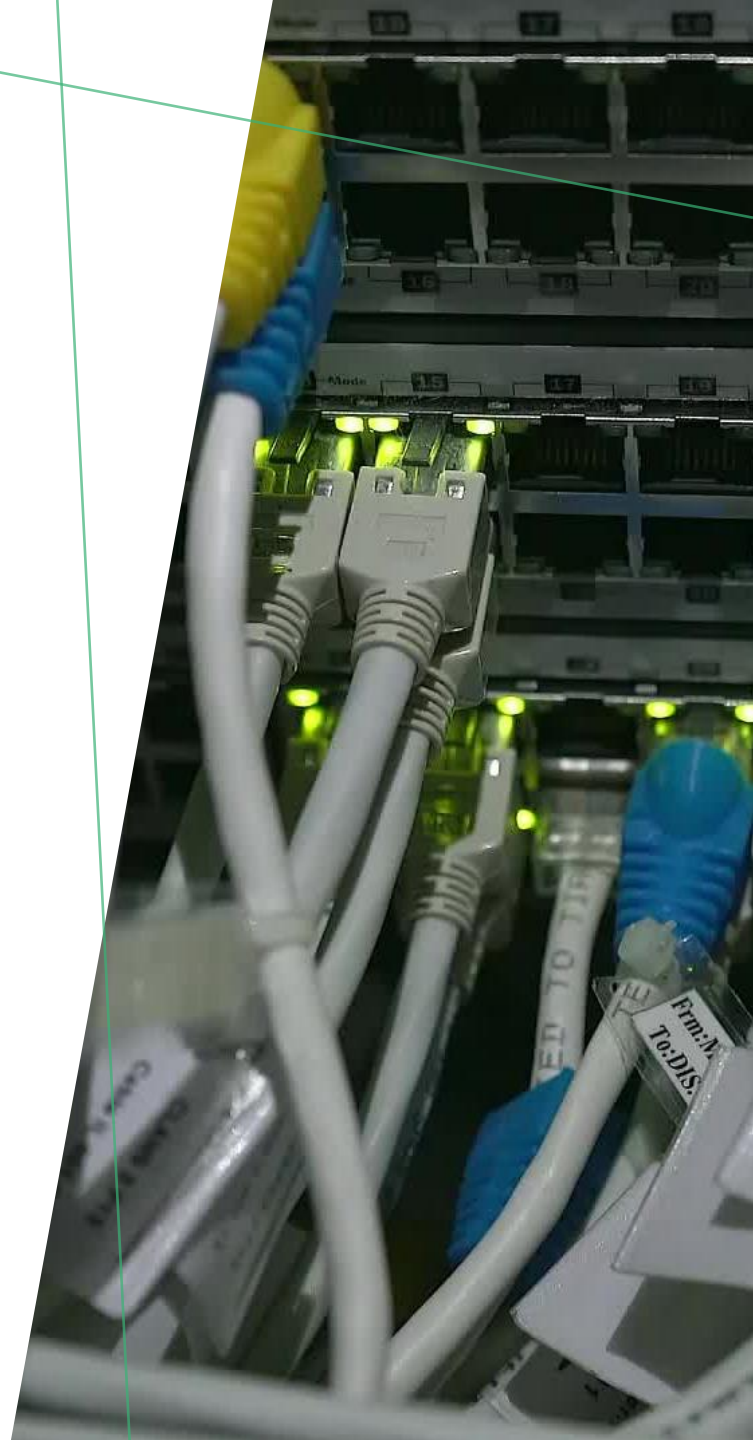
PHD ILIR SHINKO

# *PLC*



# CONTENTS

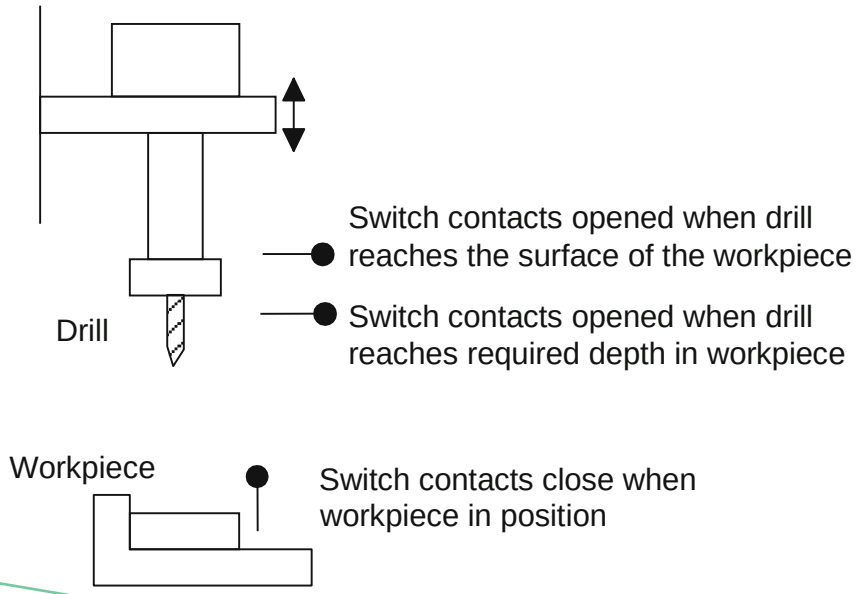
- Identify and explain the main design characteristics, internal architecture, and operating principles of programmable logic controllers.
- Describe and identify the characteristics of commonly used input and output devices.
- Explain the processing of inputs and outputs by PLCs.
- Describe communication links involved with PLC systems, the protocols, and networking methods.
- Develop ladder programs for the logic functions AND, OR, NOR, NAND, NOT, and XOR.
- Develop ladder programs involving internal relays, timers, counters, shift registers, sequencers, and data handling.
- Develop functional block diagram, instruction list, structured text, and sequential function chart programs.
- Identify safety issues with PLC systems.
- Identify methods used for fault diagnosis, testing, and debugging.

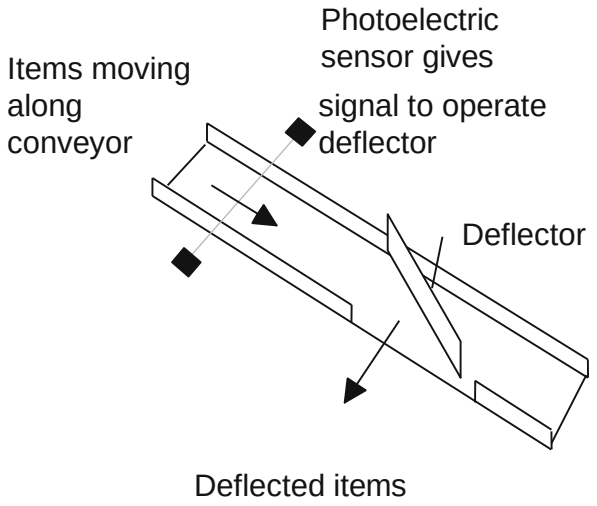
# *CONTROLLERS*

What type of task might a control system handle? It might be required to control a sequence of events, maintain some variable constant, or follow some prescribed change.

For example, the control system for an automatic drilling machine.

Another control system might be used to control the number of items moving along a conveyor belt and direct them into a packing case.



*MICROPROCESSOR-CONTROLLED SYSTEMS*

- Instead of hardwiring each control circuit for each control situation, we can use the same basic system for all situations if we use a microprocessor-based system and write a program to instruct the microprocessor how to react to each input signal from, say, switches and give the required outputs to, say, motors and valves. Thus we might have a program of the form:
  - If switch A closes
  - Output to motor circuit
  - If switch B closes
  - Output to valve circuit

- By changing the instructions in the program, we can use the same microprocessor system to control a wide variety of situations.

- As an illustration, the modern domestic washing machine uses a microprocessor system.

