

# **Industrial Automation**

## **(Automação de Processos Industriais)**

### **Introduction to PLCs**

<http://www.isr.ist.utl.pt/~pjcro/courses/api0910/api0910.html>

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## Syllabus:

**Chap. 1 – Introduction to Automation [1 week]**

...

**Chap. 2 – Introduction to PLCs [2 weeks]**

Components of Programmable Logic Controllers (PLCs).

Internal architecture and functional structure.

Input / output interfaces. Interconnection of PLCs .

...

**Chap. 3 – PLCs Programming Languages [2 weeks]**

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## Some resources available online on PLCs

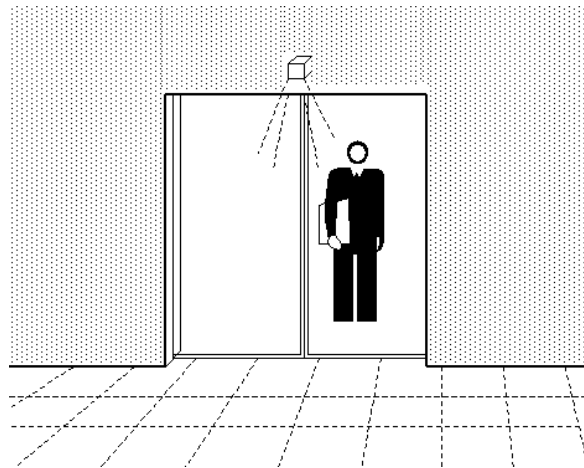
- History : <http://www.plcs.net/chapters/history2.htm>
- Tutorial: <http://www.koldwater.com/downloadform.htm>  
<http://www.htservices.com/Tutorials/plctutorial1.htm>  
<http://www.sea.siemens.com/step/templates/lesson.mason?plcs:1:1:1>
- Simulators: <http://www.thelearningpit.com/psim/psim.html>  
<http://www.keyence.com/plc/kvl.htm>  
<http://www.autoware.com/english/demo.htm>  
<http://www.apalmertraining.com/download.htm>  
[http://tytang.hypermart.net/cgi-bin/frame.pl?file=PLC\\_sim/index.html](http://tytang.hypermart.net/cgi-bin/frame.pl?file=PLC_sim/index.html)  
<http://www.thelearningpit.com/psim/psim.html>
- Bibliography : Automatic Manufacturing Systems with PLCs, Hugh Jack  
(online version available)  
Programming Logic Controller s, Frank D. Petruzella  
...
- Standards: <http://www.plcopen.org/>

## An Automation Example

### Solution based on PLCs

Example:

Automation of the Main Entrance Door, in “*PLCs Theory*,” [Omron]





Example:

Automation of the Main Entrance Door, in “*PLCs Theory*,” [Omron]

### **Functional Specifications**

*An automatic system that could command the opening and close of a door is the main purpose of these specifications.*

*The command operation will be automatic and manual. There must be a selector with two positions in a front pannel of command to select the mode of operation.*

*The manual mode resorts to the use of two push buttons to open and close the door. Once the OPEN push button is pressed, the door will be opened until the operation is completed, as detected by a limit switch. Upon pushing the CLOSE button the door will be commanded to close , untill the end of the operation is detected by other limit switch.*

*The automatic mode of operation resorts to the use of two sensors, that detect the proximity of the users. When a person is detected the automatic opening of the door starts. The door remains opened for a period from 5 to 20 seconds, following the null detection if the user. After that period the door starts to close. If during this last phase the presence of other user is detected the close operation is aborted and a new cycle of opening starts.*

Example:

Automation of the Main Entrance Door, in “*PLCs Theory*,” [Omron]

### **Technological Specifications**

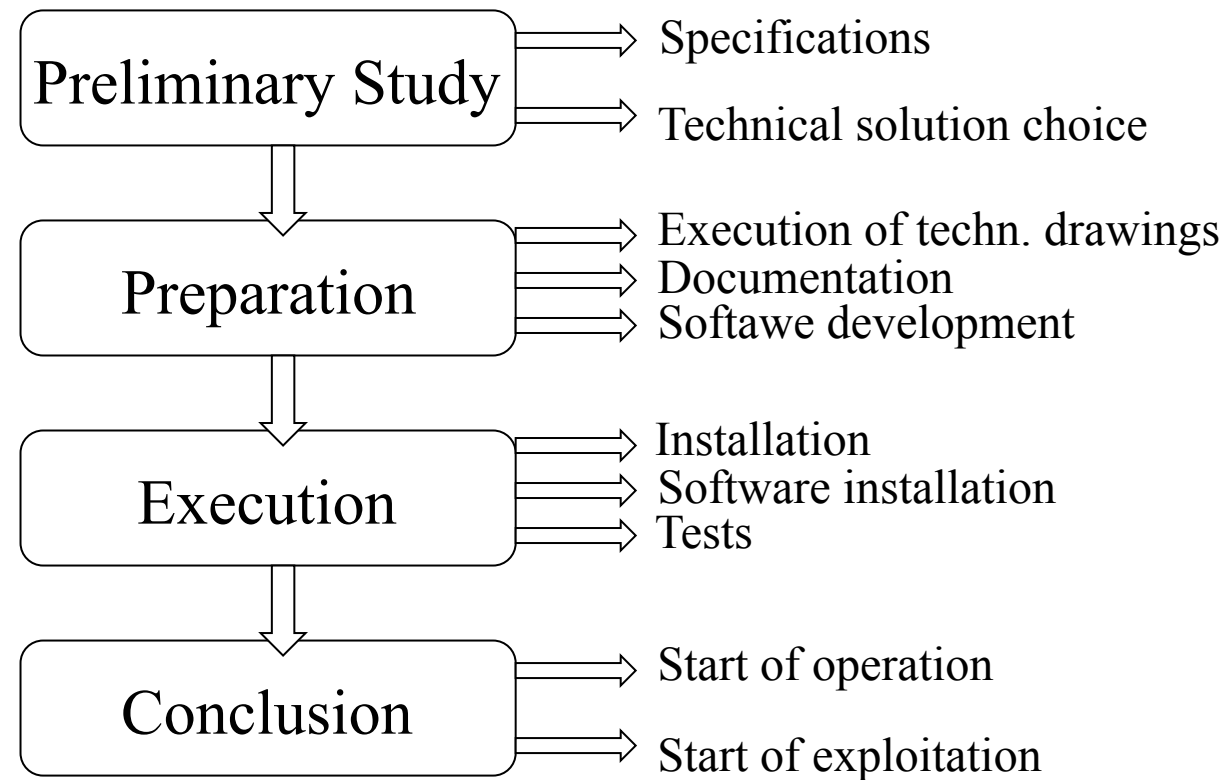
*The proximity sensor that detects the users must be of a model that can be installed over the door (one in the interior and other in the exterior), and must be based on the reflection of infrared radiations, with output by transistor. The sensor sensivity must be tuned such taht its output becomes active if an user is at 2 meters of distance or less.*

*The motor that activates the open and close of the door must be electrical , three-phasic, ..., etc.*

### **Operating Specifications**

*A key must be required to be used in the model of the automatic-manual selector. A counter of the number of operations should be incorporated in the solution, to identify when maintenance is required. The maintenance must be at each 10000 operations, ... etc*

