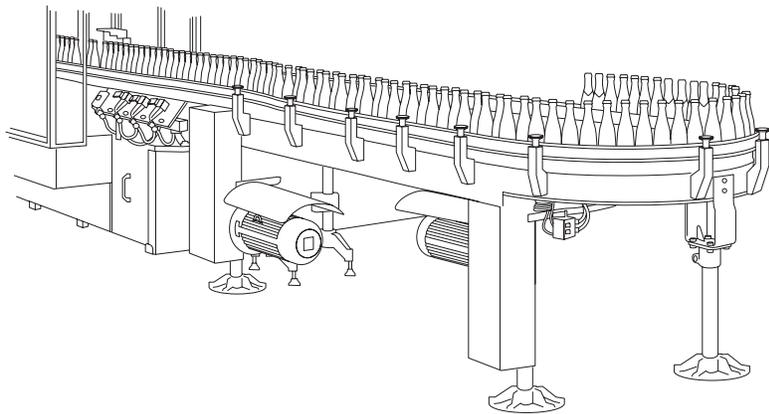


Manufacturing Applications

So far, discussion in this course has primarily centered on power distribution. We have seen how Siemens products can be used to distribute power throughout residential, commercial, and industrial applications. In industrial applications, this electrical energy is also used for lighting, heating, air conditioning, office equipment, and other non-industrial systems. Unlike commercial and residential applications, however, most of the electrical energy is used to power manufacturing equipment.



The equipment used in manufacturing varies widely depending upon the volume of production and the types of processes employed. As a result, Siemens offers a vast array of products for use in virtually every phase of manufacturing. Many of these products are purchased by machine builders or OEMs (original equipment manufacturers) for resale to the end user. In other cases, the end user may engineer a machine or process line or employ another company to do the engineering. The end result, however, is a coordinated system or process.

There is a variety of ways to represent manufacturing processes. However, since the goal of this course is to present an overview of Siemens Energy & Automation products, we need only take a high-level view of manufacturing processes.

In general, we can say that most manufacturing processes consist of one or more of the following process types:

Discrete Parts Manufacturing
Assembly
Batch Processing
Continuous Processing

The process type included in the overall manufacturing process depends upon the products being produced. Some industries, for example, are dominated by a specific process type.

<u>Process Type</u>	<u>Industry Examples</u>
Discrete Parts Manufacturing	Aircraft Parts Automotive Parts Electrical & Electronic Parts
Assembly	Aircraft Motor Vehicle Computer
Batch Processing	Food & Beverage Pharmaceutical
Continuous Processing	Chemical Petroleum

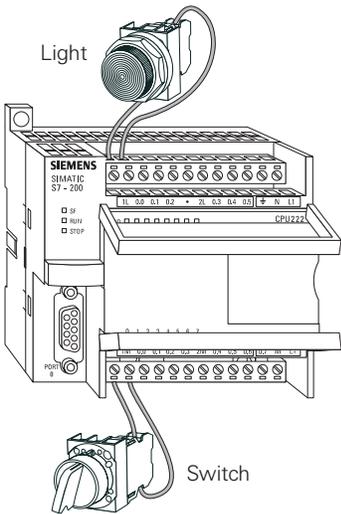
As an aid to understanding Siemens Energy & Automation products, the next section of this course will provide examples of products that could be used in each of the process types previously listed. Given the diversity of products, only representative examples will be used.

Discrete Parts Manufacturing

The process of manufacturing discrete parts typically involves the use of multiple machines. These machines may be involved with the movement and storage of raw materials, various stages of fabrication of raw materials into finished parts, packaging of parts, storage of parts, preparation of parts for shipment, and a host of related activities.

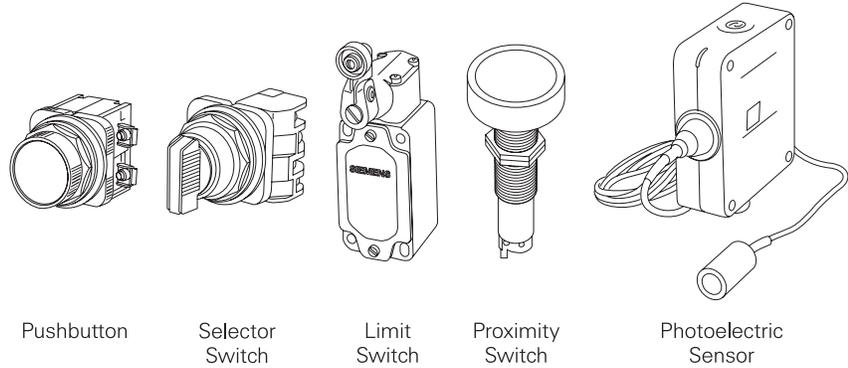
PLC-Controlled Machine

Although the various machines used as part of this process may vary widely, a typical machine will need some type of control system. This control system may be a programmable logic controller (PLC), like the Siemens S7-200 shown in the following illustration. The PLC is an industrial computer that interconnects to the machine it is controlling largely through its input-output (I/O) system. The PLC's I/O system allows it to receive inputs from switches and sensors and generate outputs to actuating devices, such as contactors and solenoids, and display devices such as indicator lights and Light Emitting Diode (LED) displays.

