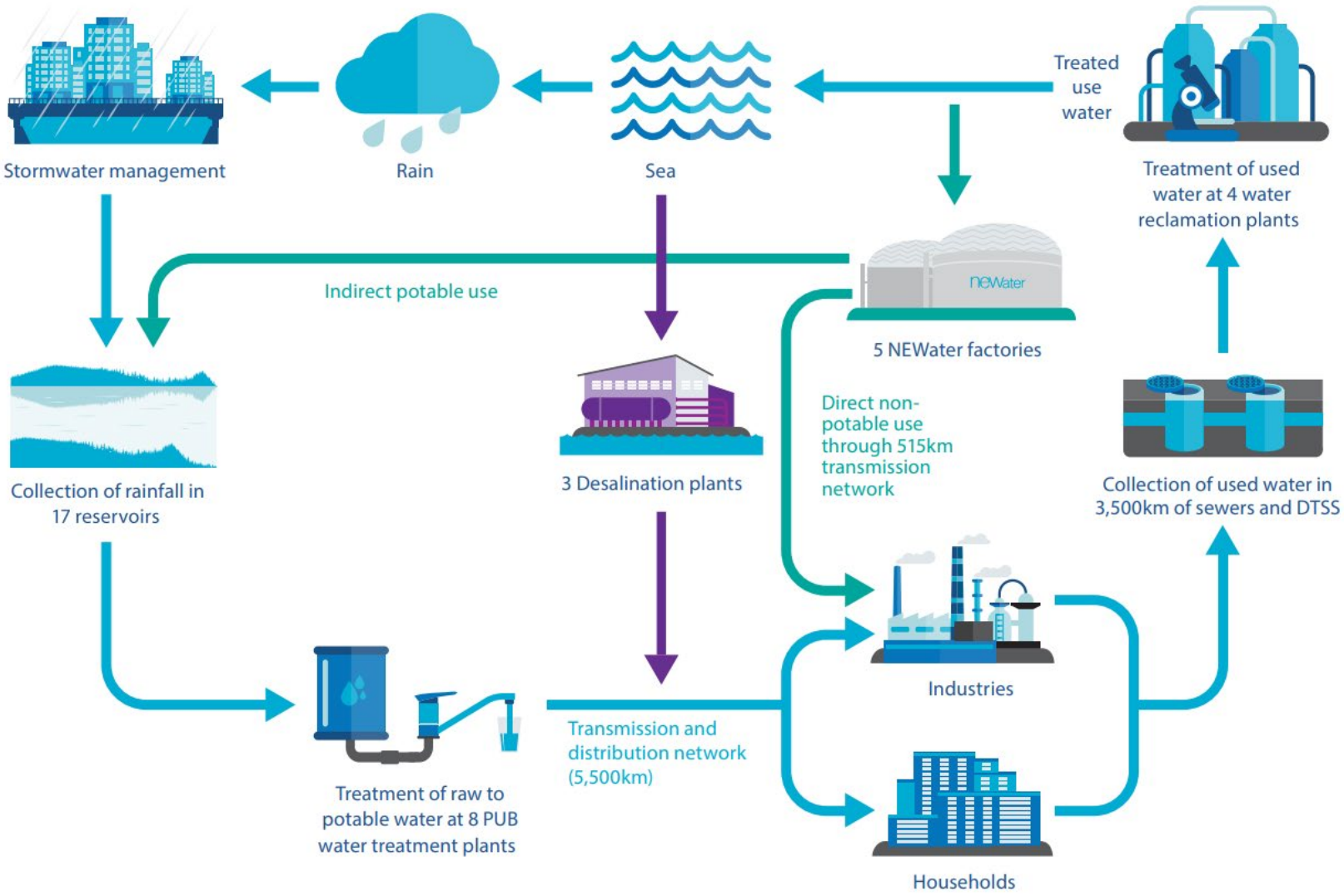
Programmable Logic Controller (PLC) Application

ET0917 PLC-A

Have you experienced automation?

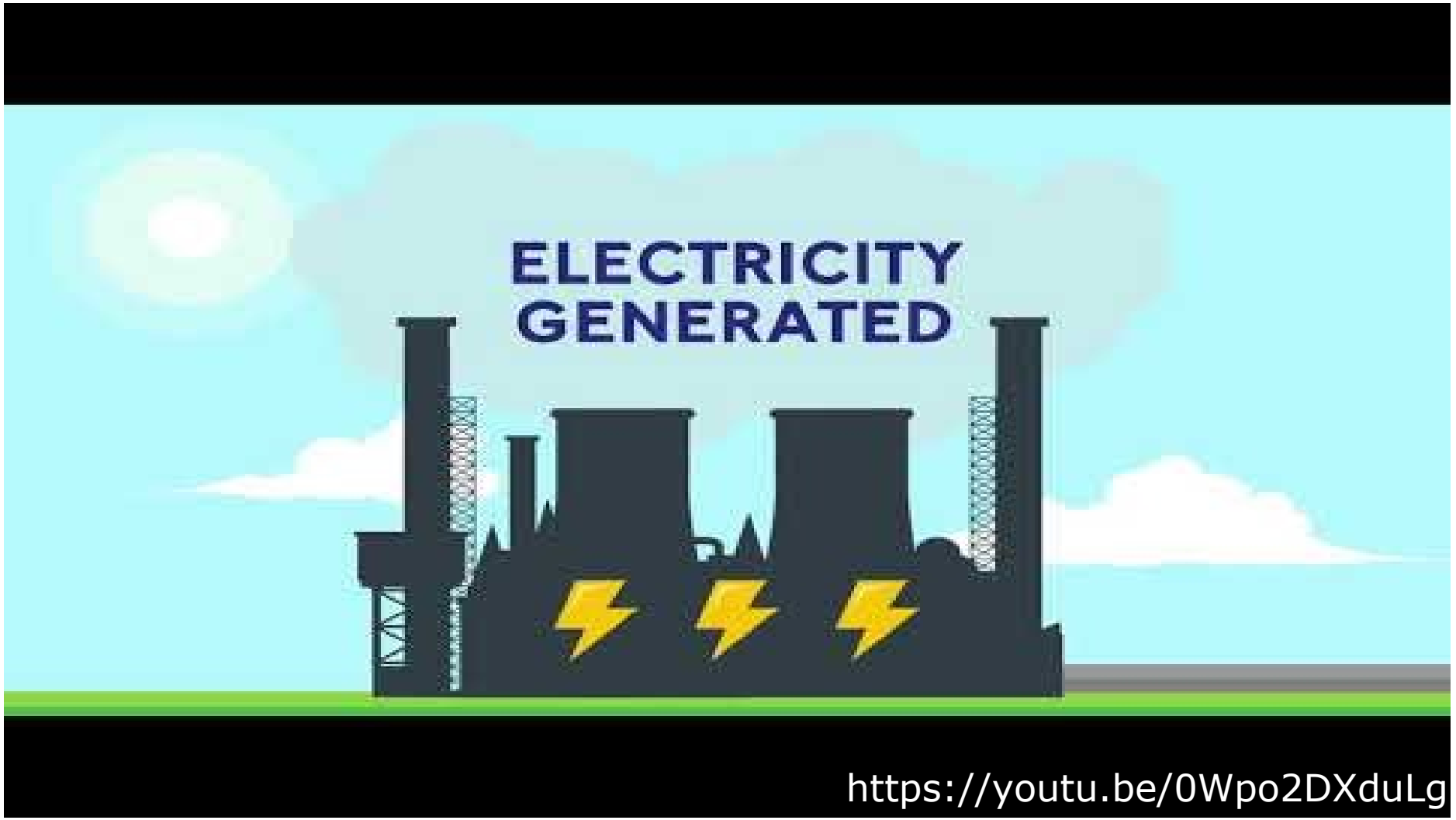
AUTOMATION = USING MACHINES AND COMPUTERS THAT OPERATES WITHOUT HUMAN INTERVENTION

HOW DO WE GET WATER TO OUR TAP?

