Benha University

Prof . Mohamed Ahmed Ebrahim

Benha University
Faculty of Engineering at Shoubra
Electrical Engineering Dept.

Industrial Controls (1)

By

Associate Prof. / Mohamed Ahmed Ebrahim Mohamed

E-mail: mohamedahmed_en@yahoo.com

mohamed.mohamed@feng.bu.edu.eg

Web site: http://bu.edu.eg/staff/mohamedmohamed033

Lecture (6)

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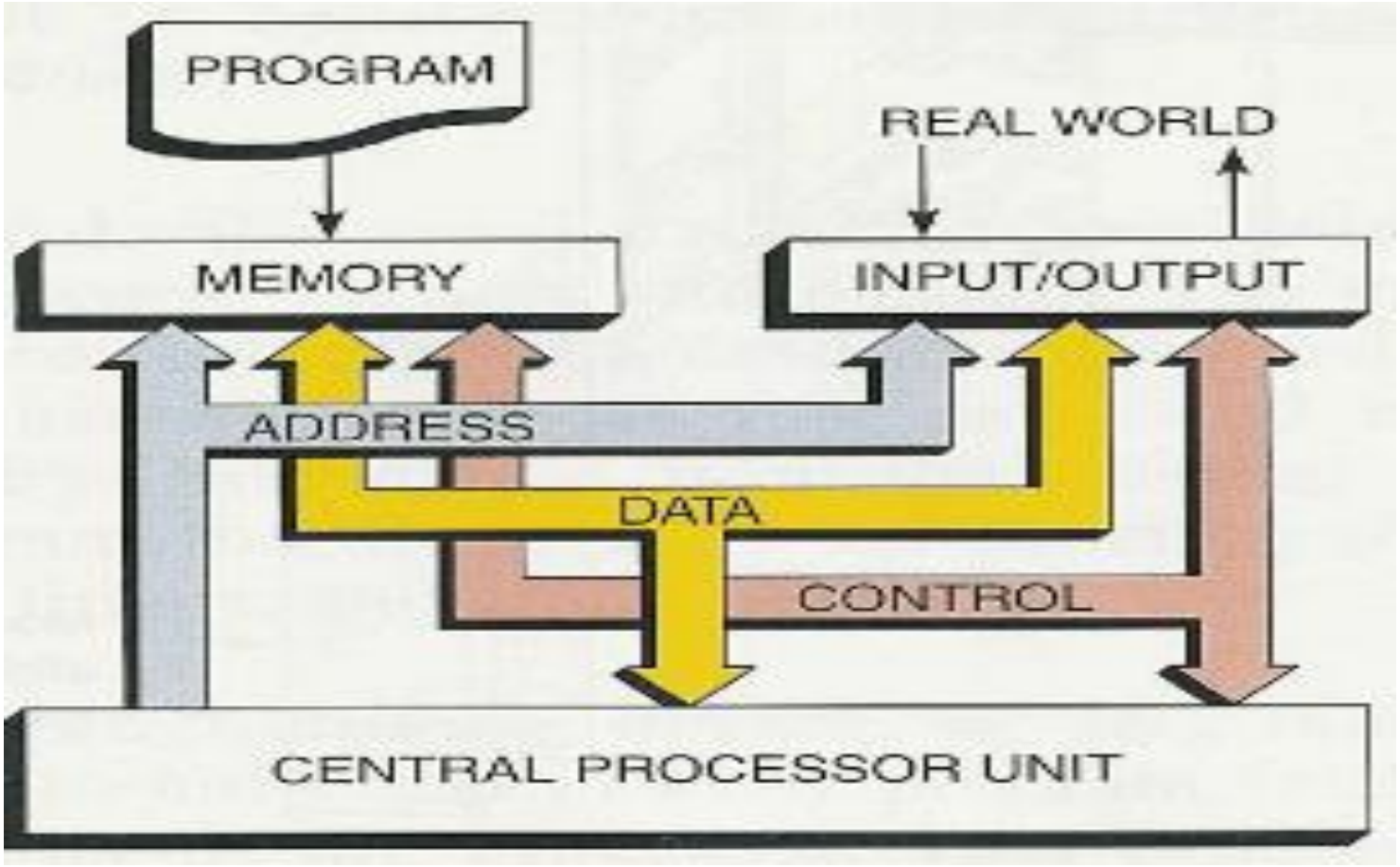
Basic design of a PLC

Prof . Mohamed Ahmed Ebrahim

PLC Basic Architecture



Basic design of a PLC

- The term 'programmable logic controller' is defined as follows by **IEC 1131, Part 1**:

1. *PLC is a digitally operating electronic system, designed for use in an industrial environment, which uses a programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic, to control, through digital or analog inputs and outputs, various types of machines or processes.*

2. *Both the PC and its associated peripherals are designed so that they can be easily integrated into an industrial control system and easily used' in all their intended functions.*

So we can say that programmable logic controller is therefore nothing more than a microcomputer, tailored specifically for certain control tasks.

The program of a PLC can be created in various ways:

- via assembler- type commands in 'statement list'
- in higher-level, problem-oriented languages such as structured text
- in the form of a flow chart such as represented by a sequential function chart
- in Europe, the use of function block diagrams based on function charts with graphic symbols for logic gates is widely used
- in America, the 'ladder diagram' is the preferred language by users

PLC Configuration

Depending on how the central control unit (CCU) is connected to the input and output modules, differentiation can be made between:

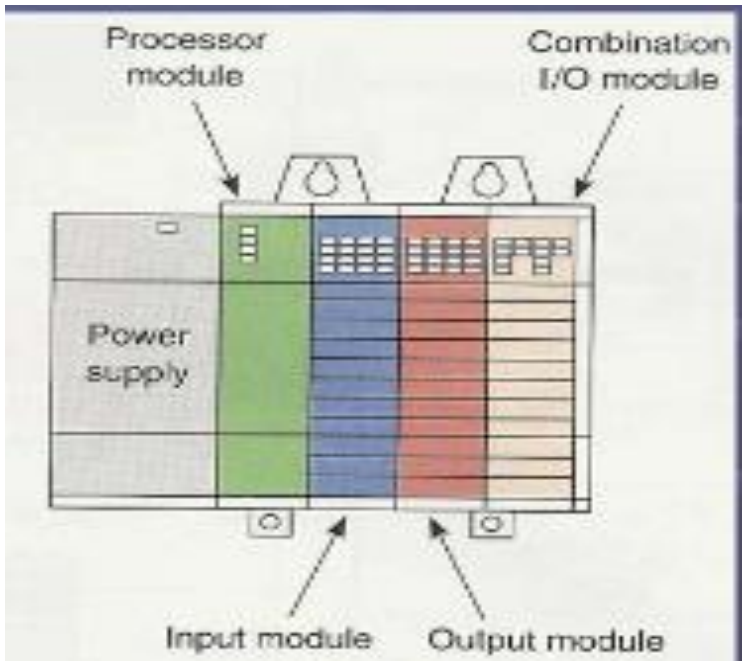
- compact PLCs (input module, central control unit and output module in one housing).
- modular PLCs.

1. Modular PLCs

- Modular PLCs may be configured individually.
- The modules required for the practical application - which can, for instance, include digital input/output modules, analogue modules, positioning and communication modules - are inserted in a rack, where individual modules are linked via a bus system. This type of design is also known as series technology.

Modular PLCs - Examples

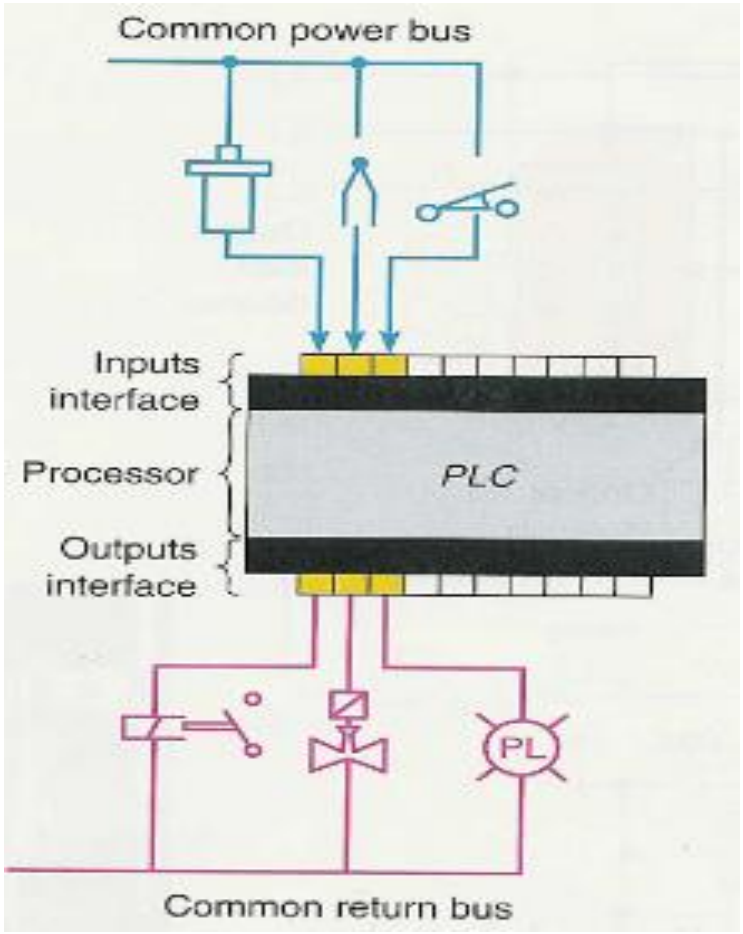
- Two examples of modular PLCs:
  1. New S7 -300 series by Siemens.
  2. Familiar modular PLC FPC405 FESTO.



Modular PLC – card format

- The card format PLC is a special type of modular PLC, developed during the last years of previous century.
- With this type, individual or a number of printed circuit board modules are in a standardised housing.
- The Festo FPC 405 is representative of this type of design.

2. Compact PLC - example



Compact Vs Modular PLC

- A wide range of variants exists, particularly in the case of more recent PLCs.

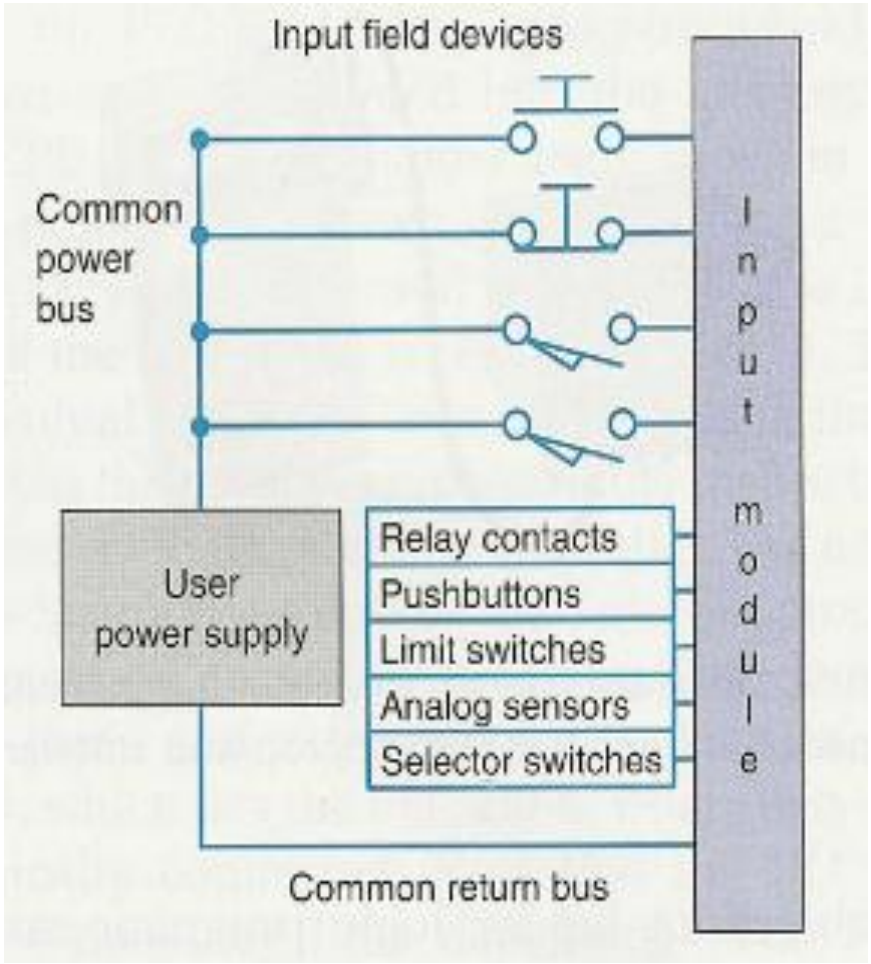
- These include both modular as well as compact characteristics and important features such as space saving, flexibility and scope for expansion.

