

CSE-3103: Microprocessor and Microcontroller

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Programmable Logic Controllers

Programmable logic controller (PLC) →
most widely used industrial process control technology.
industrial grade computer.
programmed to perform control functions.

Designed for →
multiple input and output arrangement,
extended temperature ranges,
immunity to electrical noise,
resistance to vibration and impact.

Benefits →
eliminates hardwiring associated with relay control circuits.
fast response,
easy programming and installation,
high control speed,
network compatibility,
troubleshooting and testing convenience,
high reliability.

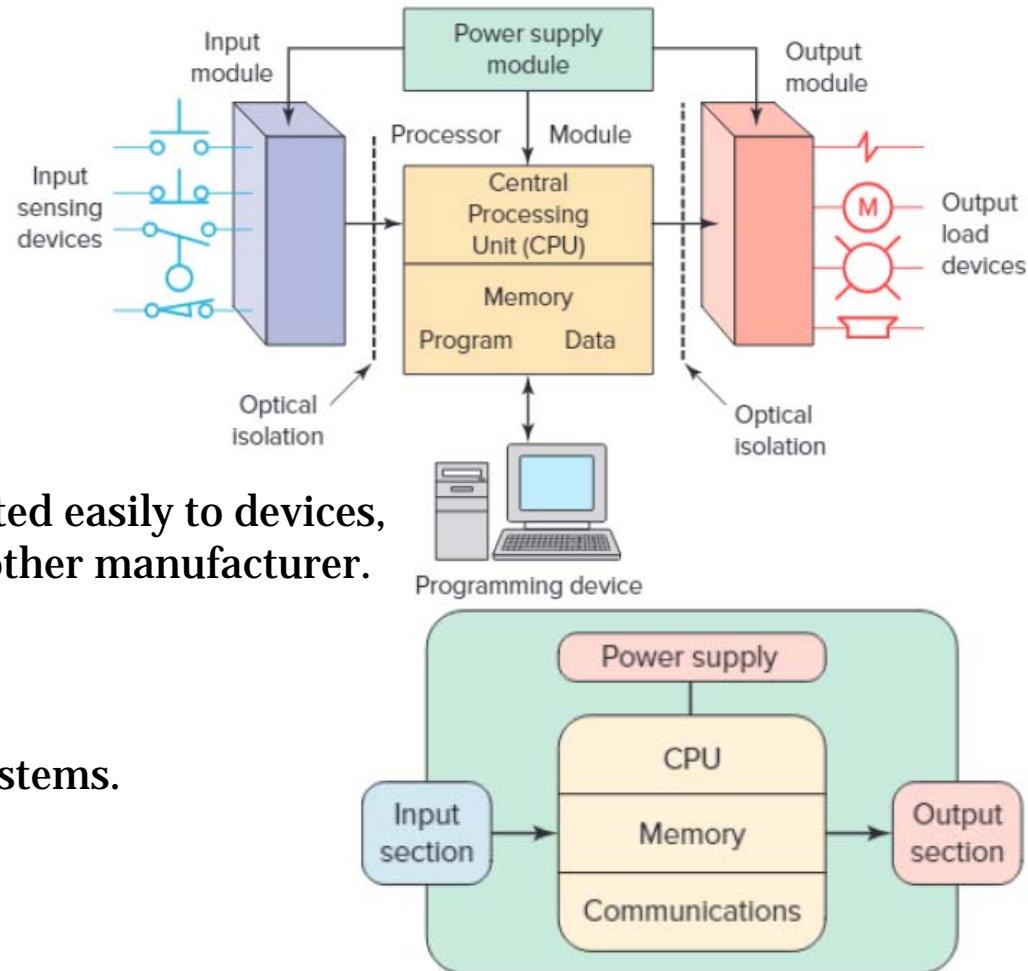
Parts of a PLC

Typical PLC parts →
central processing unit (CPU),
input/output (I/O) section,
power supply,
programming device.

Architecture →
refer to hardware, software or both.

open architecture →
allows → system to be connected easily to devices,
programs made by other manufacturer.
use off-the-shelf components.

closed architecture →
design is proprietary,
difficult to connect to other systems.



Parts of a PLC

2 ways of incorporating I/O into PLC →

- 1) Fixed I/O,
- 2) Modular I/O.

Fixed I/O →

small PLCs that come in one package =
processor and I/O are packaged together.

no separate, removable units.

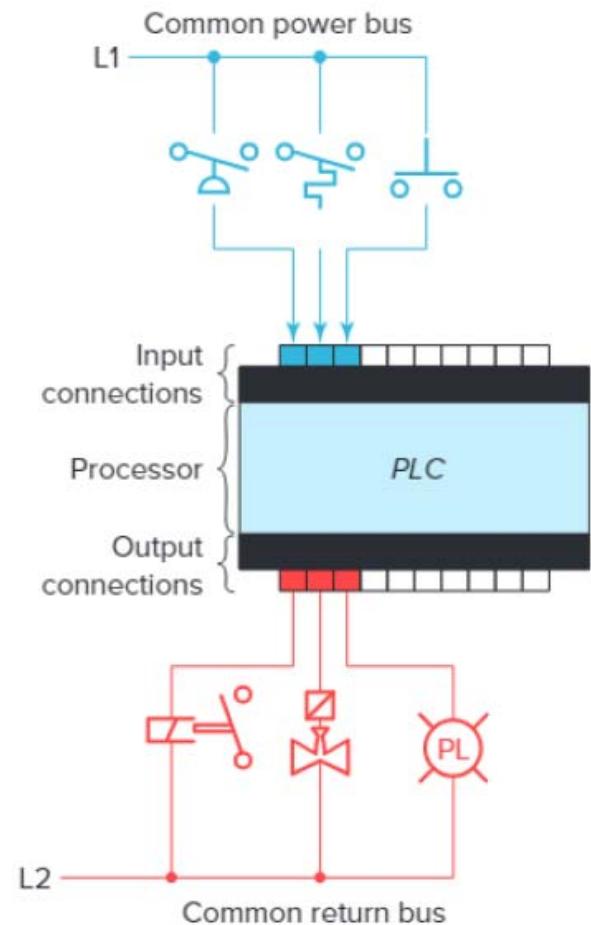
I/O terminals have fixed number of connections.

lower cost.

