



Process Control and Building Management Systems

EME501

Lec9 PLC Basics

INSTRUCTOR

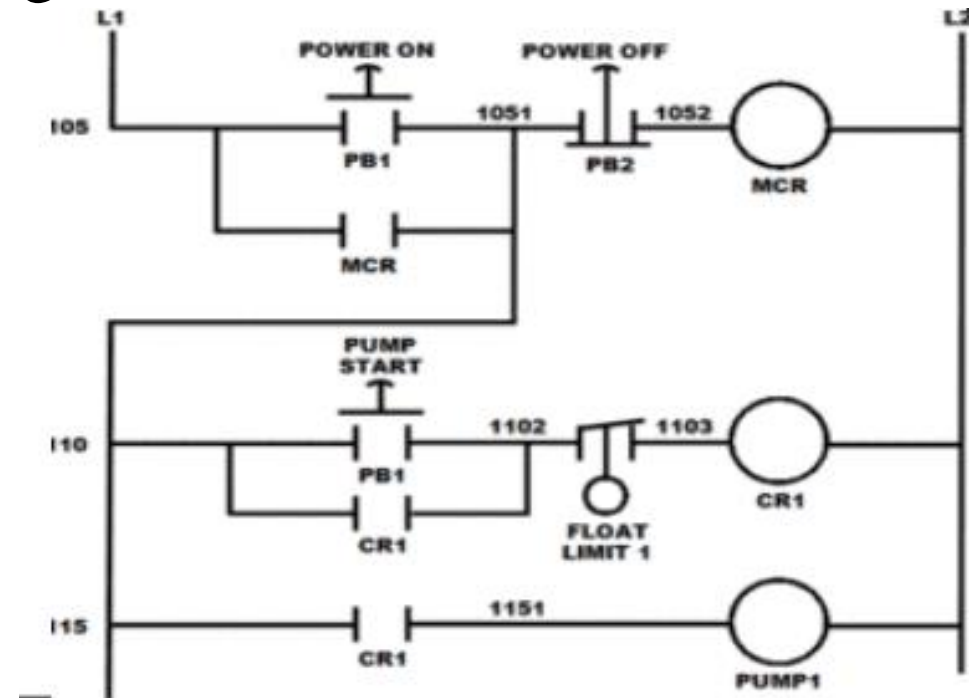
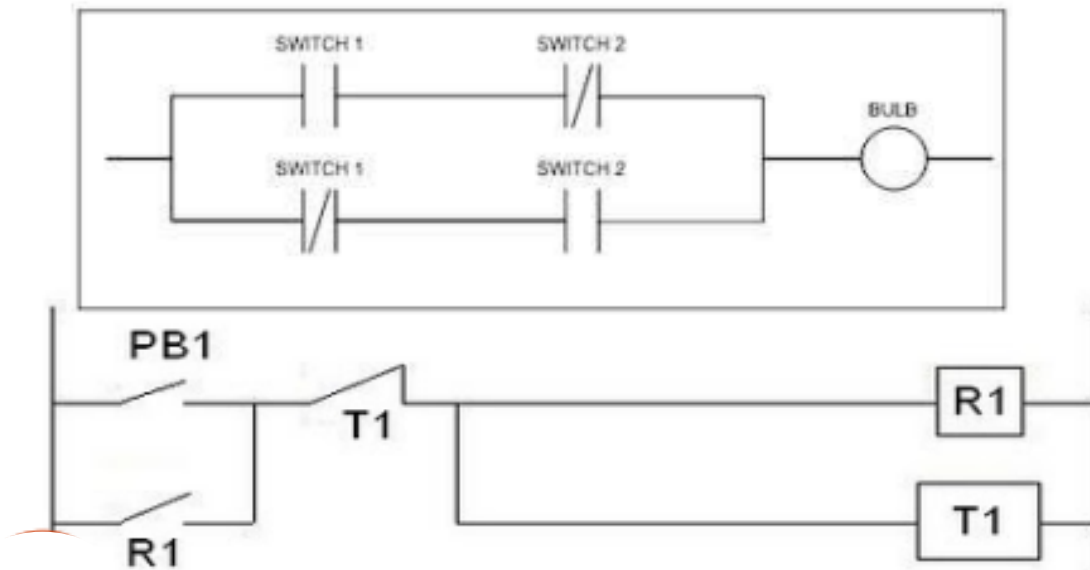
DR / AYMAN SOLIMAN

➤ **What is PLC?**

- ❑ A programmable controller, formally called the programmable logic controller (PLC) can be defined as a solid-state device member of the computer family.
- ❑ It can store instruction to implement control functions such as sequencing, timing, counting, arithmetic, data manipulation and communication to control industrial machines and processes.

➤ Prior to PLCs

- ❑ Contactors and relays hard-wired together
- ❑ Circuit first had to be designed and drawn up
- ❑ Components were specified and installed
- ❑ Electrician would then wire it all together



➤ With PLCs

- ❑ PLC can perform the same task as hard-wired devices
- ❑ Connections between field devices & relay contacts take place in PLC
- ❑ Installation is less extensive, Also more complex function.