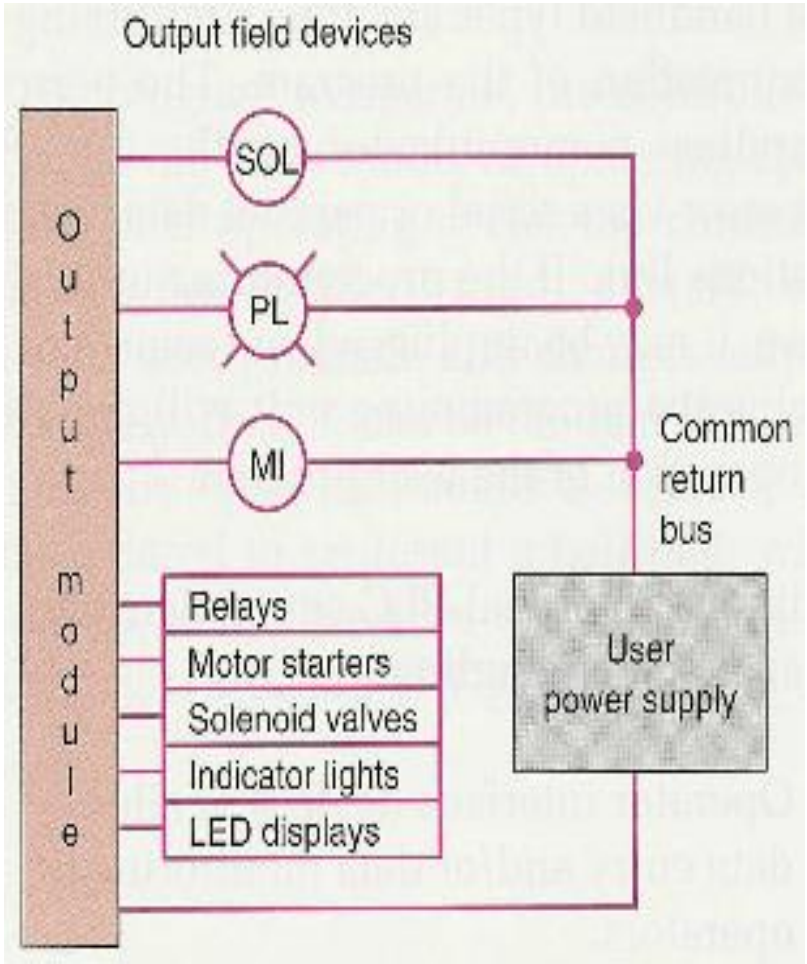
Hardware design for a PLC

The hardware design for a programmable logic controller is such that it is able to withstand typical industrial environments as regard:

- signal levels
- heat
- humidity
- fluctuations in current supply
- mechanical impact

