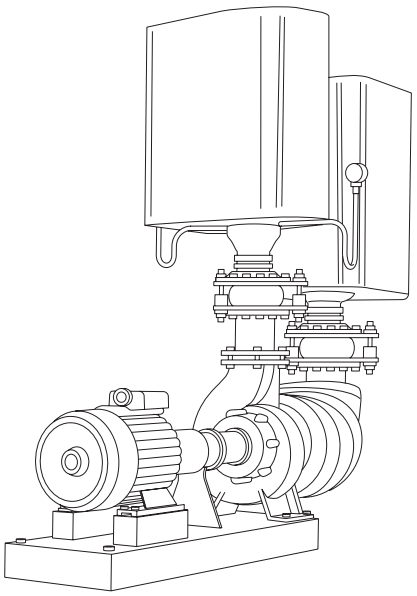
One characteristic of batch and continuous processes is their extensive use of analog data. Analog values can vary continuously within a specified range. The analog data may be representative of temperature, pressure, rate of flow, weight, thickness, viscosity, humidity, or any other characteristic of importance to the process. Both batch and continuous processes require continuous monitoring at numerous points throughout the process. In addition, a corrective action is often required to insure that the process stays within specifications. This type of control that involves measuring a value, comparing the measured value to a desired value or set point, and correcting for the error is called closed-loop control.



A variety of approaches can be used for process control depending upon the complexity of the process being controlled. A small batch process often lends itself well to control by one PLC or a few networked PLCs. A representation of the process showing its current status and a history of data recorded at various points in the process is often provided to an HMI system networked to the PLCs.

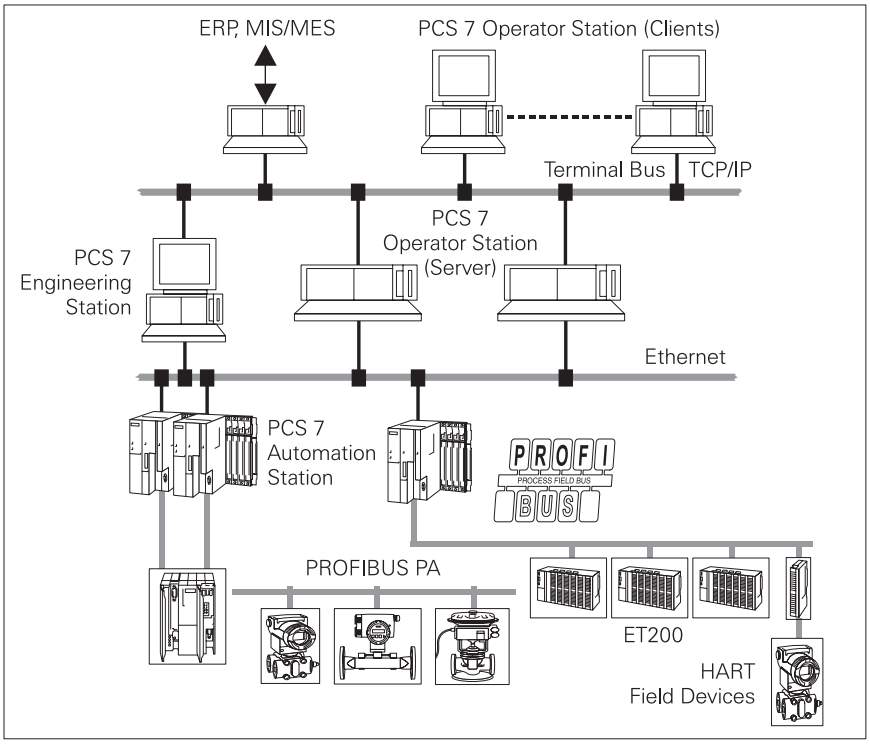


Increasingly, variable speed drives are also networked to the PLC and HMI systems. These drives are used to control the speed of pumps or fans that in turn control the flow of fluids and gases. Flow control is frequently accomplished by using control valves and vent damping systems to regulate flow while running pump and fan motors at full voltage. Using variable speed drives for pump and fan control is a more energy efficient approach to controlling process flow rates.



