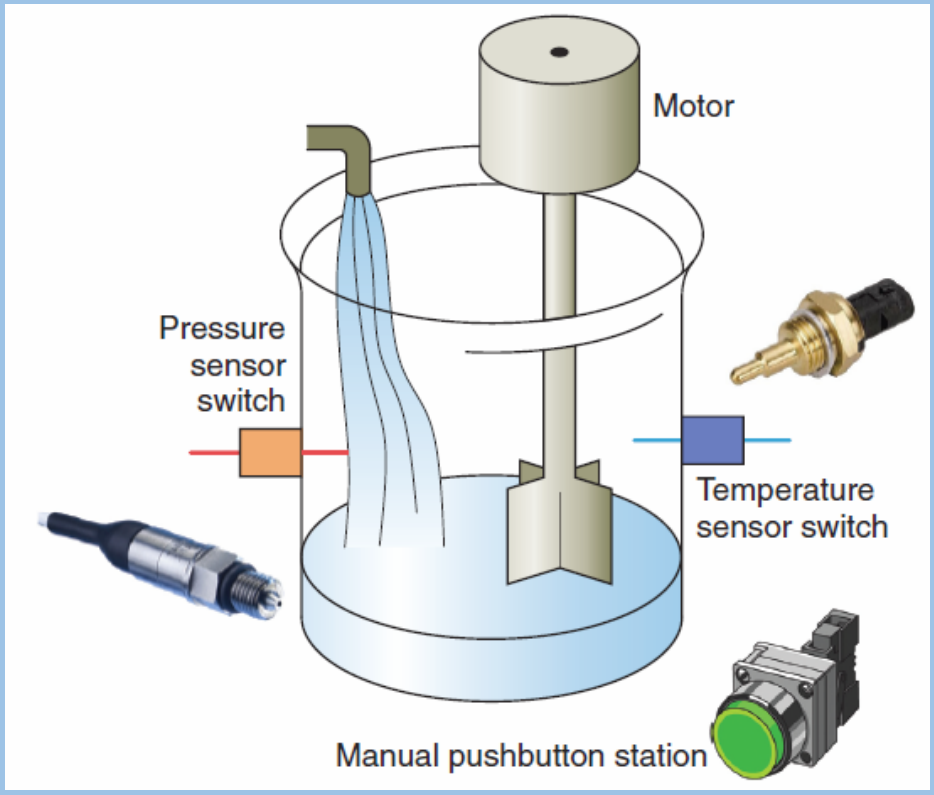
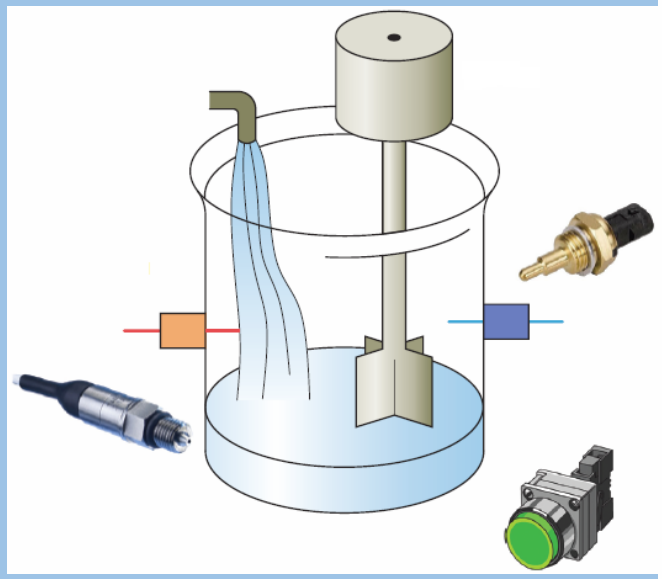
Programmable Logic Controllers
Introduction
Part 4
Principles of Operation

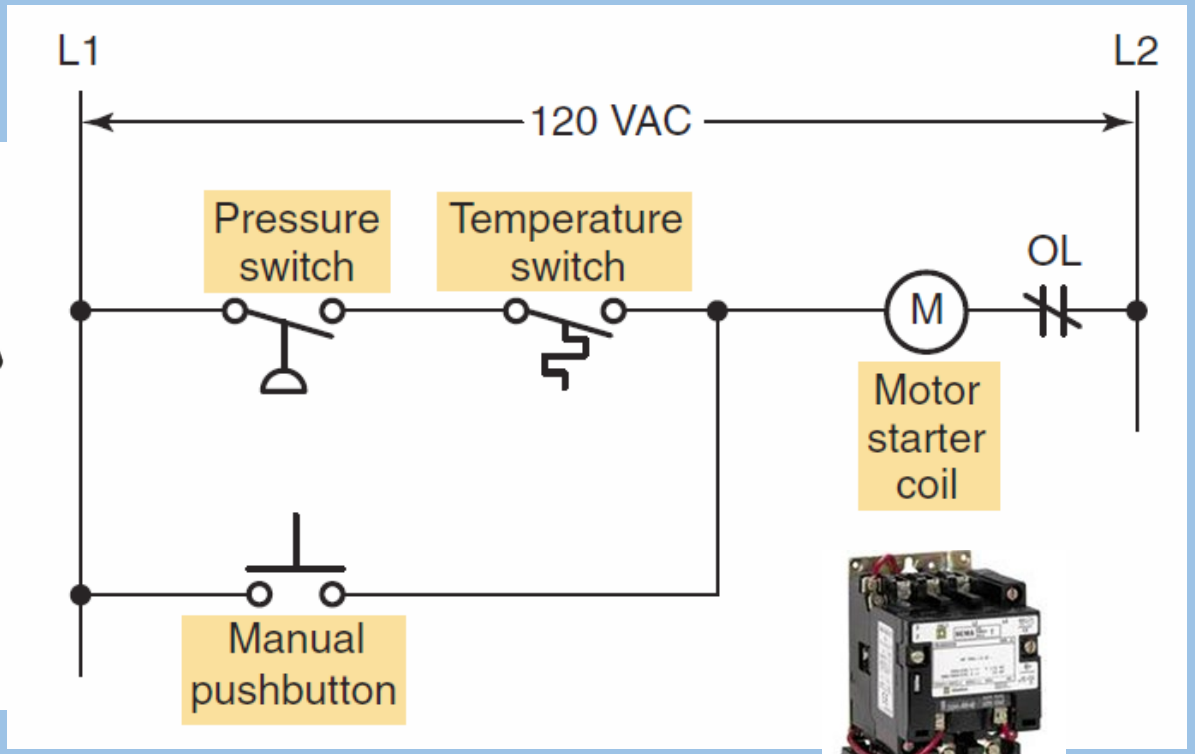
Mixer Process Control Problem



- Motor stirs liquid
  - Automatically when:
    - Temperature at set point
    - Pressure at set point
  - Manually with pushbutton

