The background features a blue gradient with several glowing spheres of varying sizes. A bright light source in the center emits horizontal rays of light, creating a sense of depth and movement.

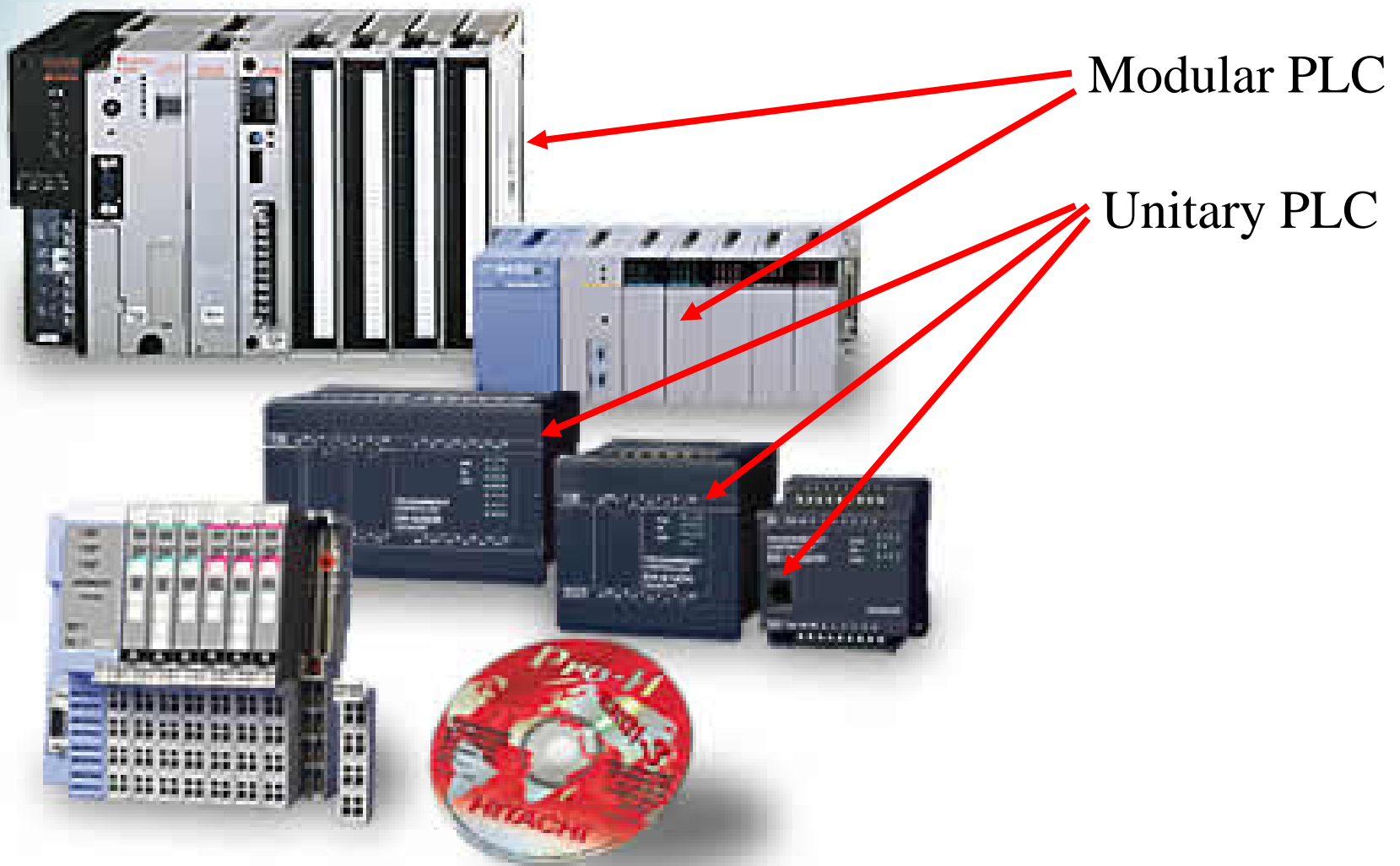
Chapter 2: Number System and Codes (Self-study)

The background features a blue gradient with several translucent spheres of varying sizes. A bright light source in the center creates a lens flare effect with horizontal rays of light passing through the spheres.

Chapter 3: PLC Hardware (Physical Components)

- ❖ Modular PLC contains several different modules that can be coupled together to build a customized controller such as electrical power regulation, microprocessor, I/O connections, ...
 - Big size (50 cm x 75 cm x 25 cm).
 - Flexible, easy to change.
 - Apply for medium to complex control system.
 - High price.
- ❖ Compact (unitary) PLC is the more simple type of controller, and contains all of the basic system components within a single housing, or box.
 - Small size.
 - Usually have 40 I/O, can execute up to 1000 commands.
 - Apply for small control system.
 - Low price.