I/O points can be expanded by buying additional I/O units.

lack of flexibility.

any part of unit fails → whole unit has to be replaced.



Parts of a PLC

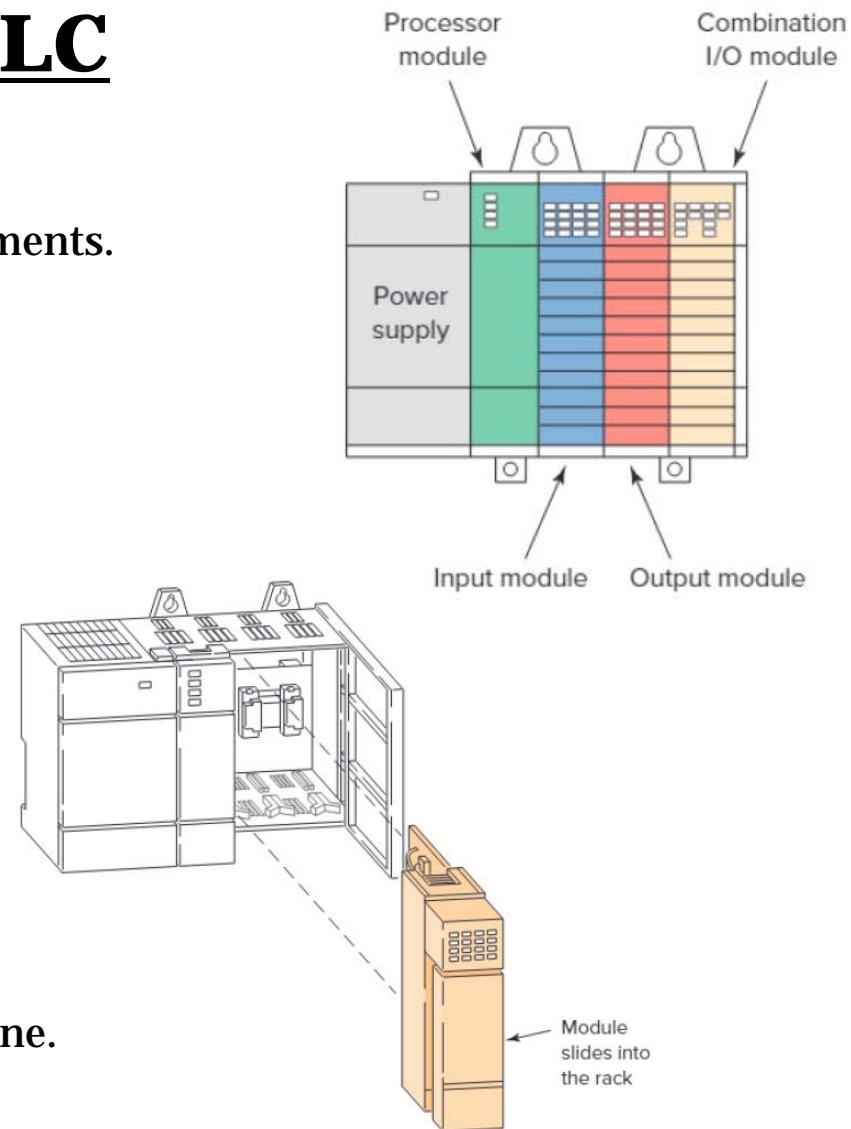
Modular I/O →

- divided by compartments.
- separate modules can be plugged into compartments.
- choose and mix modules as you desire.
- modular controller consists of →
 - rack,
 - power supply,
 - processor module (CPU),
 - I/O modules,
 - operator interface for → programming,
monitoring.

modules plug into rack.

Backplane →

- series of contacts.
- located at rear of rack,
- module is slid into rack →
 - makes electric connection with backplane.
- PLC processor is connected to backplane.



Parts of a PLC

Processor (CPU) →

brain of PLC.

controls all PLC activities.

consists of →

1) microprocessor →

implements logic,

controls communication among modules.

2) memory →

stores user program instructions,

numerical values,

I/O devices status.

PLC scan →

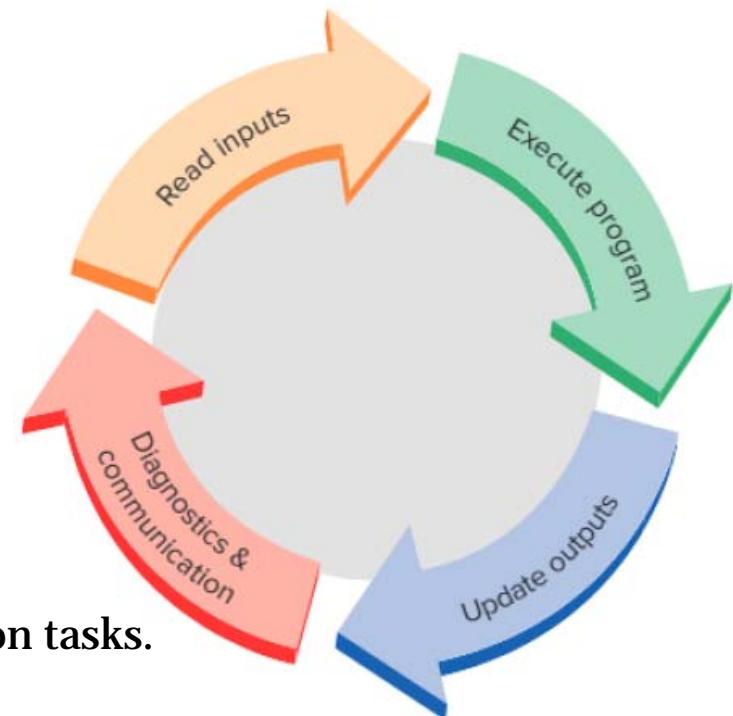
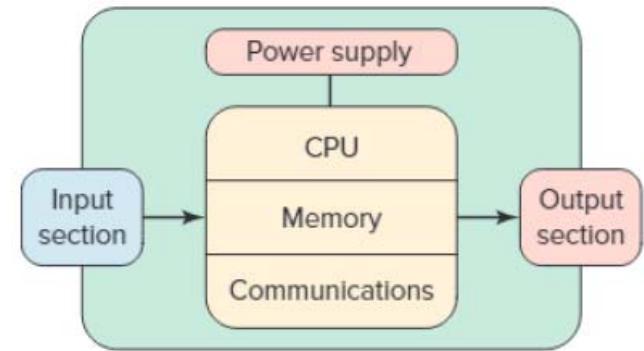
user enter desired program in relay ladder logic.