Mixer Process - Hardwired Control





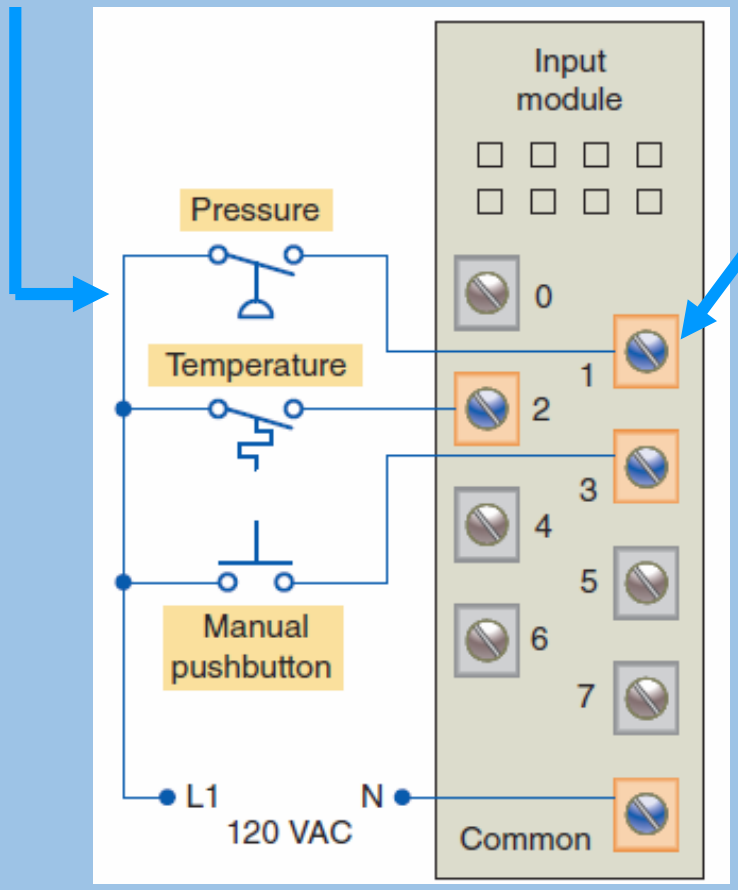
Coil (M) energized when:

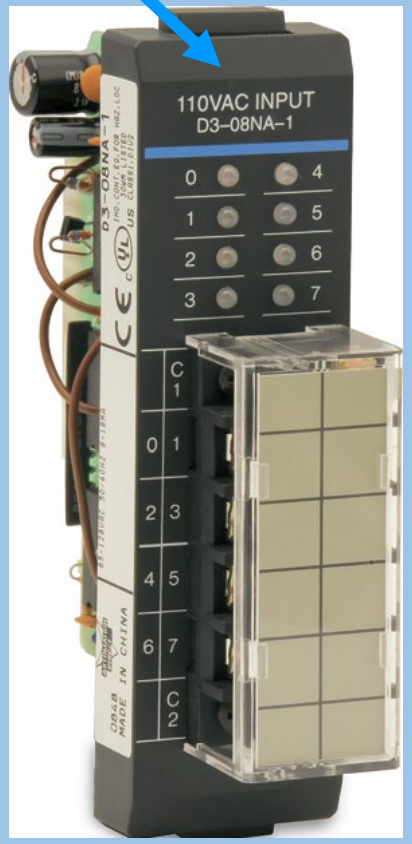
- Pressure and temperature switches are closed
- *or*
- Manual pushbutton is pressed.

Mixer Process PLC Control

Same input field devices (pressure switch, temperature switch, and pushbutton)

Field devices hardwired to input module.

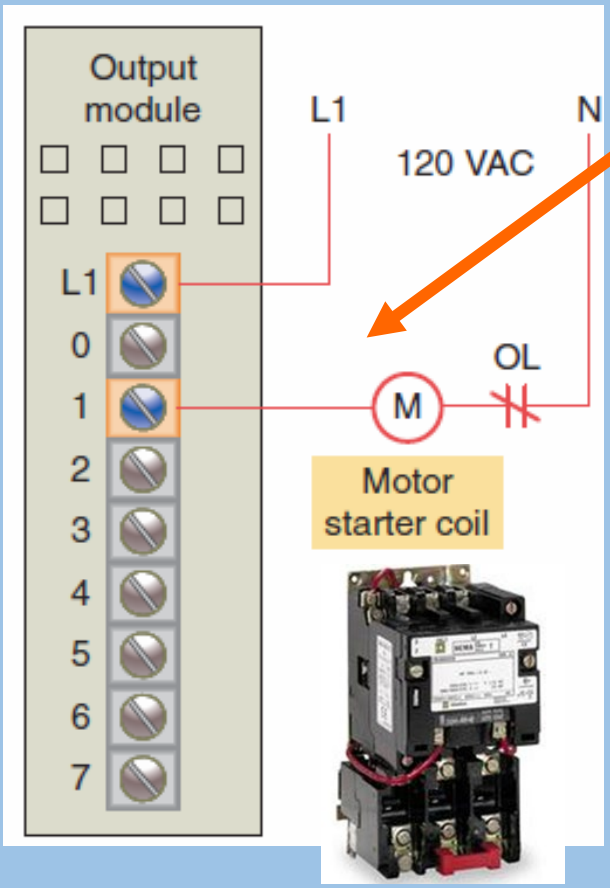


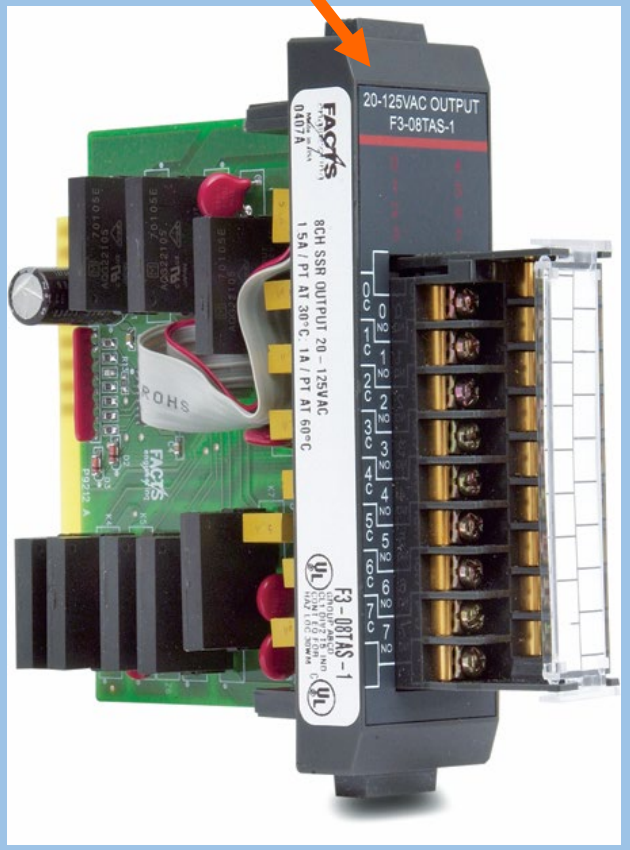


Mixer Process PLC Control

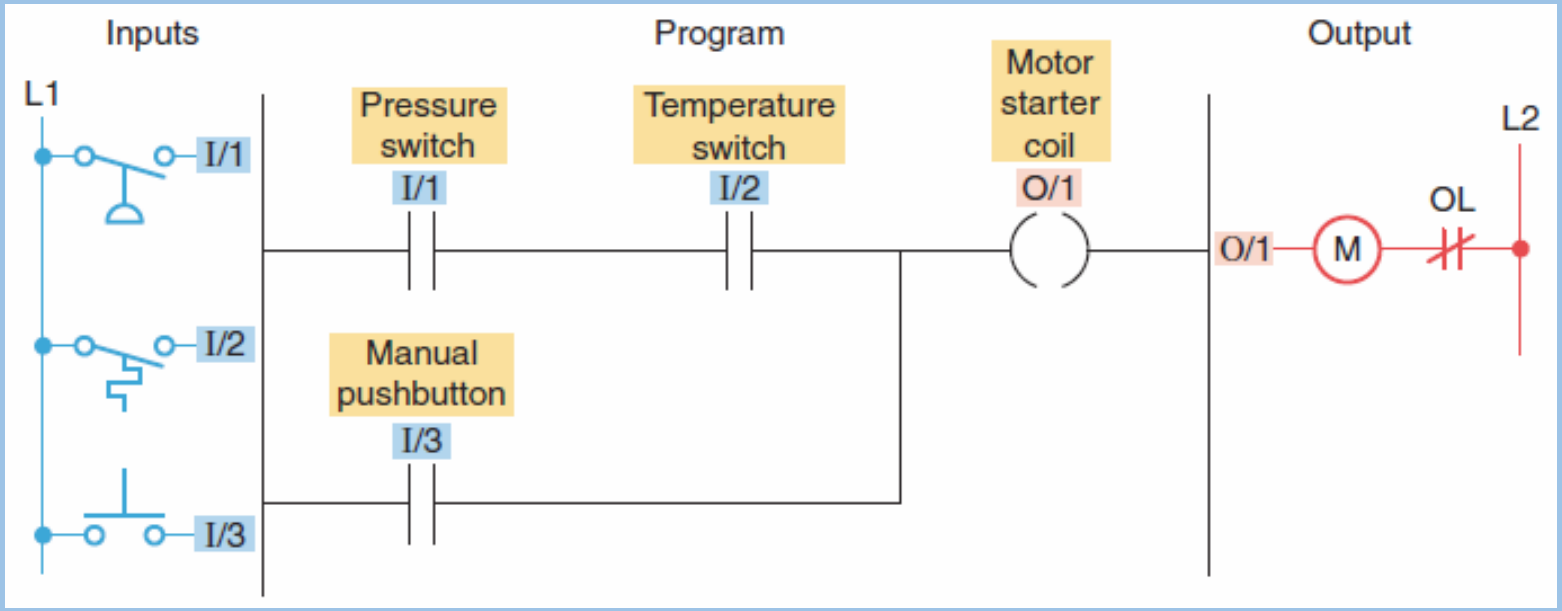
MS coil hardwired to output module.