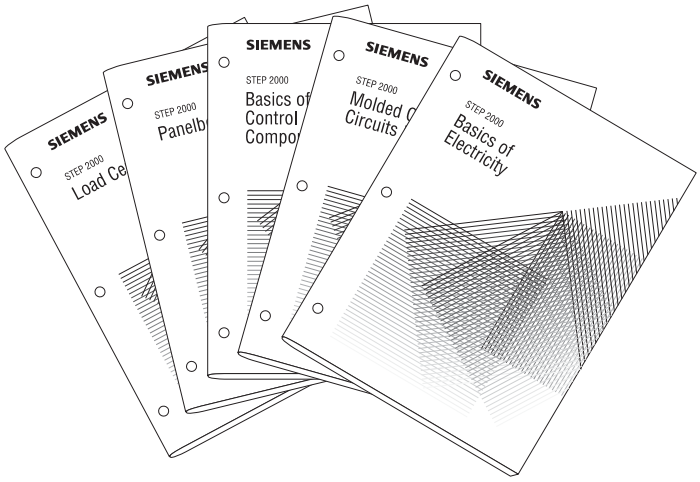
Supervisory Control

Traditionally, medium to large applications in process industries have been controlled by distributed control systems (DCS) that are based on proprietary hardware and software. By utilizing industrial standards (Microsoft NT, Ethernet, PROFIBUS) the industry now moves towards scalable hybrid systems, like SIMATIC PCS 7. Hybrid systems contain powerful process controllers and networks combined with all software tools integrated into one common Engineering system. By using PCS 7, customers reduce engineering time, installation costs and spare part inventory. PCS 7 is built upon Totally Integrated Automation components and provides a complete toolset for developing the control strategy, the HMI, networks and interfaces to MES/ERP systems.



Other STEP 2000 Courses

Hopefully, this course along with our STEP 2000 Basics of Electricity course, has provided you with a base of knowledge that will make our other STEP 2000 courses more useful and interesting to you. Keep this book handy so that you can use the pictorial glossary to assist you in your additional training or with your daily work.



Review 5

1. _____ _____ controllers start a motor by applying voltage gradually from an initial low voltage to 100% voltage.

2. An AC or DC _____ is used to control the speed and torque of a motor.

3. _____ is a name associated with three types of LANs that are used at the field and process level.

4. _____ is an example of a LAN that is used at the device level.

5. Paint, fertilizer, and cement are examples of _____ processes.

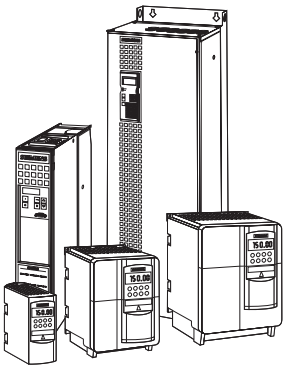
6. _____ - _____ involves measuring a value, comparing the measured value to a desired set point, and correcting the error.

Pictorial Glossary

The pictorial glossary includes definitions and illustrations to many terms that are frequently used in the electrical industry. Terms that are underlined and italicized are included in the glossary as a separate definition.

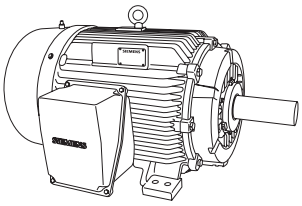
AC Drive

An electronic device used to control the speed and *torque* of an *AC motor*. Also called a *variable frequency drive*, *variable speed drive*, and an *inverter*.



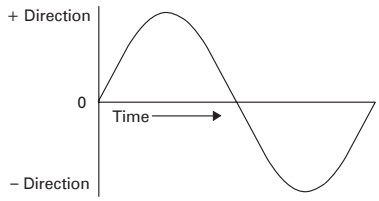
AC Motor

A *motor* that uses *alternating current* to convert electrical energy into mechanical energy. Many AC motors used in industrial applications are three-phase induction *motors*.



Alternating Current (AC)

Current that periodically reverses direction.



Ambient Temperature

The temperature of the medium (air, water, etc.) surrounding a device.

American National Standards Institute (ANSI)

A nongovernmental organization that promotes and coordinates the development of standards and approves standards written by other organizations.