## *THE PROGRAMMABLE LOGIC CONTROLLER*

- A programmable logic controller (PLC) is a special form of microprocessor-based controller that uses programmable memory to store instructions and to implement functions such as logic, sequencing, timing, counting, and arithmetic in order to control machines and processes.
- It is designed to be operated by engineers with perhaps a limited knowledge of computers and computing languages.
- They are not designed so that only computer programmers can set up or change the programs. Thus, the designers of the PLC have preprogrammed it so that the control program can be entered using a simple, rather intuitive form of language.
- The term logic is used because programming is primarily concerned with implementing logic and switching operations; for example, if A or B occurs, switch on C; if A and B occurs, switch on D.
- Input devices (that is, sensors such as switches) and output devices (motors, valves, etc.) in the system being controlled are connected to the PLC.
- The operator then enters a sequence of instructions, a program, into the memory of the PLC.
- The controller then monitors the inputs and outputs according to this program and carries out the control rules for which it has been programmed.

## *THE PROGRAMMABLE LOGIC CONTROLLER*

- PLCs have the great advantage that the same basic controller can be used with a wide range of control systems:

- To modify a control system and the rules that are to be used, all that is necessary is for an operator to key in a different set of instructions. There is no need to rewire. The result is a flexible, cost-effective system that can be used with control systems, which vary quite widely in their nature and complexity.

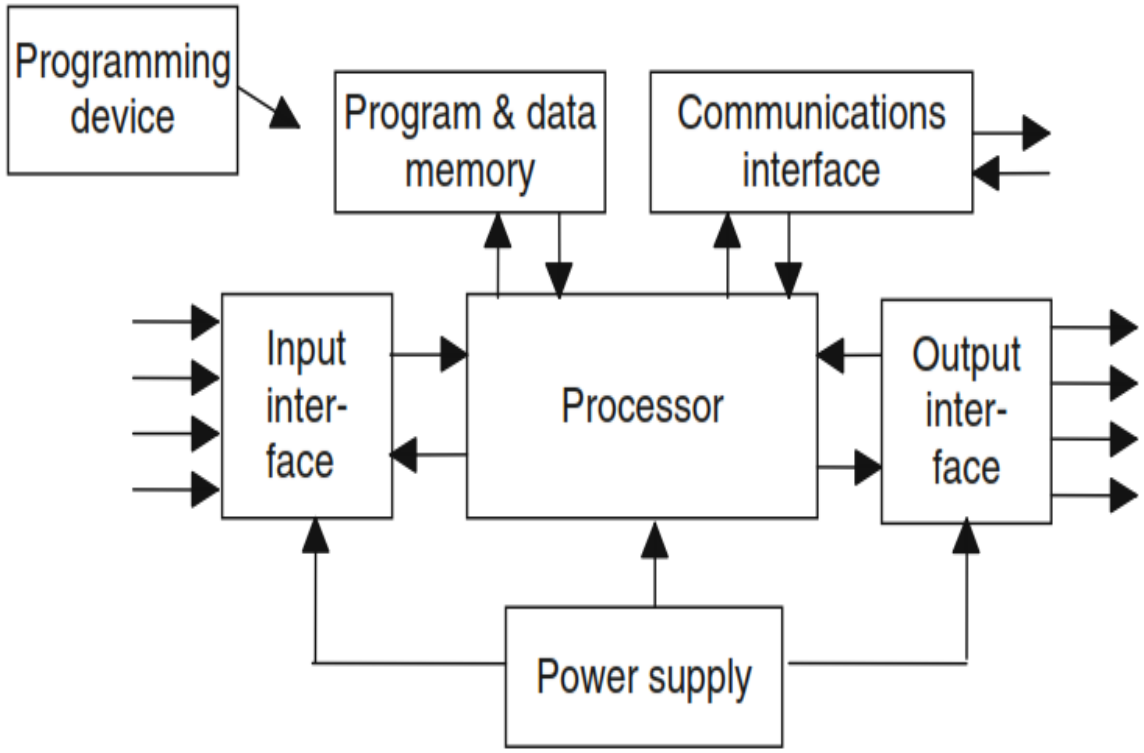
- PLCs are similar to computers, but whereas computers are optimized for calculation and display tasks, PLCs are optimized for control tasks and the industrial environment. Thus PLCs:

- Are rugged and designed to withstand vibrations, temperature, humidity, and noise.
- Have interfacing for inputs and outputs already inside the controller.
- Are easily programmed and have an easily understood programming language that is primarily concerned with logic and switching operations.