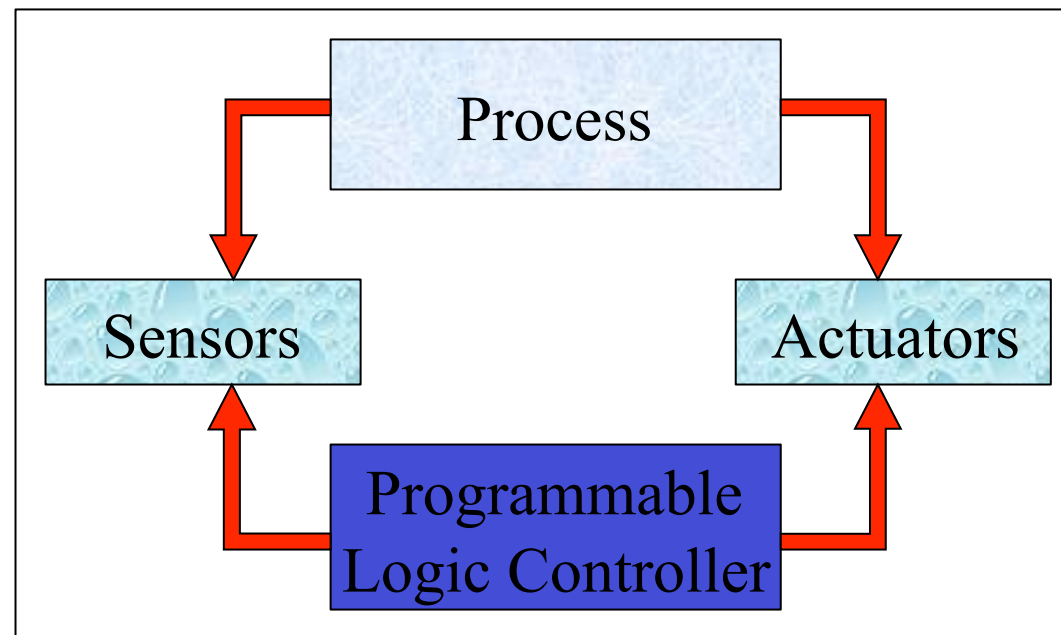
Phases of a Project in EE&CS:  
(Automation included)



## Automation Problems

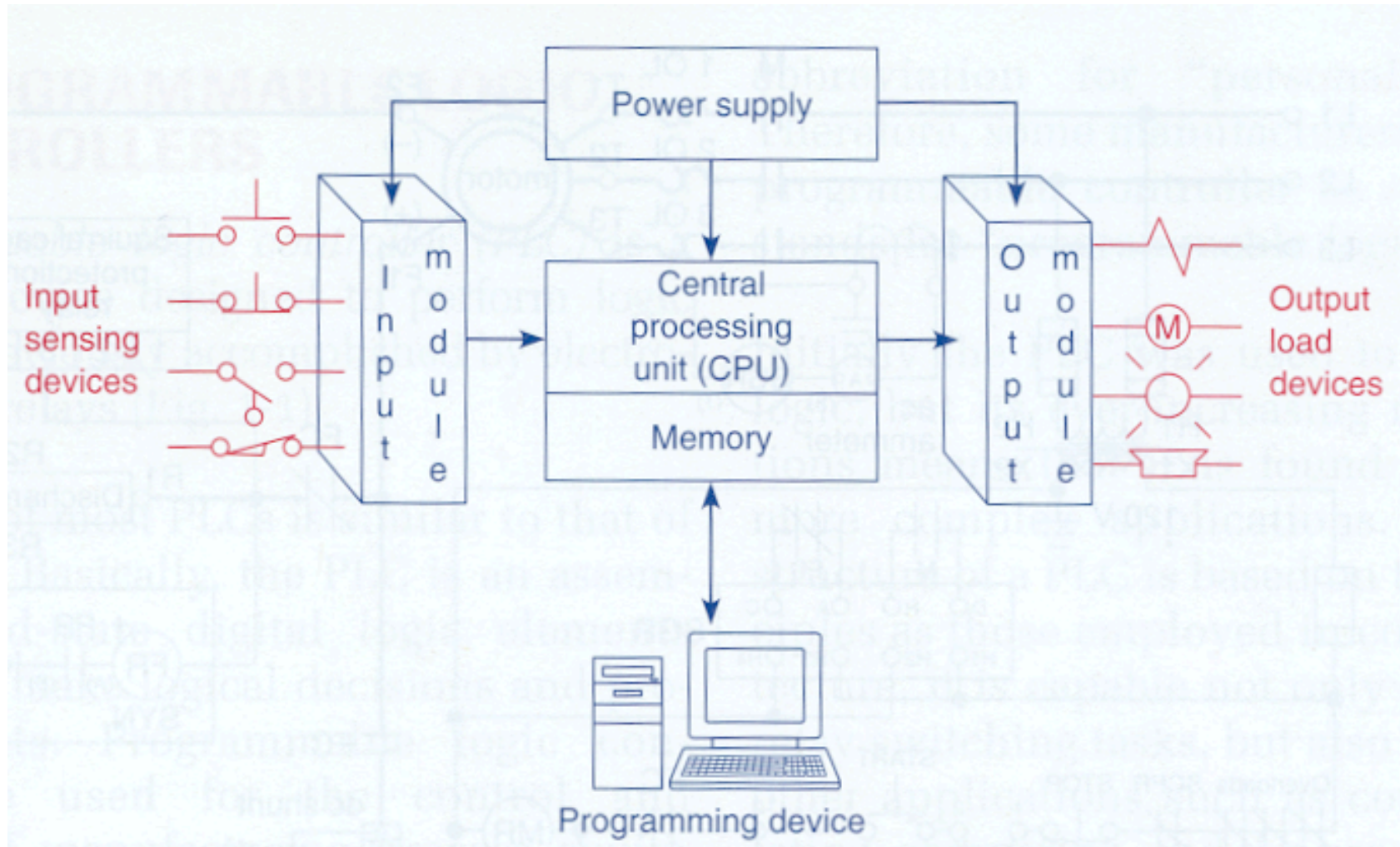
### PLC based solutions

To use PLCS the connection to input devices (for detection and sensing) and to output devices (for command and control) is required.



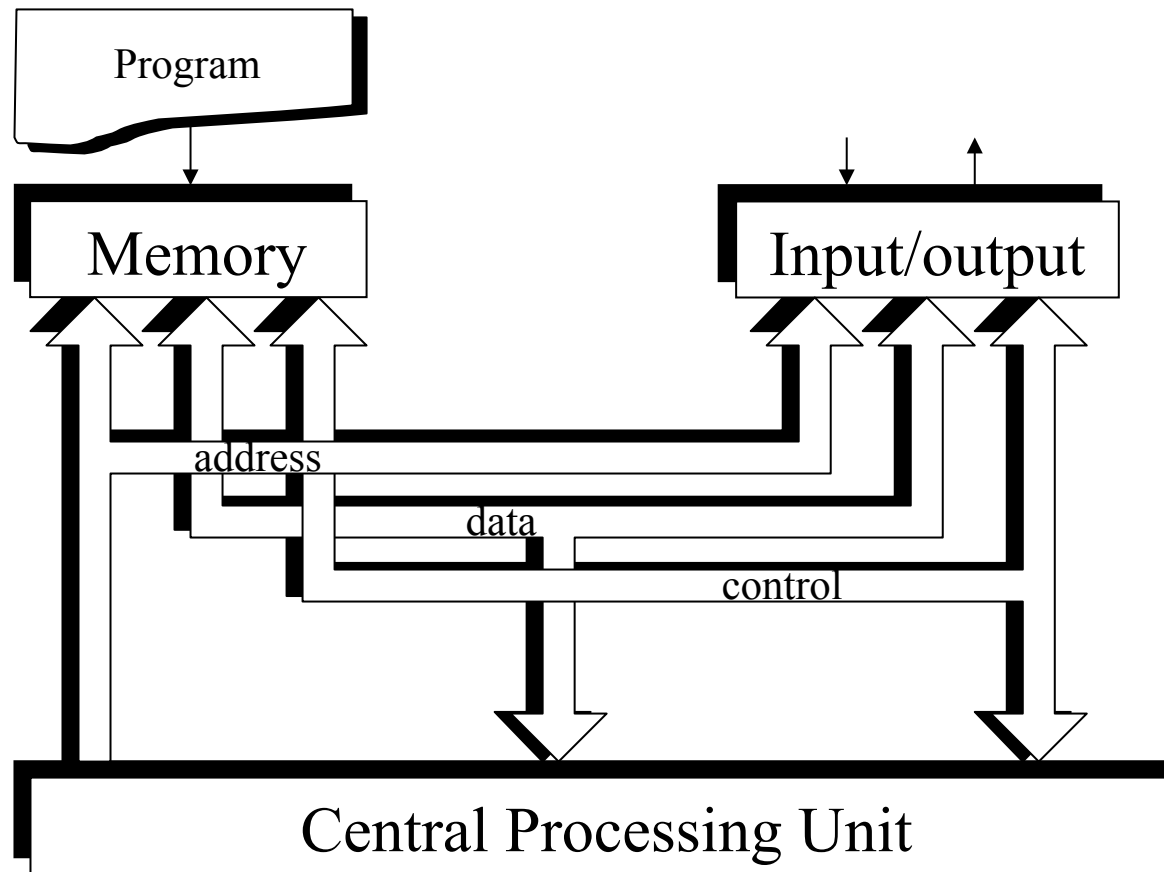
A software program to implement the proposed solution will be implemented in the PLC.