Input/output Modules





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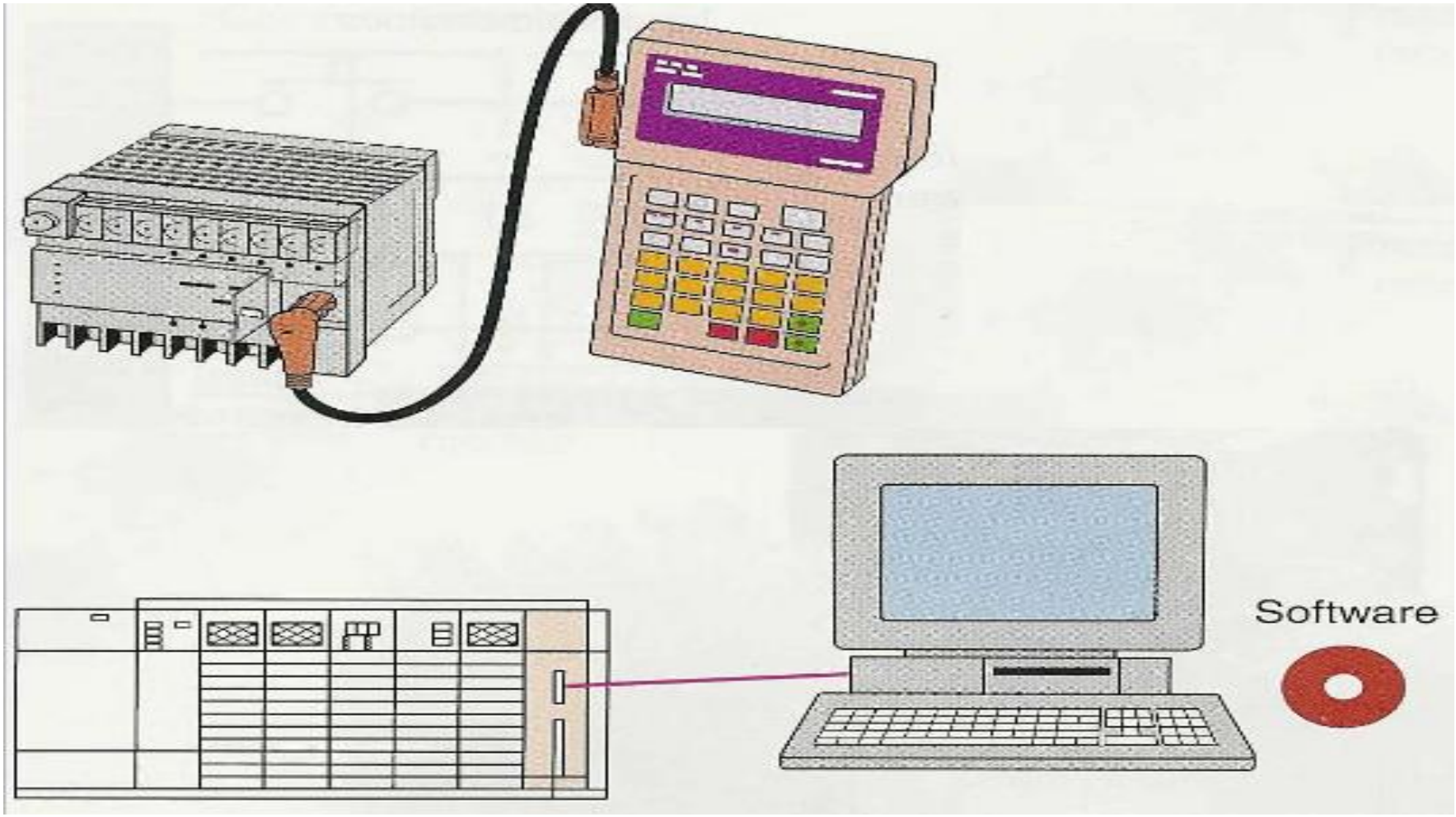
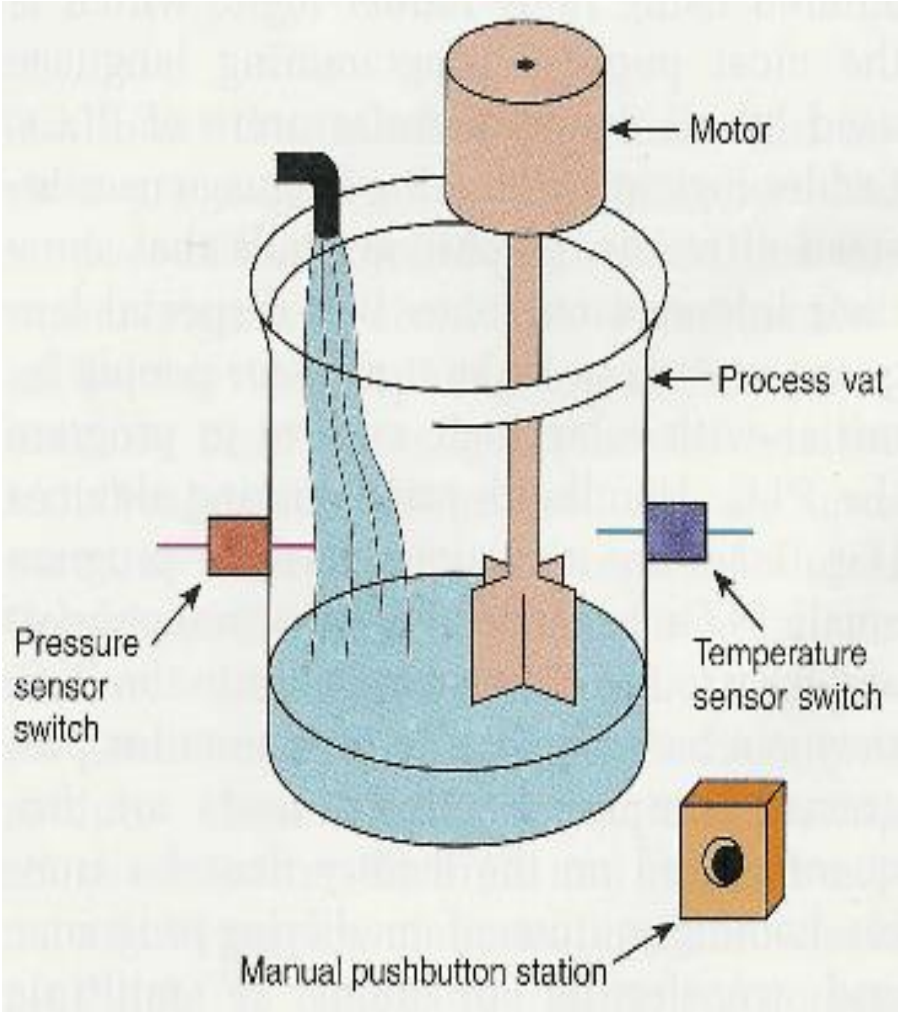
Programming the PLC