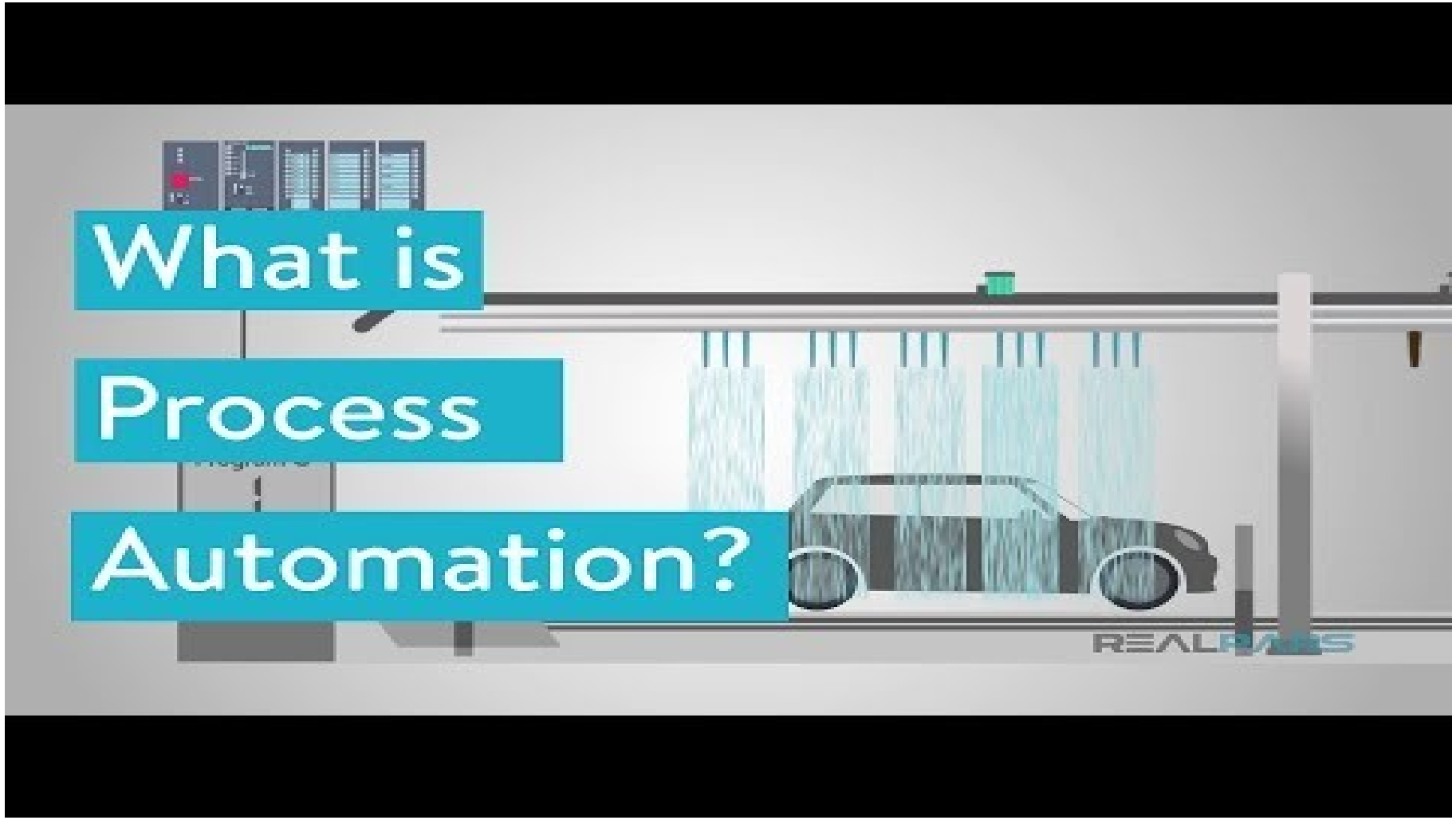


https://www.pub.gov.sg/Documents/Water-loop.pdf

HOW DO WE GET ELECTRICITY FROM THE SWITCH?



GIVE YOU AN IDEA OF AUTOMATION



https://www.youtube.com/watch?v=uEhuxYXPTOE

THE HEART OF THE AUTOMATION IS THE PROGRAMMABLE LOGIC CONTROLLER (PLC)

Learning Outcome

1. Describe the hardware architecture of a PLC system
2. Explain the working principles of PLC

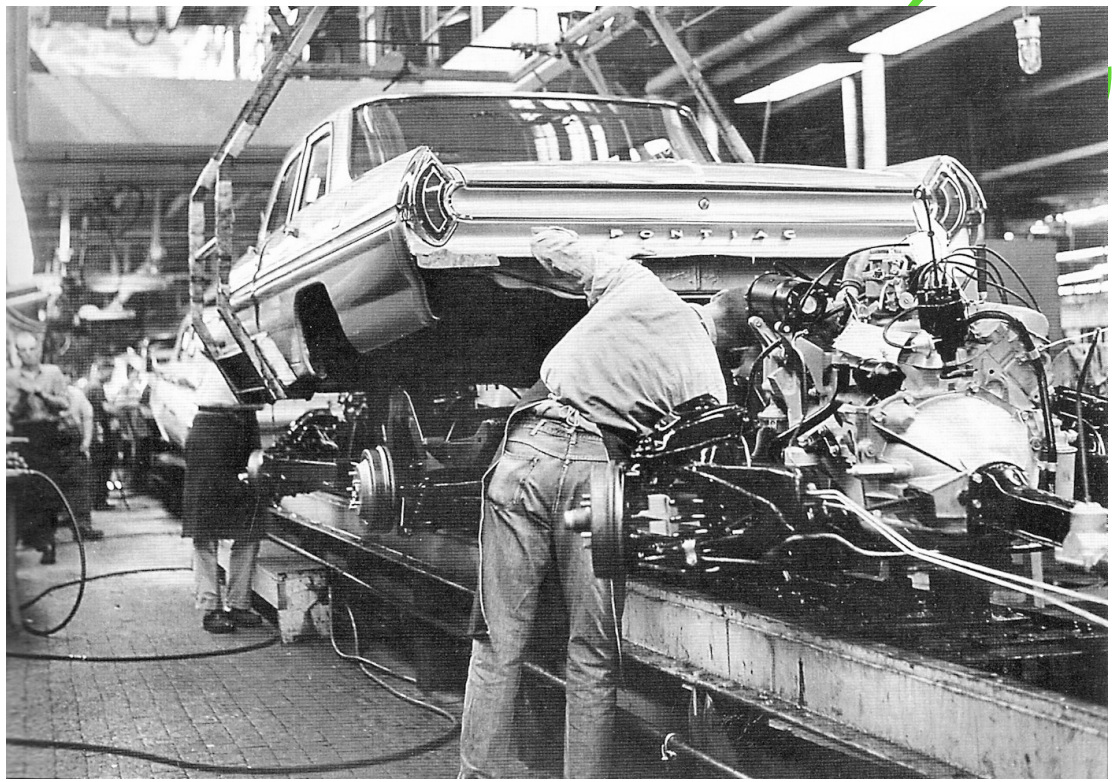
THE FIRST PLC!