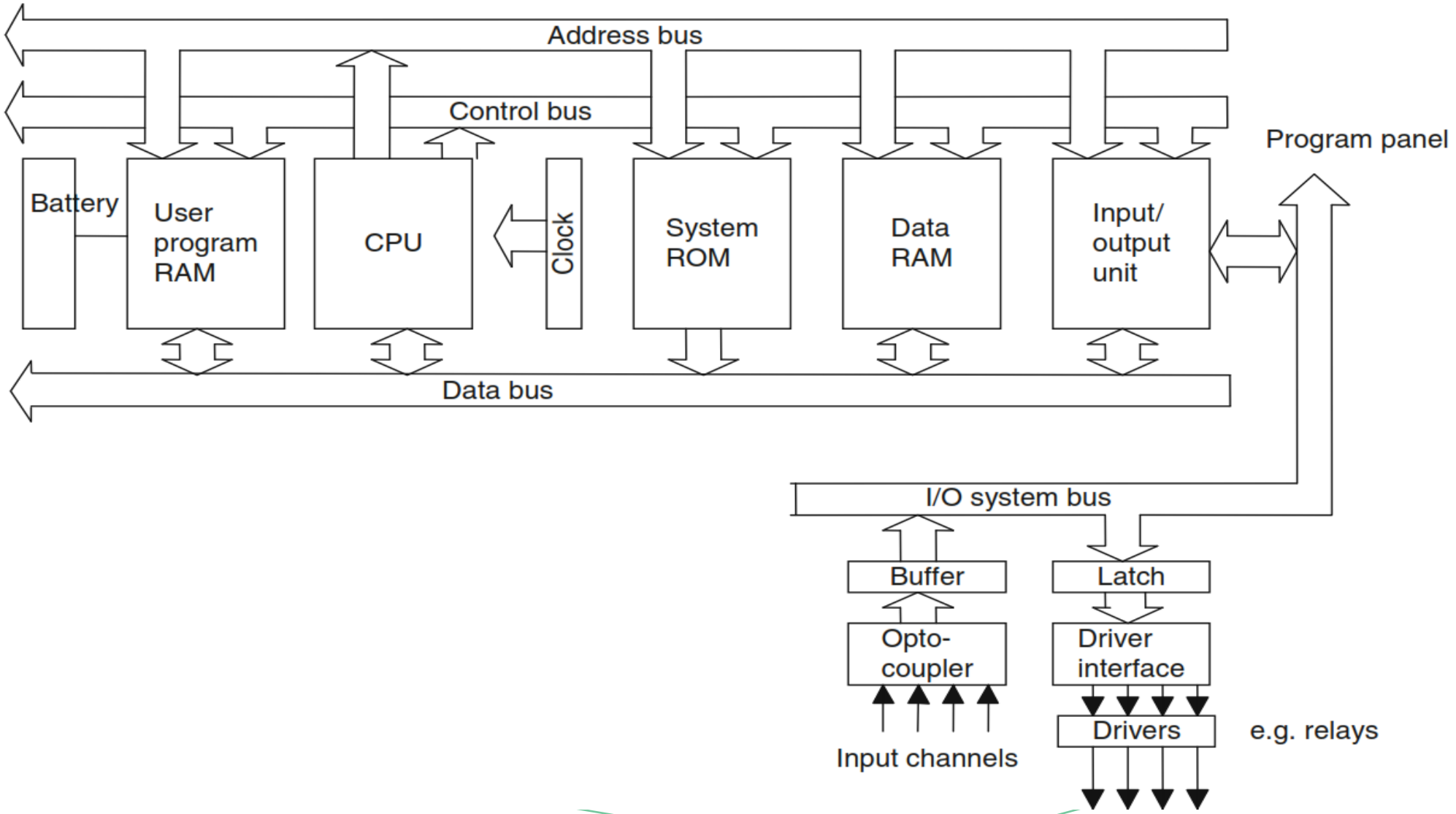
- The first PLC was developed in 1969. PLCs are now widely used and extend from small, self-contained units for use with perhaps 20 digital inputs/outputs to modular systems that can be used for large numbers of inputs/outputs, handle digital or analog inputs/outputs, and carry out proportional-integral-derivative control modes.