Same output field device (MS) coil

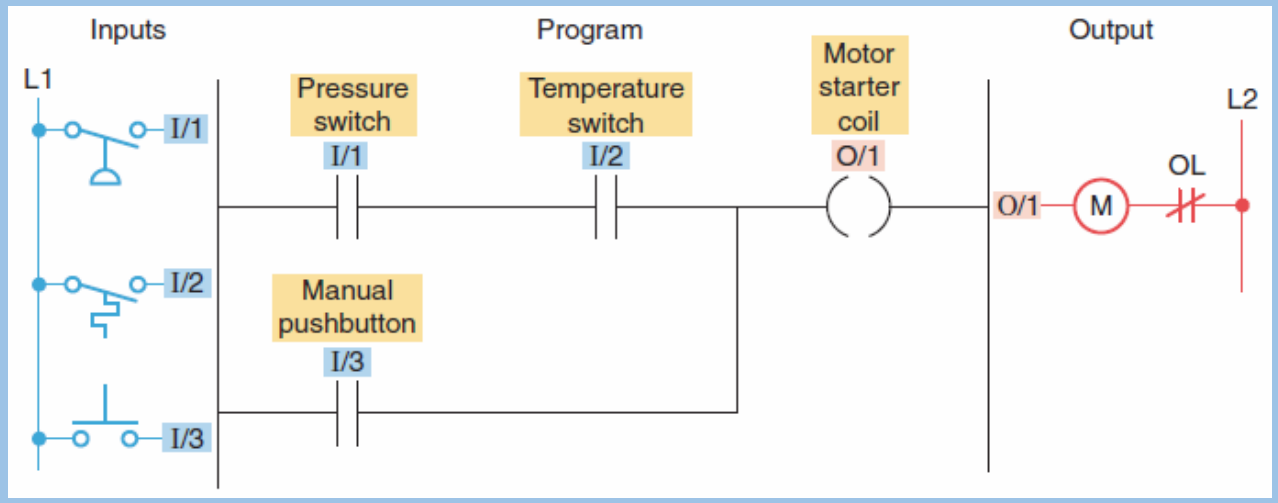




Mixer Process PLC Control



- Enter the logic into the CPU processor program
- Symbols represent instructions
- Numbers represent instruction's addresses
- Addresses let PLC know where devices are connected

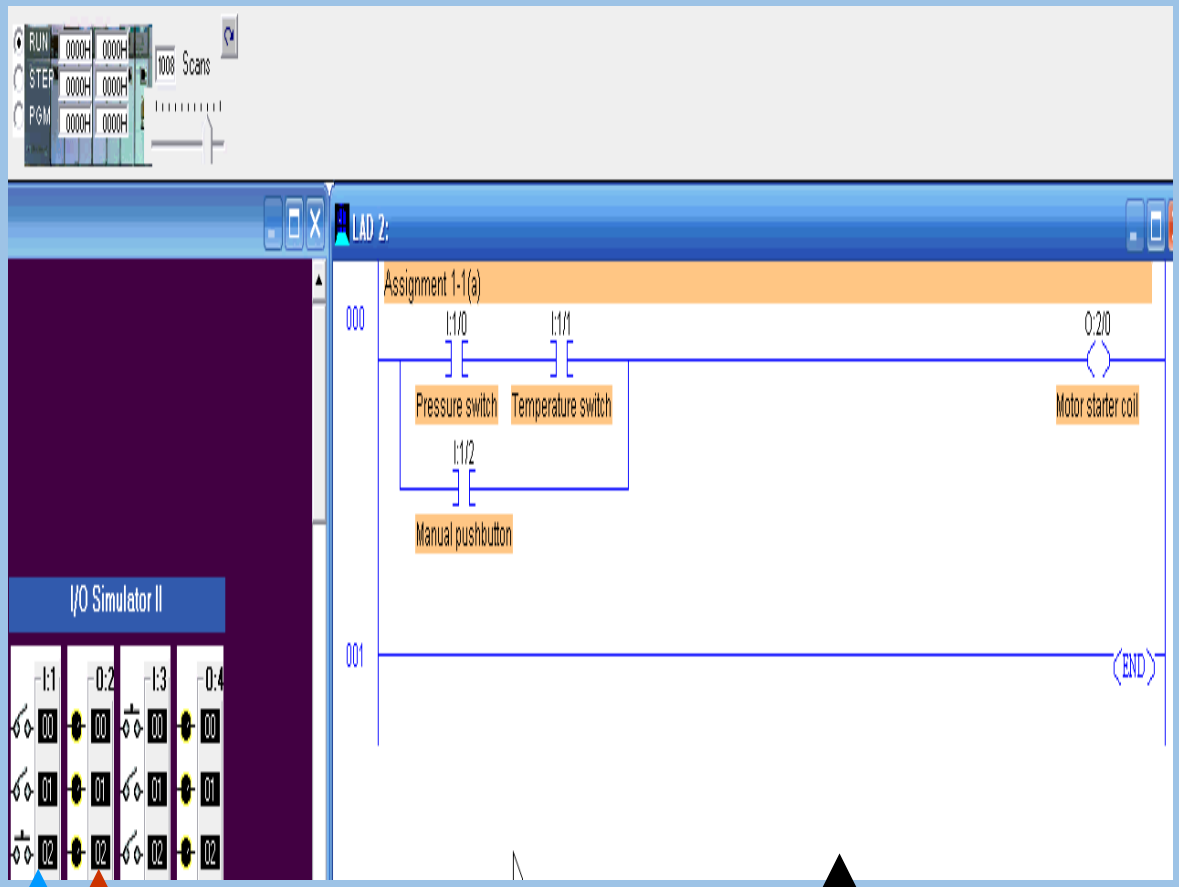


To Execute the Program

- Controller is placed in RUN
- Controller examines (scans) status of inputs
- Executes user program
- Changes outputs accordingly