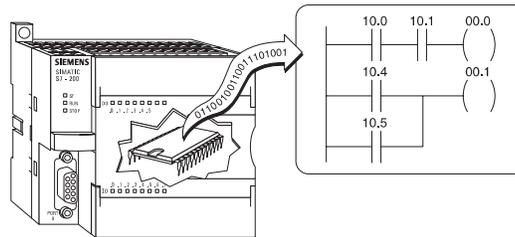


Input Devices

Inputs the PLC receives from various switches and sensors can provide signals representative of the actual condition of a machine. In addition, switches and other operator interfaces provide the PLC with signals representative of operator commands.

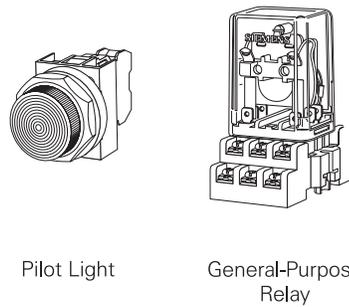


Inputs, as well as the current condition of PLC outputs and internal data values, are analyzed by the PLC's stored program.



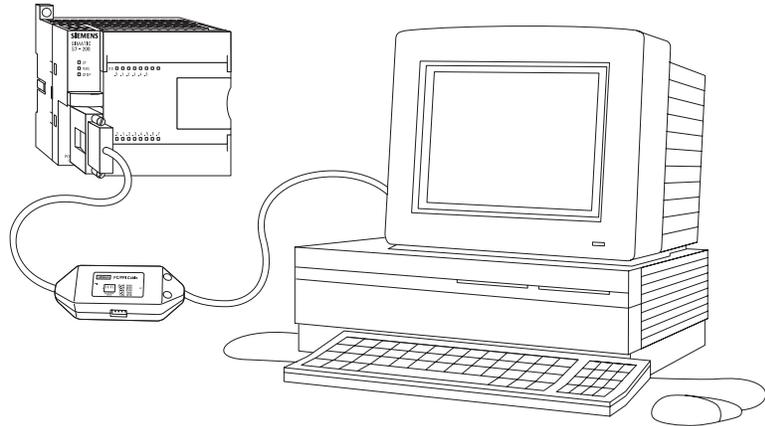
Output Devices

The PLC uses this process to determine the signals it sends to output devices that control the operation of the machine or indicate machine conditions such as RUN or STOP.



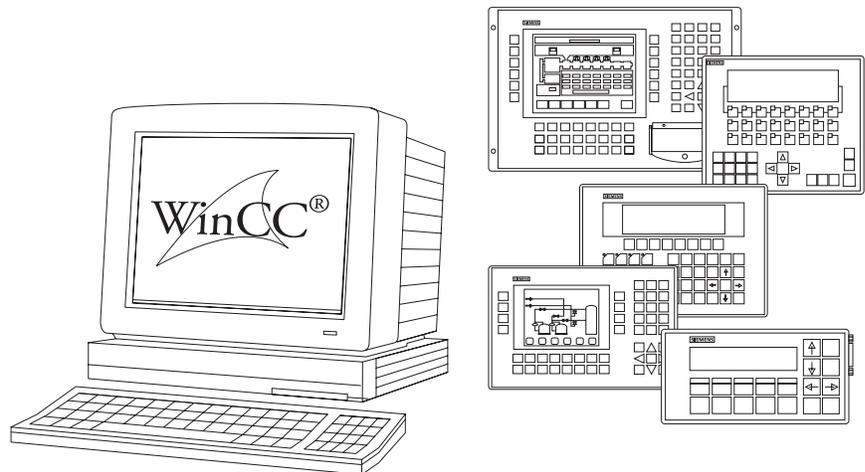
Communication

In addition to signals provided to the PLC through its I/O system, the PLC may also communicate with other devices via one or more communication ports. Communication ports can provide a pathway for the PLC to communicate with devices such as operator interfaces, variable speed drives, computers, and other PLCs.



Human Machine Interface

A Human Machine Interface (HMI) is any device that acts as a link between the operator and the machine. Typically, however, the term HMI is used to refer to devices that display machine or process information and provide a means for entering data or commands. Siemens HMI products include both hardware, like the SIMATIC[®] HMI operator panels, and software, like WinCC[®].