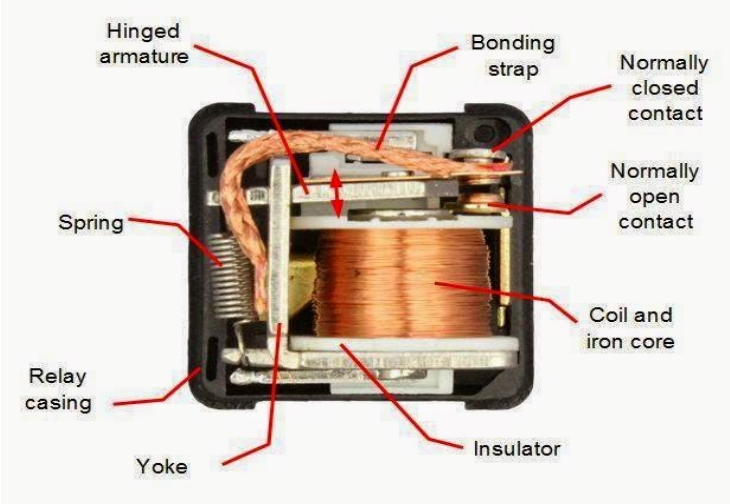
The first PLC was manufactured in 1970s.

It is designed to replace conventional relay control circuits to a major car manufacturer.

Electromechanical relays were commonly used for implementation of logic control.

PLC is an microprocessor based computer unit capable of performing control functions.