American Standard Code for Information Interchange (ASCII)

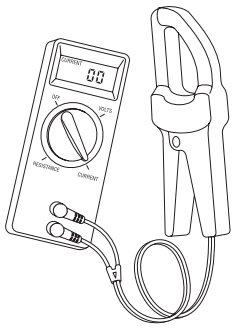
A seven-*bit* code, sometimes with an additional parity bit added for error checking. The ASCII code is used to represent numbers, letters, symbols, and control codes.

American Wire Gage (AWG)

A common method of specifying wire size (cross-sectional area). Larger numbers represent smaller wires. After AWG No. 1, the largest sizes are AWG No. 0, AWG No. 00, AWG No. 000, and AWG 0000. AWG No. 0 is called one-aught, AWG No. 00 is called two-aught, etc.

Ammeter

A meter designed to measure *current*.



Ampacity

The rated continuous *current* capacity of a conductor or device.

TABLE 1-Ampacities of Insulated Conductors (From NEC Table 310-16)
Not More Than Three Insulated Conductors in Raceway
(Based on Ambient Temperature of 30°C, 86°F)

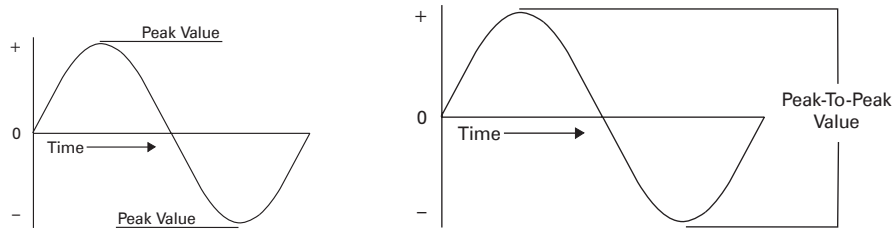
	COPPER CONDUCTORS			
Size	60°C (140°F)	75°C (167°F)	85°C (186°F)	90°C (194°F)
AWG MCM	TYPES ① RUW T TW UF	TYPES ① FEPW RH RHW RUH THW THWN XHHW USE ZW	TYPES V, MI	TYPES TA, TBS SA,AVB SIS FEP,① FEPB,① RHH,① THHN,① XHHW①②
18	---	---	---	14
16	---	---	18	18
14	20③	20③	25	25③
12	25③	25③	30	30③
10	30	35③	40	40③
8	40	50	55	55
6	55	65	70	75
4	70	85	95	95
3	85	100	110	110
2	95	115	125	130
1	110	130	145	150
1/0	125	150	165	170
2/0	145	175	190	195
3/0	165	200	215	225
4/0	195	230	250	260

Ampere, Amp

The basic unit for *current*. The ampere, also called an amp, is equal to a current of 1 *Columb* per second. The symbol for ampere is "A."

Amplitude

The total variation of a waveform. Amplitude can be expressed as a peak value, peak-to-peak value, or *effective value*.

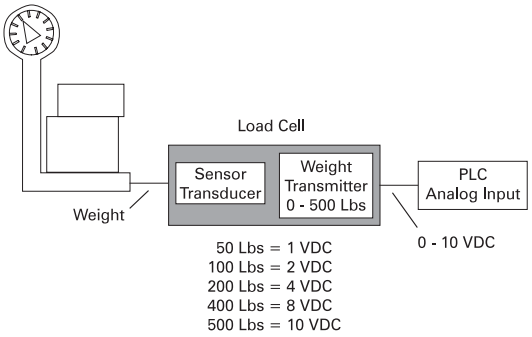


Analog

A value that is continuously variable. Also used to describe circuits that work with analog signals.

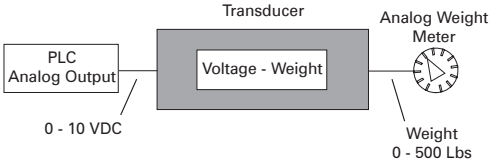
Analog Input

An input to a system that can continuously vary over a range of *current* or *voltage* such as 4 to 20 milliamps or 0 to 10 volts.



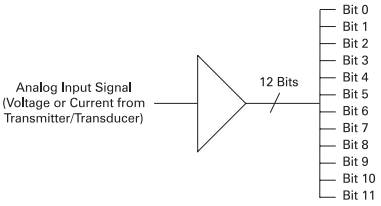
Analog Output

An output from a system that can continuously vary over a range of *current* or *voltage* such as 4 to 20 milliamps or 0 to 10 volts.