# Architecture of PLCs



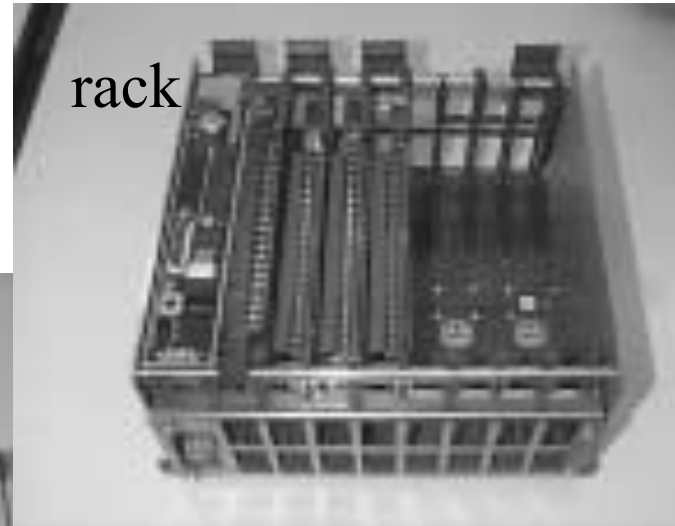
## Architecture of PLCs

... and internally, how is it implemented?

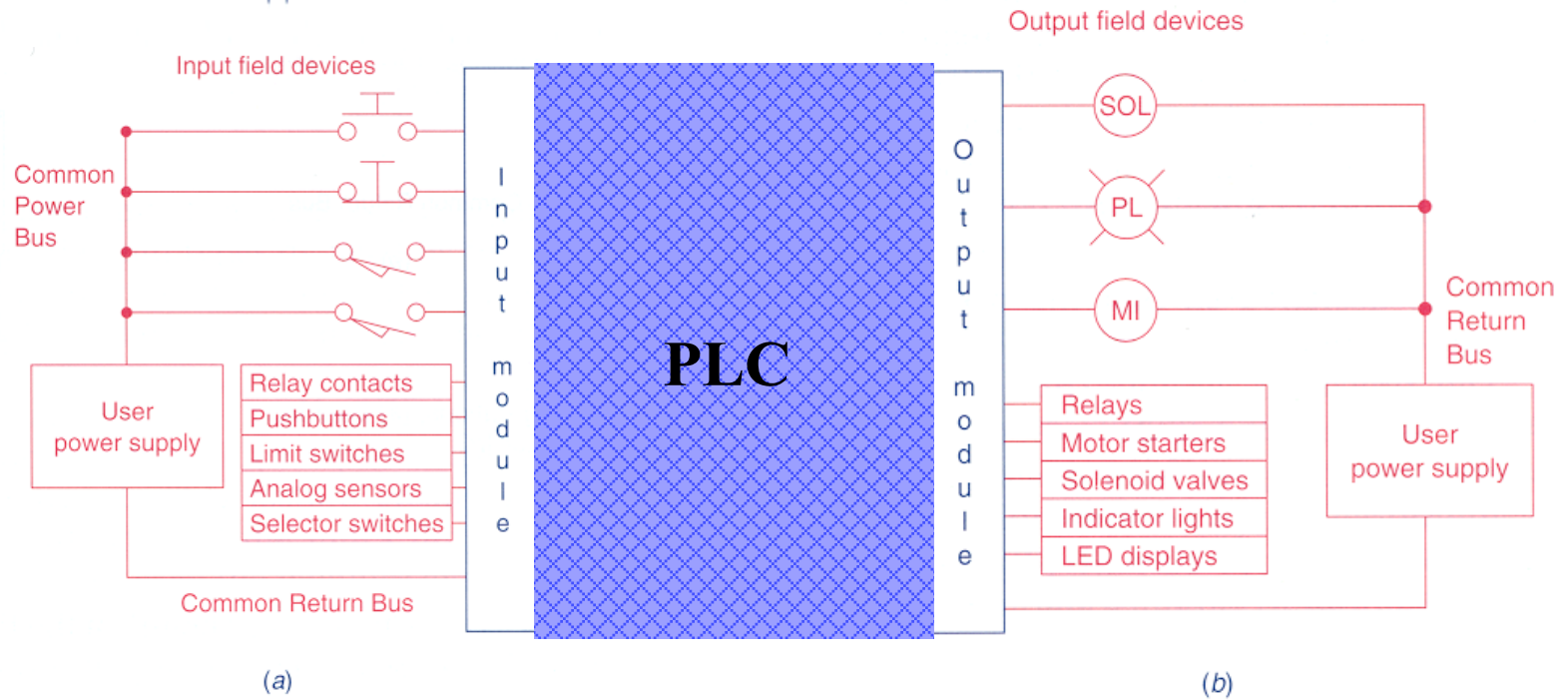


## Architecture of PLCs

### Types of PLCs



# Architecture of PLCs

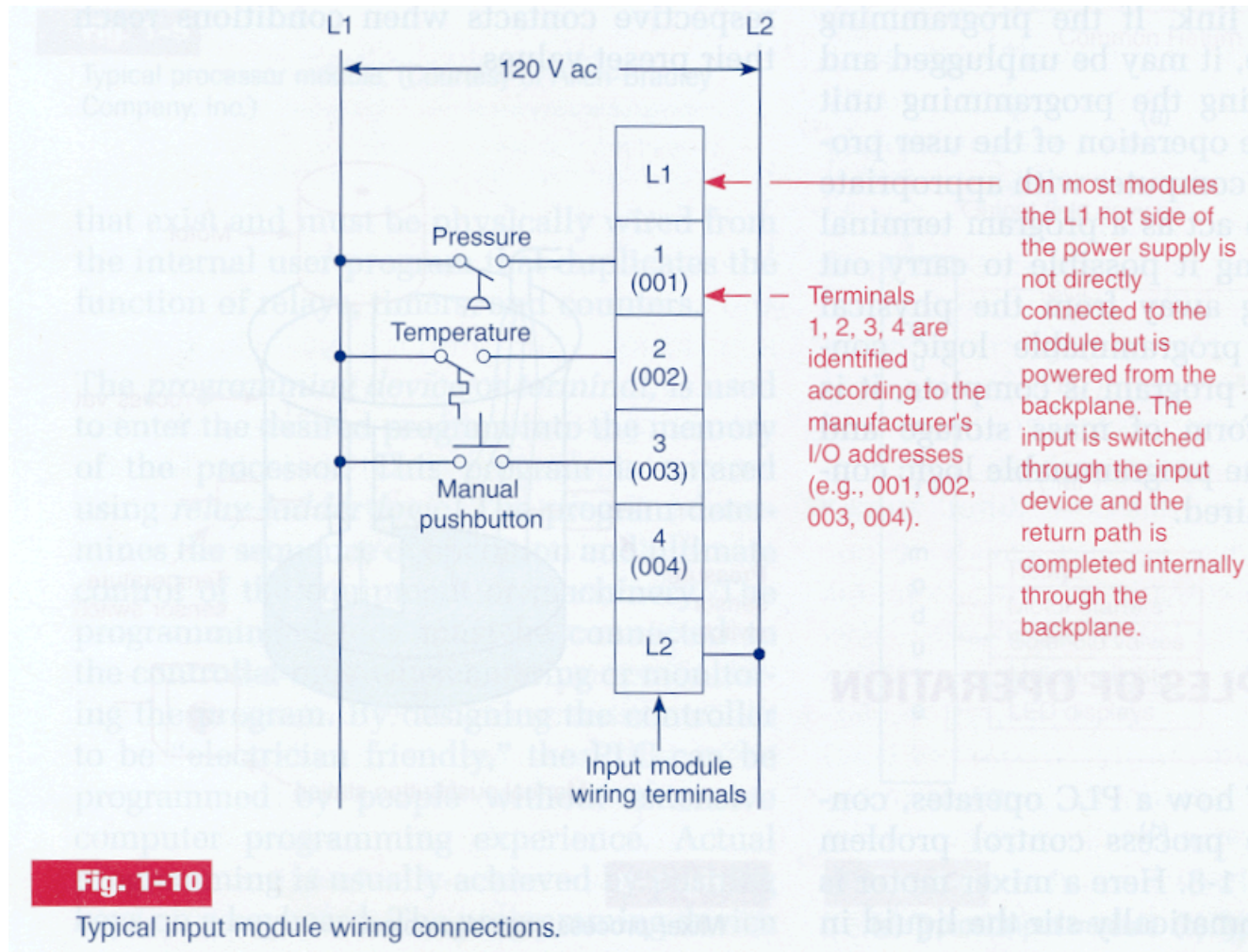


**Fig. 1-6**

(a) Typical input module. (b) Typical output module.