Hardware



Classification by application ranges:

- ❖ **Micro PLCs:** up to 32 I/O devices
- ❖ **Small PLCs:** from 32 to 128 I/O
- ❖ **Medium PLCs:** from 64 to 1024 I/O
- ❖ **Large PLCs:** from 512 to 4096 I/O
- ❖ **Very large PLCs:** from 2048 to 8192 I/O

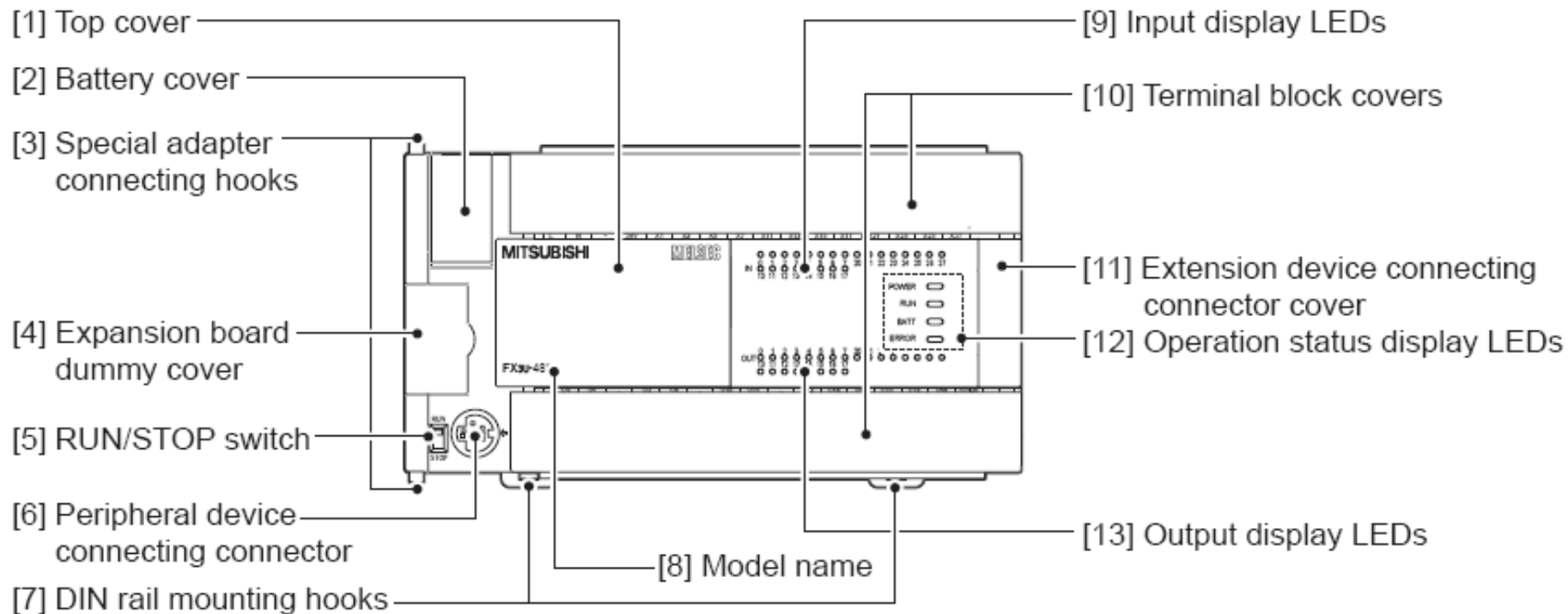
Hardware – FX Family PLC (Mitsubishi)



Hardware – FX Family PLC (Mitsubishi)