CPU reads status of inputs.

application program is executed.

status of all outputs is updated.

CPU performs internal diagnostic and communication tasks.



Parts of a PLC

I/O system →

forms interface by which field devices are connected to controller.

condition signals received from or sent to external field devices.

input devices are hardwired to input terminals.

output devices are hardwired to output terminals.

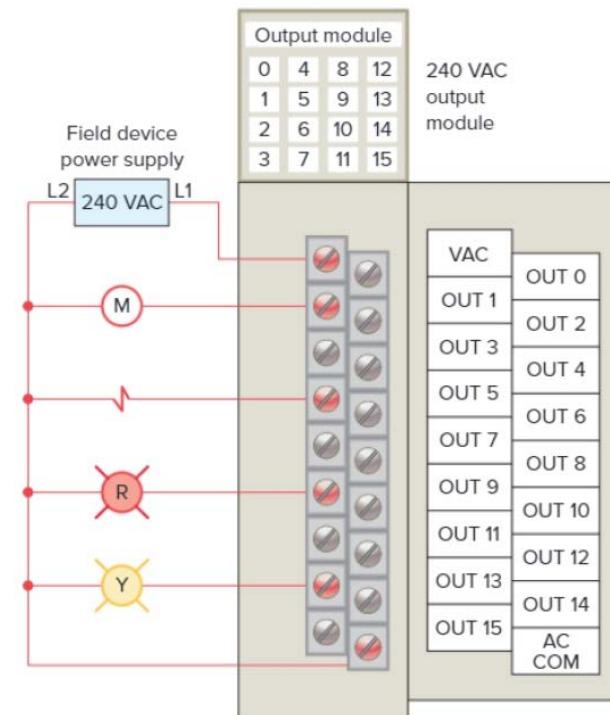
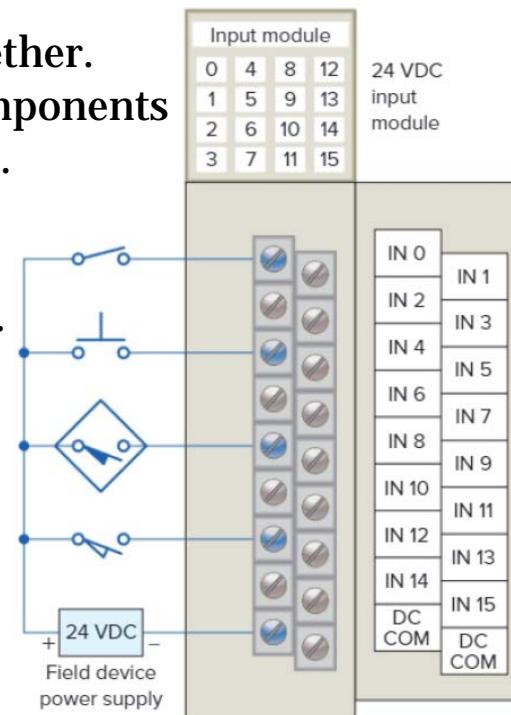
optical isolators →

couple circuits together.

isolate internal components
from I/O terminals.

external devices =

field or real-world
inputs and outputs.



Parts of a PLC

Power supply →

supplies DC power to other modules that plug into rack.

larger systems →

power to field devices = external AC or DC supplies.

small micro PLC systems →

power to field devices = power supply.

Programming device →

used to enter desired program into memory.

relay ladder logic →

programming language.

uses graphic symbols.

symbols show their intended outcome.

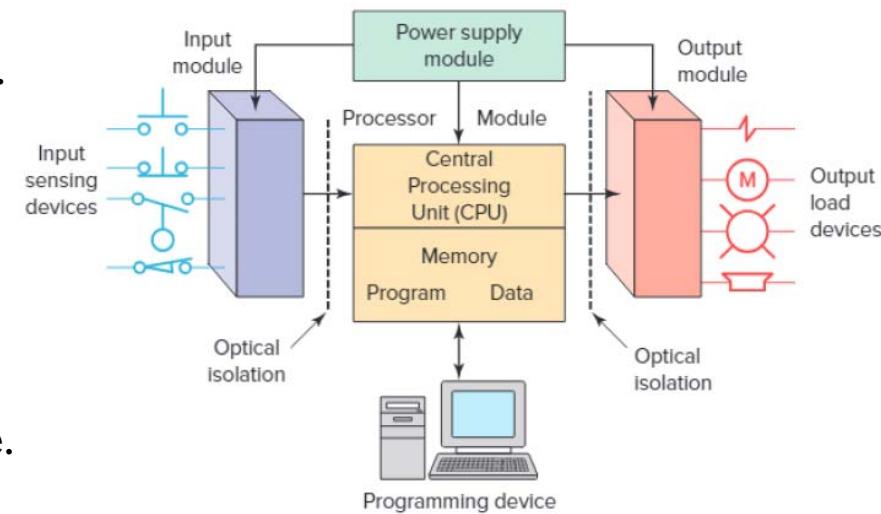
= schematic for relay control circuit.

Hand-held programming devices →

program small PLCs.

inexpensive and easy to use.

plugged into PLC → used to enter and monitor programs.