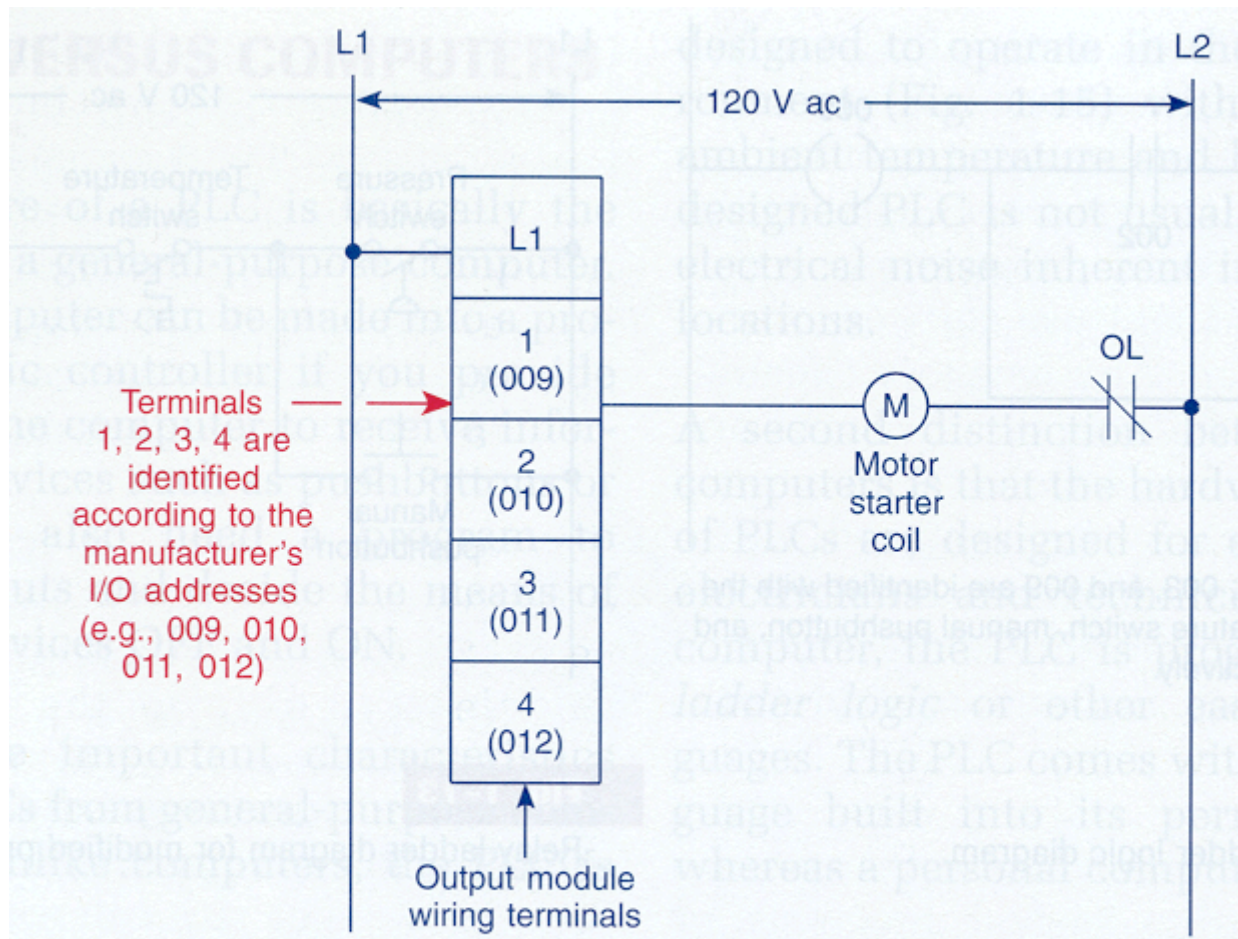
# Architecture of PLCs



**Fig. 1-10**

Typical input module wiring connections.

# Components of Programmable Logic Controllers



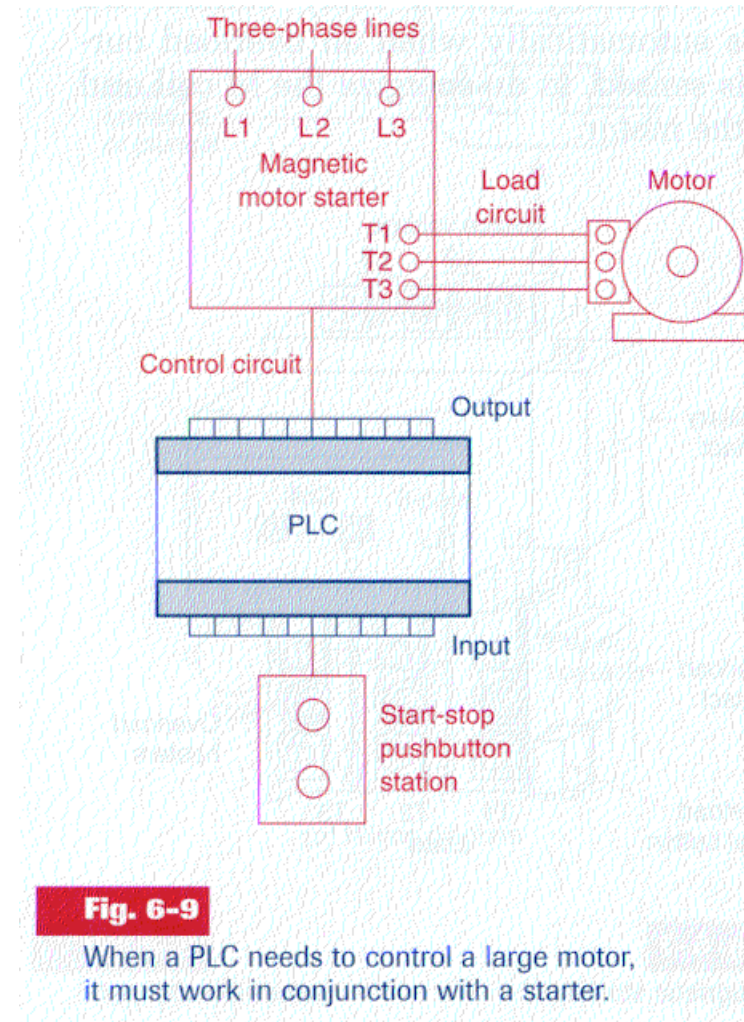
**Fig. 1-11**

Typical output module wiring connections.