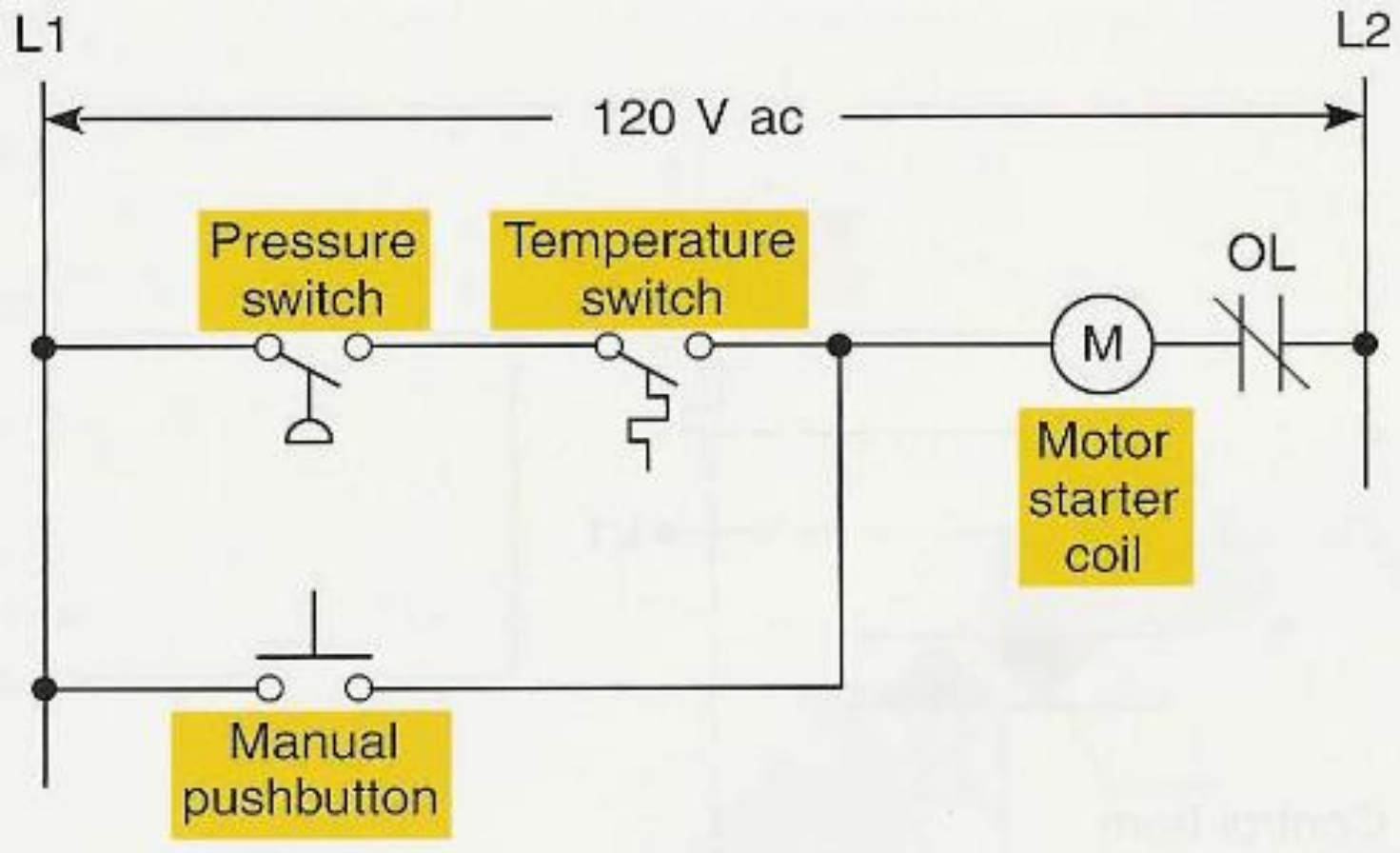


Principles of Operation

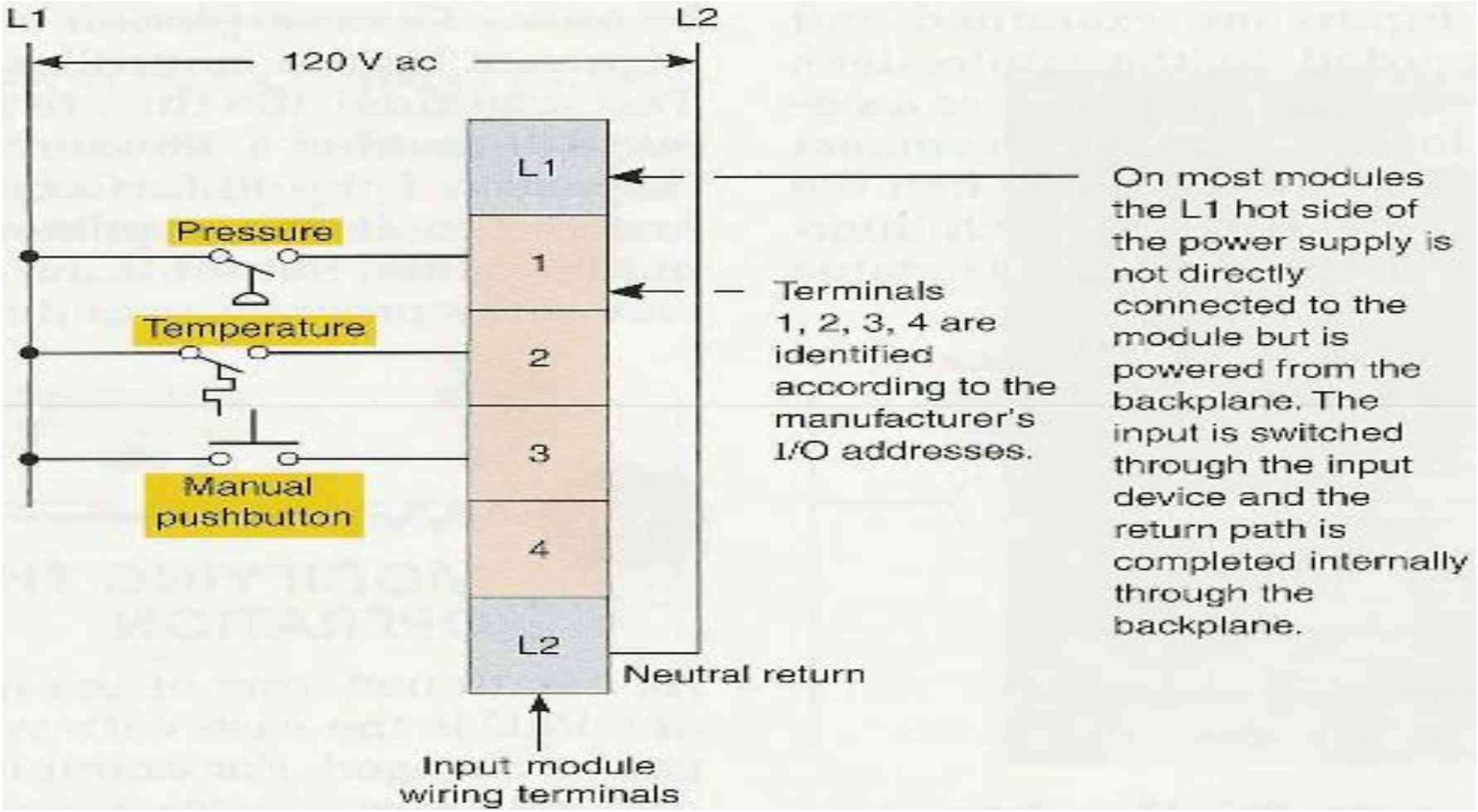
- To get an idea on how PLC operates lets consider the following simple process control problem.