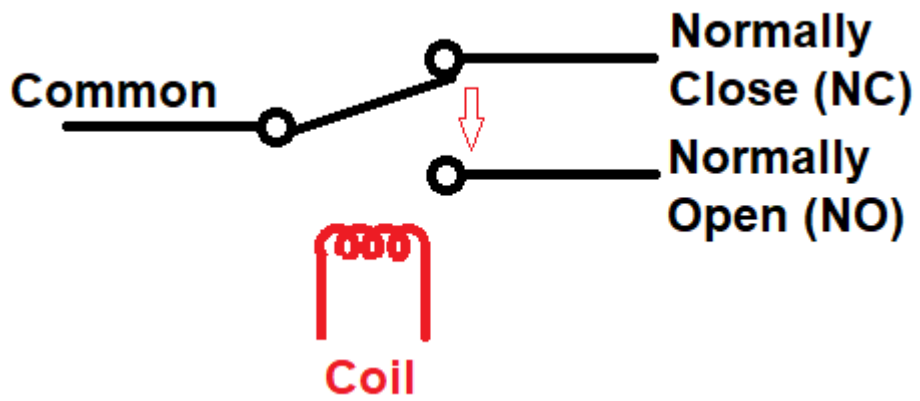


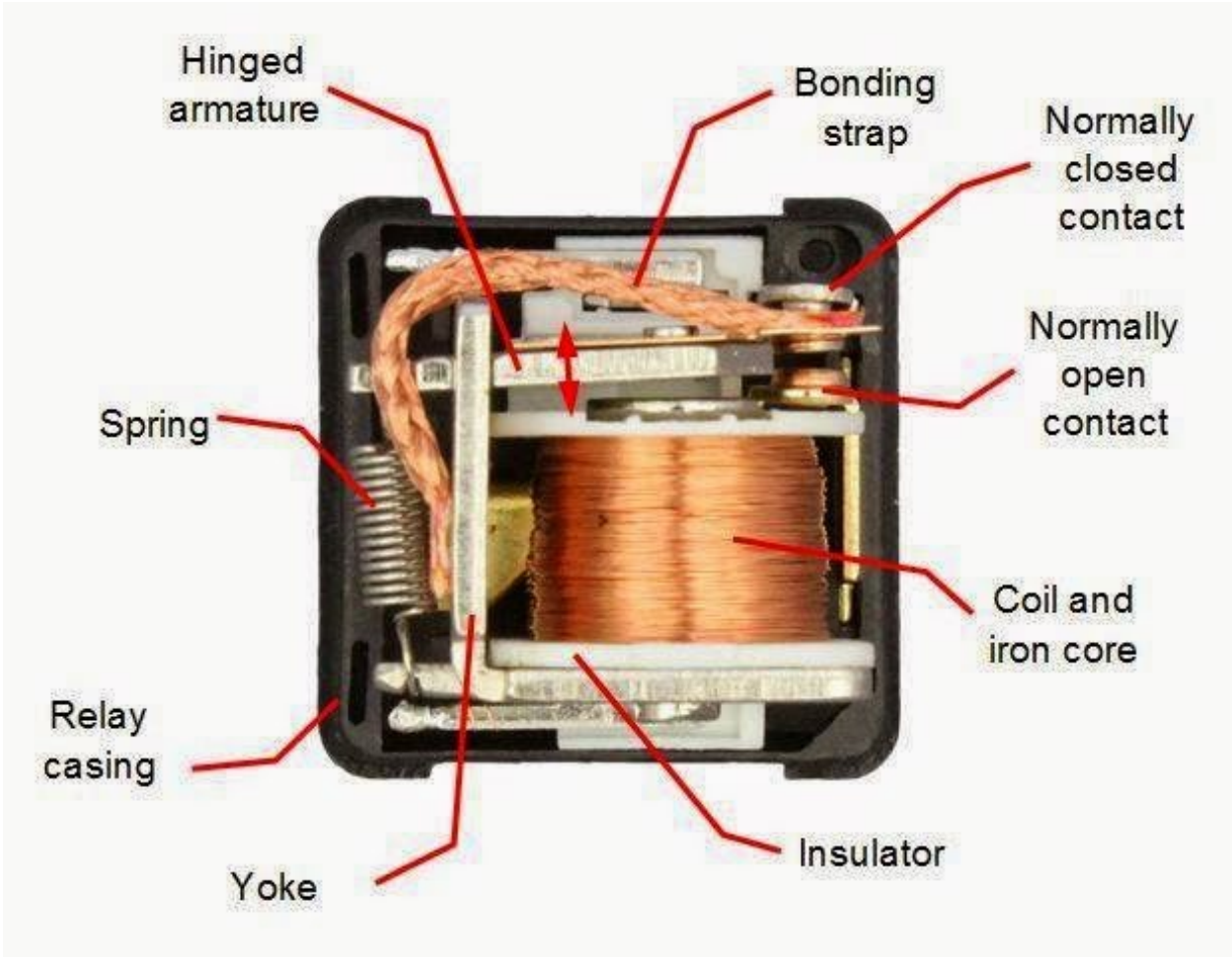


ELECTROMECHANICAL RELAY

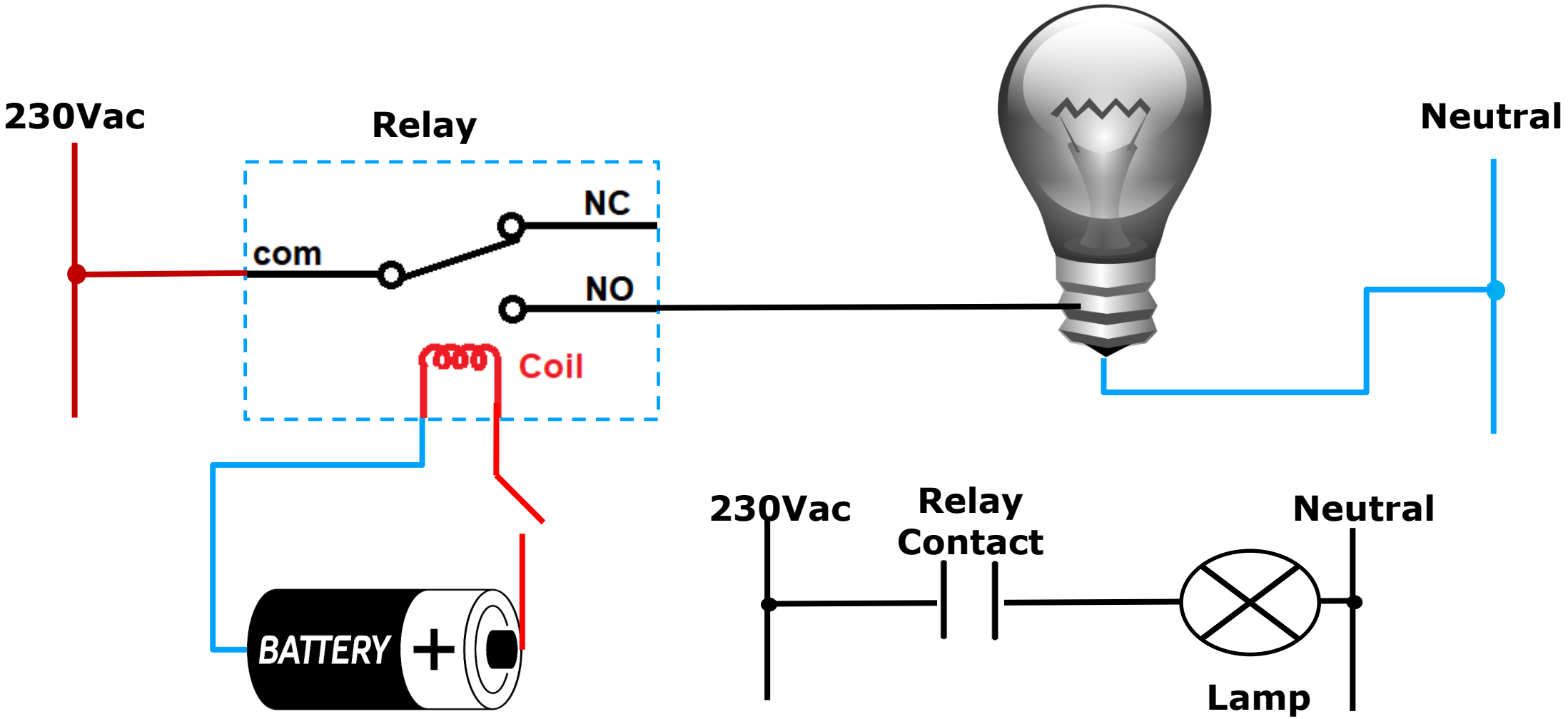
Electromechanical switch

1. Voltage applied to coil
2. Electromagnetic field generates force that pulls contacts
3. Normally open contact -> closes
4. Normally close contact -> opens

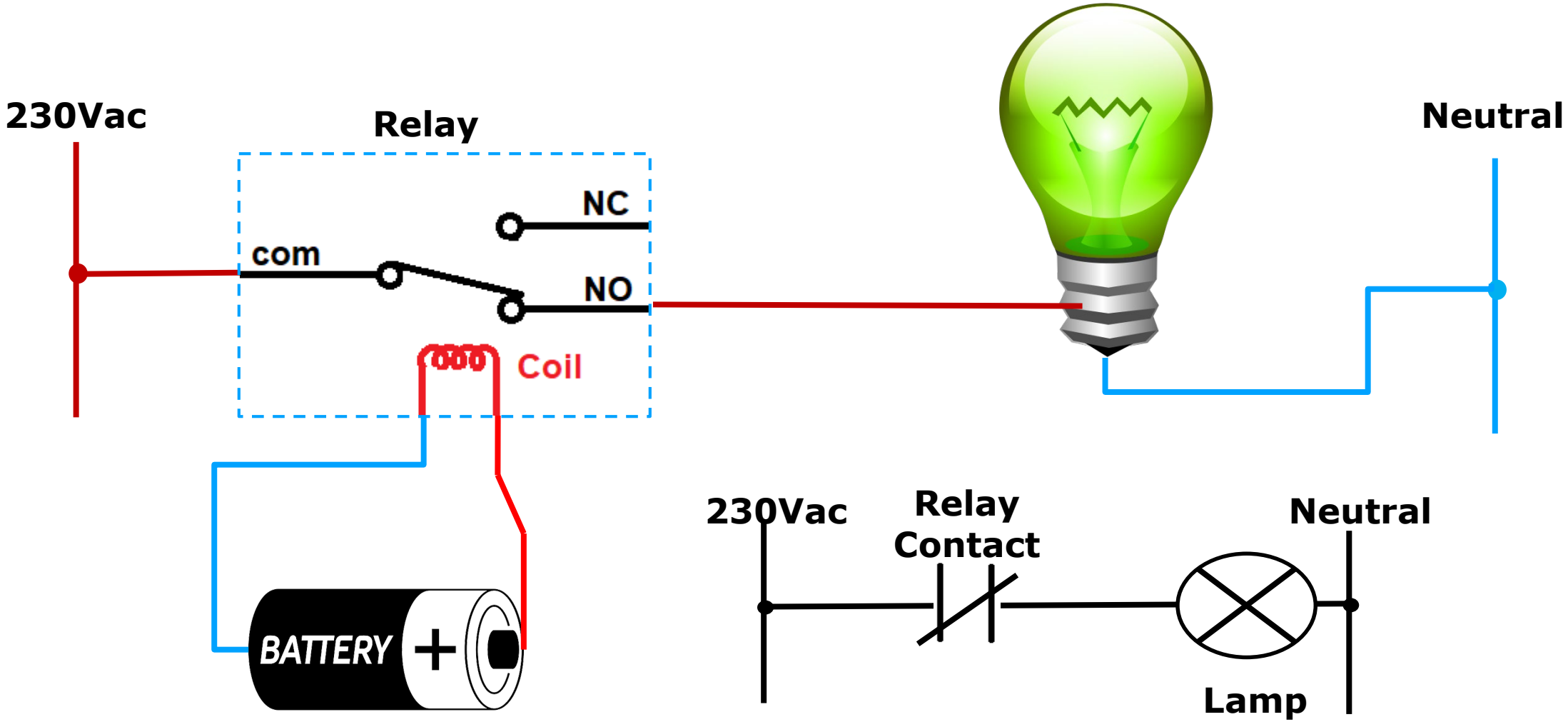




SIMPLE RELAY CONTROL



SIMPLE RELAY CONTROL



RELAY CONTACT RATING

Contact Ratings

Number of poles	1 pole		2 poles	
Load	Resistive load (cosΦ = 1)	Inductive load (cosΦ = 0.4; L/R = 7 ms)	Resistive load (cosΦ = 1)	Inductive load (cosΦ = 0.4; L/R = 7 ms)
Rated load	10 A at 250 VAC; 10 A at 30 VDC	7.5 A at 250 VAC; 5 A at 30 VDC	5 A at 250 VAC; 5 A at 30 VDC	2 A at 250 VAC; 3 A at 30 VDC
Rated carry current	10 A		5 A	
Max. switching voltage	440 VAC, 125 VDC		380 VAC, 125 VDC	
Max. switching current	10 A		5 A	
Max. switching power	2,500 VA, 300 W	1,875 VA, 150 W	1,250 VA, 150 W	500 VA, 90 W
Failure rate (reference value) *	100 mA at 5 VDC		10 mA at 5 VDC	