Parts of a PLC

Personal computer (PC) →

- software is available to use PC as programming device.
- software allows users to create, edit, document, store and troubleshoot ladder logic programs.
- communicates with PLC processor via →
 - serial or parallel data communications link,
 - Ethernet.

Program →

- user-developed series of instructions,
- directs PLC to execute actions.

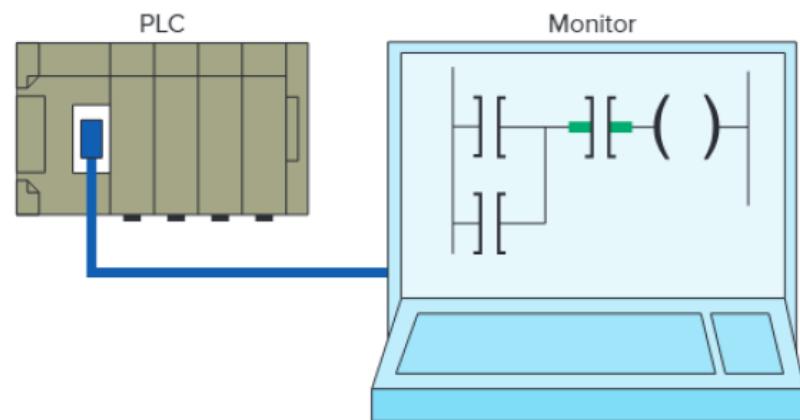
Programming language →

- rules for combining instructions,
- produces desired actions.
- relay ladder logic (RLL) →

- standard language used with PLCs.

- origin: electromechanical relay control.

- graphically represents rungs of contact, coils, instruction blocks.

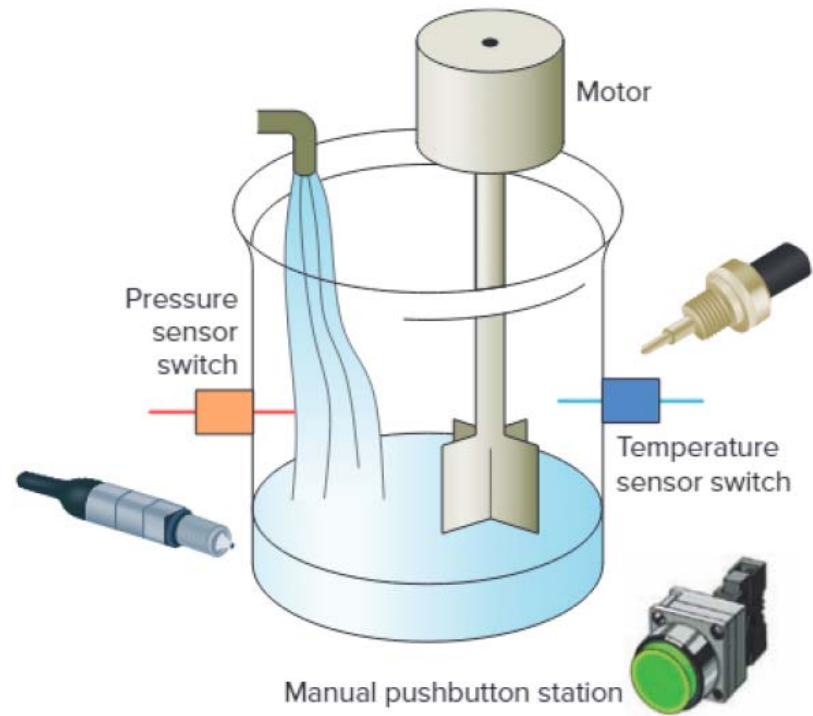
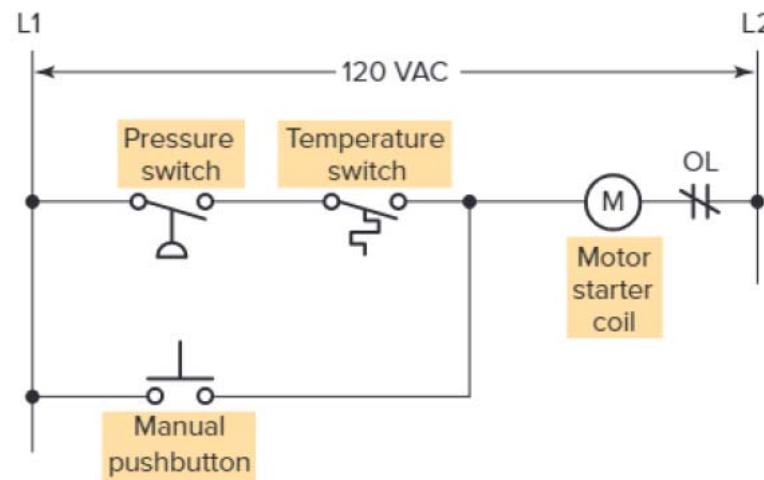


Principles of Operation

Problem: A mixer motor is to be used to automatically stir the liquid in a vat when the temperature and pressure reach preset values. In addition, direct manual operation of the motor is provided by means of a separate pushbutton station. The process is monitored with temperature and pressure sensor switches that close their respective contacts when conditions reach their preset value.

Solution of control problem →

relay method for motor control,
relay ladder diagram.