Review program operation shown

LogicPro simulation of the PLC program



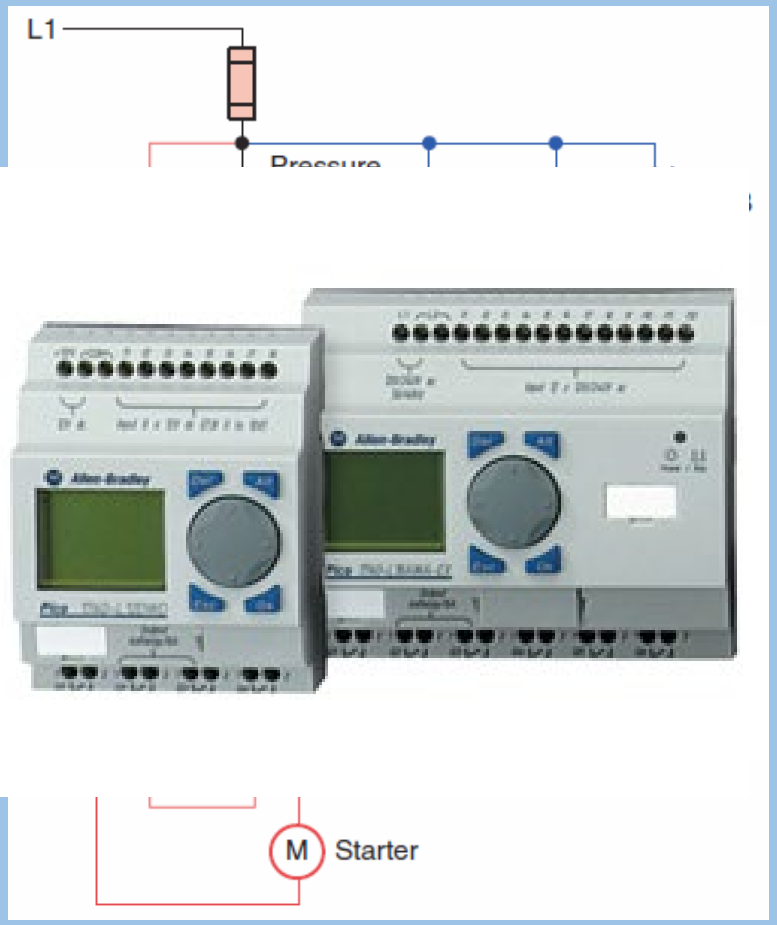
Input Module

Output Module

Ladder Logic Program

Typical wiring for a fixed PLC controller

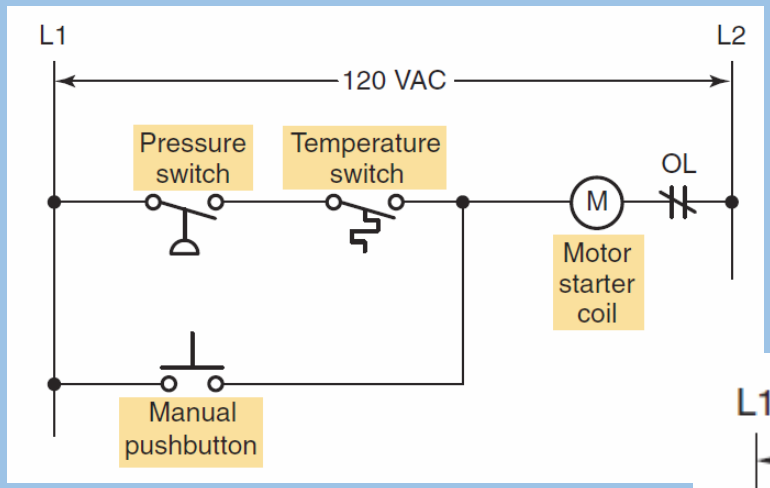
Review circuit & operation shown

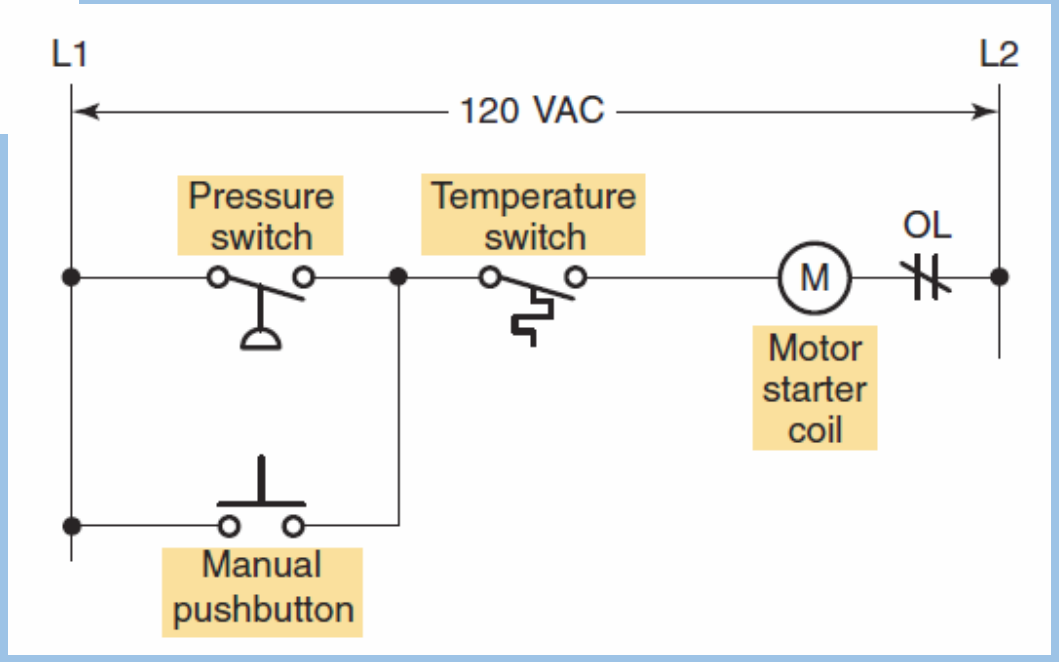


Programmable Logic Controllers
Introduction
Part 4
Modifying the Operation

One important PLC

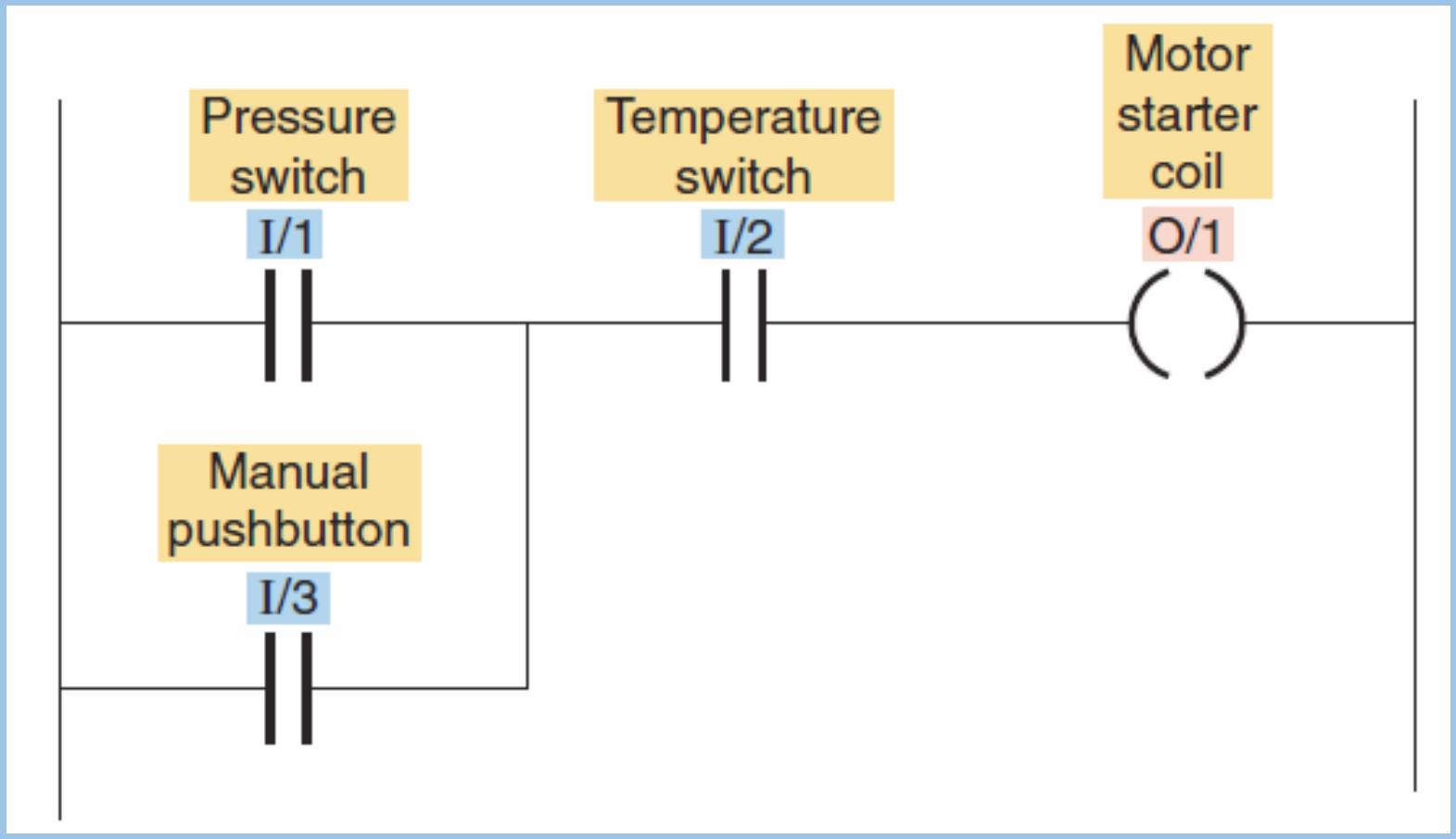
- **Ease of changing program**