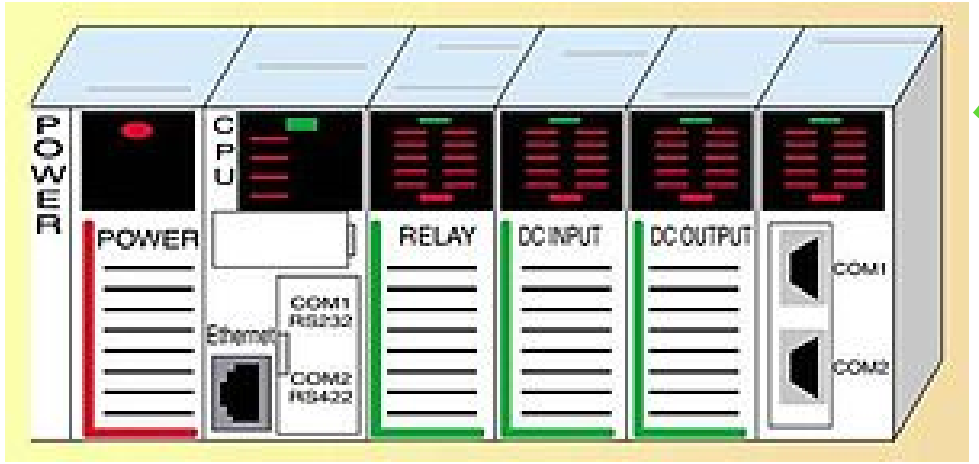
http://www.ia.omron.com/products/family/1731/specification.html

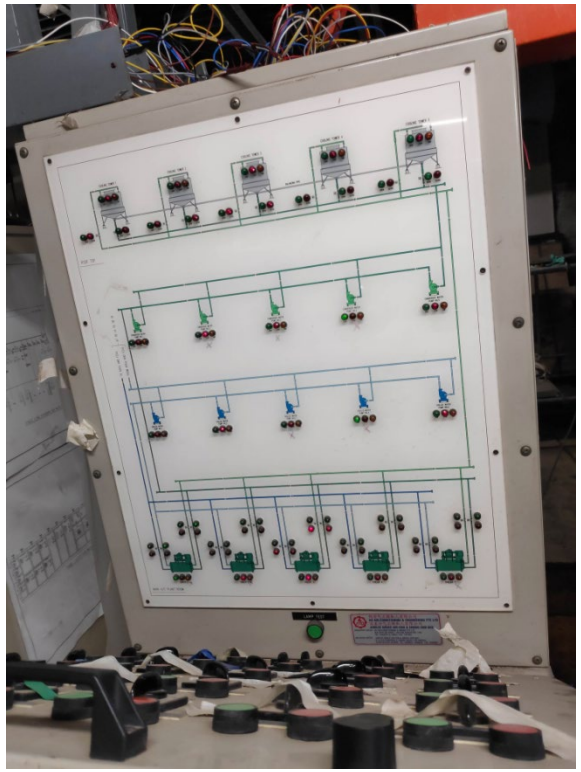
BENEFITS OF PLC

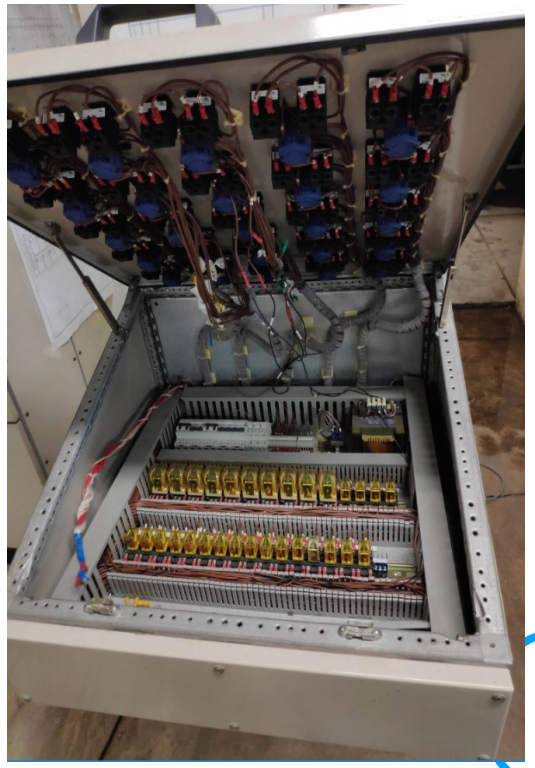
Before PLC became popular, control circuits were relay based, which takes up space, time and labour to implement and troubleshoot.

Process do not remain the same forever, if the logical function requires change or expanding the functions, the panel would need lots or rewiring!

A small PLC could easily replace the large panel that required 30 relays for a simple on/off control!