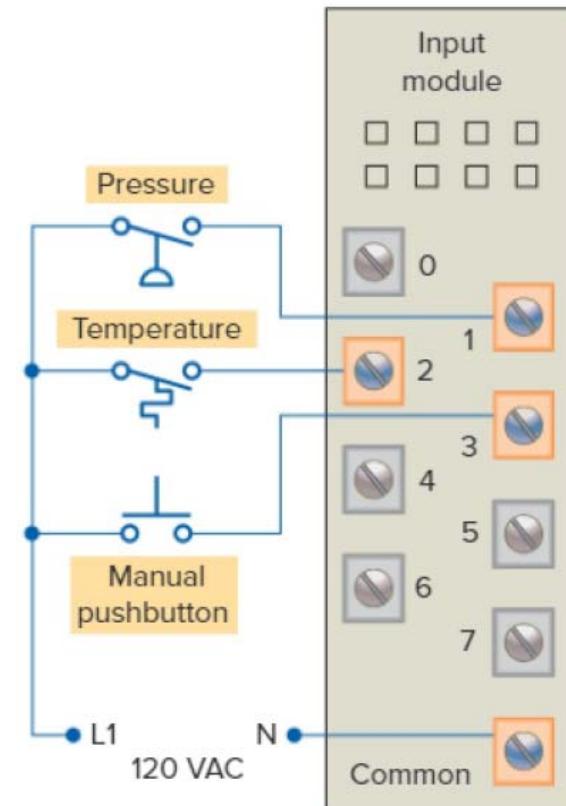
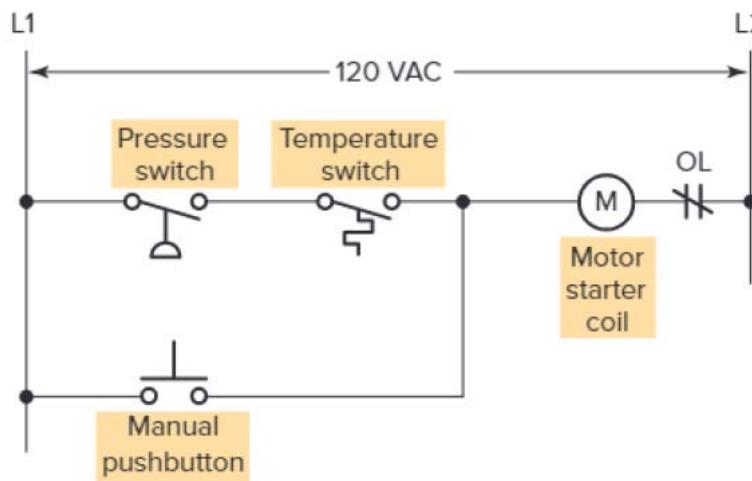


Principles of Operation

Input field devices →

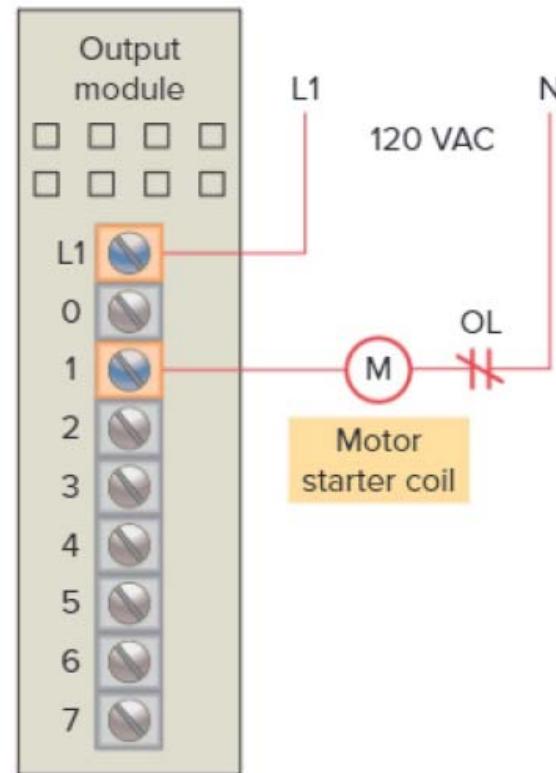
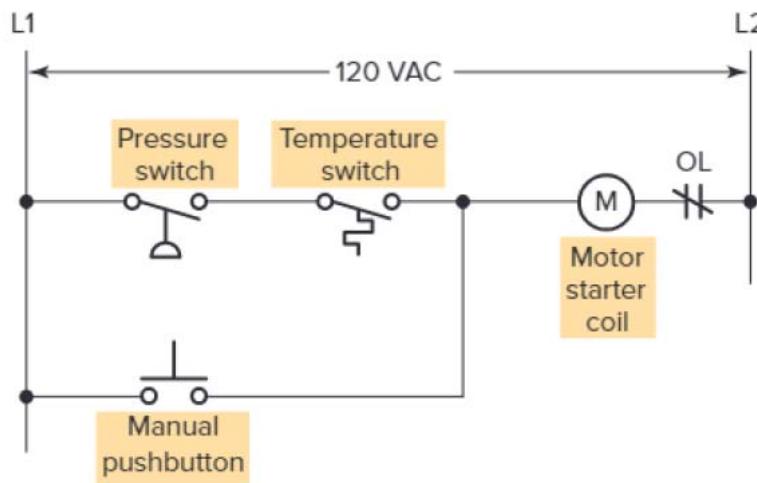
pressure switch,
temperature switch,
pushbutton.

hardwired to input module,
manufacturer's addressing location scheme.
module = 120 VAC modular configured.



Principles of Operation

Output field devices →
motor starter coil.
hardwired to output module,
manufacturer's addressing location scheme.
module = 120 VAC modular configured.



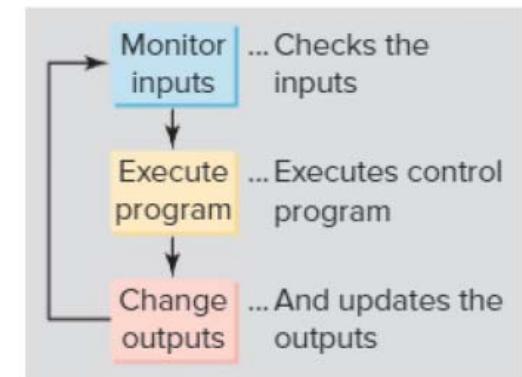
Principles of Operation

PLC ladder logic program →
constructed into programming device,
entered into CPU memory.
stored in user program portion of memory.