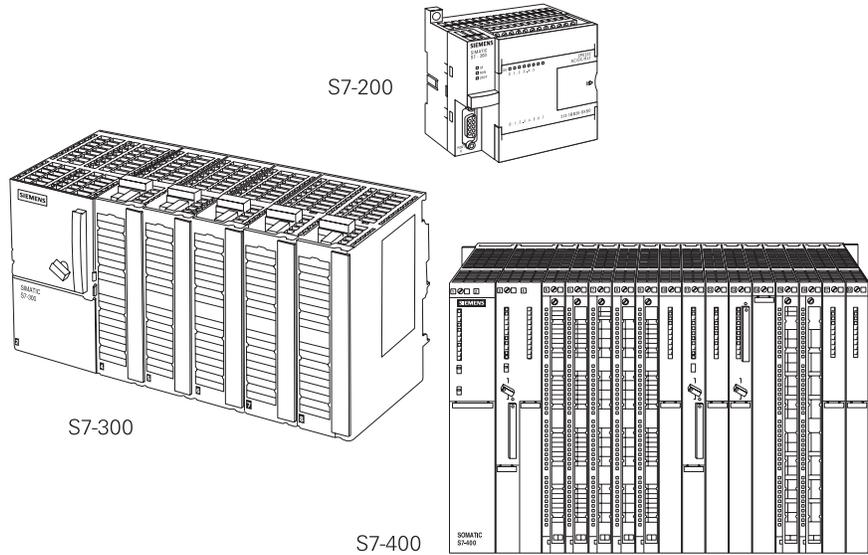


WinCC

SIMATIC HMI Operator Panels

Siemens PLCs

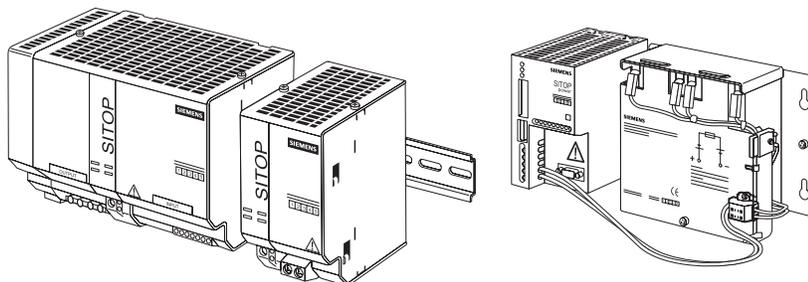
Since the characteristics of machines vary considerably, no one PLC can satisfy all machine control requirements. Therefore, Siemens provides PLCs of varying sizes and capabilities. The Siemens SIMATIC family of PLCs include the 505, S5, and the S7-200, S7-300, and S7-400, which are shown below.



SITOP Power Supplies

Depending on the application, PLCs, operator panels, and control components may require a regulated power supply. The SITOP[®] power supply provides a regulated source of 24 VDC power and the ability to ride through momentary power dips between 3 to 10 ms. Longer ride-through times can be achieved with an optional back up module which can provide up to 100 ms at 40 amps (200 ms at 20 amps and so on). An optional DC UPS (uninterruptable power supply) module and an external battery is also available.

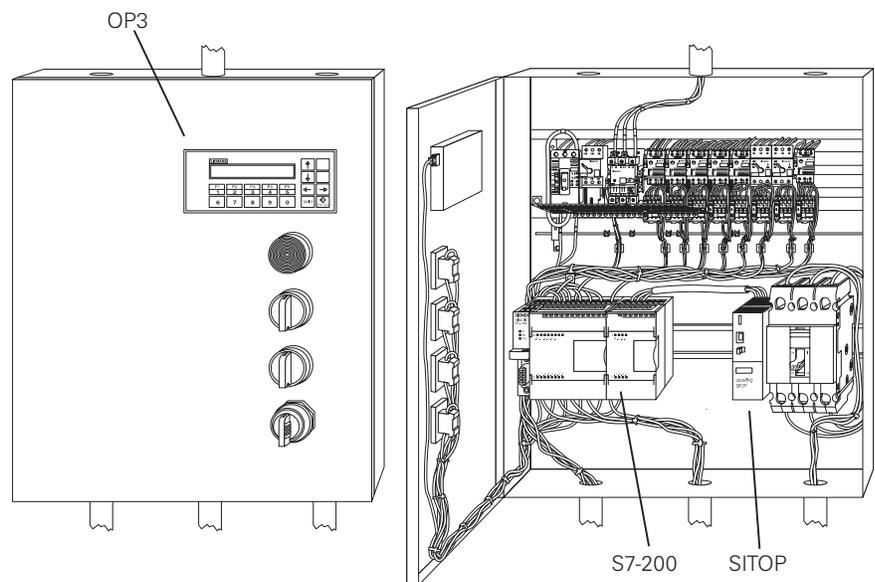
SITOP power supplies meet standards of agencies worldwide. They are suitable for use on worldwide networks and require no fusing on the secondary. Models are available up to 40 amps and SITOP can be used at 100% of the rated output current.