# PLC HARDWARE

- The processor unit or central processing unit (CPU) is the unit containing the microprocessor.
- The power supply unit is needed to convert the mains AC voltage to the low DC voltage (5 V).
- The programming device is used to enter the required program into the memory of the processor.
- The memory unit is where the program containing the control actions to be exercised by the microprocessor is stored and where the data is stored from the input for processing and for the output.
- The input and output sections are where the processor receives information from external devices and communicates information to external devices.
- The communications interface is used to receive and transmit data on communication networks from or to other remote PLCs



# INTERNAL ARCHITECTURE



# INTERNAL ARCHITECTURE

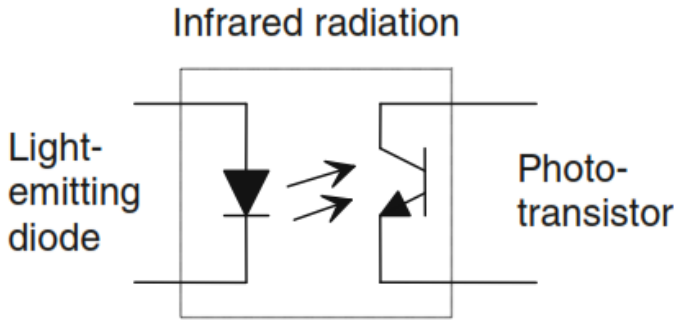
- The internal structure of the CPU depends on the microprocessor concerned. In general, CPUs have the following:
  - An arithmetic and logic unit (ALU) that is responsible for data manipulation and carrying out arithmetic operations of addition and subtraction and logic operations of AND, OR, NOT, and EXCLUSIVE-OR.
  - Memory, termed registers, located within the microprocessor and used to store information involved in program execution.
  - A control unit that is used to control the timing of operations.
- The buses are the paths used for communication within the PLC.
  - The data bus carries the data used in the processing done by the CPU.
  - The address bus is used to carry the addresses of memory locations. So that each word can be located in memory, every memory location is given a unique address.
  - The control bus carries the signals used by the CPU for control, such as to inform memory devices whether they are to receive data from an input or output data and to carry timing signals used to synchronize actions.
  - The system bus is used for communications between the input/output ports and the input/output unit.

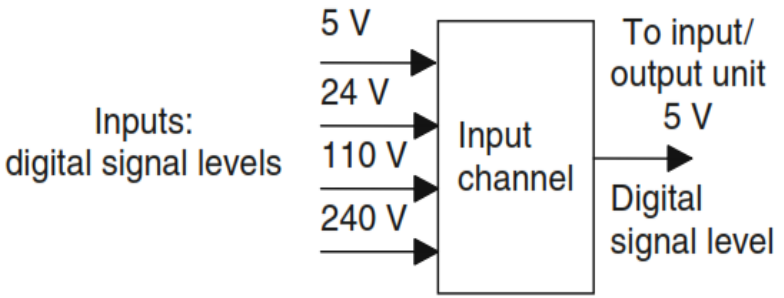
# INTERNAL ARCHITECTURE

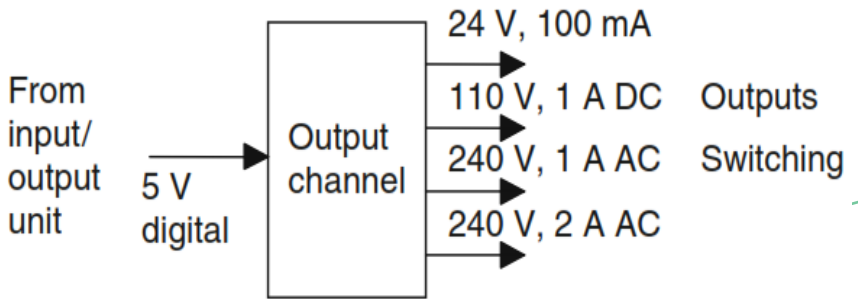
- To operate the PLC system there is a need for it to access the data to be processed and instructions, that is, the program, which informs it how the data is to be processed. Both are stored in the PLC memory for access during processing. There are several memory elements in a PLC system:
- System read-only-memory (ROM) gives permanent storage for the operating system and fixed data used by the CPU.
- Random-access memory (RAM) is used for the user's program.
- Random-access memory (RAM) is used for data. This is where information is stored on the status of input and output devices and the values of timers and counters and other internal devices. The data RAM is sometimes referred to as a data table or register table.
- Possibly, as a bolt-on extra module, erasable and programmable read-only-memory (EPROM) is used to store programs permanently.