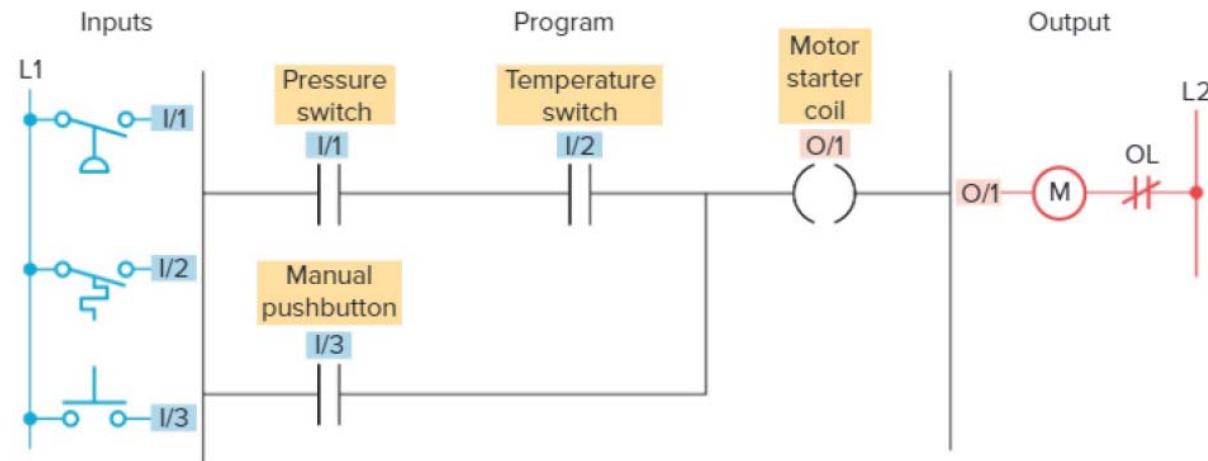
Symbols = instructions.

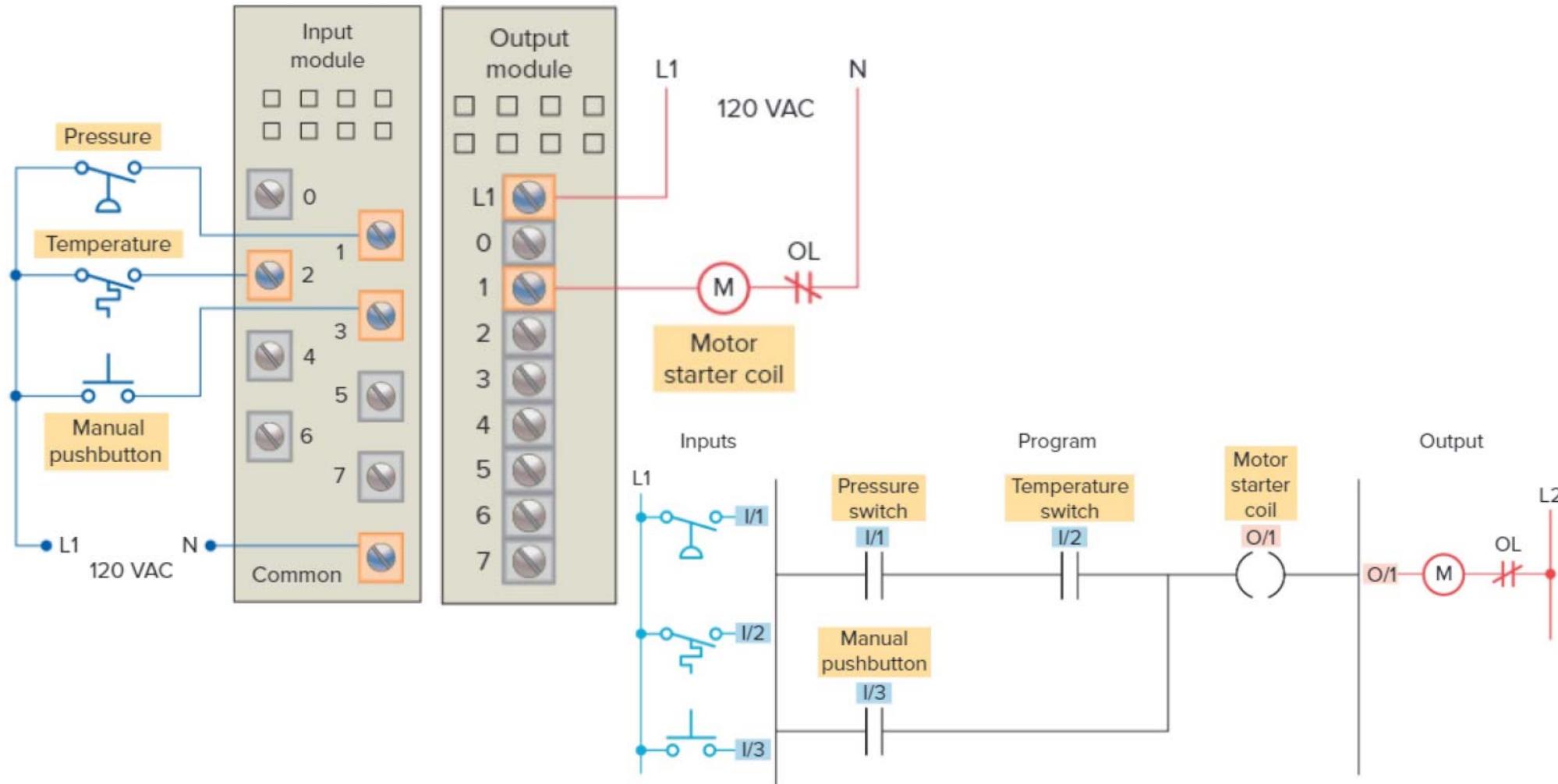
Numbers = instruction location address.

Address →
each I/O device,
let PLC know devices physical connection.



Program to operate →
controller is placed in RUN
mode or operating cycle.
program scan,
controller monitors inputs,
execute control program,
changes output accordingly.





Principles of Operation

RUN operation scheme →

field inputs are examined,
status is recorded in controller's memory.

closed contact = logic 1,
open contact = logic 0.