Machine Example

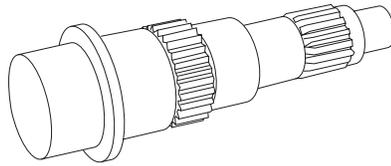
In the machine example shown below, an S7-200 PLC is mounted in a machine's control panel. The manufacturer of the machine has chosen to use field devices that require 24 VDC power. The power for the field devices and the PLC is provided by SITOP power supplies, one of which is shown adjacent to the S7-200.

As the S7-200 PLC executes its control program, it receives inputs from manual switches mounted on the front of the panel. It also communicates with a SIMATIC HMI OP3 operator panel that provides for manual inputs from the machine operator or maintenance person and displays alphanumeric messages indicating machine status. The PLC also receives inputs from other control devices such as limit switches or proximity switches that change state as a result of machine operations. In this example, the outputs of the PLC control electromechanical devices such as motor starters and contactors that turn on and off to control various aspects of the machine.



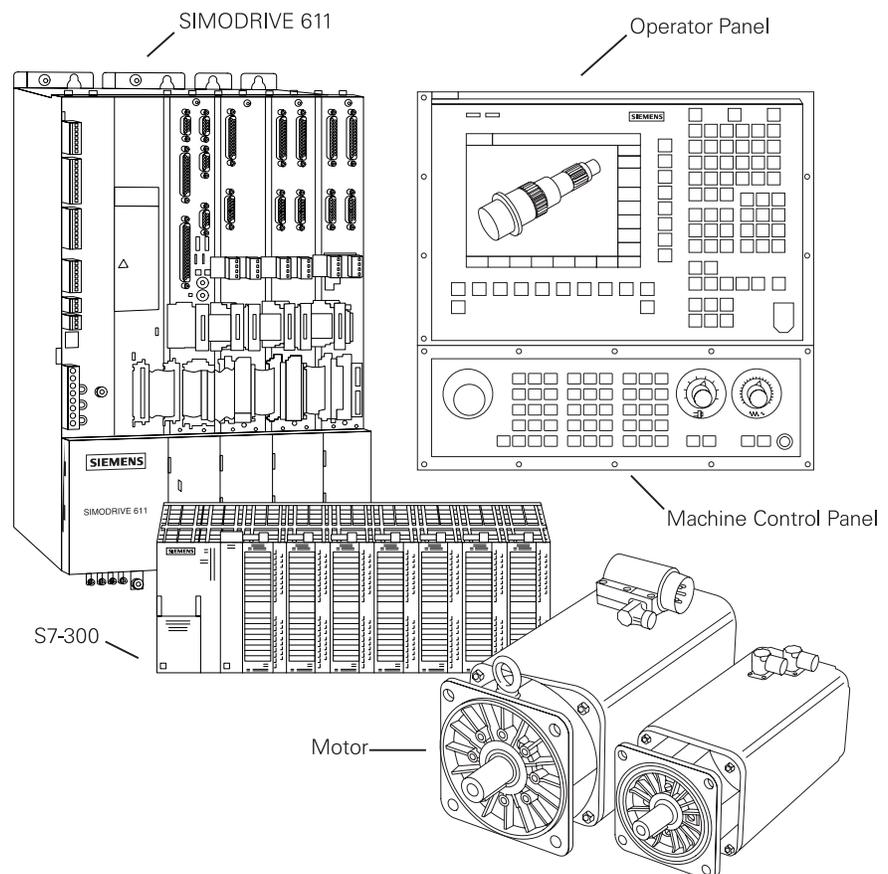
CNC-Controlled Machine Tool

PLCs are not the only control systems used for machines. Machine tools such as lathes, grinding machines, and machining centers are used to produce precisely machined parts. Machine tools typically combine a PLC control system with a computer numerical control (CNC). CNC-controlled machine tools allow parts to be machined to complex and exacting specifications. A gear, similar to the one illustrated, is one example of a part that might be made with a CNC-controlled machine tool.



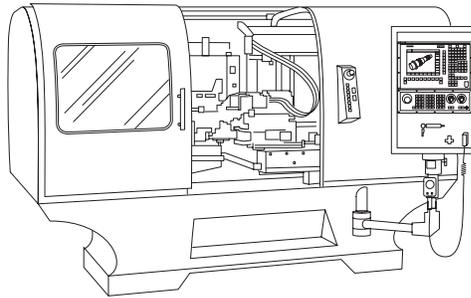
SINUMERIK

Siemens offers a range of SINUMERIK[®] CNC models such as the 810D, 840Di, 840D, and the compact FM357-2 positioning and path control module. These products provide the coordinated multi-axis control needed for milling, drilling, turning, and grinding applications. SINUMERIK CNCs also interconnect operator panels and SIMODRIVE servo and spindle drives and associated motors to form a complete control system for the machine tool.