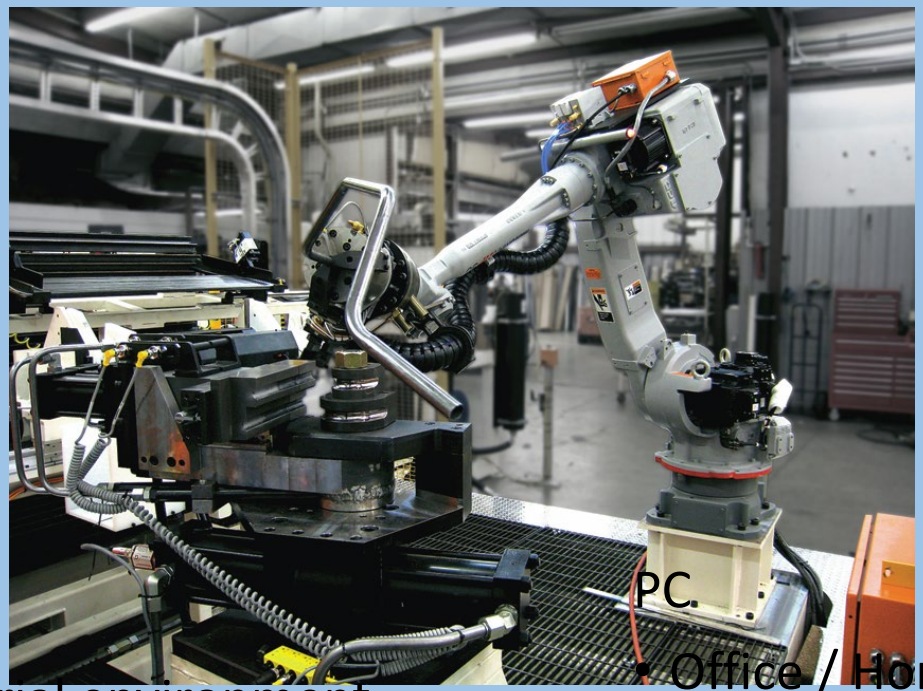
- **Relay circuit change requires physical rewire**
- **Review operation of modified hardwired circuit**

- PLC requires no rewiring
- I/O connections and addressing remain the same
- Requires PLC ladder logic program change only
- Review PLC modified program



PLCs versus Computers

PLC architecture basically same as PC



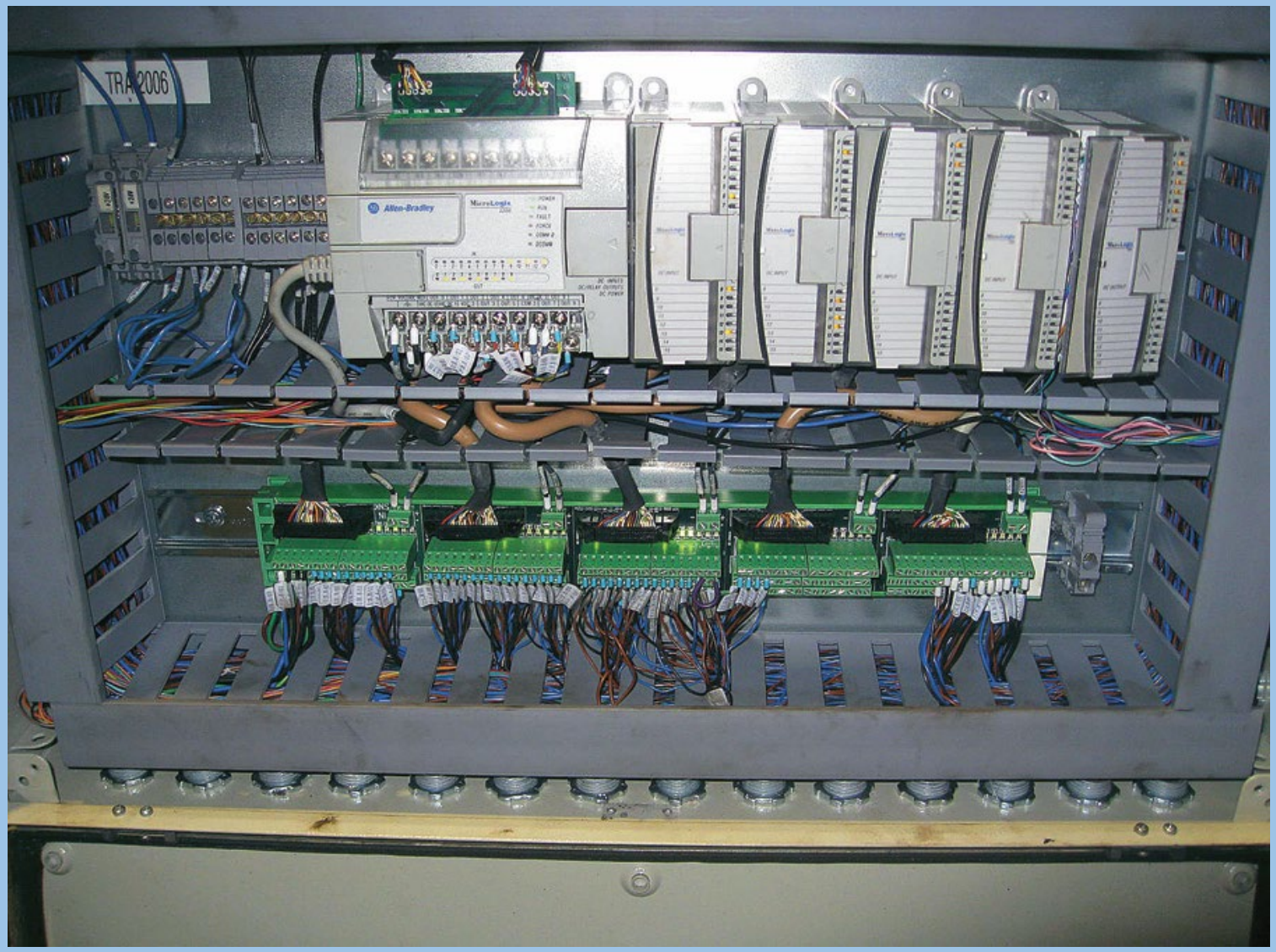
PLC

- Industrial environment
- Wide ranges ambient temperature
- Varied humidity
- Varied dust/dirt