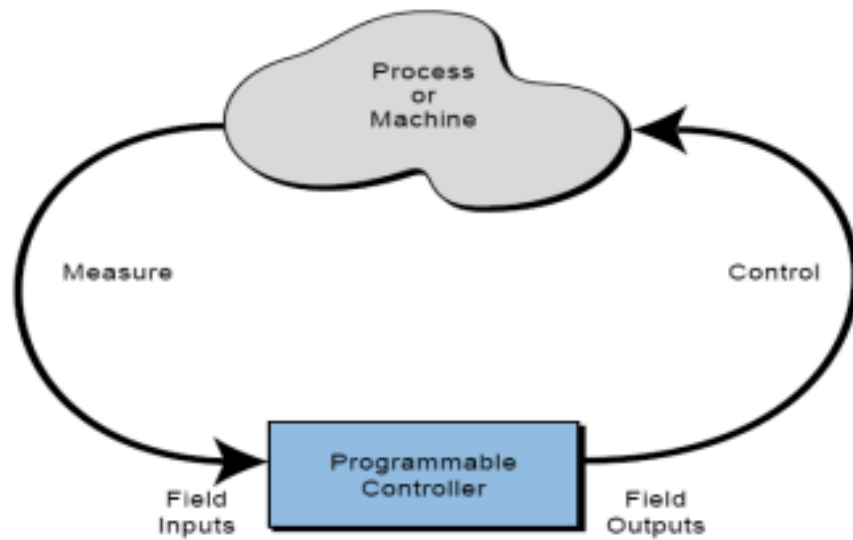
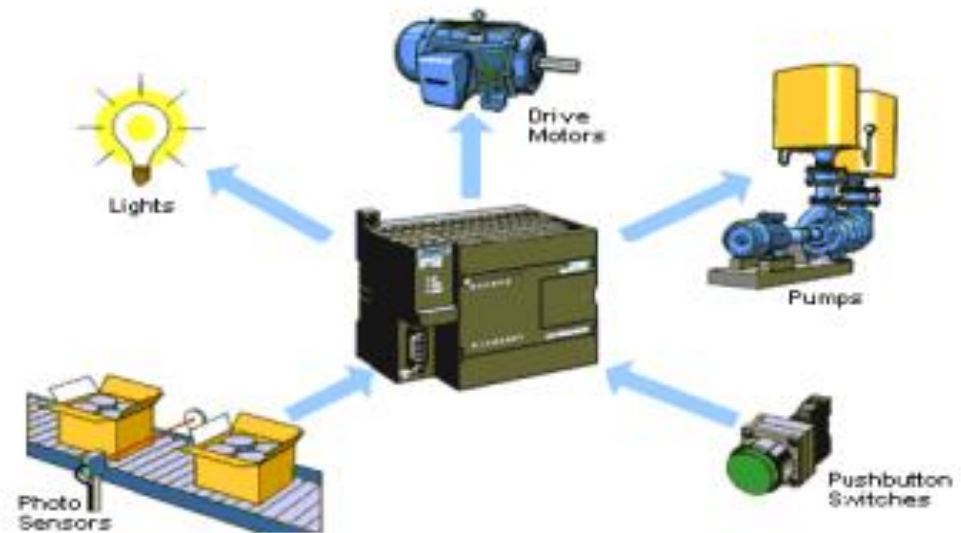
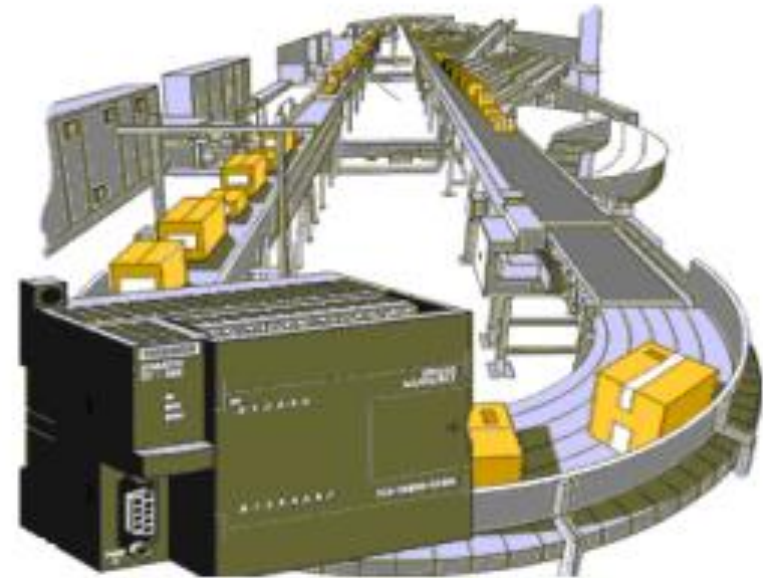


Figure 1-1. PLC conceptual application diagram.



➤ **Advantages of PLCs**

- Faster and less costly duplication of application
- Easier and faster system changes
- Integrated diagnostic and override functions
- Centrally available diagnostic
- Immediate documentation
- Smaller size



➤ **Advantages of PLCs**

- ❑ Less wiring.
- ❑ Wiring between devices and relay contacts are done in the PLC program.
- ❑ Easier and faster to make changes.
- ❑ Trouble shooting aids make programming easier and reduce downtime.
- ❑ Reliable components make these likely to operate for years before failure.