Machine Tool Example

Typically, machine tools are designed to perform a specific task, such as grinding, drilling, or cutting. Machine tools can be programmed to a predetermined pattern or model to obtain the desired shape of the finished piece. In the following example a SINUMERIK CNC controls a rotary grinding machine. The rotary grinding machine takes a piece of stock that has already been cut and shaped on another machine tool, removes any burrs or high spots, and grinds the material to a fine finish.

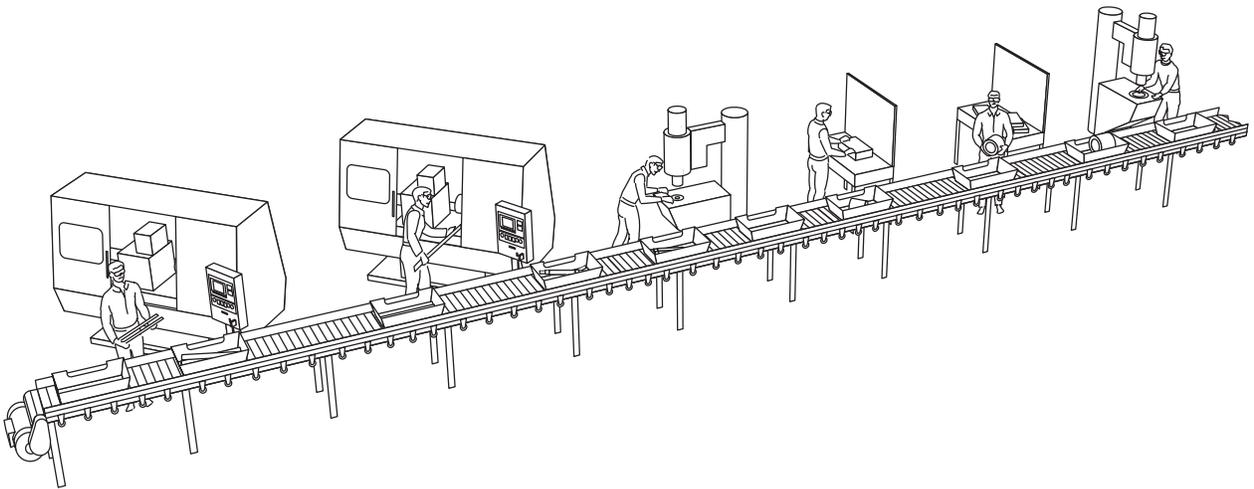


Review 4

1. A _____ is an example of an output device used for a PLC.
 - a. pushbutton
 - b. pilot light
 - c. photoelectric sensor
 - d. limit switch
2. The term "SIMATIC HMI" is used to identify a type of _____ manufactured by Siemens.
 - a. PLC
 - b. power supply
 - c. operator panel
 - d. machine tool
3. SITOP power supplies provide a regulated source of _____ VDC.
4. _____ is a Siemens trade name that identifies a complete control system used in the machine tool industry.

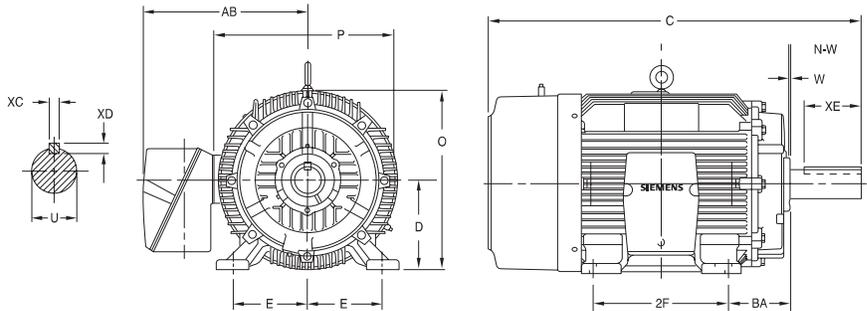
Assembly Processes

Assembly processes may involve assembling an entire system or subsystem at one location. In many cases, however, parts may be mounted sequentially through a series of assembly stations. Units being assembled are then moved from station to station via some type of transporter mechanism such as a conveyor. Any specific assembly station may utilize only manual assembly operations or may include one or more machine operations. The latter is particularly true when just-in-time manufacturing techniques requiring parts to be manufactured as needed are employed.