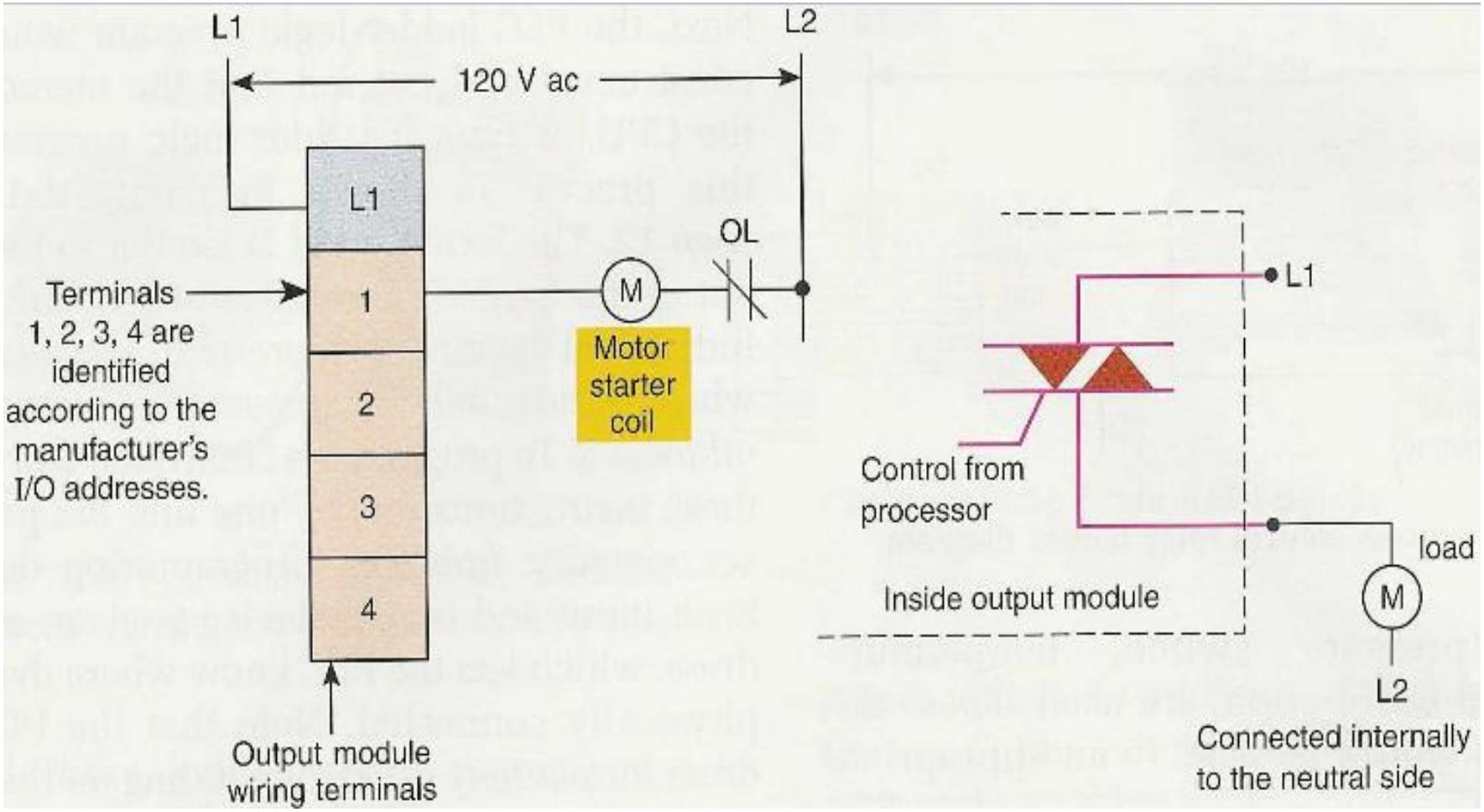
Process Control Description



PLC Inputs Connection



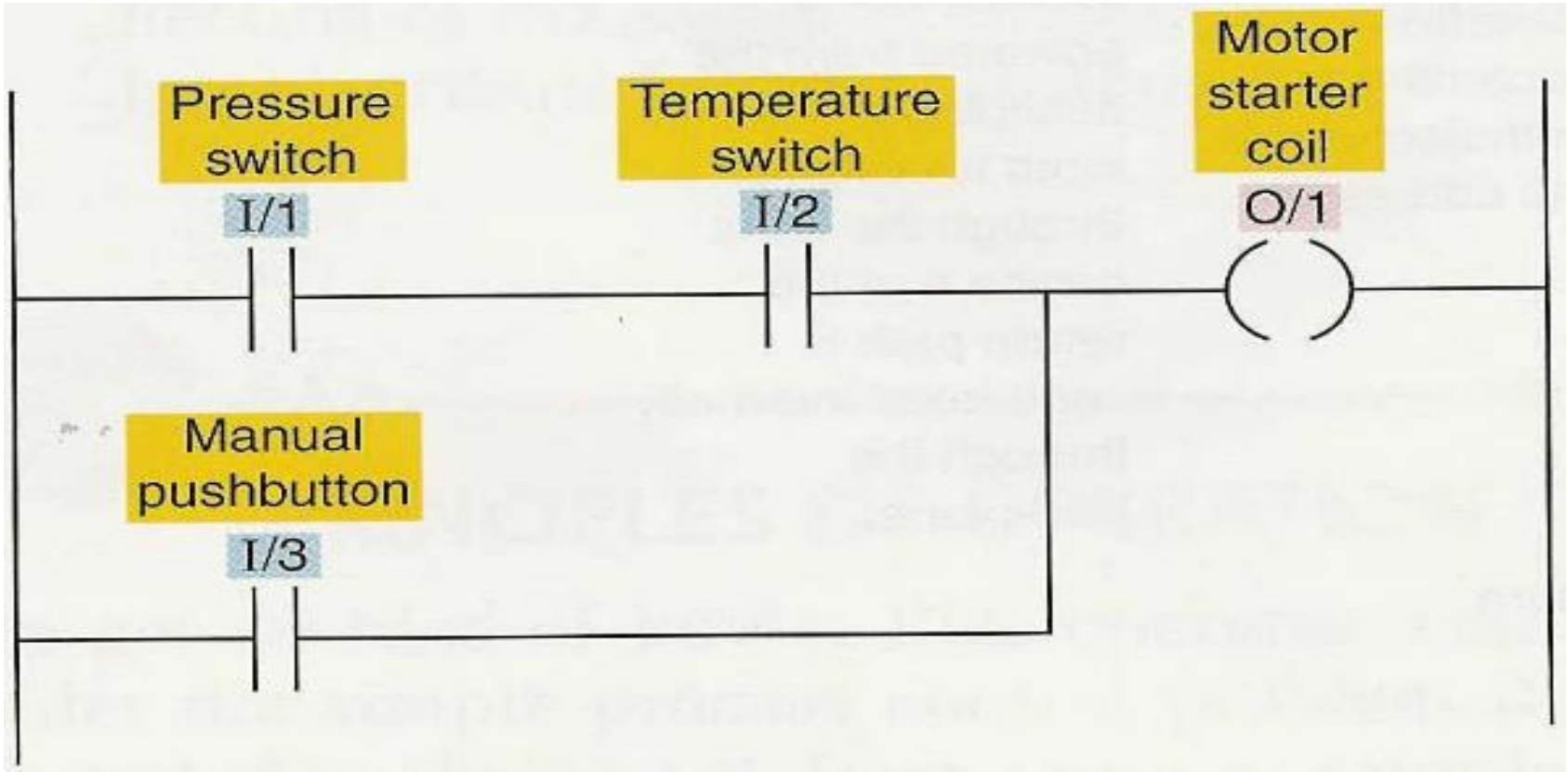
PLC Output Connections



Programming the PLC

1. To implement the described system using the PLC, a description in ladder logic should be provided.
2. Next, the ladder logic is complied and translated to basic instructions and down loaded to the internal memory.
3. During programming, the PLC should be in the Terminal or Programming mode.