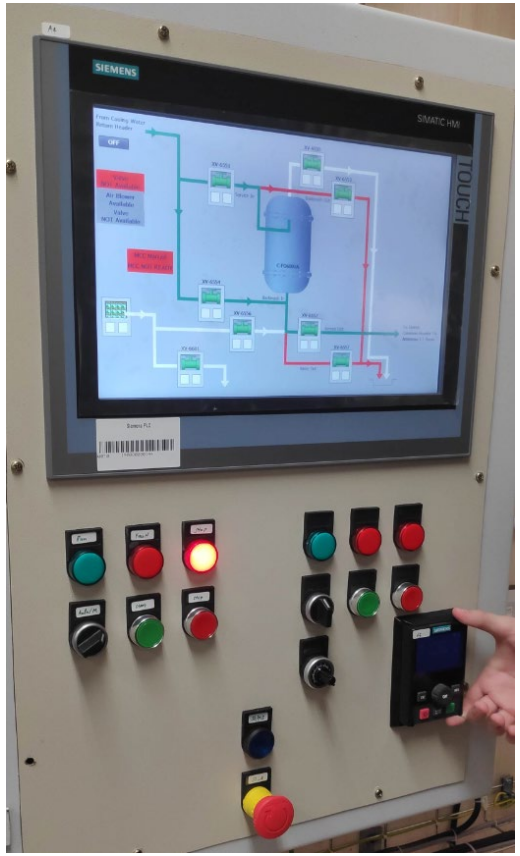


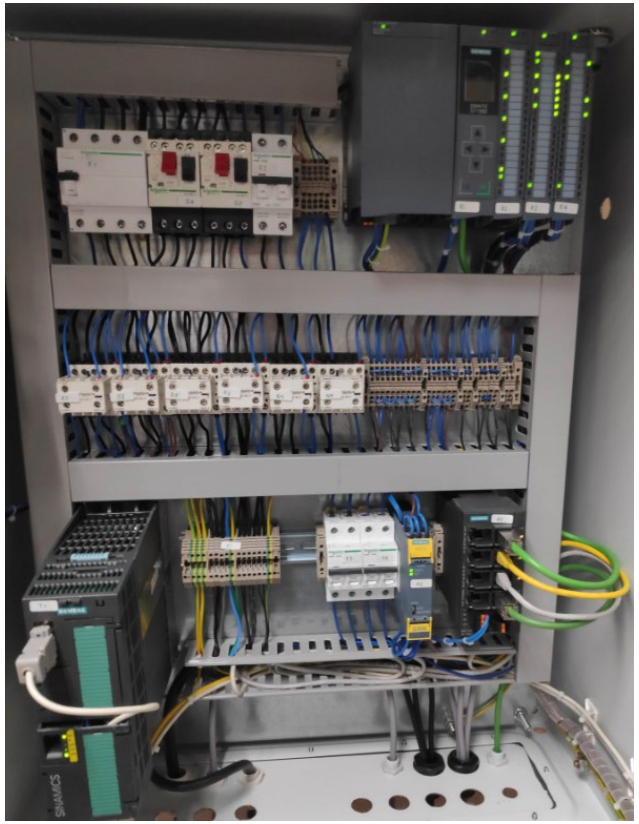


BENEFITS OF PLC

PLC is designed for:

1. Handle multiple input and output
2. Extended temperature range
3. Immune to electrical noise
4. Resistant to vibration





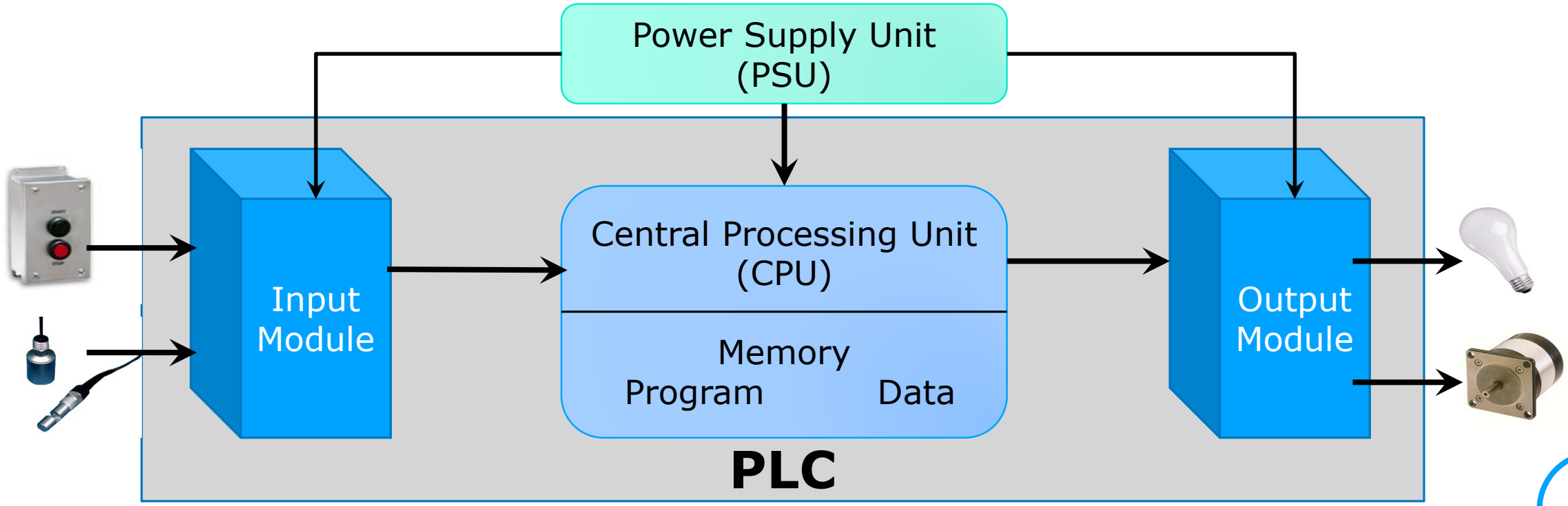
APPLICATIONS OF PLC AROUND YOU

Utilities – Water & Power	Manufacturing	Food & Beverage	Oil & Gas
Water & Waste Water Treatment Plant	Home appliance	Beverage pasteurization	Oil Refining
Waste Incineration Plant	Wafer-fab Semiconductor	Milk/Milo powder production	Liquefied Natural Gas
Combine-Cycle Electric Power Plant	Medical equipment	Bottling and packaging	Petrochemical

This list is non-exhaustive, there are plenty of applications utilising PLC!

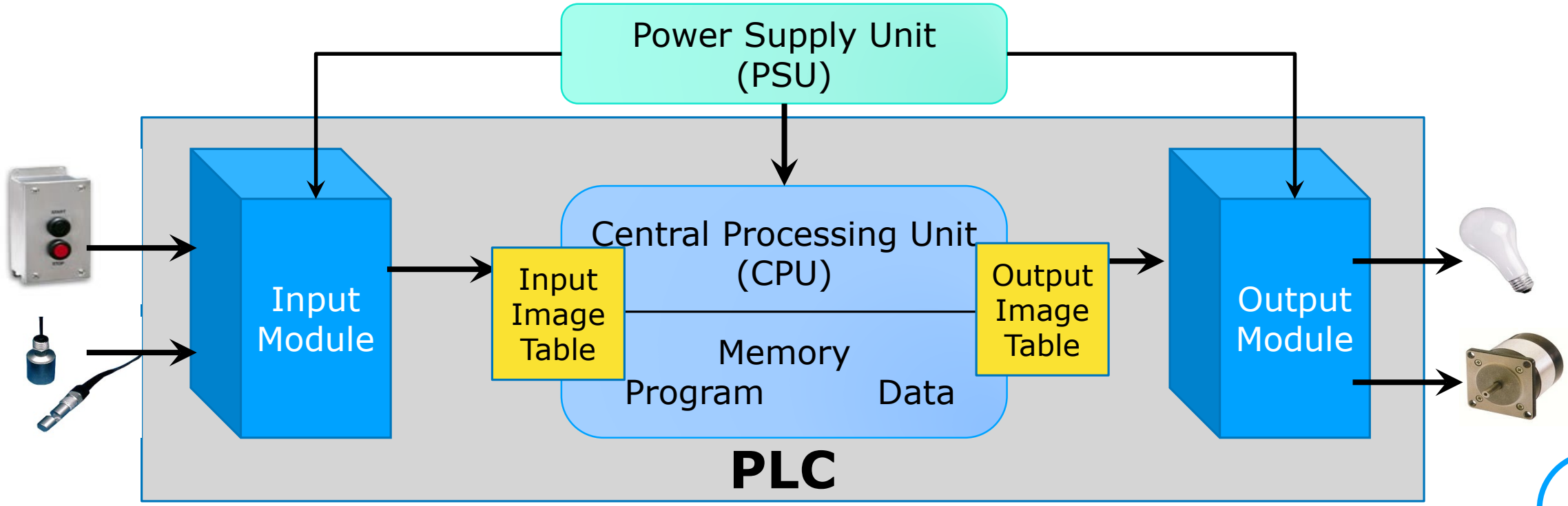
WHAT IS A PLC?