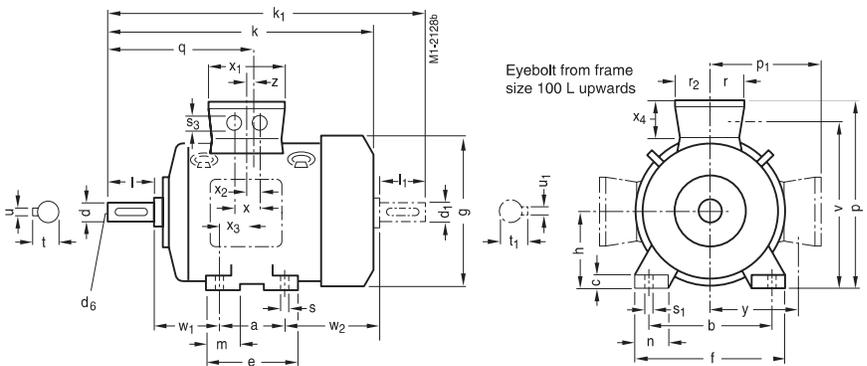


Motors

There are many aspects of assembly processes that are similar to discrete parts manufacturing and, in fact, many factories combine both types of processes. Therefore, it should come as no surprise that the electrical products used in both types of processes are often the same. For instance, AC motors are used in both types of processes to change electrical energy into mechanical energy, the reverse of what a generator does. In the U.S. the most common type of industrial motor is a NEMA frame size, three-phase AC induction motor. The term "NEMA frame size" is used to indicate that the motor corresponds to frame dimensions specified by the National Electrical Manufacturers Association. Siemens manufactures a variety of motors, including motors too large to correspond to NEMA frame dimensions (above NEMA motors) and motors that correspond to International Electrotechnical Commission (IEC) specifications.



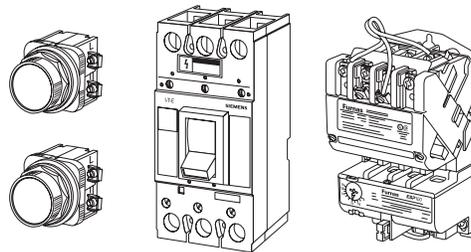
NEMA Motor



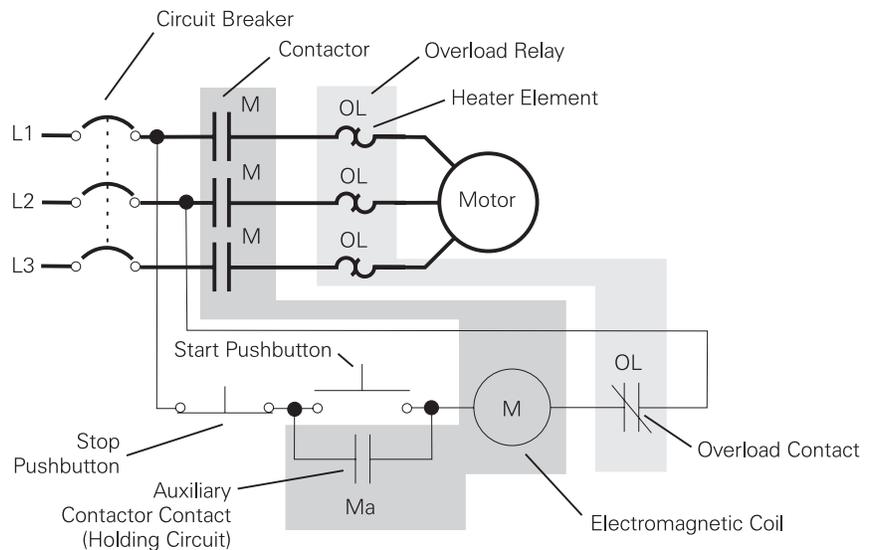
IEC Motor

Motor Control

Wherever motors are used, they must be controlled. The most basic type of AC motor control involves turning the motor on and off. This is often accomplished by using a motor starter, which is made up of a contactor and an overload relay. The contactor's contacts are closed to start the motor and opened to stop the motor. This is accomplished electromechanically using start and stop pushbuttons or other pilot devices wired to control the contactor. The overload relay protects the motor by disconnecting power to the motor when an overload condition exists. An overload could occur, for instance, when a conveyor is jammed. Although the overload relay provides protection from overloads, it does not provide short-circuit protection for the wiring providing power to the motor. For this reason, a circuit breaker or fuses are also used.