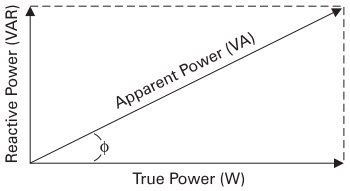
Analog-to-Digital (A/D) Converter

A circuit that converts *analog* signals to signals that can be used by *digital* circuits.



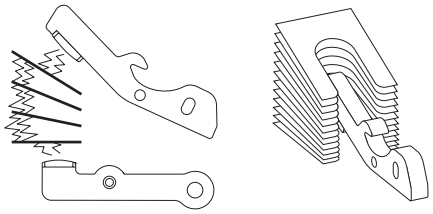
Apparent Power

The vector sum of *true power* and *reactive power*. Apparent power is calculated by multiplying *current* times *voltage*. The unit for apparent power is the volt-ampere or VA.



Arc Chute Assembly

An assembly of metal plates surrounding *circuit breaker* or *contactor* contacts. The arc chutes are used to reduce contact damage by quickly extinguishing the arc created when circuit breaker contacts open.

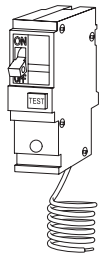


Arc Fault

An arc fault occurs when a *current*-carrying *conductor* has arcing condition to ground or another *conductor*.

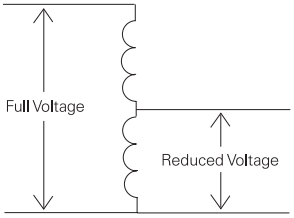
Arc Fault Circuit Interrupter (AFCI)

A *circuit breaker* designed to provide protection from the effects of an *arc fault* by recognizing the characteristics unique to arcing and de-energizing the circuit when an arc fault is detected.



Autotransformer

A type of *transformer* in which the secondary coil is part of the primary coil. Often the secondary *voltage* is adjustable via a movable tap.

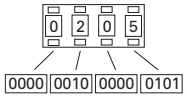


Baud Rate

A way of describing the amount of data that can be sent on a signal line. Often used synonymously with *bits* per second; however, baud rate was originally intended for use in telegraphy application to refer to signal events per second.

Binary-Coded Decimal (BCD)

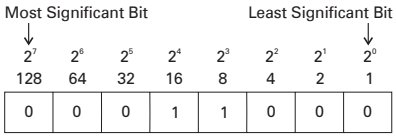
Usually refers to the 8-4-2-1 code where four *bits* are used to represent decimal digits 0 through 9.



Decimal Numbers	BCD Numbers
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

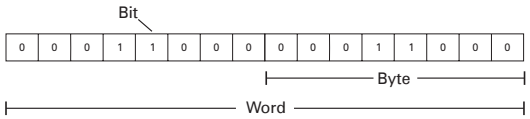
Binary Number

A number made up only of 1's and 0's that represent powers of two (2). *Digital* equipment uses binary numbers to represent numerical values or the on or off condition of devices.



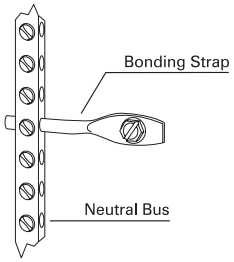
Bit

A 1 or 0 representing one position in a *binary* number.



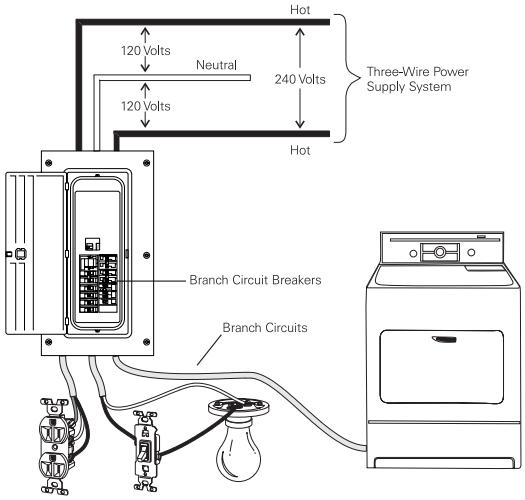
Bonding

The permanent joining of metal parts to form an electrically conductive path.