## Components of Programmable Logic Controllers

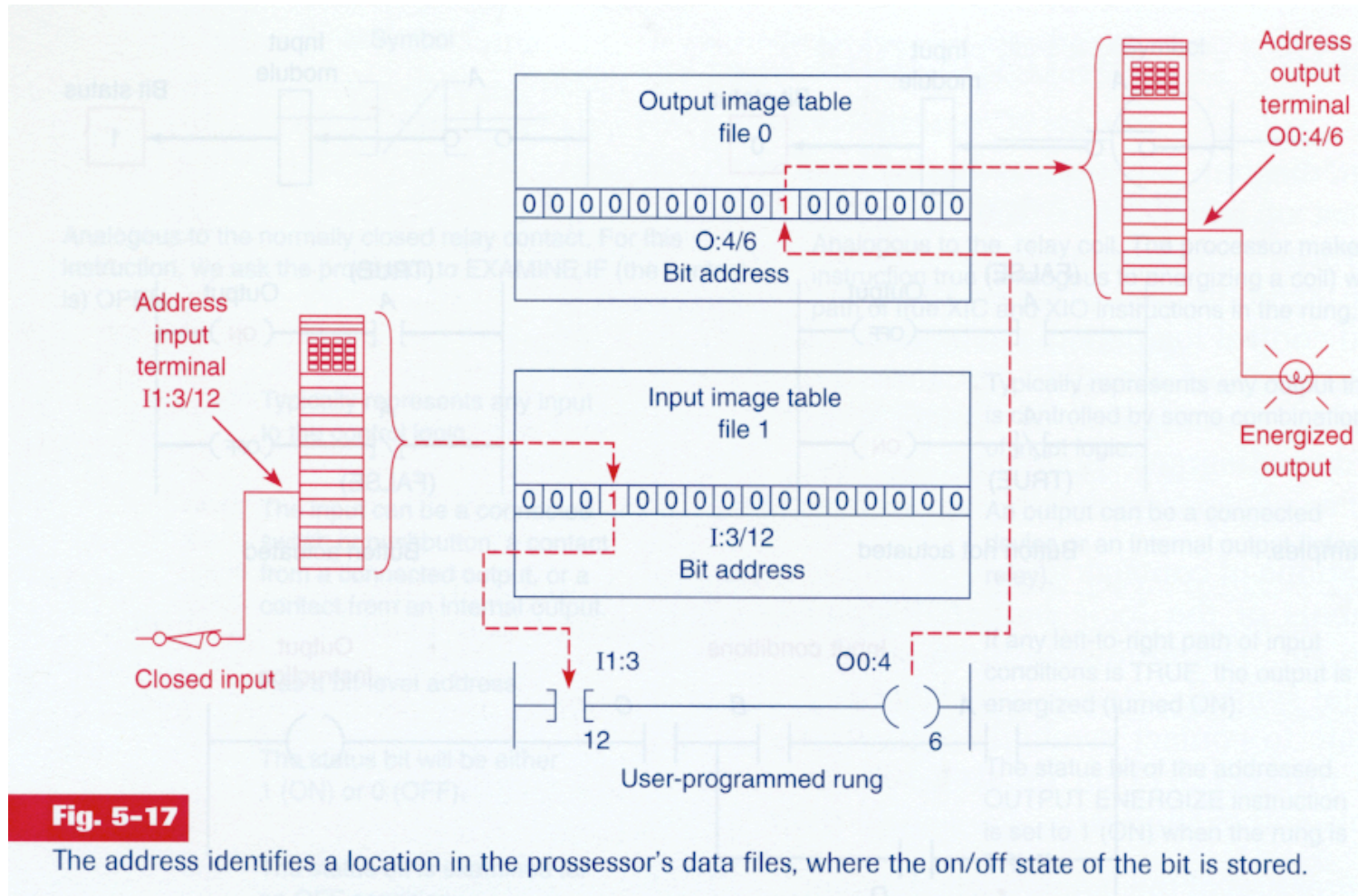
Example:

Command of a motor from a console with start and stop buttons.





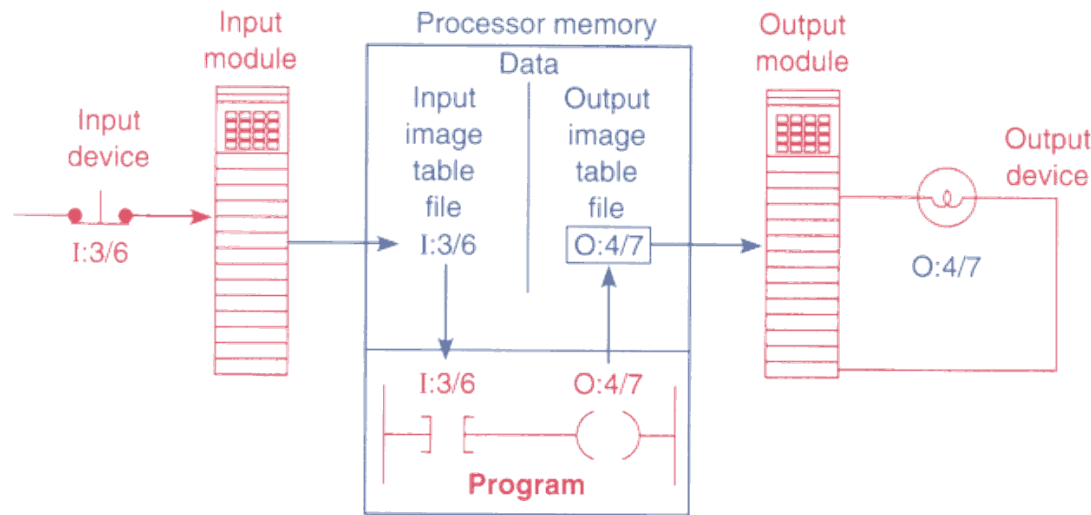
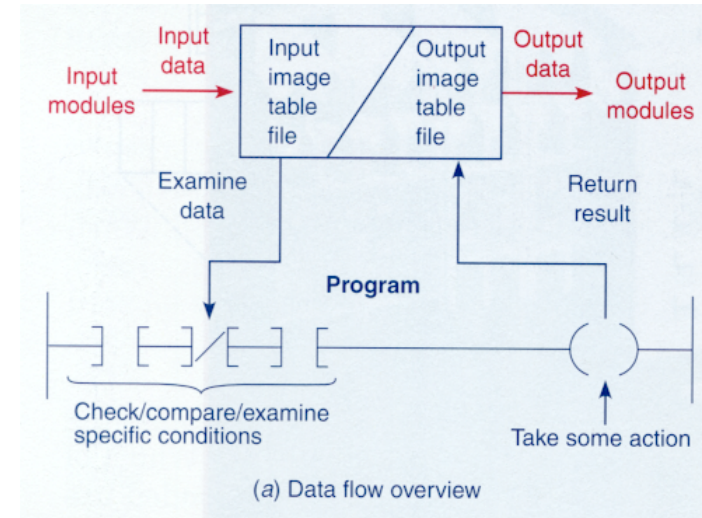
# Components of Programmable Logic Controllers



**Fig. 5-17**

The address identifies a location in the processor's data files, where the on/off state of the bit is stored.

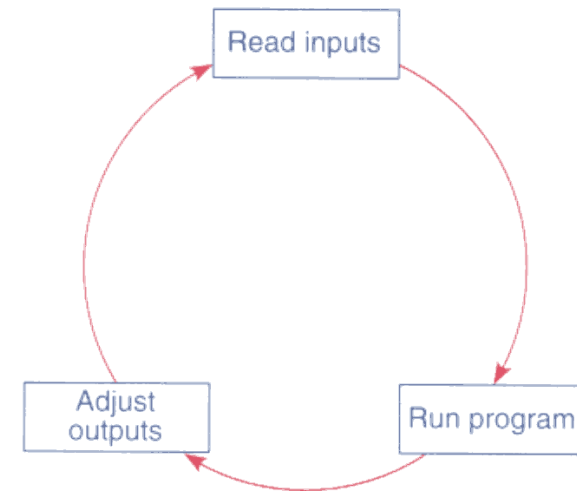
# Internal structure and Work principles



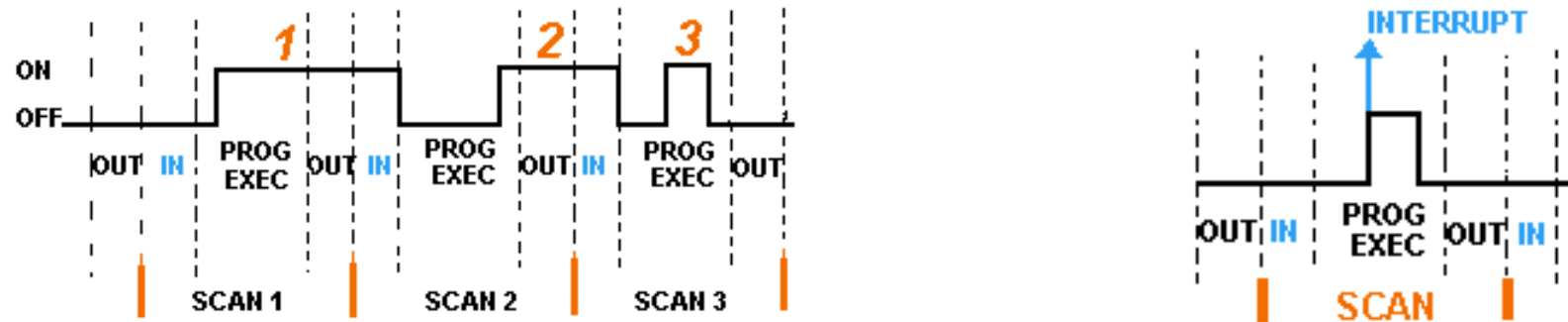
**Fig. 5-7**

Scan process.