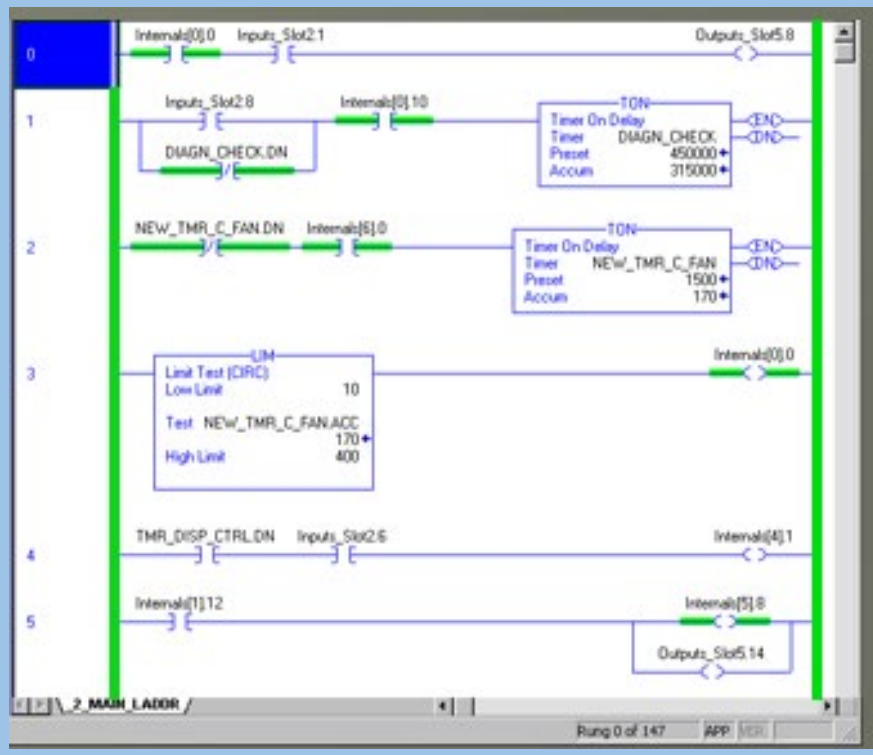
PC

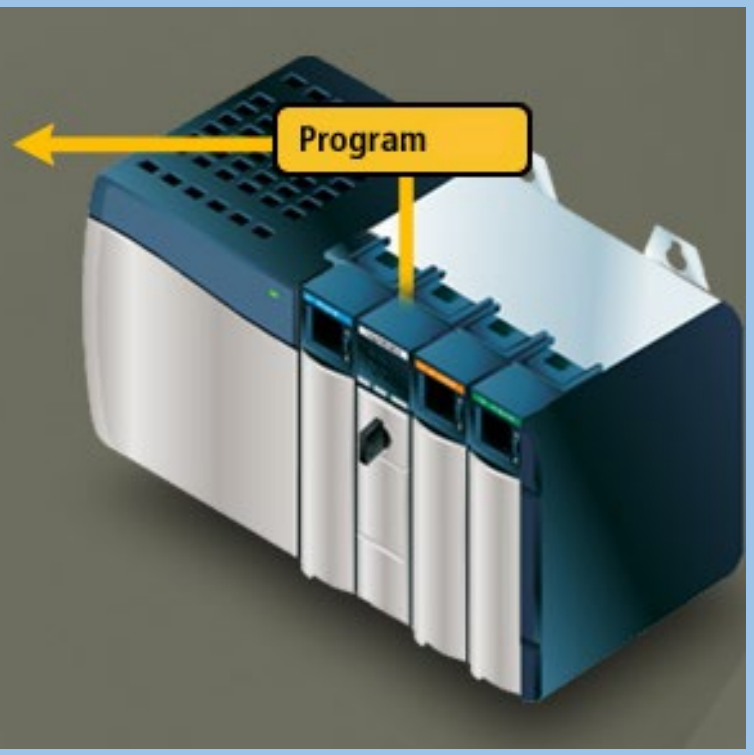
- Office / Home environment
- Controlled low temperatures
- Controlled humidity
- Controlled dust / dirt

Properly installed PLC
No / little electrical noise inherent in industrial locations



PLC programmed in ladder logic or other easily learned languages





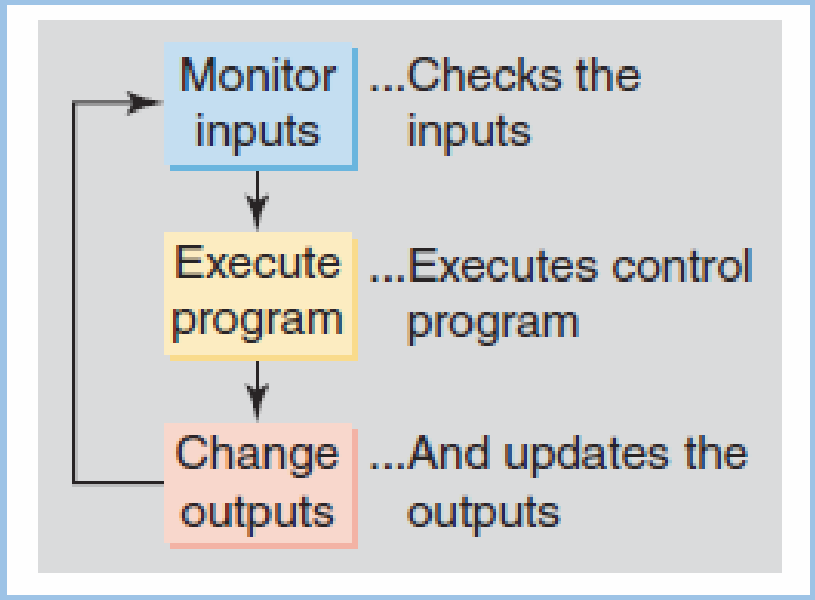
PLC comes with program language

Does not require

- **Permanently attached keyboard**
- **External drive**
- **Monitor**

Computers

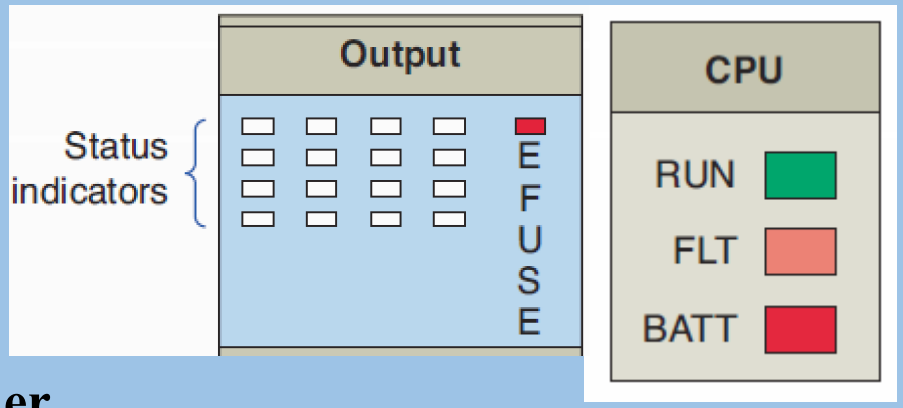
- Complex computing machines
- Execute several programs / tasks simultaneously
- Can run programs any order



PLC

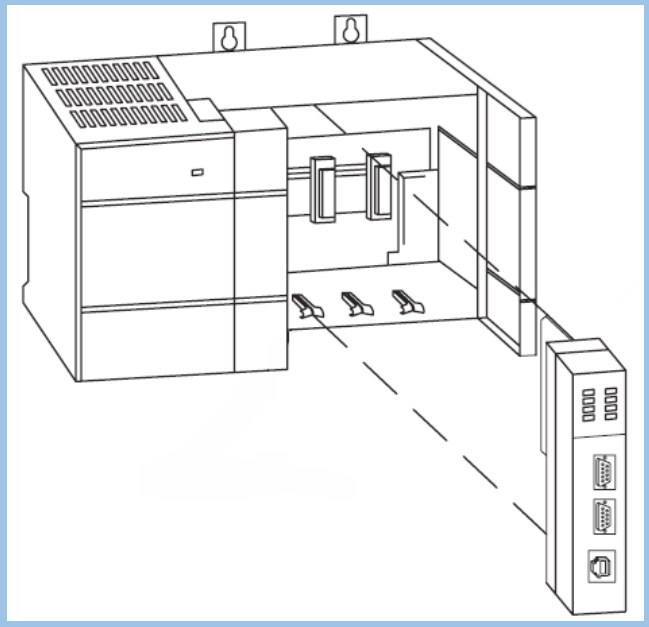
- Execute single program
- Orderly / sequential execution (scan cycle)
- First to last instruction
- Repeats cycle