➤ Shapes of PLCs



➤ How PLC works

- ❑ Input from field devices
 - ✓ Discrete, analog input
- ❑ Execution of the program
 - ✓ timers, counters, data manipulation
- ❑ Output to the field devices
 - ✓ Discrete, analog output
- ❑ PLC Scan



➤ PLC “Programmable Logic Controller

❑ Origin

- ✓ Developed to **replace relays** in the late 1960s
- ✓ Costs dropped and became popular by 1980s
- ✓ Now used in many industrial designs

❑ The Hydramatic Division of the General Motors Corporation specified the design criteria for the first programmable controller in 1968

❑ Their primary goal: **To eliminate the high costs associated with inflexible, relay-controlled systems.**

➤ **Historical Background**

- ❑ The controller had to be designed in modular form, so that subassemblies could be removed easily for replacement or repair.
- ❑ The control system needed the capability to pass data collection to a central system.
- ❑ The system had to be reusable.
- ❑ The method used to program the controller had to be simple, so that it could be easily understood by plant personnel.

➤ Programmable Controller Development

- ❑ 1968 Programmable concept developed
- ❑ 1969 HW CPU controller, with logic instructions, 1KB & 128 IO pts
- ❑ 1974 Use multi-processors within a PLC - timers & counters; arithmetic operations; 12K of memory and 1024 IO pts
- ❑ 1976 Remote input/output systems introduced
- ❑ 1977 Microprocessors - based PLC introduced
- ❑ 1980 Intelligent I/O modules developed Enhanced communications facilities, SW features (e.g. documentation) Use of PC as programming aids.
- ❑ 1983 Low - cost small PLC's introduced
- ❑ 1985&on Networking of all levels of PLC, computer and machine using SCADA software.

➤ **Programmable Logic Controllers**

(Definition according to NEMA standard ICS3-1978)

- ❑ A digitally operating electronic apparatus which uses a programming memory for the internal storage of instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic to control through digital or analog modules, various types of machines or process.

➤ Leading Brands Of PLC

AMERICAN

- 1) Allen Bradley
- 2) Modicon
- 3) Texas Instruments
- 4) General Electric
- 5) Westinghouse
- 6) Cuttler Hammer

EUROPEAN

- 1) Siemens
- 2) Klockner & Moeller
- 3) Telemecanique

JAPANESE

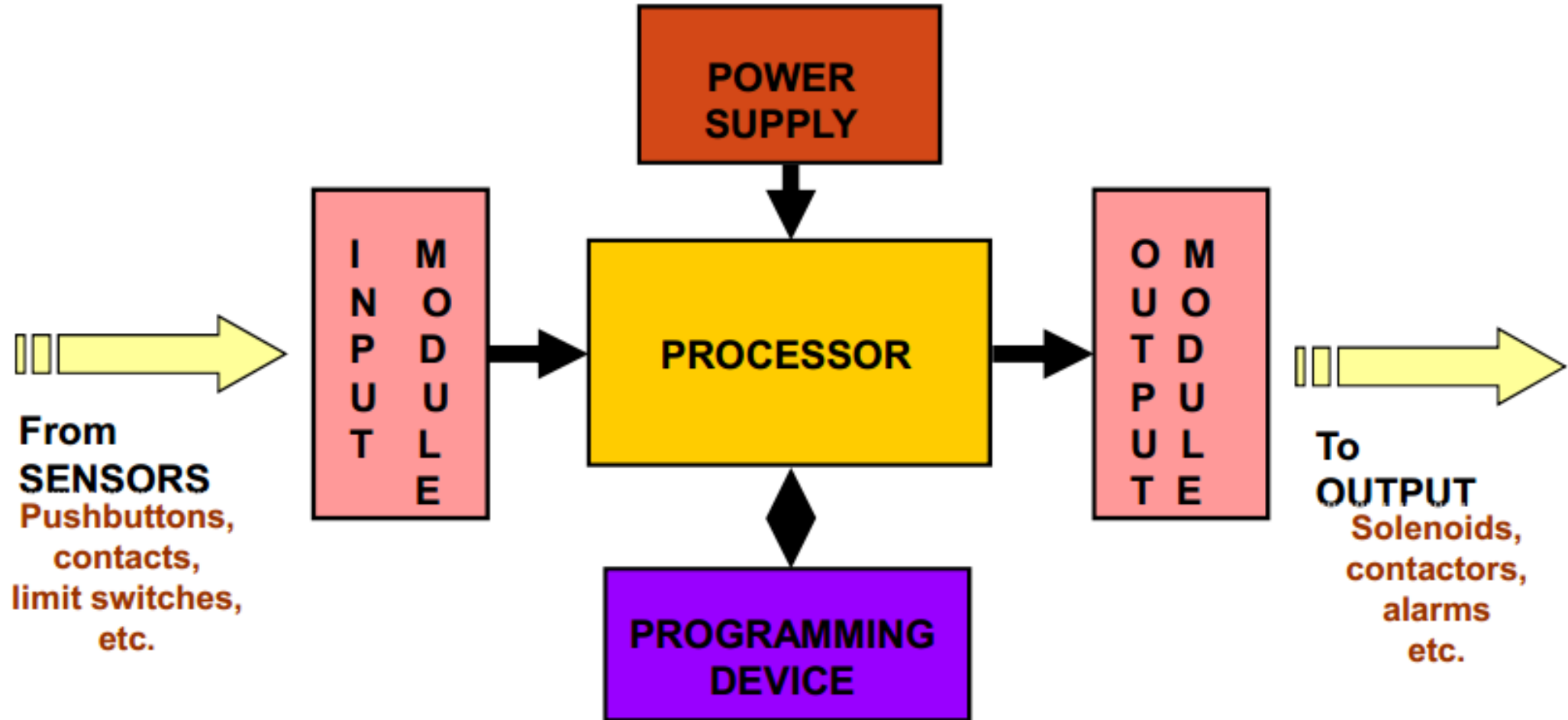
- 1) Toshiba
- 2) Omron
- 3) Fanuc
- 4) Mitsubishi
- 5) Hitachi