(b) Scan cycle



## Internal structure and work principles

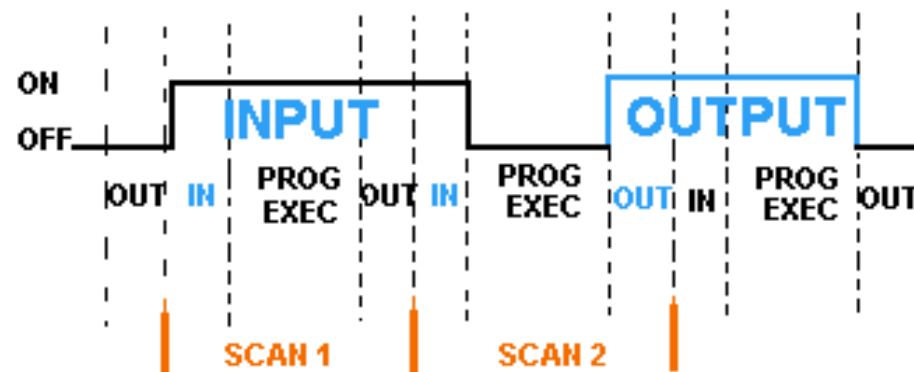


Scan Cycle, Scan Period

The inputs must be active for at least one scan cycle to have impact (no uncertainty) in the internal PLC state and indirectly in the outputs.

Exception: interrupts...

## Internal structure and work principles



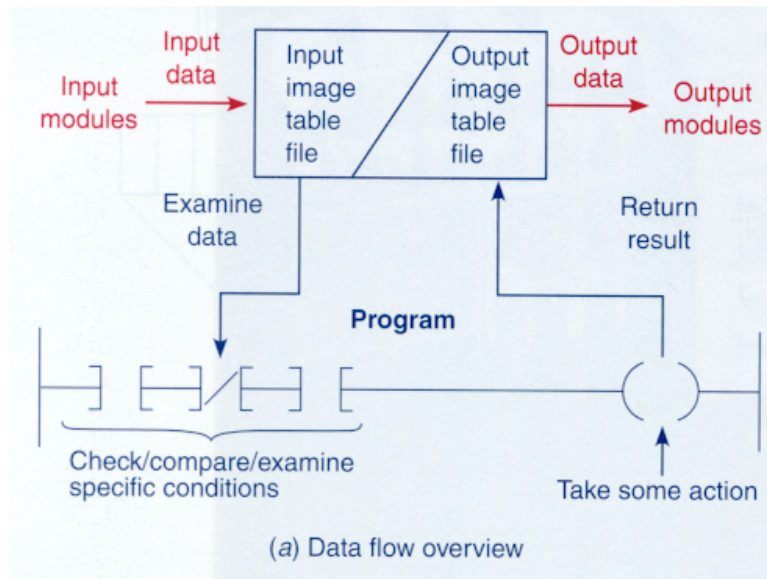
Time interval for an input to have impact on an output (with probability one)?

### 2 \* SCAN PERIOD

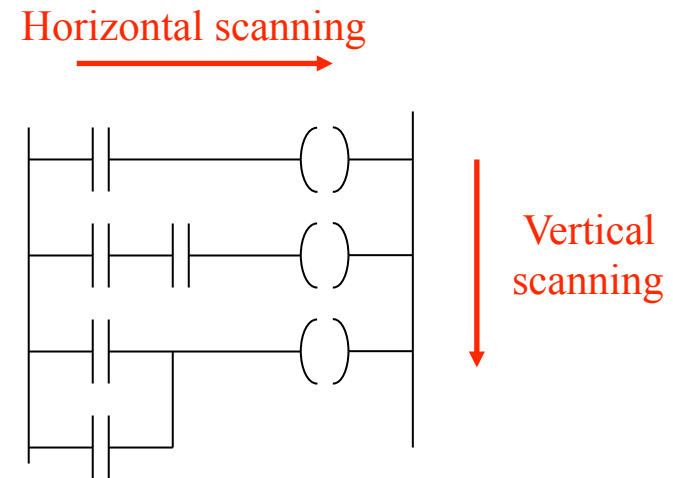
Smaller time interval (with probability greater than zero) that the change in one input can impact in one output?

**SCAN PERIOD – READ TIME – WRITE TIME = EXECUTION TIME**

## Internal structure and work principles



Interface for inputs and outputs



Scanning rangs...