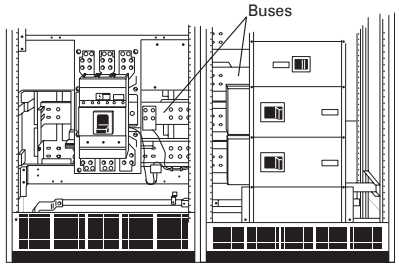
Branch Circuit

A part of a *power* distribution system extending beyond the final *overcurrent* protection device.



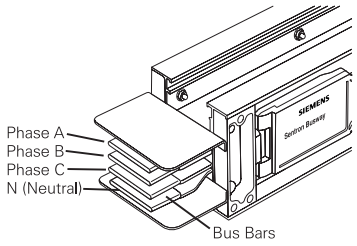
Bus

A group of *conductors* used to supply *power*, data, or control signals downstream.



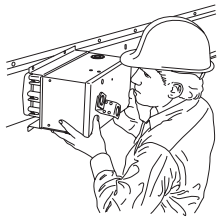
Bus Bar

A *conductor* that serves as a common connection for two or more circuits.



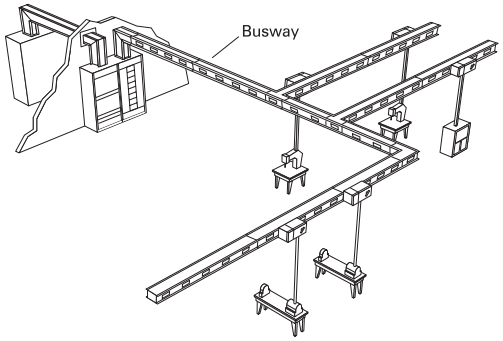
Bus Plug

A device used with *plug-in busway* to allow *power* to be distributed to a load.



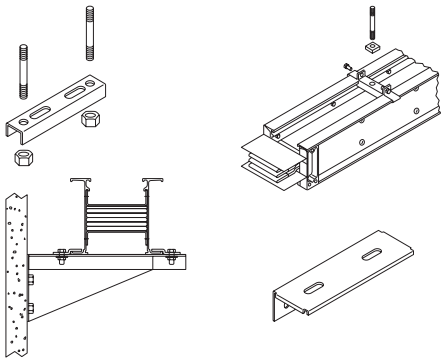
Busway

A prefabricated electrical distribution system that uses *bus bars* in its own protective *enclosure*.



Busway Hangers

Devices used to suspend *busway* from a ceiling or mount it to a wall.

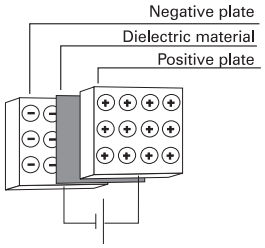


Byte

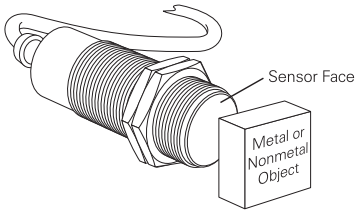
Eight consecutive *bits*.

Capacitance

The property of a circuit that allows it to store an electrical charge. The symbol for capacitance is "C." The unit for capacitance is the *farad*.



Capacitive Proximity Sensor A type of *sensing switch* that produces an electrostatic field to detect the presence of metal and nonmetallic objects without coming into contact with them.



Capacitive Reactance The opposition to *alternating current* resulting from circuit *capacitance*. Capacitive reactance is inversely proportional to *frequency* and *capacitance*. The symbol for capacitive reactance is "X_C." The unit for capacitive reactance is the *ohm*.

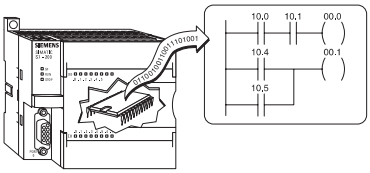
$$X_C = \frac{1}{2\pi fc}$$

Capacitor A device manufactured to have a specific *capacitance*.