➤ Areas of Application

- Manufacturing / Machining
- Food / Beverage
- Metals
- Power
- Mining
- Petrochemical / Chemical



➤ Major Components of a Common PLC



➤ **Major Components of a Common PLC (cont.)**

❑ **POWER SUPPLY**

Provides the voltage needed to run the primary PLC components

❑ **I/O MODULES**

Provides signal conversion and isolation between the internal logic-level signals inside the PLC and the field's high-level signal.

➤ **Major Components of a Common PLC (cont.)**

❑ **PROCESSOR**

Provides intelligence to command and govern the activities of the entire PLC systems.

❑ **PROGRAMMING DEVICE**

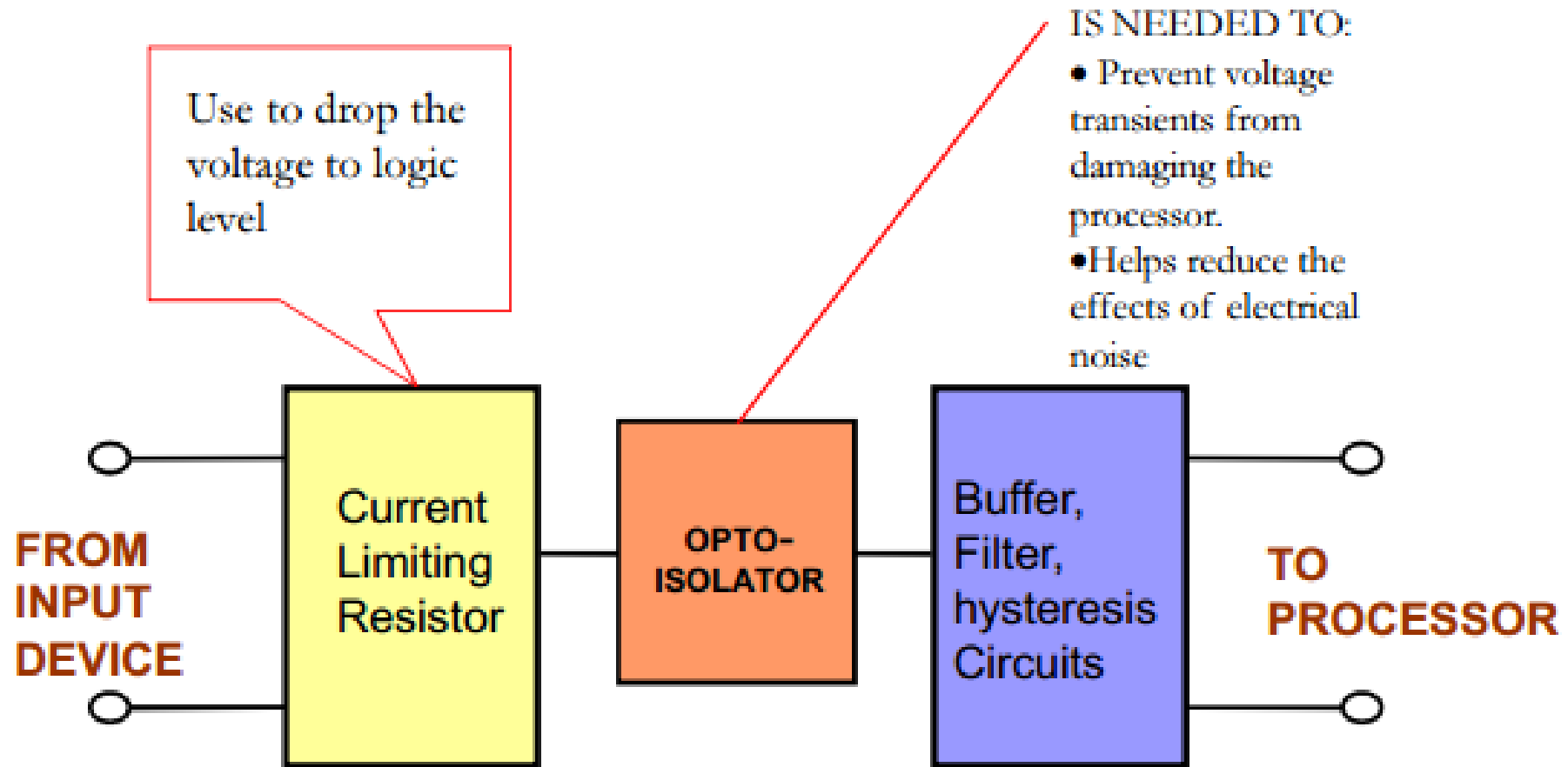
used to enter the desired program that will determine the sequence of operation and control of process equipment or driven machine.