# INTERNAL ARCHITECTURE

- The input/output unit provides the interface between the system and the outside world, allowing for connections to be made through input/output channels to input devices such as sensors and output devices such as motors and solenoids.
- It is also through the input/output unit that programs are entered from a program panel. Every input/output point has a unique address that can be used by the CPU.
- It is like a row of houses along a road; number 10 might be the “house” used for an input from a particular sensor, whereas number 45 might be the “house” used for the output to a particular motor.
- The input/output channels provide isolation and signal conditioning functions so that sensors and actuators can often be directly connected to them without the need for other circuitry.....



# INTERNAL ARCHITECTURE

- .....
- Outputs are specified as being of relay type, transistor type, or triac type (see Chapter 3 for more details):
- With the relay type, the signal from the PLC output is used to operate a relay and is able to switch currents of the order of a few amperes in an external circuit. The relay not only allows small currents to switch much larger currents but also isolates the PLC from the external circuit. Relays are, however, relatively slow to operate. Relay outputs are suitable for AC and DC switching. They can withstand high surge currents and voltage transients.
- The transistor type of output uses a transistor to switch current through the external circuit. This gives a considerably faster switching action. It is, however, strictly for DC switching and is destroyed by overcurrent and high reverse voltage. For protection, either a fuse or built-in electronic protection is used. Optoisolators are used to provide isolation.
- Triac outputs, with optoisolators for isolation, can be used to control external loads that are connected to the AC power supply. It is strictly for AC operation and is very easily destroyed by overcurrent. Fuses are virtually always included to protect such outputs.

# *PLC SYSTEMS*

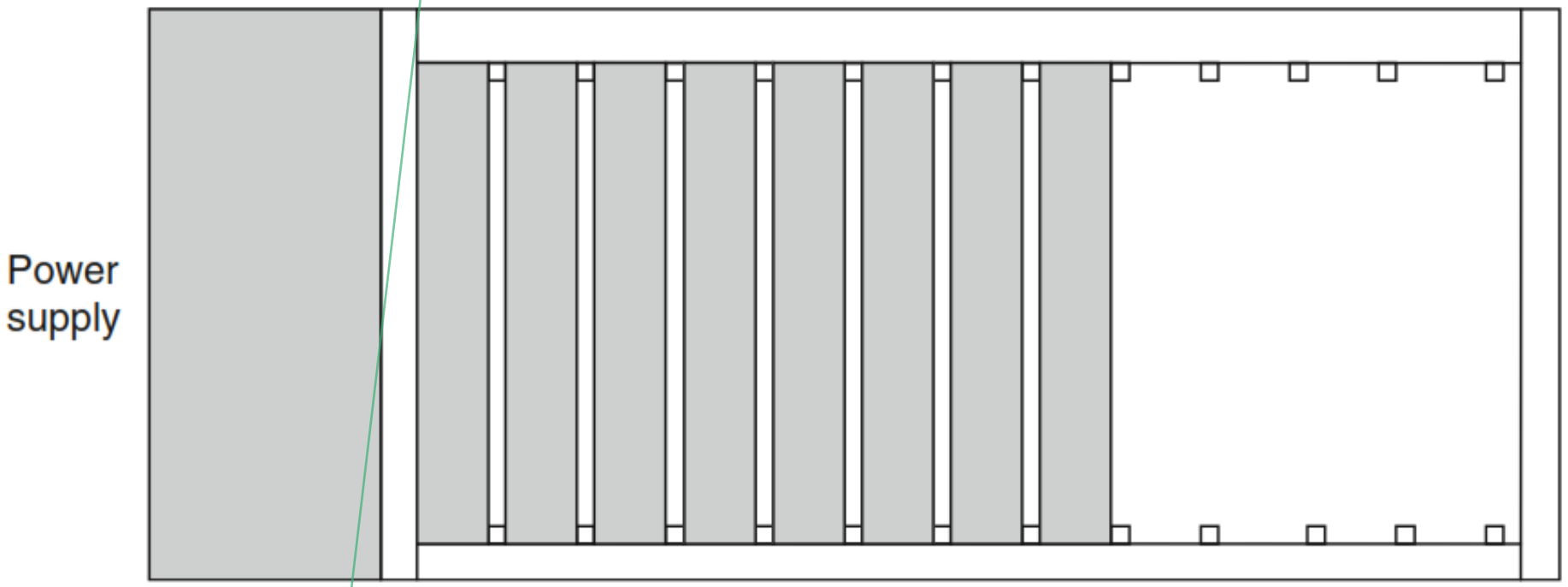
- There are two common types of mechanical design for PLC systems—a single box and the modular/rack types.
- The single-box type (or, as it’s sometimes called, a brick) is commonly used for small programmable controllers and is supplied as an integral compact package complete with power supply, processor, memory, and input/output units. Typically such a PLC might have 6, 8, 12, or 24 inputs and 4, 8, or 16 outputs and a memory that can store some 300 to 1000 instructions.