- An industrial computer that receives inputs from input devices
- Evaluates inputs in relation to stored logic program
- Generates outputs



WHAT IS A PLC?

- Input devices statuses updated in PLC input image – real time
- User program in PLC memory loaded thru programming device
- Output devices driven in real time according to output table values

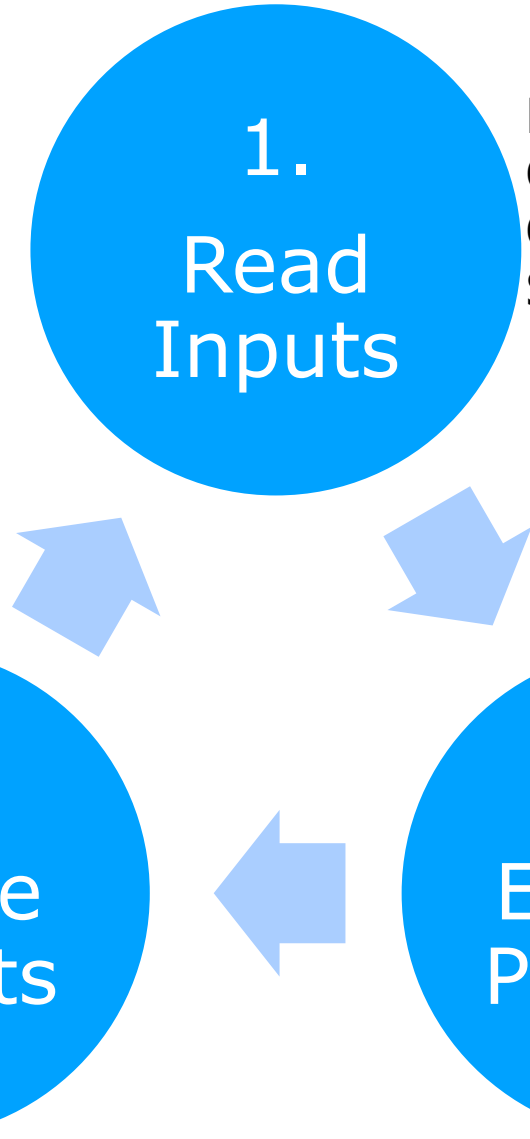


PLC SCAN CYCLE

Completion of 1 full cycle of this sequence by is a scan.

Time taken to execute this scan is scan time.

Scan time = time taken for PLC to respond



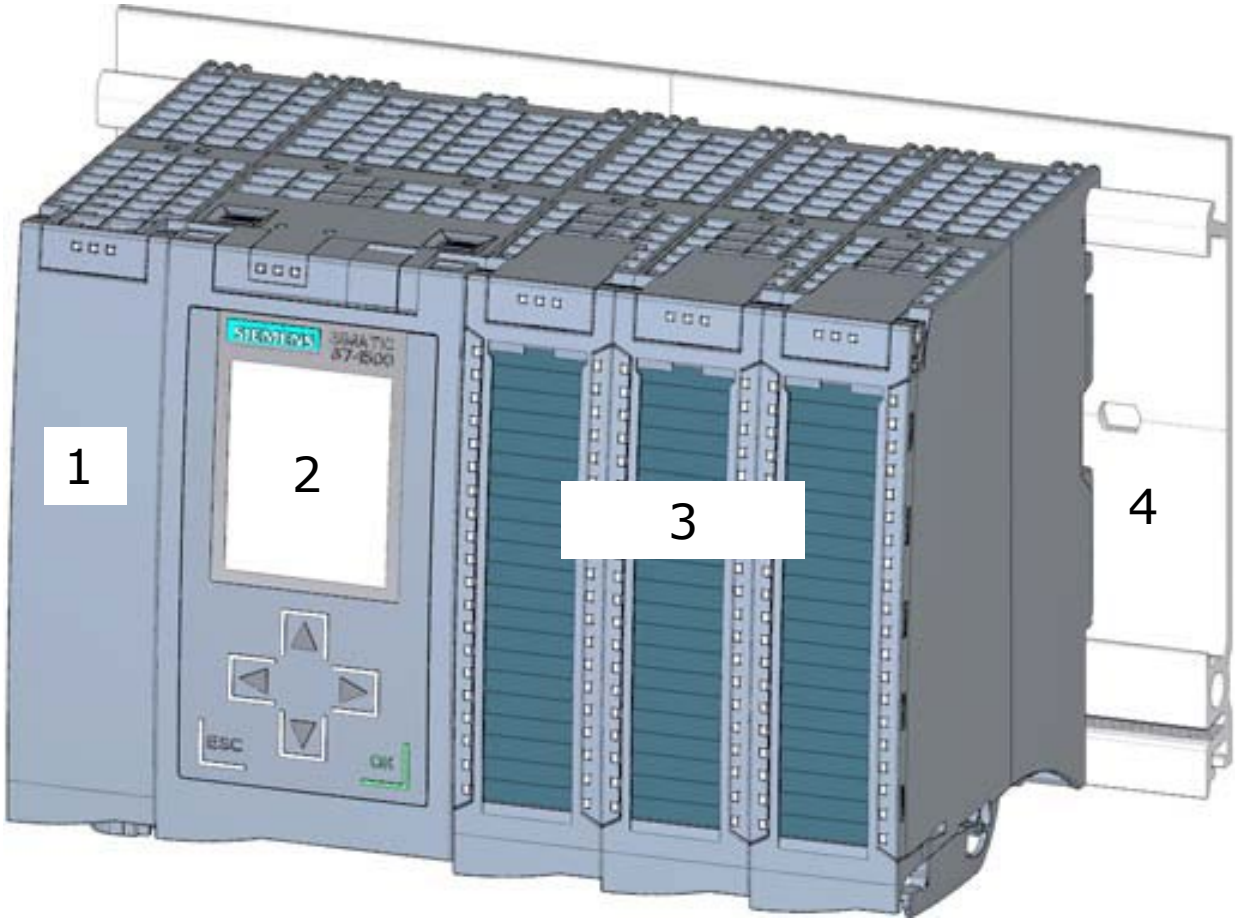
Read from input module
Close contact = logic 1
Open contact = logic 0
Store status in memory