➤ **I/O Module**

- ❑ The I/O interface section of a PLC connects it to external field devices.
- ❑ The main purpose is also adaptive the various signals received from or sent to the external input and output devices.
- ❑ Input modules converts signals from discrete or analog input devices to logic levels acceptable to PLC's processor.
- ❑ Output modules converts signal from the processor to levels capable of driving the connected discrete or analog output devices.

➤ I/O Module

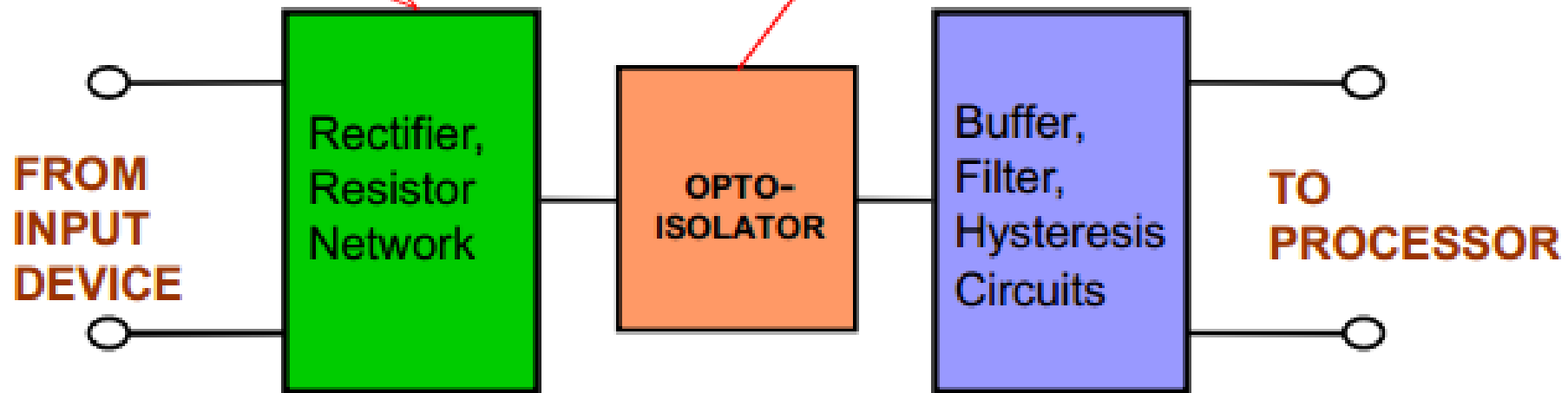
❑ DC INPUT MODULE



➤ I/O Module

❑ AC INPUT MODULE

Converts the AC input to DC and drops the voltage to logic level



IS NEEDED TO:

- Prevent voltage transients from damaging the processor.
- Helps reduce the effects of electrical noise