# *PLC SYSTEMS*

- Systems with larger numbers of inputs and outputs are likely to be modular and designed to fit in racks. The modular type consists of separate modules for power supply, processor, and the like, which are often mounted on rails within a metal cabinet.
- The rack type can be used for all sizes of programmable controllers and has the various functional units packaged in individual modules that can be plugged into sockets in a base rack.
- The mix of modules required for a particular purpose is decided by the user and the appropriate ones then plugged into the rack.
- Thus it is comparatively easy to expand the number of I/O connections by simply adding more input/output modules or to expand the memory by adding more memory units.
- The power and data interfaces for modules in a rack are provided by copper conductors in the backplane of the rack.
- When modules are slid into a rack, they engage with connectors in the backplane.

# *PLC SYSTEMS*

A possible assembled system



# *PLC SYSTEMS-IEC STANDARD*

The full IEC 61131 standard covers the complete life cycle of PLCs:

Part 1: General definition of basic terminology and concepts.

Part 2: Electronic and mechanical equipment requirements and verification tests for PLCs and associated equipment.

Part 3: Programming languages. Five languages are defined: ladder diagram (LAD), sequential function charts (SFC), function block diagram (FBD), structured text (ST), and instruction list (IL).

Part 4: Guidance on selection, installation, and maintenance of PLCs.

Part 5: Software facilities needed for communication with other devices based on the

Manufacturing Messaging Specification (MMS).

Part 6: Communications via field bus software facilities.

Part 7: Fuzzy control programming.

Part 8: Guidelines for the implementation of PLC programming languages defined in Part 3.

# *PLC SYSTEMS-PROGRAMMING PLCS*

- A programming device can be a handheld device, a desktop console, or a computer. *Only when the program has been designed on the programming device and is ready is it transferred to the memory unit of the PLC.*
- A handheld programming device normally contains enough memory to allow the unit to retain programs while being carried from one place to another.
- Desktop consoles are likely to have a visual display unit with a full keyboard and screen display.
- Personal computers are widely configured as program development workstations.
- Some PLCs only require the computer to have appropriate software; others require special communication cards to interface with the PLC.
- PLC manufacturers have programming software for their PLCs.

ognuno uno diverso, useremo quello di mistsubishi

  - For example, Mitsubishi has MELSOFT; Siemens has SIMATIC STEP 7.
  - Rockwell Automation manufactures RSLogix for the Allen-Bradley PLC, OMRON has CX-One, and Telemecanique has ProWorx 32

*FALEMINDERIT*

*THANK YOU*