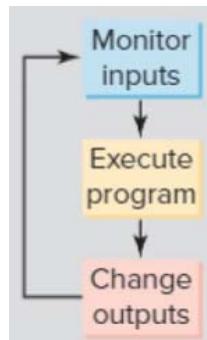
ladder program is evaluated,
each internal contact = OPEN or CLOSED status.

states of input contacts provide logic continuity from left to right →
output coil memory location = logic 1,
output module interface contacts = closed.

no logic continuity of program rung →
output coil memory location = logic 0,
output module interface contacts = open.

Principles of Operation

RUN operation scheme →



scan = completion of one cycle of sequence.

scan time →

time required for one full cycle.

speed of response of PLC.

during scan →

output memory location is updated.

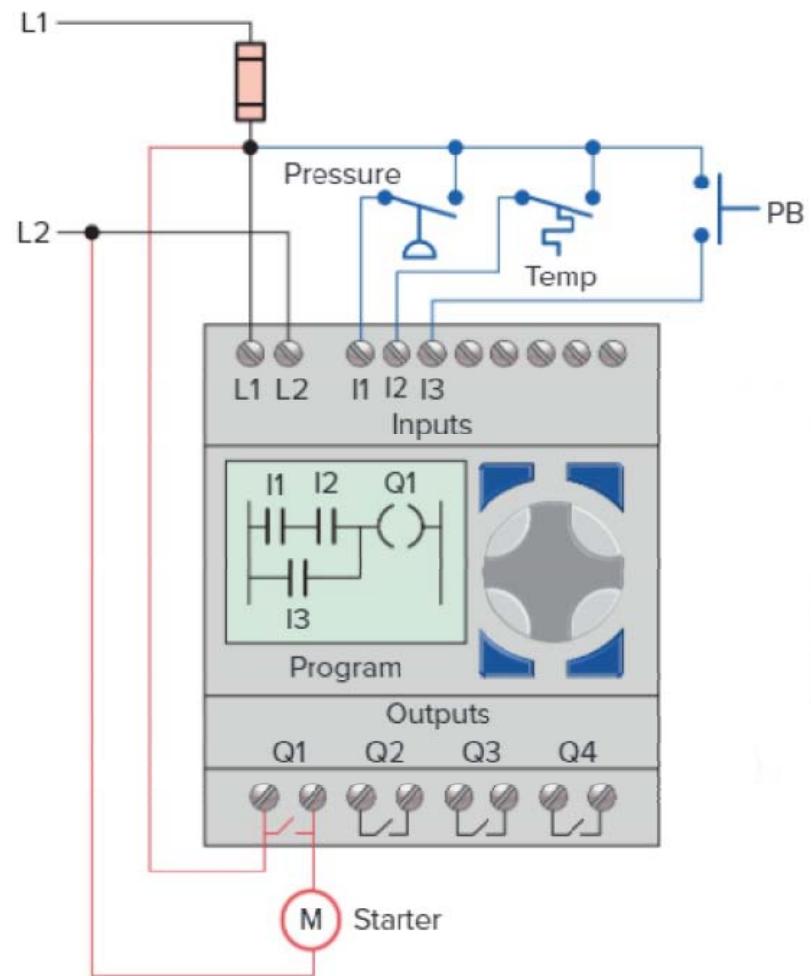
actual output is not updated.

I/O scan →

actual output is updated.

end of program scan.

Wiring required to implement process control scheme →



Principles of Operation

Installation steps →

fused power lines are connected to
controller's L1 and L2 terminals.

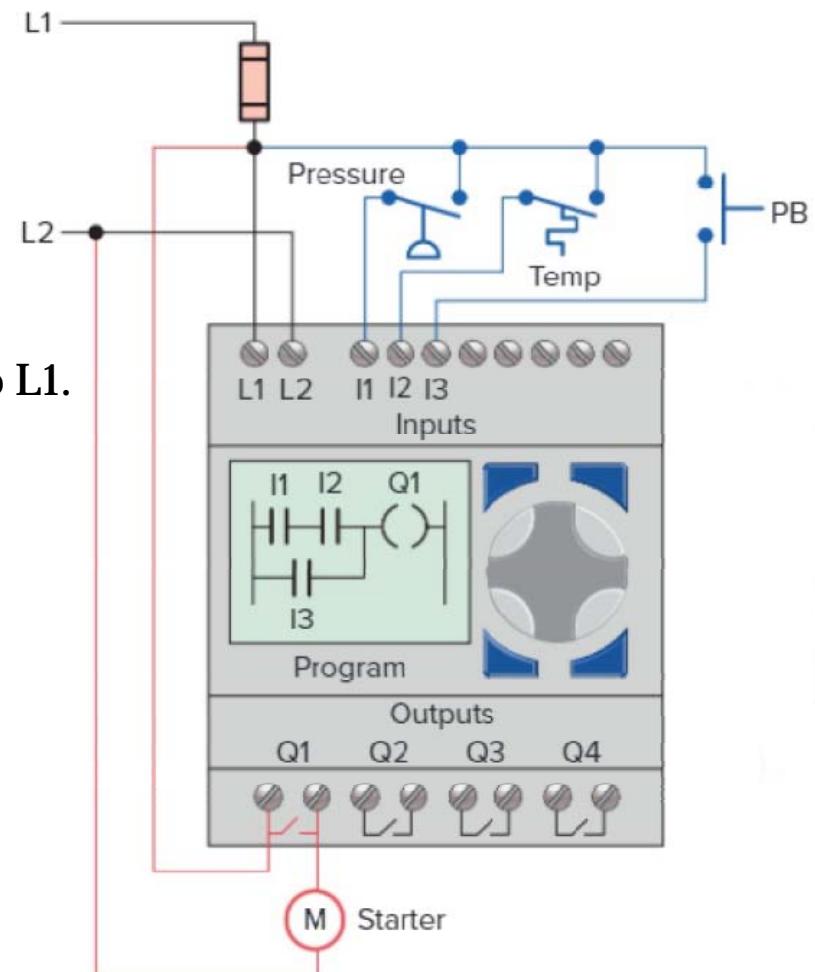
field input devices are hardwired between
L1 and input terminals I1, I2 and I3.

motor starter coil is connected →
directly to L2,
in series with Q1 relay output contacts to L1.

ladder logic program is entered using →
front keypad,
LCD display.