Ladder Logic Program



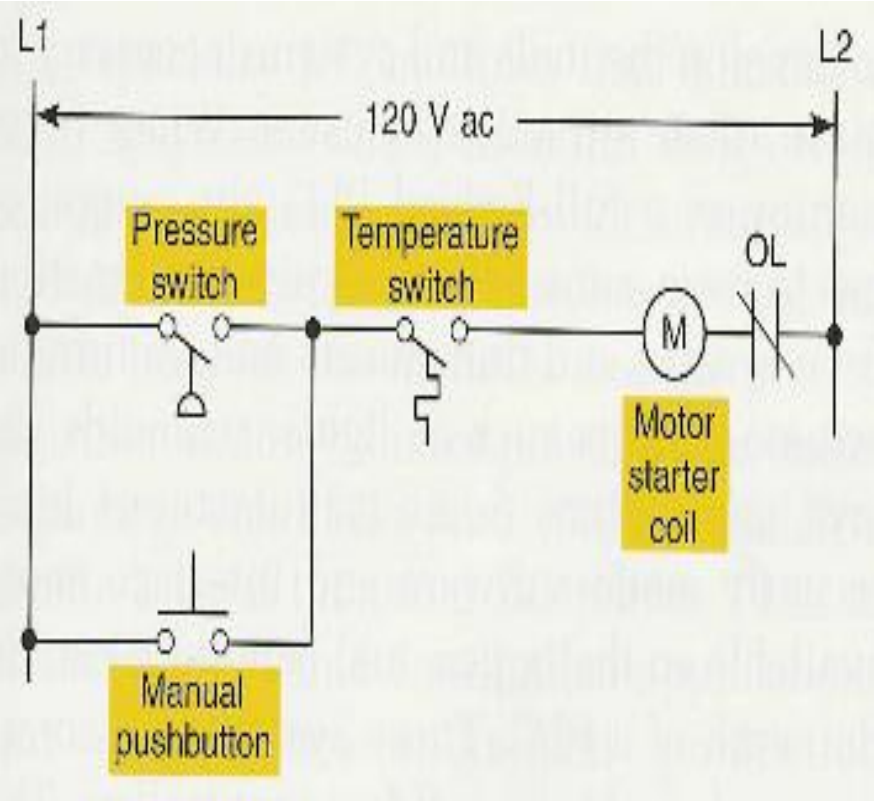
Running the Program

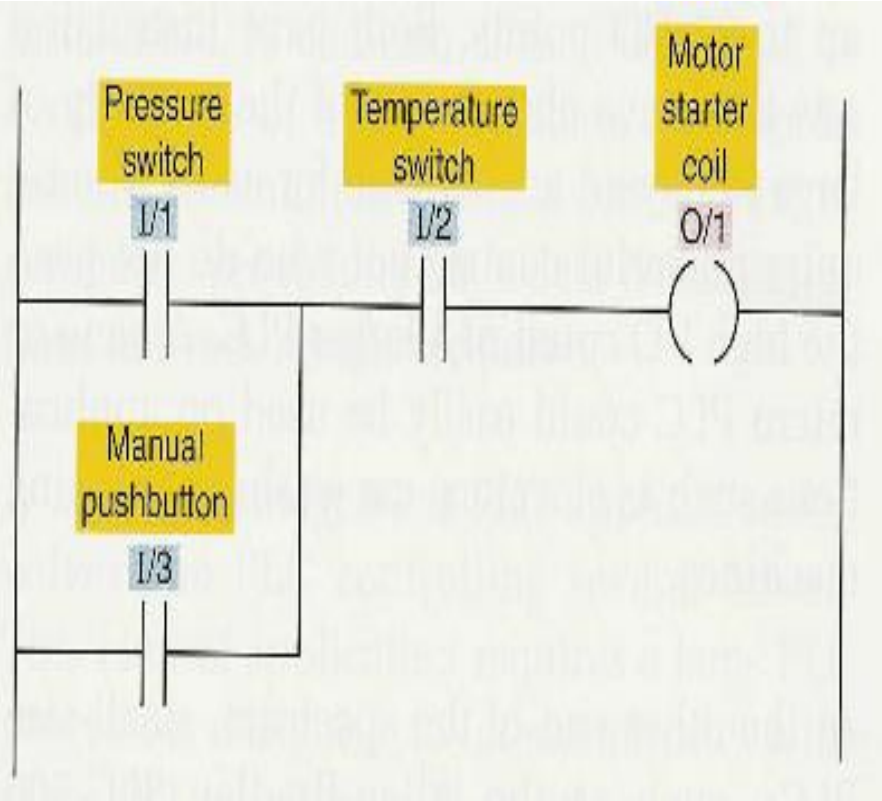
- For the program to operate the PLC should be put on the Run mode or Operating cycle.
- In the operating cycle, first the controller examines the inputs and their status is recorded in the PLC memory.
- Then, the ladder diagram is evaluated, and changes ladder diagram is evaluated, and changes are sent to the outputs accordingly.

Scan Time

- The completion of a cycle of the controller is called a Scan.
- The scan time needed to complete a full cycle by the controller gives the measure of execution for the PLC.
- Generally, outputs are updated in memory during the scan but the actual output is updated until the end of the program updated during the I/O scan.

Process Modification





PLC Vs Computer

PLC	computer
Designed for extreme industrial environments.	Designed mainly for data processing and calculation.
Can operate in high temperature and humidity.	Optimized for speed.
High immunity to noise.	Can't operate in extreme environments.
Integrated command interpreter(proprietary).	Can be programmed in different languages.

The new PLC standard IEC 1131

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Previously PLC standards

- Previously valid PLC standards focussing mainly on PLC programming were generally geared to current state of the art technology in Europe at the end of the seventies.
- This took into account non-networked PLC systems, which primarily execute logic operations on binary signals.
- DIN 19 239, for example, specifies programming languages which possess the corresponding language commands for these applications.

Previously situation

- no equivalent, standardised language elements existed for the PLC developments and system expansions made in the eighties such as
  - processing of analogue signals
  - interconnection of intelligent modules
  - networked PLC systems etc.

  Consequently, PLC systems by different manufacturers required entirely different programming.

International standard