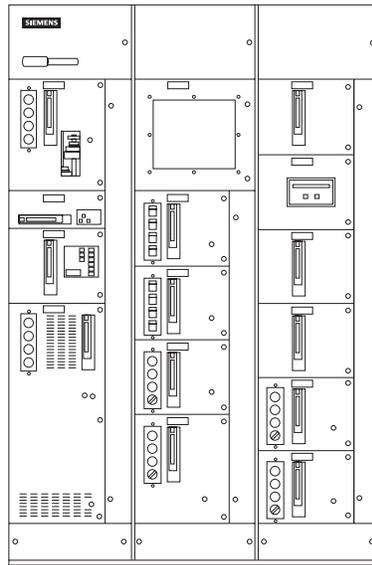


Pushbuttons Circuit Breaker Motor Starter



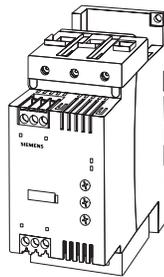
Motor Control Centers

When only a few geographically dispersed AC motors are used, the circuit protection and control components may be located in a panel near the motor. When a larger number of motors are used these components are often concentrated in a motor control center. A motor control center is a type of enclosure that is sectionalized so that control circuits associated with each motor are mounted in a removable container called a pan or bucket. Siemens TIASTAR motor control centers can be manufactured to fit a wide range of customer requirements. Motor control centers can also include items such as reduced-voltage controllers, variable speed drives, and PLCs.

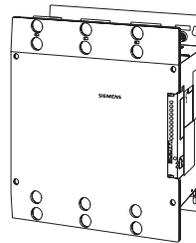


Reduced Voltage Controllers

While it is common to turn motors on and off instantaneously, this abrupt transition results in power surges and mechanical shock that may need to be avoided especially when larger motors are involved. Solid-state reduced-voltage controllers, however, can apply voltage gradually from an initial low voltage to 100% voltage. The motor experiences reduced inrush current and speed is accelerated smoothly. In addition, just enough torque can be applied to start and accelerate the motor. This is beneficial for loads that have problems with the initial jerk and rapid acceleration of across-the-line starting. Reduced-voltage controllers, such as the Siemens SIRIUS and SIKOSTART, can also be included in Siemens motor control centers.



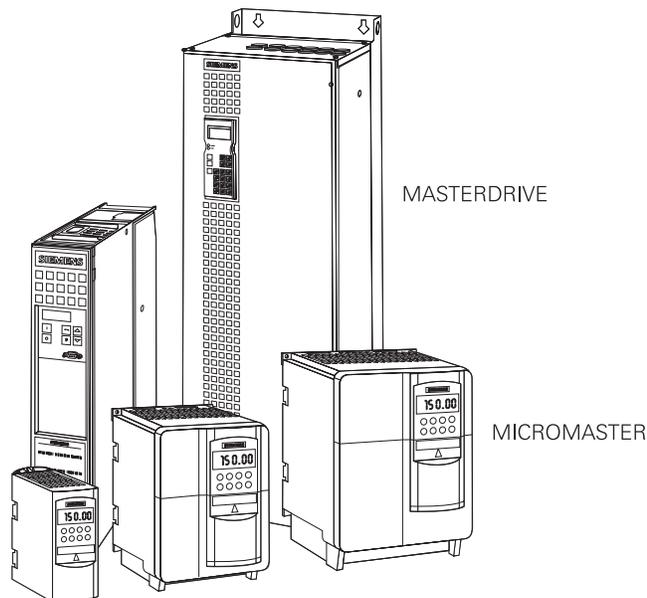
SIRIUS



SIKOSTART

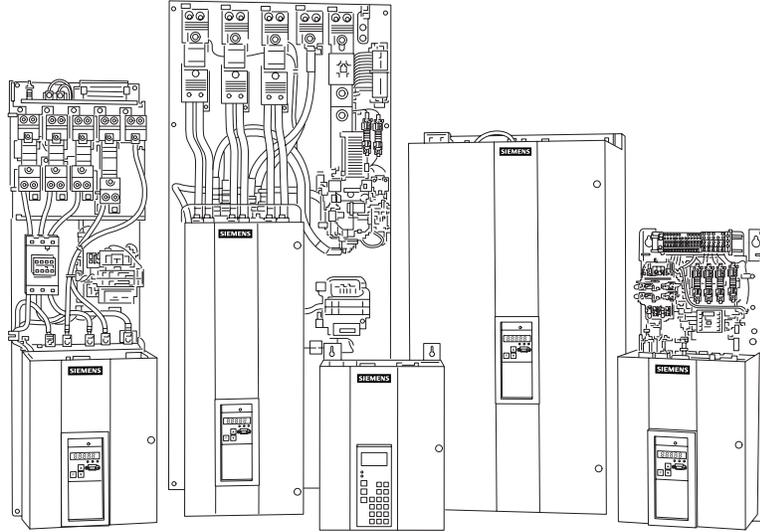
AC Drives

Although reduced voltage controllers can control an AC motor during starting and stopping, many applications require control of motor speed and torque. Controlling motor speed and torque is the job of a variable speed drive. Since AC motors are available in a range of ratings and types, Siemens offers a broad range of AC drives, including multiple models of the MICROMASTER and MASTERDRIVE.