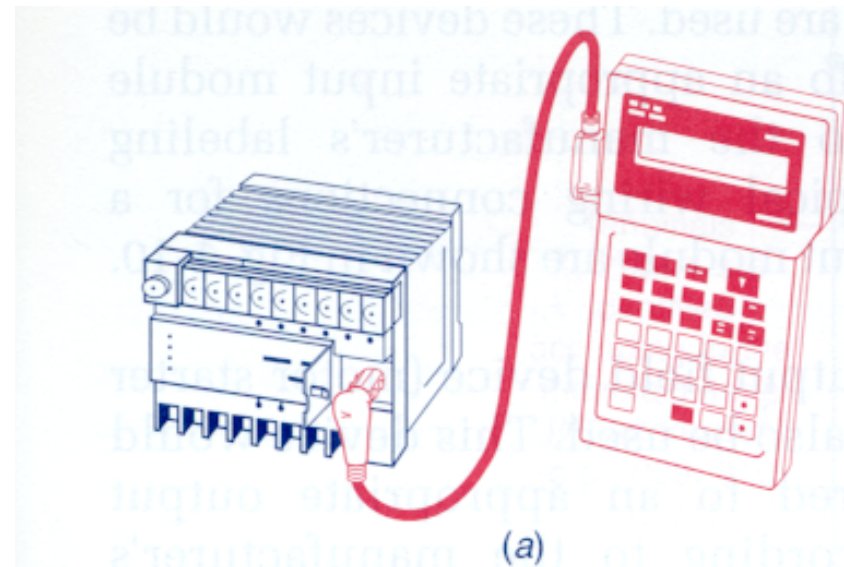


## Components of Programmable Logic Controllers

Programming using specific devices



OMRON console

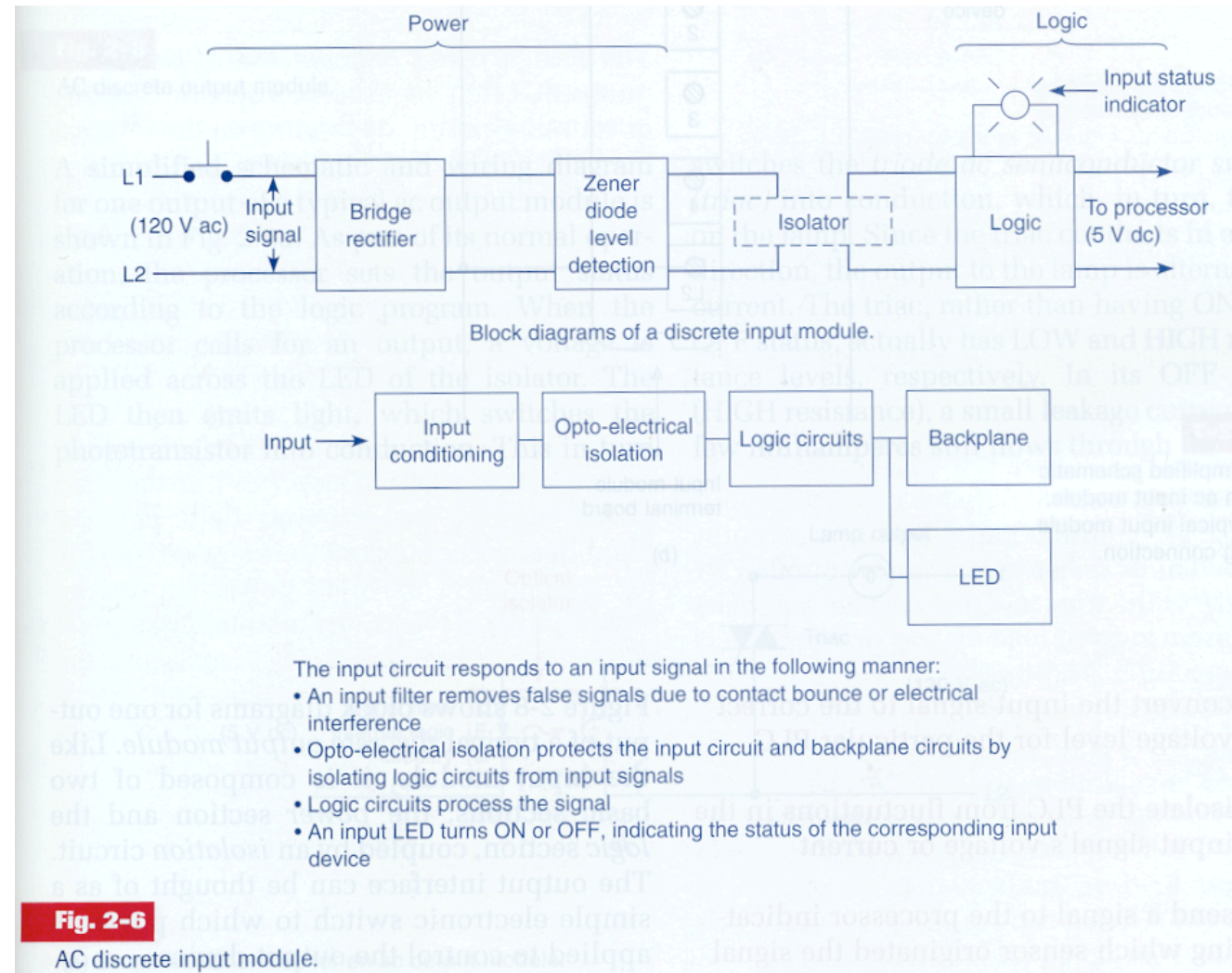


**Fig. 1-7**

Programming devices: (a) hand-held unit with light-emitting diode (LED) display; (b) industrial terminal video unit (Courtesy of Honeywell, Inc.); (c) personal computer with appropriate software.