Ladder diagram
Evaluated with states
From memory

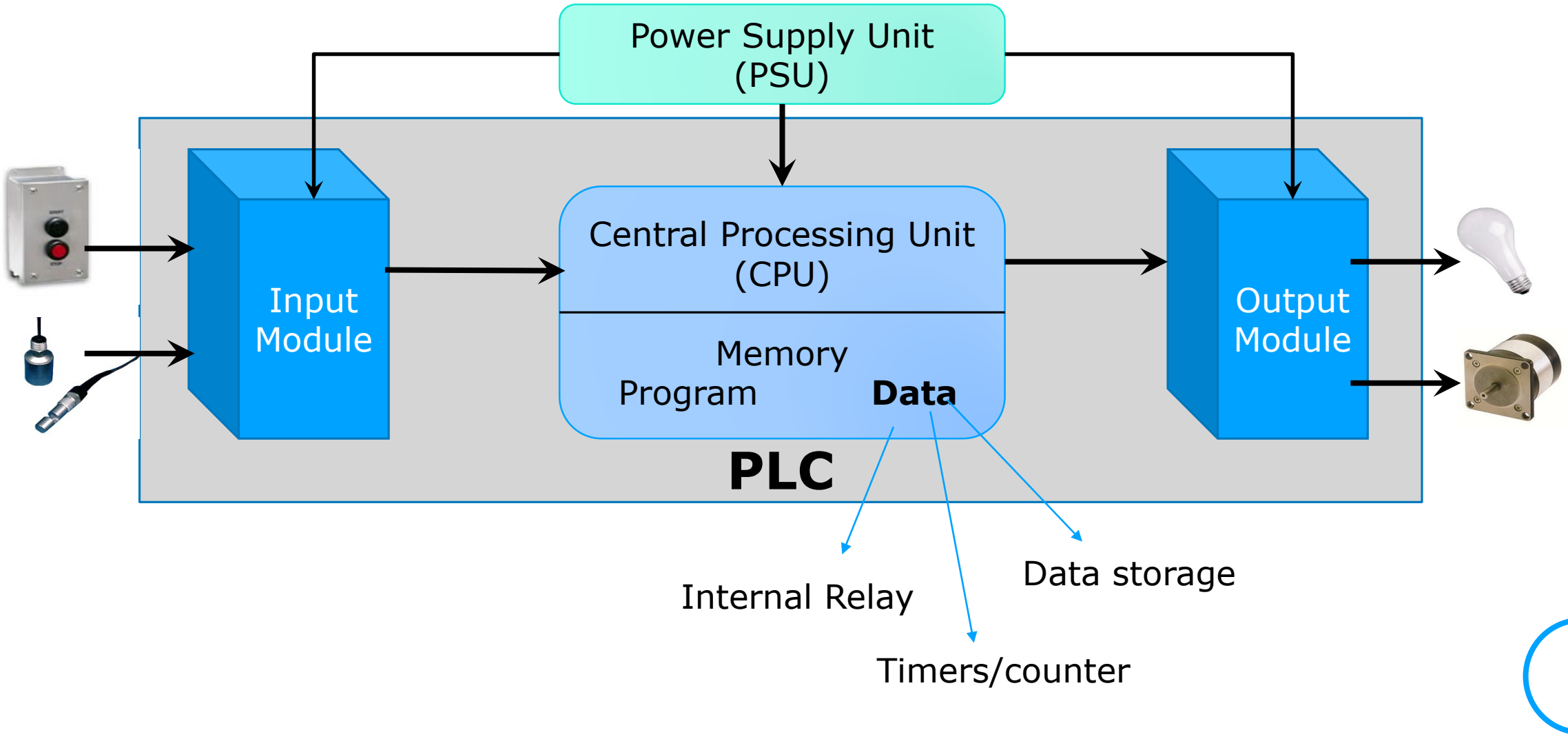
Output coil memory
Status as per program
To update output module

SIMATIC S7-1500 PLC

1. Power Supply Unit
2. CPU with integrated display
3. Input & Output unit
4. DIN Rail



PLC ARCHITECTURE

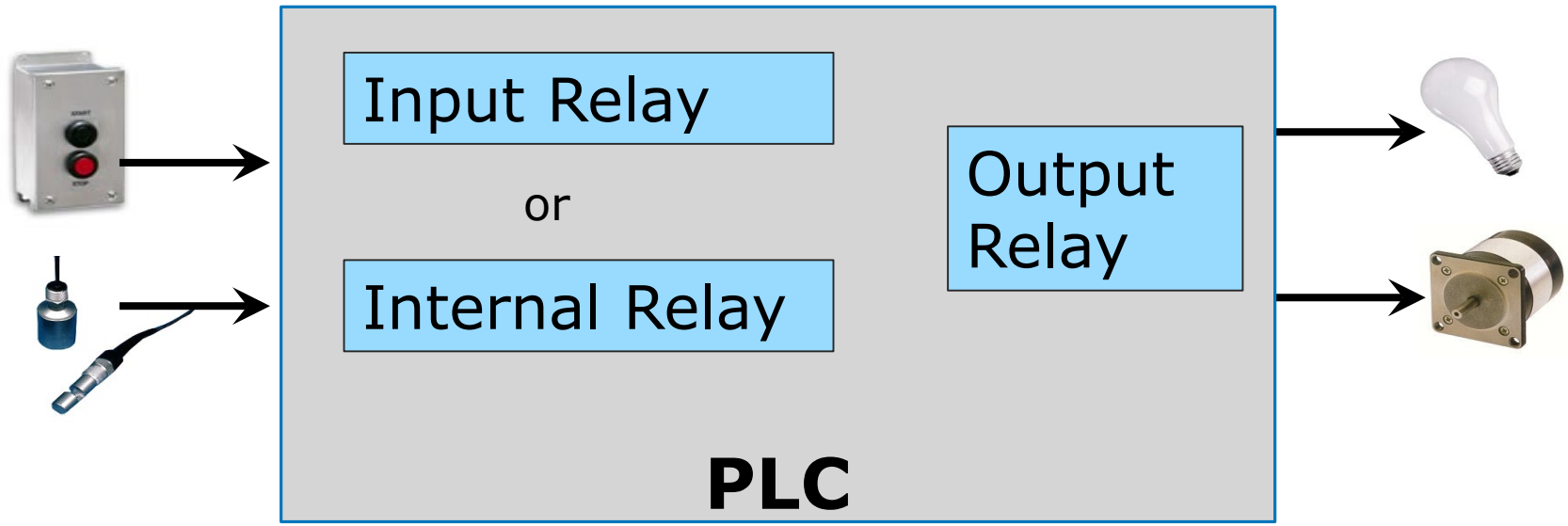


PLC ARCHITECTURE

- PLC mainly consist of:
  - Central Processing Unit (CPU)
  - Power Supply
  - Communication module
  - Circuits to handle inputs and outputs (I/O)
- PLC could be seen as an intelligent box with “infinite” number of relays, counters & timers.
  - Infinite as they do not exist physically – it is from the data storage
  - Internal relays are simulated via bit locations in memory registers
  - Counters and timers are software simulated to count up/down and on/off delay timers

PLC ARCHITECTURE

- Inputs and outputs are physically connected to real world
  - Input relays and output relays physically exist!
- Data storage: high-speed memory/register to store data
  - Registers: usually used in math or data manipulation as temporary storage
  - Store values associated with I/O signals, timers, counters



PLC VS COMPUTERS

Architecture of PLC is basically the same as personal computer… are they interchangeable?

Comparison	PLC	PC
Environment	Designed for harsh industrial environment	Common PCs are not designed for harsh environment. Industrial PCs at higher cost
Ease of Use	Easier for technician / engineers to interface with common programming language and easy IO connections	Operating systems (OS) such as Windows, UNIX and Linux are common. IO connection to PC could be difficult
Flexibility	Usually in rack form, designed for modularity and expansion	Typical PCs are limited by the number of special card (PCI) that it could accommodate / expand

PLC VS COMPUTERS

Comparison	PLC	PC
Speed	Execute single program in sequential order. Has better ability to handle real-time event	Designed to multitask. Real-time OS can handle real-time events
Reliability & Data management	Hardly crash over long period of continuous working. Has limited memory for storage / analysis	Lock up and crashes more frequently. Large memory space, very good with long term data storage, modeling, simulation and trending.
Programming languages	According to IEC61131-3 with ladder logic, function block, structure text, instruction list & sequential function chart	Very flexible and powerful in running a wide variety of programming tools

ROADMAP FOR PLCA