➤ Dual-optocoupler and DC input circuit

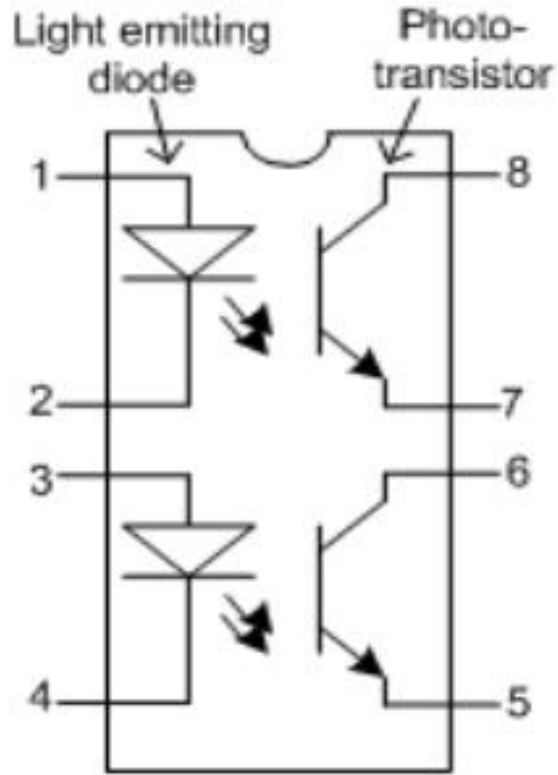


Figure 1 Dual-optocoupler IC in 8-pin DIP

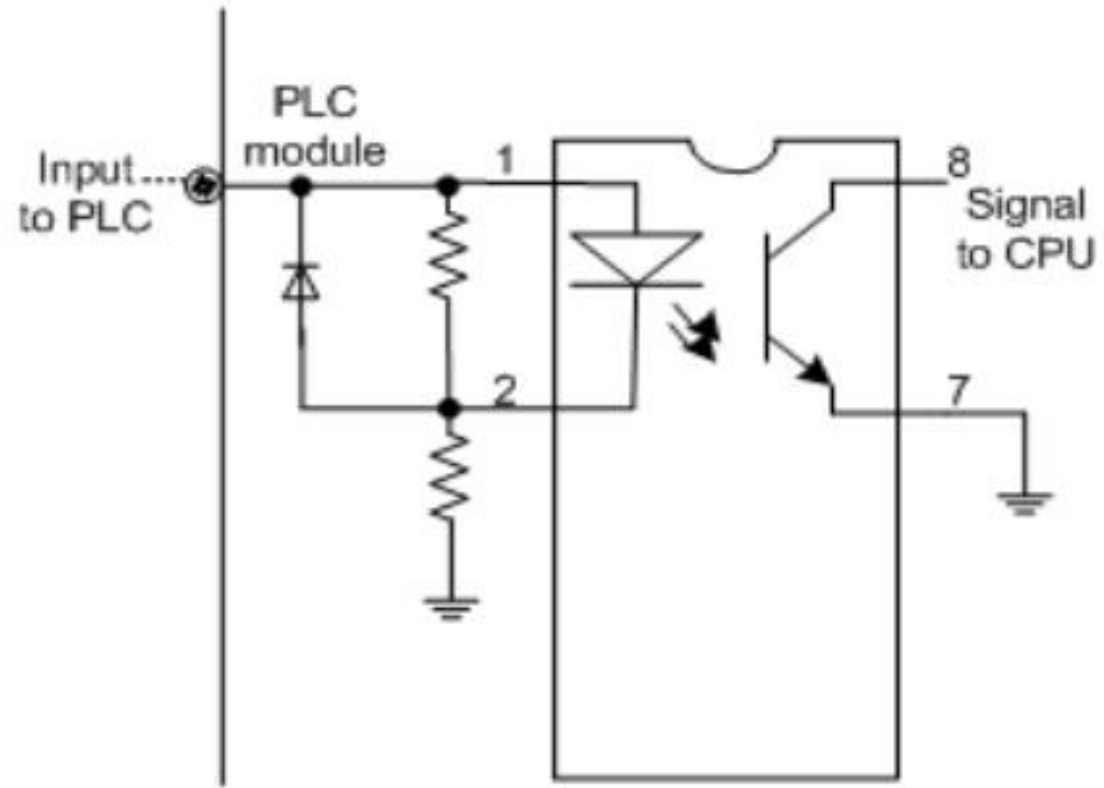
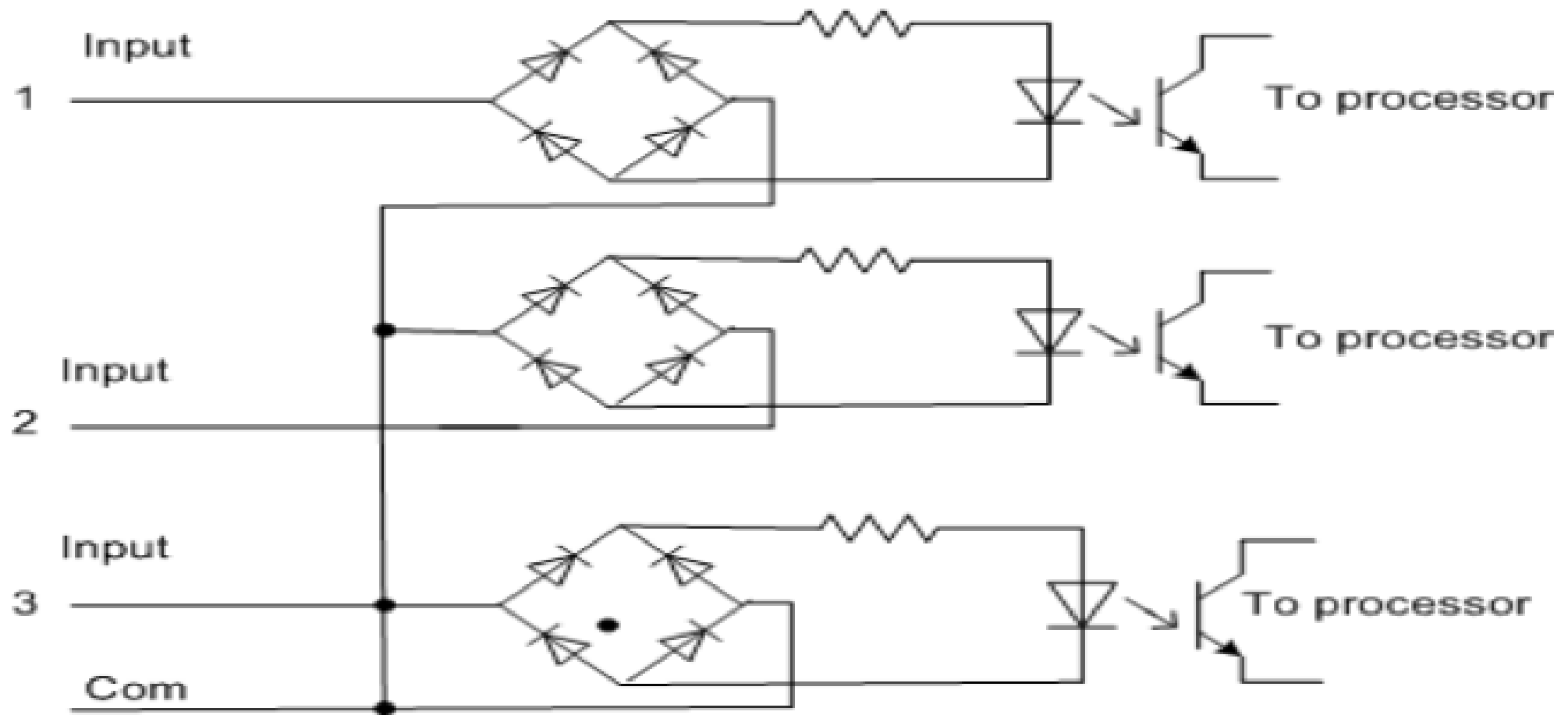