Programming software →

create and test program,
in personal computer.

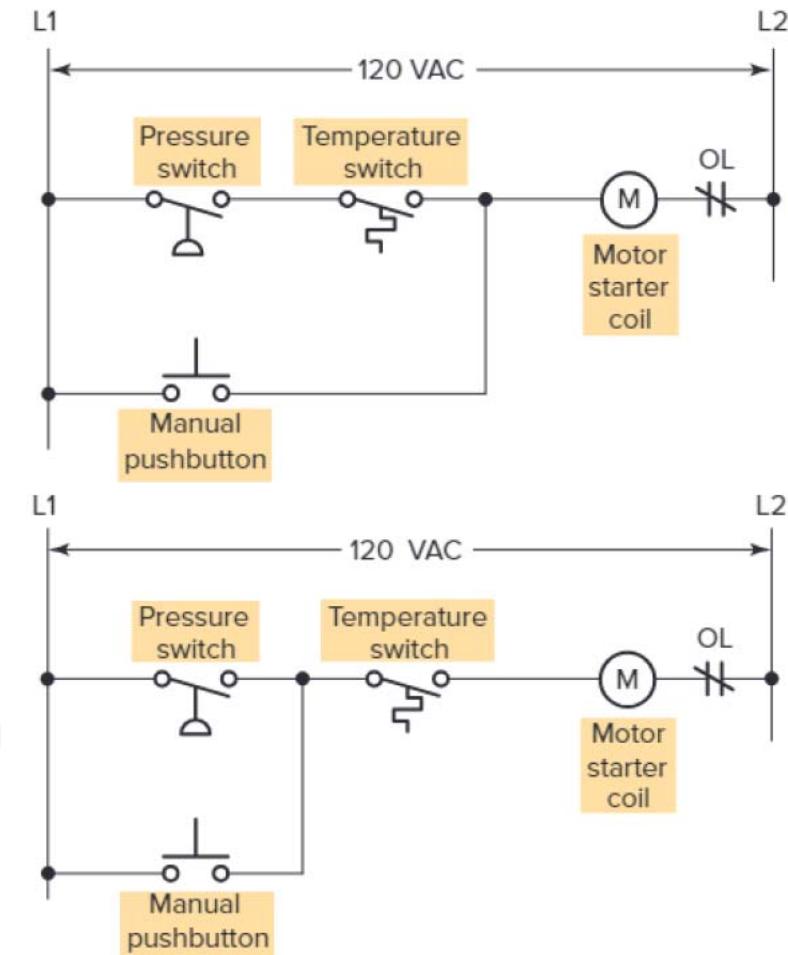
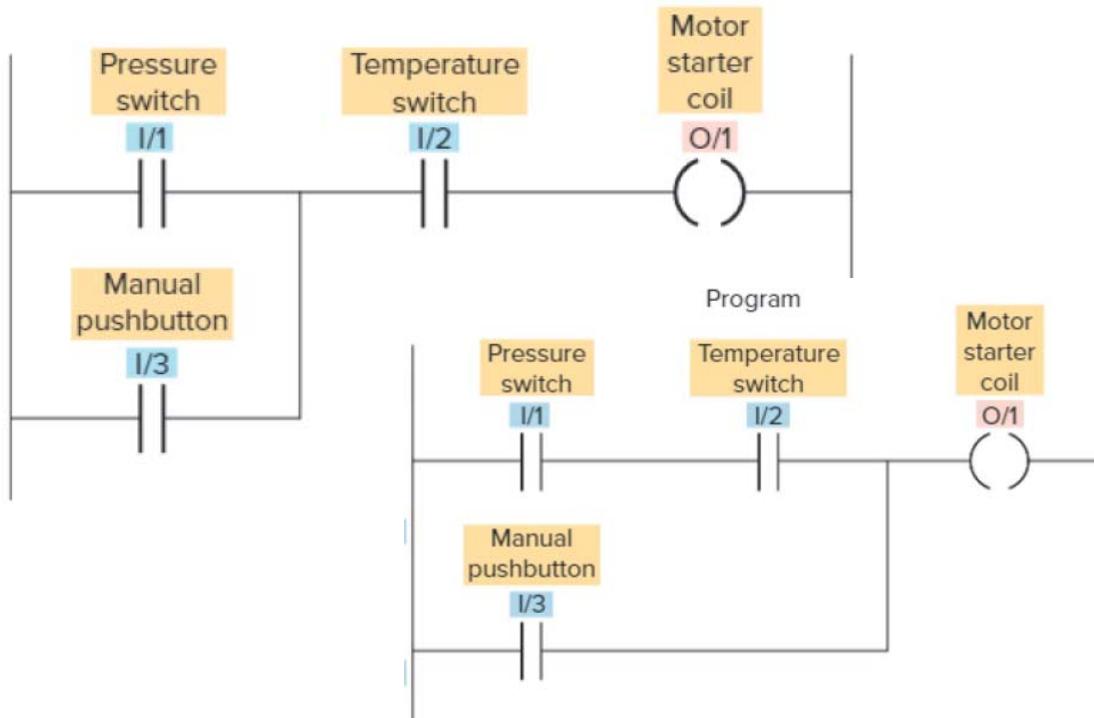


Modifying Operation

Modified process control circuit for mixing operation →

Change →

manual pushbutton control operates →
at any pressure,
but at specified temperature setting.



I/O Section of a PLC

Input/output section →

to which all field devices are connected.

provides interface between field devices and CPU.

input/output arrangement →

built into fixed PLC or

external I/O modules plug into PLC.

input interface modules →

accept signals from machine or process devices,
convert them into controller usable signals.

output interface modules →

convert controller signals into external signals,
control machine or process.

each slot in rack →

can accommodate any type of I/O module.