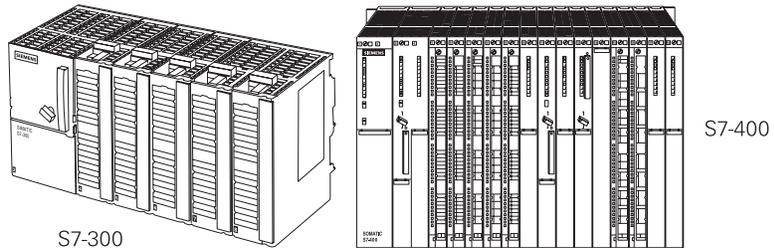
DC Drives

Although AC motors are more commonly used, many factories also use DC motors for selected applications. In many of these applications, precise control of motor speed and torque is required. For these applications Siemens offers the SIMOREG® DC MASTER.



PLCs

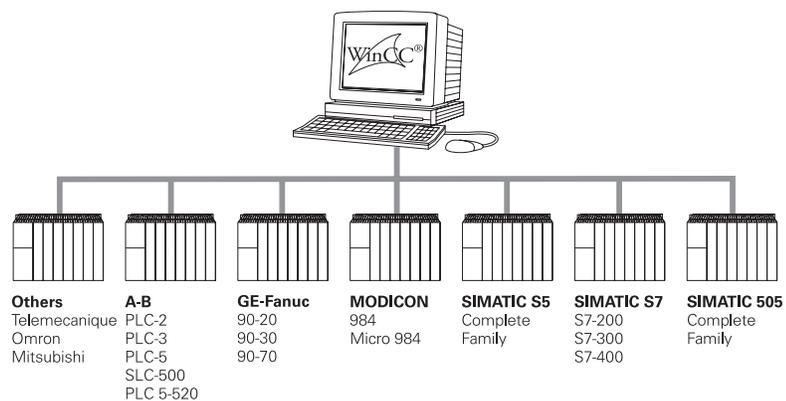
Since assembly processes vary in complexity, the types of control systems and related devices employed will also vary. In addition to small- and medium-sized PLCs or other control systems used to control individual machines, one or more larger PLCs may be employed to collect data and coordinate operation of some or all of the system. This overall coordination may include control of the full range of motor control devices discussed thus far from full-voltage starters to AC and DC drives. The specific PLC model used will be determined by the size and complexity of the application. Examples of Siemens PLC models that may be employed include the S7-300 and S7-400.



Human Machine Interface

Just as it is often necessary to use a PLC to coordinate the operation of multiple machines in an assembly process, it is also often necessary to provide a graphical representation of the current status of this process. In addition to providing this graphical representation, a Human Machine Interface (HMI), such as Siemens WinCC, can provide a custom interface to allow operation personnel to control some or all of the process and for maintenance personnel to obtain system diagnostic information.

Since many manufacturing facilities use multiple PLC models and often models produced by multiple companies, WinCC can communicate with many types of PLCs. In addition, WinCC versions are available for computers using Windows 95 or Windows NT operating systems.



Local Area Network

In any complex assembly process the need for rapid information flow is critical. Conditions at any point in the process may impact the entire process. This need for information flow often requires that intelligent devices such as PLCs, intelligent sensors, drives, computers, and operator interface systems be interconnected by one or more local area networks (LAN).

A LAN is a communication system designed for private use in a limited area. LANs are used in office areas as well as in manufacturing environments; however, LANs used in industrial applications must be able to operate reliably in conditions that might be unsuitable for office-grade equipment. Industrial environments typically have a high level of electrical noise and a greater range of temperature and humidity than found in office environments.

Specifications for industrial LANs vary considerably depending upon the requirements of the application. Issues such as the amount of data to be communicated, the rate at which data must be communicated, the number of devices to be connected, the reliability and noise immunity required, compatibility with other networks, and cost are examples of important considerations. In general, it is not possible for one network type to maximize all characteristics. For instance, a network that can communicate a large amount of data in a short time is likely to be more expensive than a network that has more limited requirements. Therefore, many factories use a multi-level structure for communication.

In the past, these networks were often proprietary systems designed to a specific vendor's standards. Siemens has been a leader in pushing the trend to open systems based upon international standards developed through industry associations. Examples of these open networks are listed below.

Network Level	Examples	Examples of Devices or Systems Connected
Management Level	Ethernet	Computers Running Management Information Systems (MIS)
Control Level	Ethernet	PLCs, Industrial Computers
Field and Process Level	PROFIBUS FMS PROFIBUS DP PROFIBUS PA	PLCs, CNCs, Variable Speed Drives HMI's, Industrial PCs
Device Level	Actuator Sensor Interface (ASI)	Actuators (Output Devices), Sensors (Input Devices)