Figure 2 Basic DC input circuit

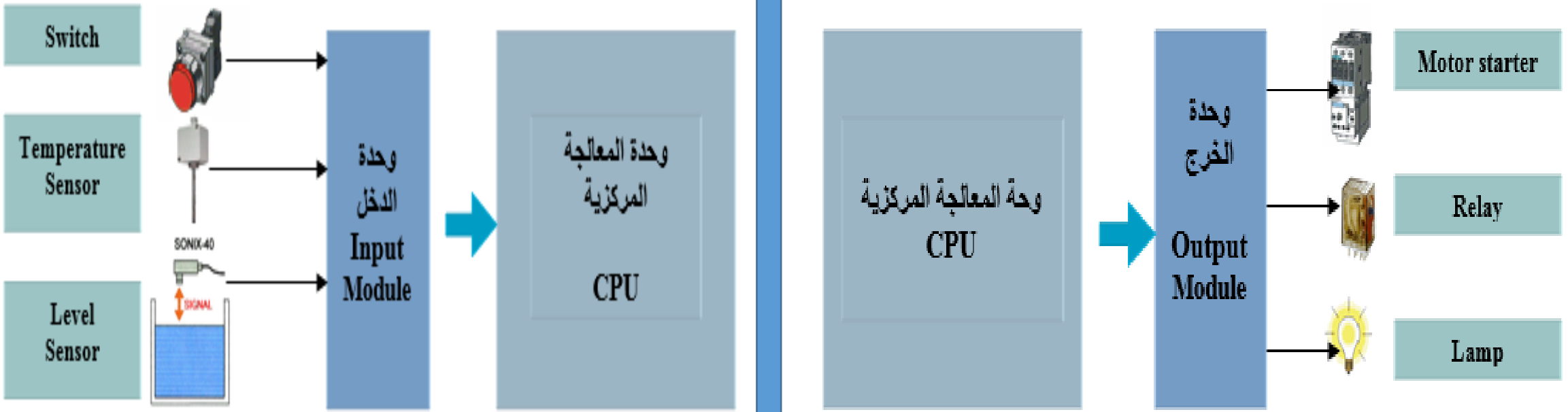
➤ 3-input circuit diagram



➤ Input Module

&

Output Module



➤ Digital Inputs المداخل الرقمية

تتعامل المداخل الرقمية مع الإشارات الصادرة من المجسات التي تكون إما في الحالة (ON) أو (OFF) مثل :

Pushbuttons Switches

■ مفاتيح ضغط الزر

Limit Switches

■ المفاتيح الحدية

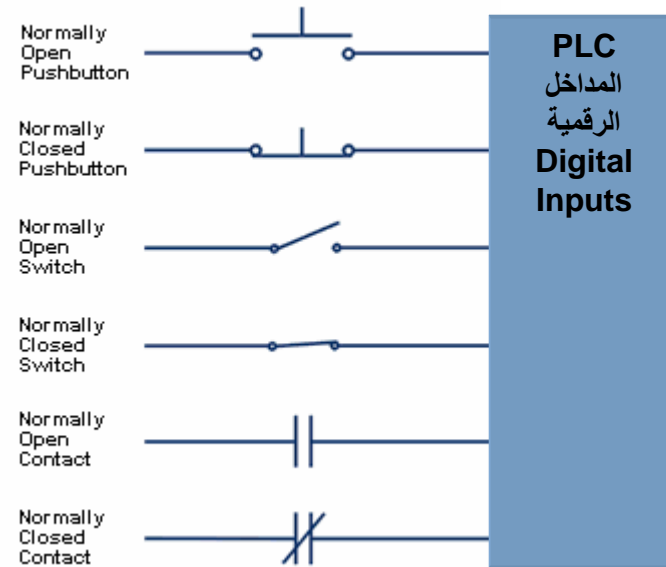
Normally Open Contacts

■ الملامسات المفتوحة

Normally Closed Contacts

■ الملامسات المغلقة

يبين الشكل التالي العناصر التي توصل بالمداخل الرقمية لوحدة الـ PLC



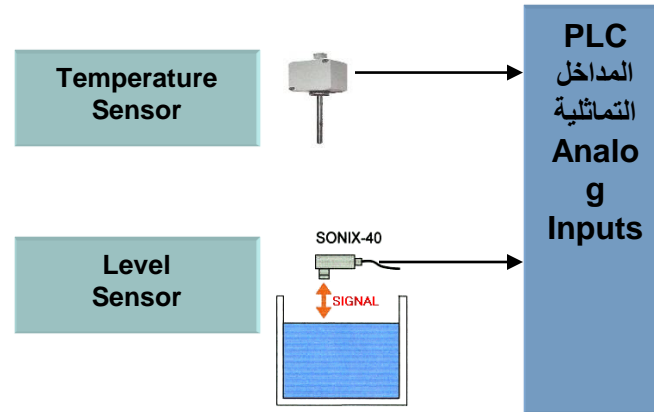
➤ Analog inputs المداخل التماثلية

تتعامل المداخل التماثلية مع المجسات التي تتحسس القيم المتغيرة مثل مجسات قياس درجة الحرارة و مستوى السوائل و السرعة و ذلك بعد تحويل الحالة الفيزيائية للقيمة المقاسة إلى إشارة كهربائية متغيرة بأحدى الصور التالية :

■ من 0 إلى 20mA أو من 4 إلى 20mA.