PLC control system
Designed for ease of install and maintenance



Simplified troubleshooting

- fault indicators
- messages displayed programmer



I/O modules

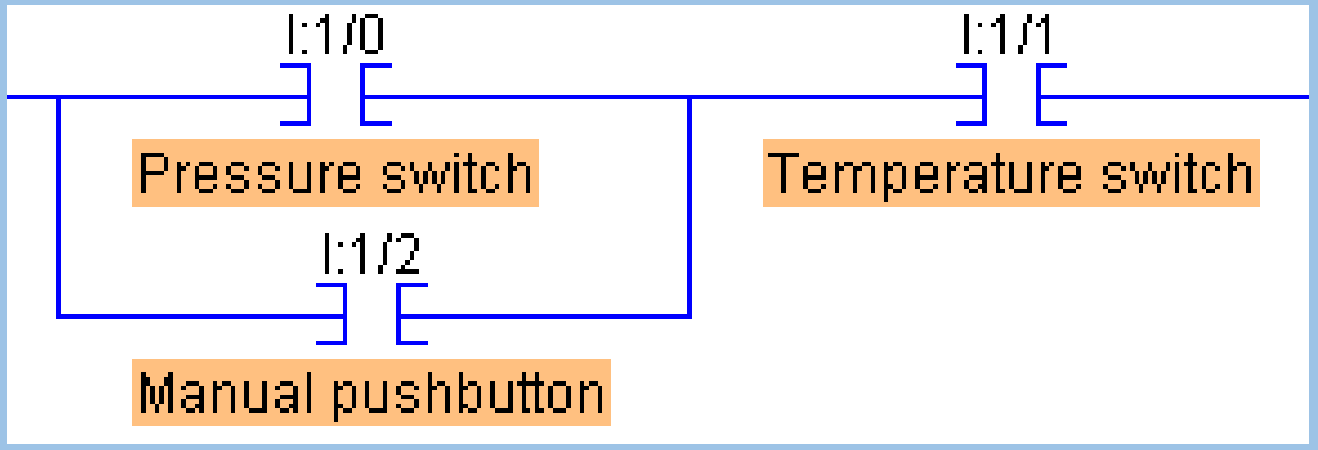
- Connect field device easily
- Ease replacing field devices
- Ease replacing modules

PLC software written / runs on PC

- Two broad categories:
  - User accessible
  - HMI Monitoring

User Accessible

- User program and document
- User tools to program
  - Ladder logic or another programming language
  - Document / explain program in detail



Human machine interface (HMI)

Enables user to:

- **View a process (graphical representation)**
- **Determine system run, trend values, alarms, etc…**
- **May not allow direct program access**

PLC Size and Application

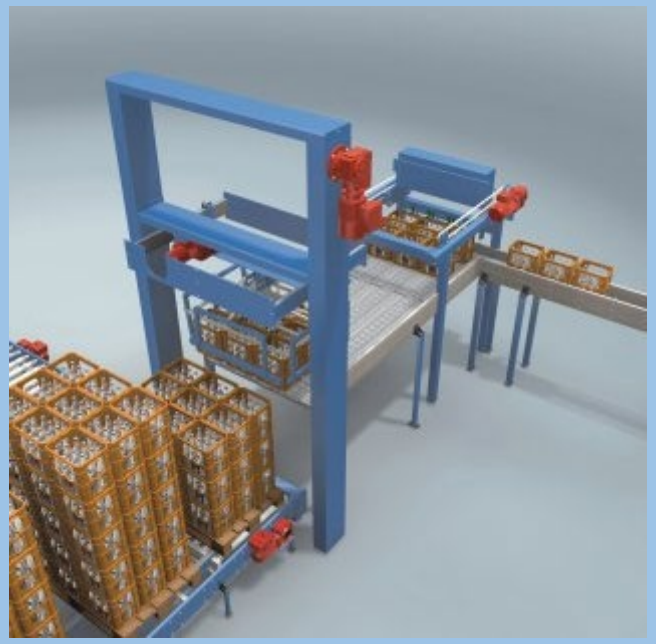
Categorizing PLCs include:

- Functionality
- Required number of I/O
- Cost
- Physical size

I/O count most important size factor

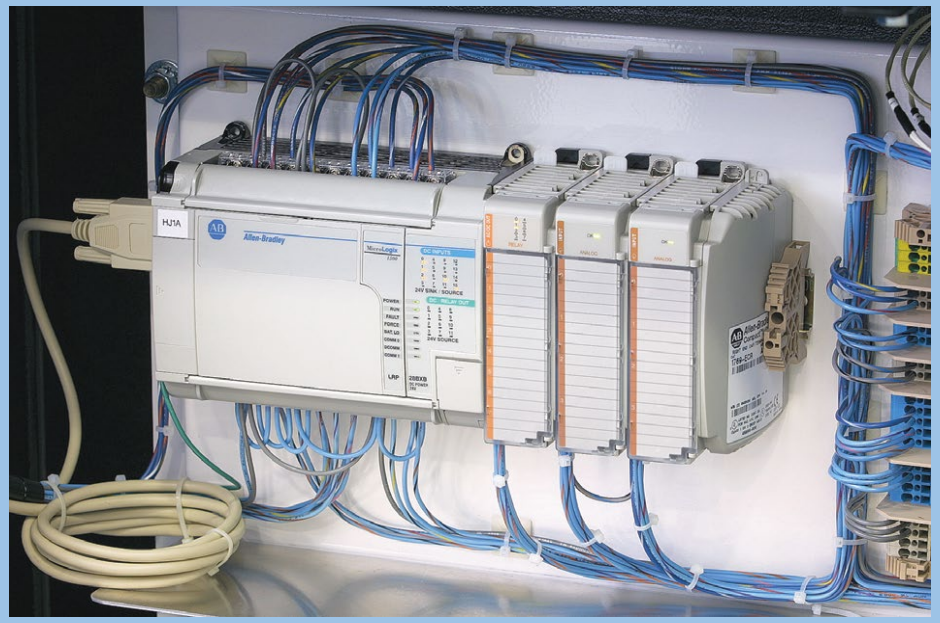
- *Nano*
  - Smallest size
  - Less than 15 I/O points
- *Micro*
  - 15 to 128 I/O points
- *Medium*
  - 128 to 512 I/O points
- *Large*
  - over 512 I/O points

Matching PLC with application is key to selection



Three major types PLC applications:

- Single ended
- Multitask
- Control management



Single ended application

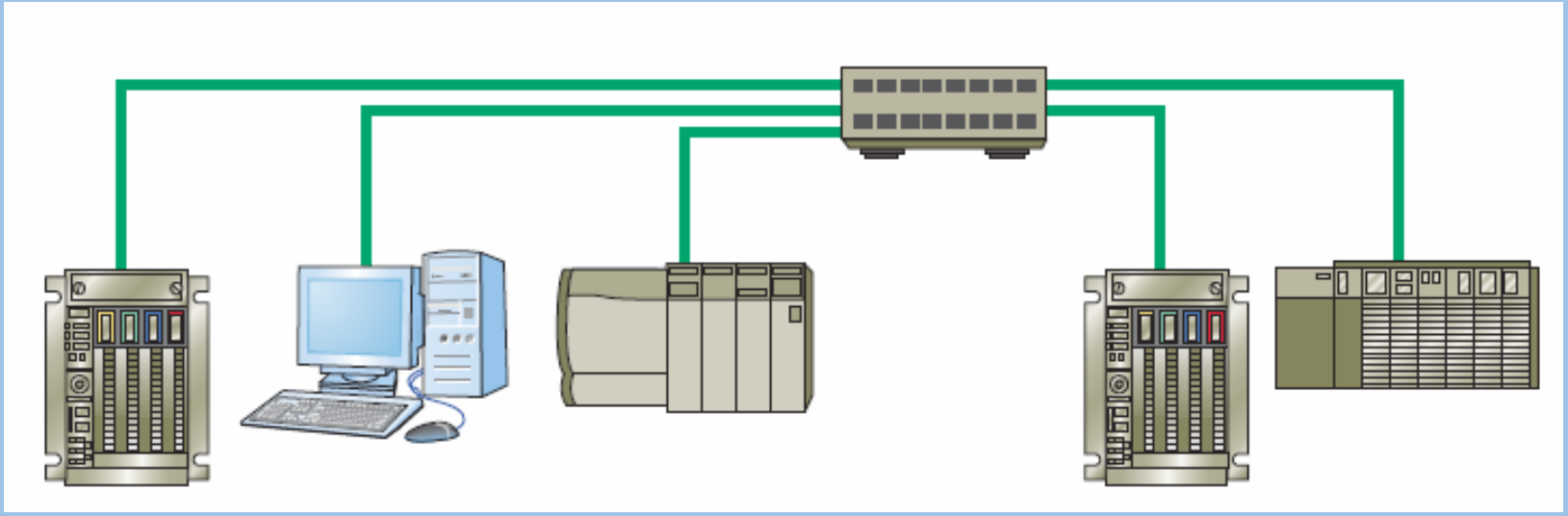
- Involves one PLC controlling one process

Multitask PLC application involves

- One PLC controlling several processes
- Adequate I/O significant factor in this type of installation

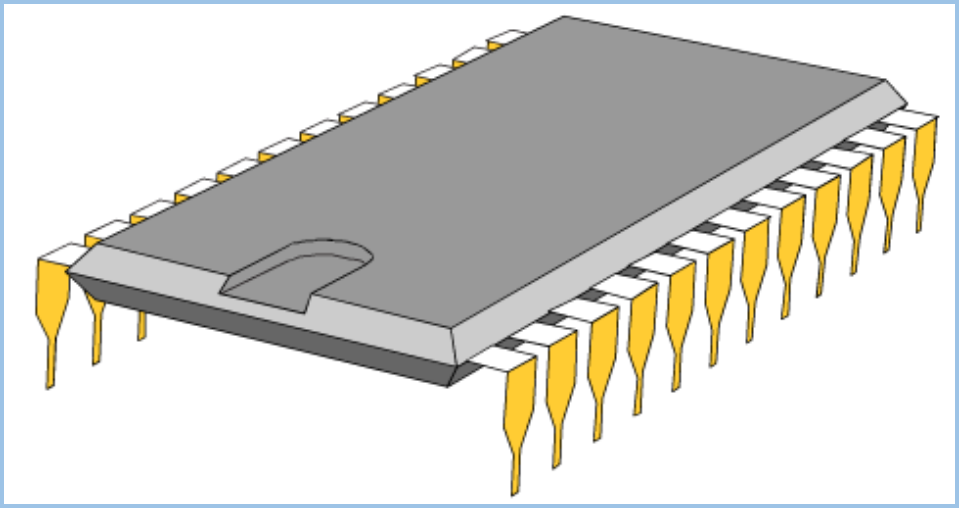
Control management PLC application

- Involves one PLC controlling several other PLC's
- Requires large PLC processor
- Must communicate with other PLCs and computers
- Control management PLC supervises several PLCs
  - Downloads programs to other PLCs
  - Specifies what operation needs done



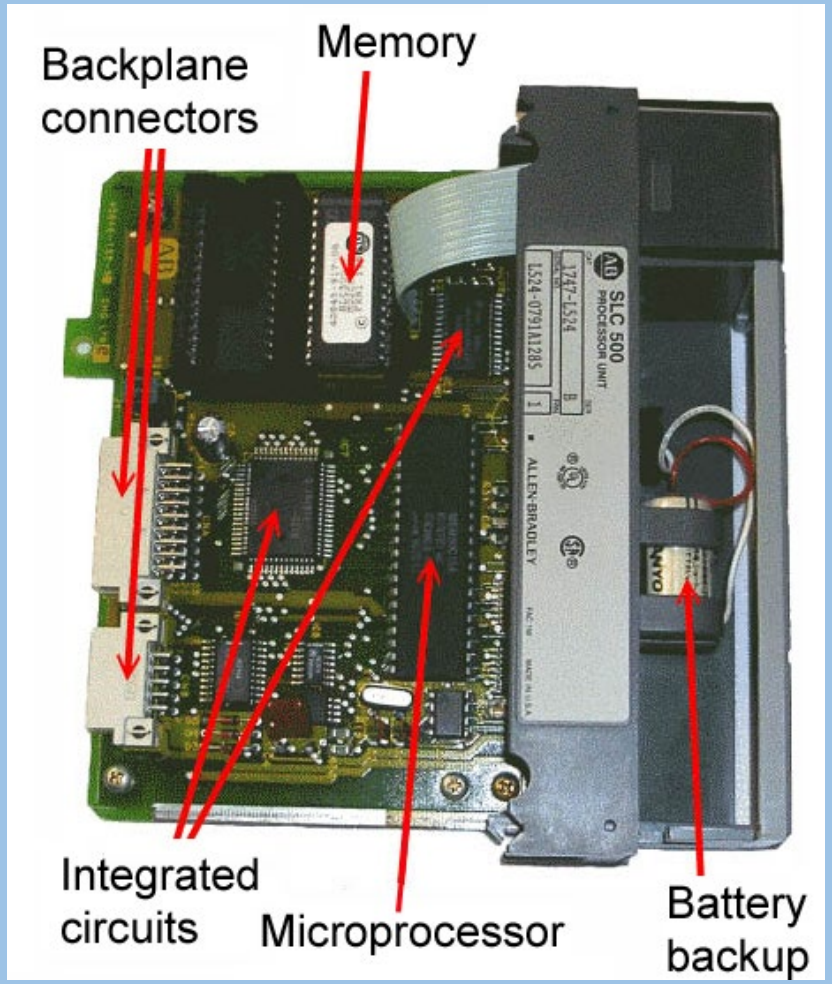
Memory

- **Part of PLC controller**
- **Stores data**
- **Store instructions**
- **Stores and runs control program**



Amount of memory required depends on:

- Number of I/O points used
- Size of control program
- Data-collecting requirements
- Supervisory functions required
- Future expansion



Instruction set

- **Particular PLC instructions supported**

Table 1-1 Typical PLC Instructions

Instruction	Operation
XIC (Examine ON)	Examine a bit for an ON condition
XIO (Examine OFF)	Examine a bit for an OFF condition
OTE (Output Energize)	Turn ON a bit (nonretentive)
OTL (Output Latch)	Latch a bit (retentive)
OTU (Output Unlatch)	Unlatch a bit (retentive)
TOF (Timer Off-Delay)	Turn an output ON or OFF after its rung has been OFF for a preset time interval
TON (Timer On-Delay)	Turn an output ON or OFF after its rung has been ON for a preset time interval
CTD (Count Down)	Use a software counter to count down from a specified value
CTU (Count Up)	Use a software counter to count up to a specified value

Summary Review

- Process application & converting relay diagram to PLC program
- Modifying relay circuit vs. PLC program change
- PLC vs PC
- PLC four considerations
  - Functionality
  - I/O
  - Physical size
  - Cost

Summary Review

- Three major types PLC applications
  - Single ended
  - Multi-task
  - Control management
- Four PLC sizes
  - Nano
  - Micro
  - Medium
  - Large
- Break (15 Minutes)
- Lab Exercise Setup