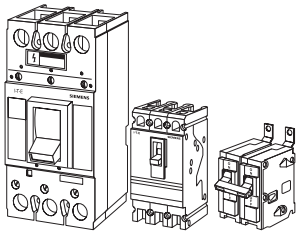
$$C = K\frac{A}{d}$$

A — Area of plates
d — Distance between plates
K — Dielectric constant

Central Processor Unit (CPU) The decision-making part of a computer. May also be used to describe the processing circuits together with memory and other circuits needed for processing information.

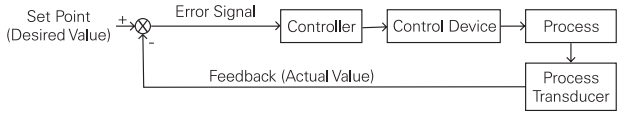


Circuit Breaker A device that can be used to open or close a circuit manually and can also open a circuit automatically when *current* is excessive.



Closed-Loop Control

A control technique that compares a *feedback* signal representative of an actual value with a desired value and responds to minimize the error.

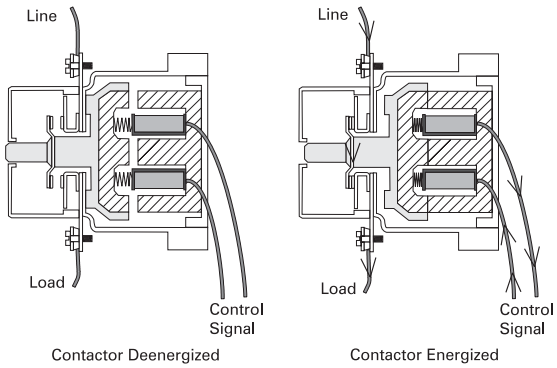


Conductor

A material that permits many electrons to move through it. Copper, silver, and aluminum are examples of materials that are good conductors. Also used generically to refer to a wire, cable, or *bus bar* that is made from a conducting material.

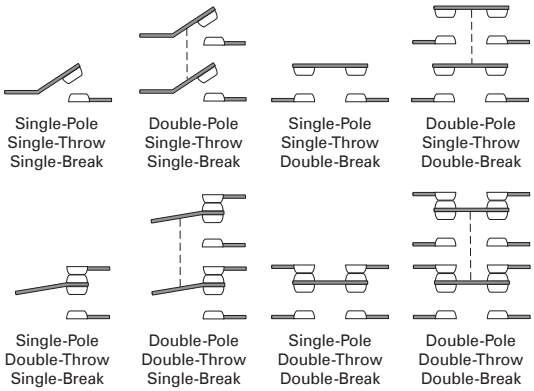
Contactor

A device used to energize and de-energize an electrical circuit.



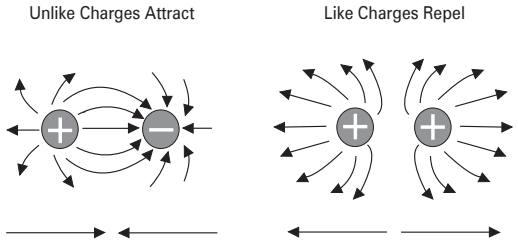
Control Relay

A device used to remotely open and close contacts.



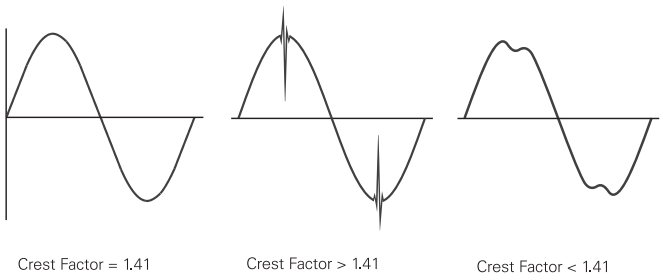
Coulomb A unit of electrical charge equal to 6.24×10^{18} electrons.

Coulomb's Law A law that states that charged objects attract or repel each other with a force that is directly proportional to the product of their charges and inversely proportional to the square of the distance between them. Unlike charges attract, and like charges repel each other.



Counter emf A *voltage* created in an inductive circuit that opposes a change in *current* flow.

Crest Factor A ratio of the peak value of an *alternating current* source to the *effective value*.



Current The flow of electrons in a circuit. Current is designated by the symbol "I" and is measured in *amperes*.