- Since 1992, an international standard now exists for programmable logic controllers and associated peripheral devices (programming and diagnostic tools, testing equipment, human-to-machine (HMI) interfaces etc.).
- In this context, a device configured by the user and consisting of the above components is known as a PLC system.

The new IEC 1131 standard consists of six parts:

- Part 1: General information
- Part 2: Equipment requirements and tests
- Part 3: Programming languages
- Part 4: User guidelines (in preparation with IEC)
- Part 5: Messaging service specification (in preparation with IEC)
- Part 7: Fuzzy control programming

The purpose of the new standard

- to define and standardise
  - the design and functionality of a PLC
  - the languages required for programming

  to the extent where users were able to operate using different PLC systems without any particular difficulties

The simple Ladder Logic

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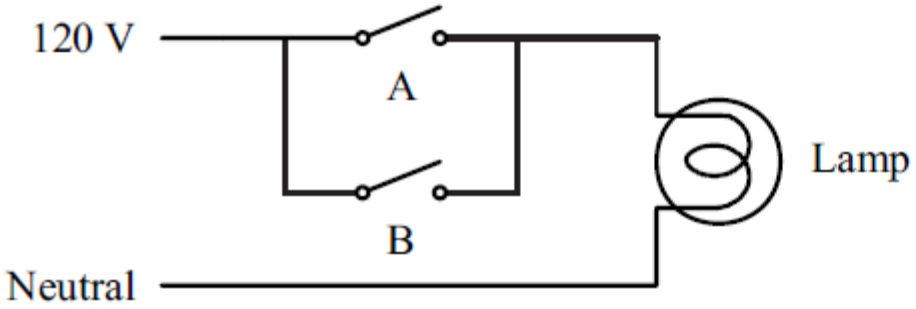
Simple ladder logic

- To introduce ladder logic programming simple switch circuits are converted to relay logic and then to PLC ladder logic.
- **Example(1):** OR Circuit. Two switches labeled A and B are wired in parallel controlling a lamp as shown in the Figure. Implement this function as PLC ladder logic where the two switches are separate inputs.



(a)

A	B	Lamp
off	off	off
off	on	on
on	off	on
on	on	on

(b)

Parallel switch circuit: *(a)* switch circuit; *(b)* truth table.

Solution.

- The switch circuit action is described as, "The lamp is on when switch A is on (closed) or switch B is on (closed)."
- The switches A and B are not connected to the lamp directly, but are connected to relay coils labeled AR and BR whose normally-open (NO) contacts control a relay coil, LR, whose contacts control the lamp.
- The switches, A and B, are the inputs to the circuit. When either switch A or B is closed, the corresponding relay coil AR or BR is energized, closing a contact and supplying power to the LR relay coil. The LR coil is energized, closing its contact and supplying power to the lamp.

Thank You For Your Attention

Mohamed Ahmed Ebrahim