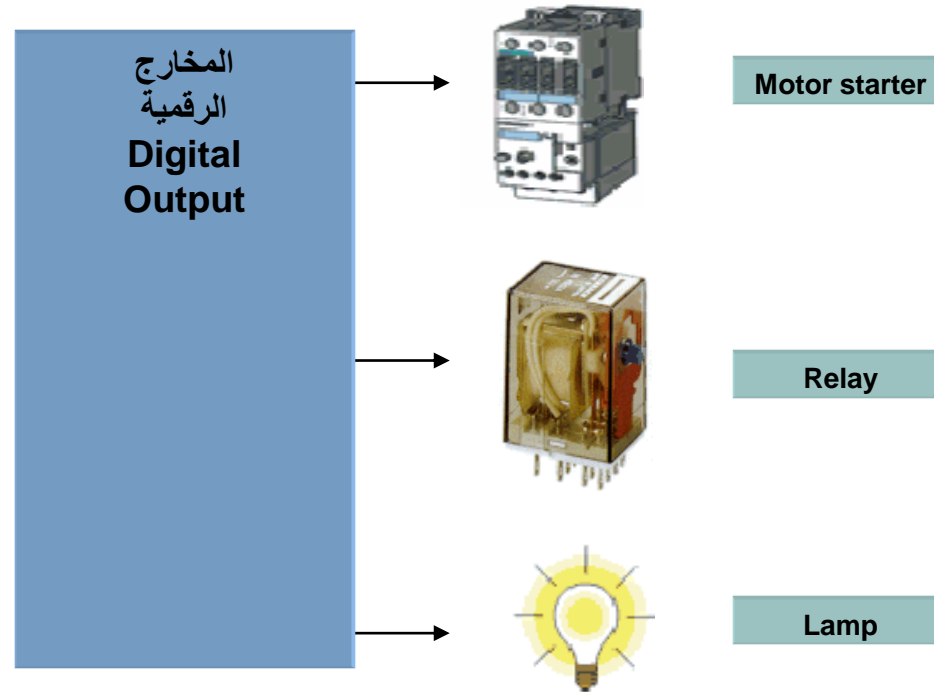
■ من 0 إلى 10V.

يبين الشكل التالي العناصر التي توصل بالمداخل التماثلية لوحدة الـ PLC



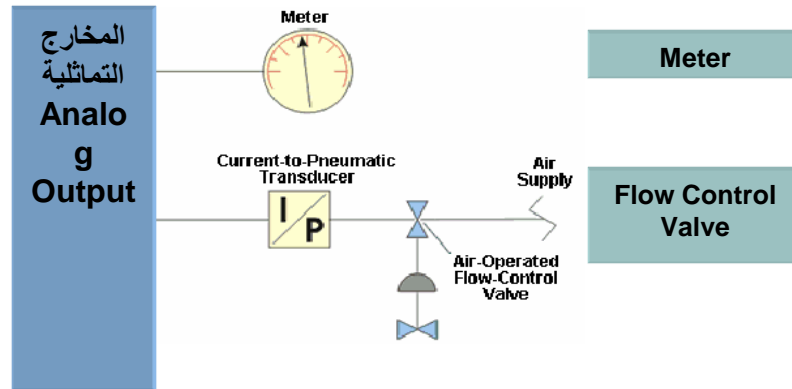
➤ Digital Outputs المخرجات الرقمية

- وهي المخرجات التي تكون حالة أشارتها إما ON أو OFF
- المصابيح و ملفات المرحلات و القواطع الكهربائية و الصمامات الوشيعية هي أمثلة من المشغلات التي توصل بالمخرجات الرقمية لوحدة الـ PLC



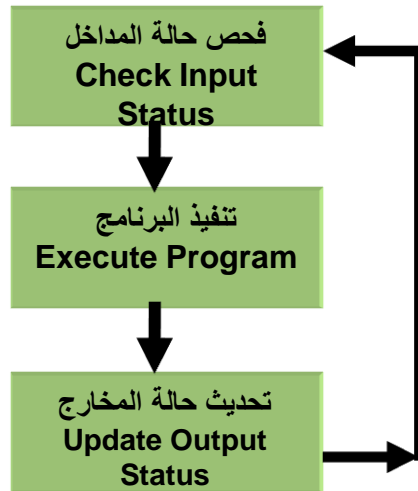
➤ Analog Outputs المخرجات التماثلية

■ يتم فيها تحويل الإشارة المنطقية المرسله من وحدة المعالجة المركزية إلى إشارة تماثلية ($0-10\text{ V}$ أو $4-20\text{mA}$ أو $0-20\text{mA}$) ومن ثم ترسل الإشارة التماثلية إلى الأجهزة التي يتم التحكم بها و التي تتعامل مع هذا النوع من الإشارات مثل مقياس السرعة، درجة الحرارة، الوزن و صمامات التحكم في التدفق الموصلة مع المخرجات التماثلية لوحدة PLC.



PLC Programming برمجة وحدة الـ

■ يتكون البرنامج من مجموعة من التعليمات لأنجاز مهام محددة
توجد طرق مختلفة للبرمجة مثل



- السلم المنطقي (Ladder Logic)
- قوائم الإجراءات (Statement Lists)
- المخططات الصندوقية الوظيفية (Function Block Diagrams)

Thank

you