# Input and output interfaces

## AC input module (discrete)

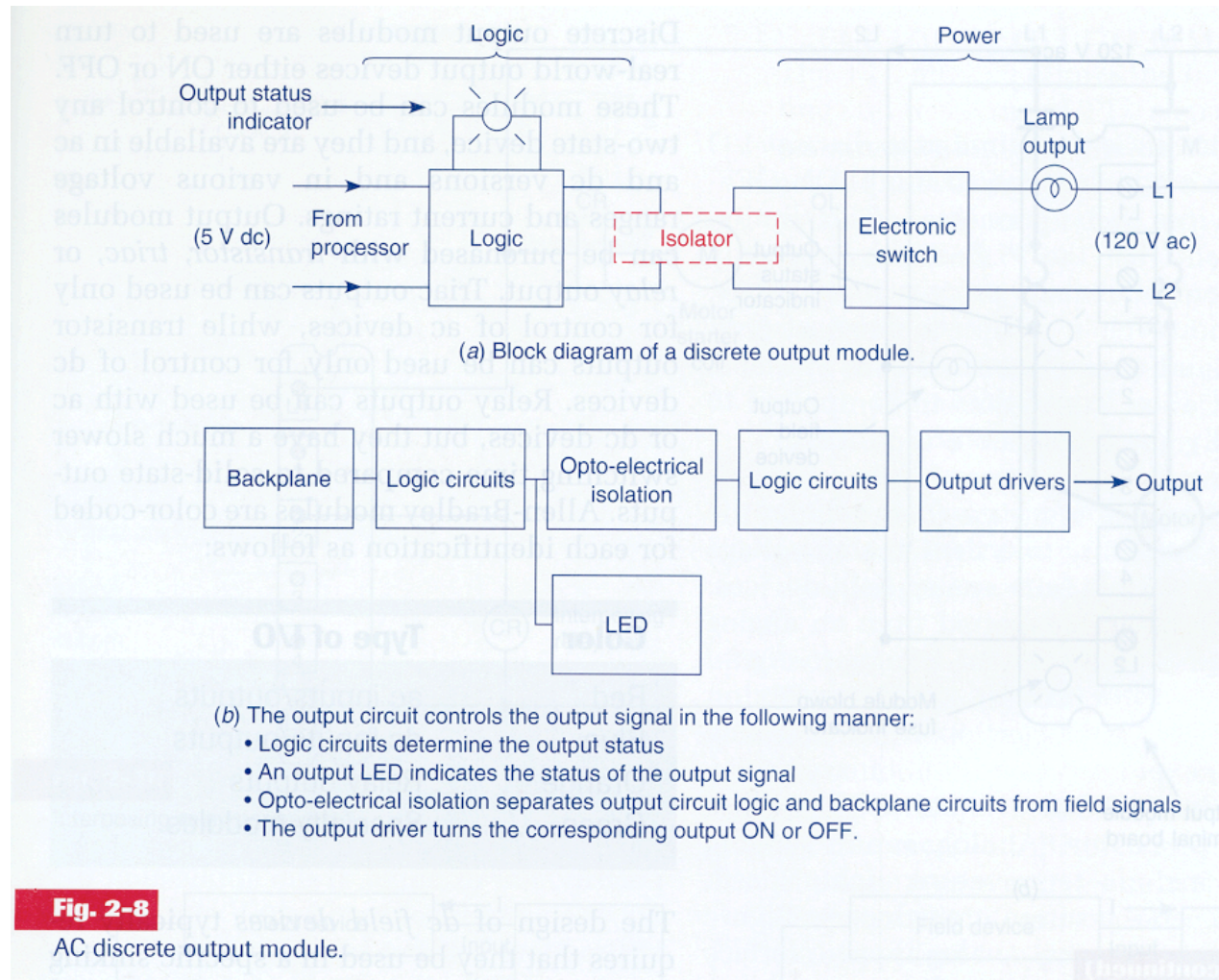






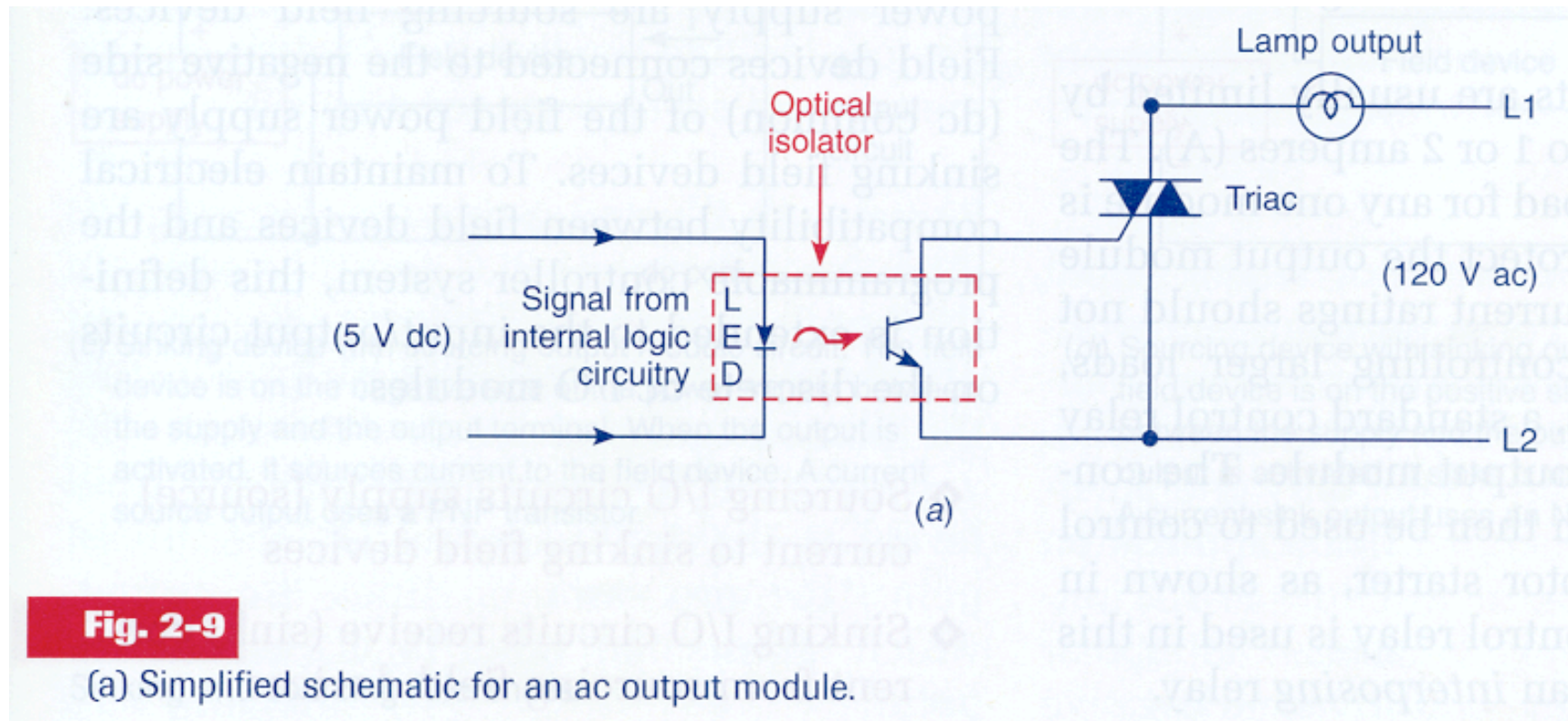
# Input and output interfaces

## AC output module (discrete)



## Input and output interfaces

### AC output module (discrete)



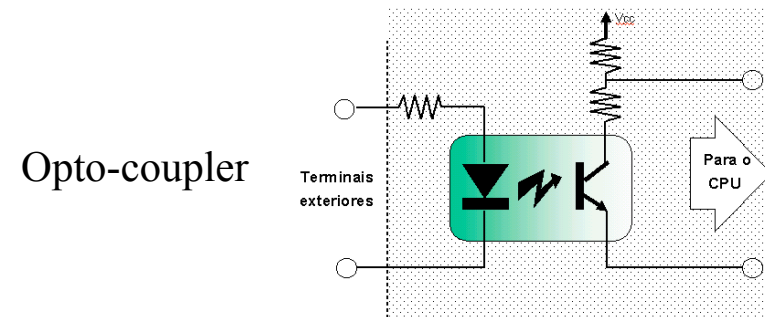
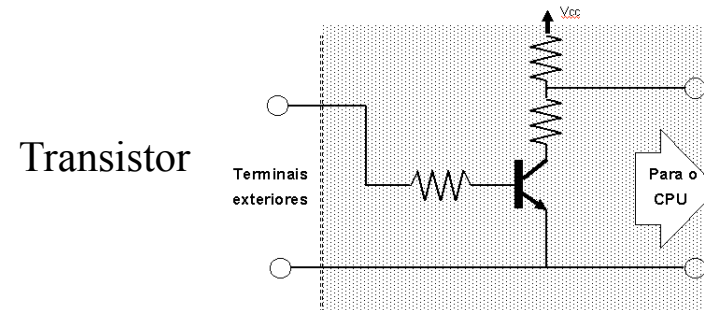
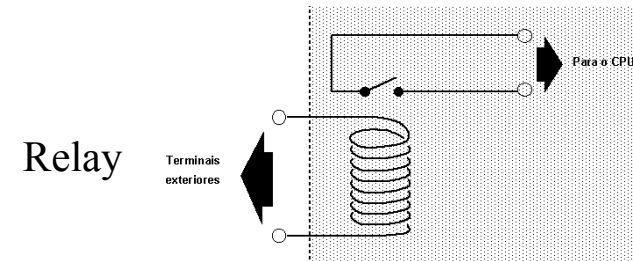
Circuito electrónico (simplificado)

# Input and output interfaces

## DC input module (discrete)

Attention to:

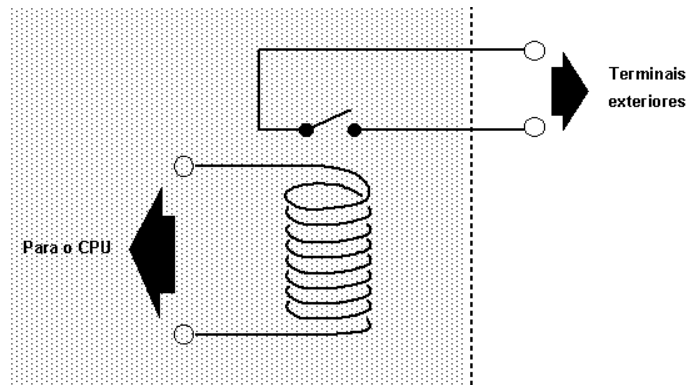
- Galvanic isolation
- Economy
- Consumption
- Switching speed
- Noise immunity



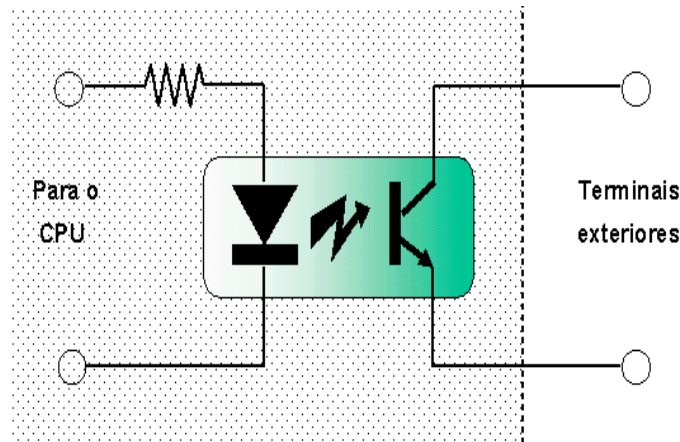
# Input and output interfaces

## DC output module (discrete)

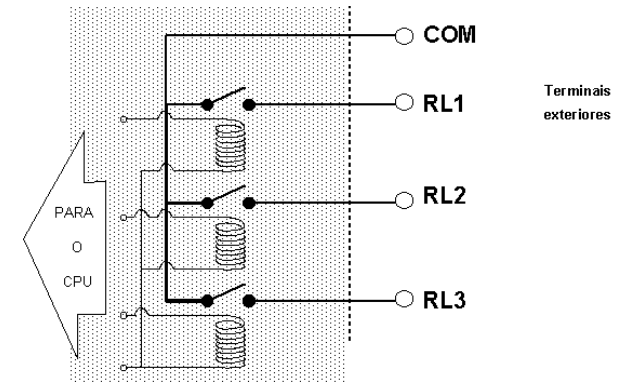
Relay



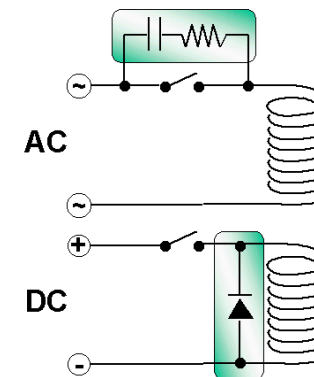
Transistor



### Connections to terminals ...



### ... and protections.

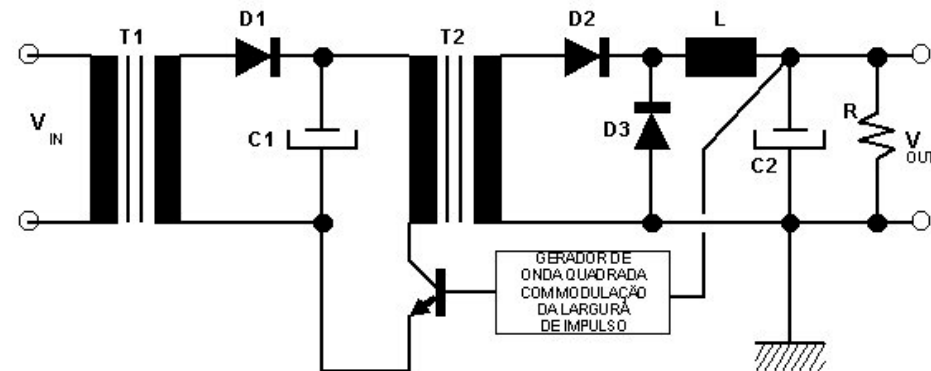


## Components of Programmable Logic Controllers

### Power sources

Attention to:

- Isolation to the noise
- Isolation relative to disturbances on the network
- Efficiency
- Consumption
- Size (volume and weight)
- Robustness relative to load variations



Switching power sources