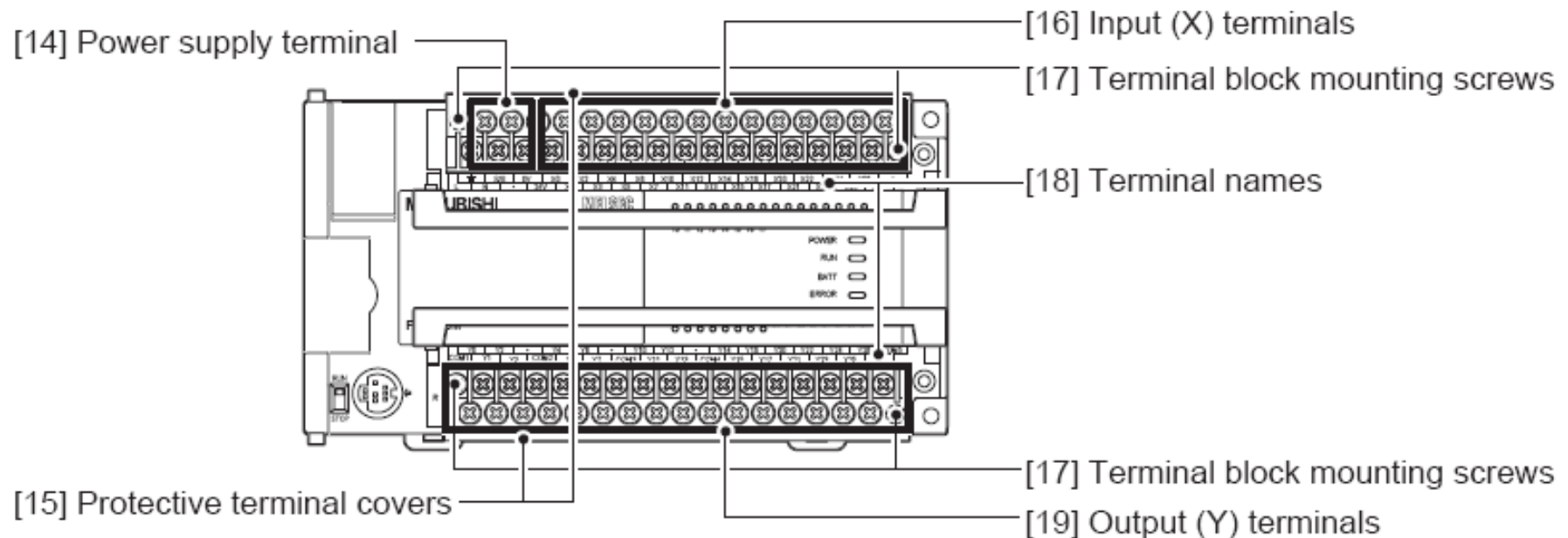


Front Panel



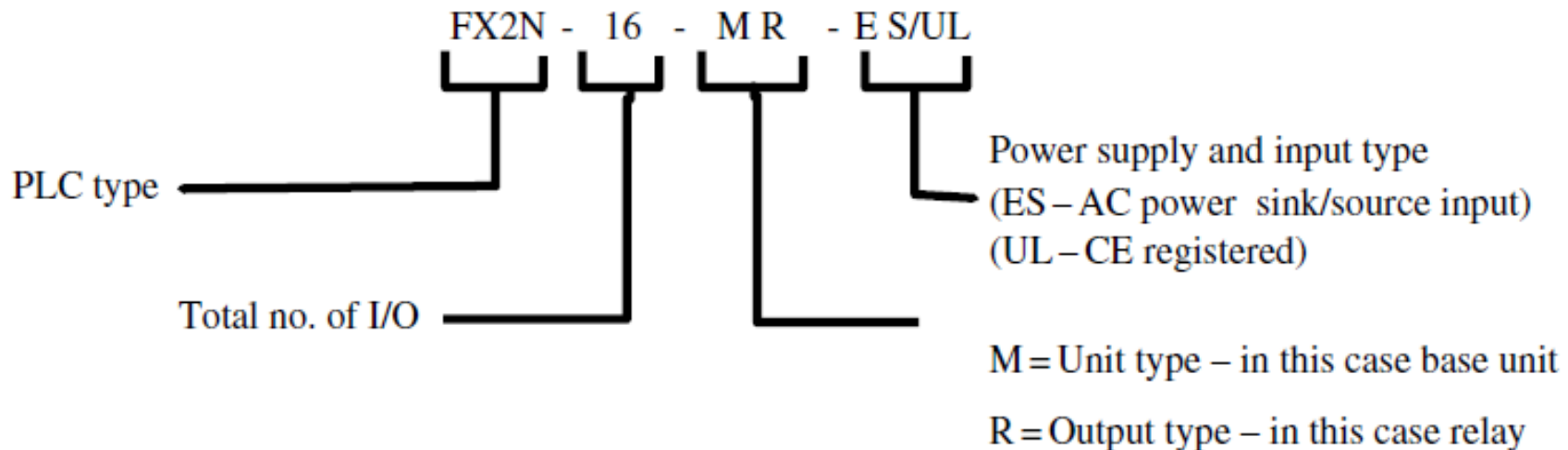
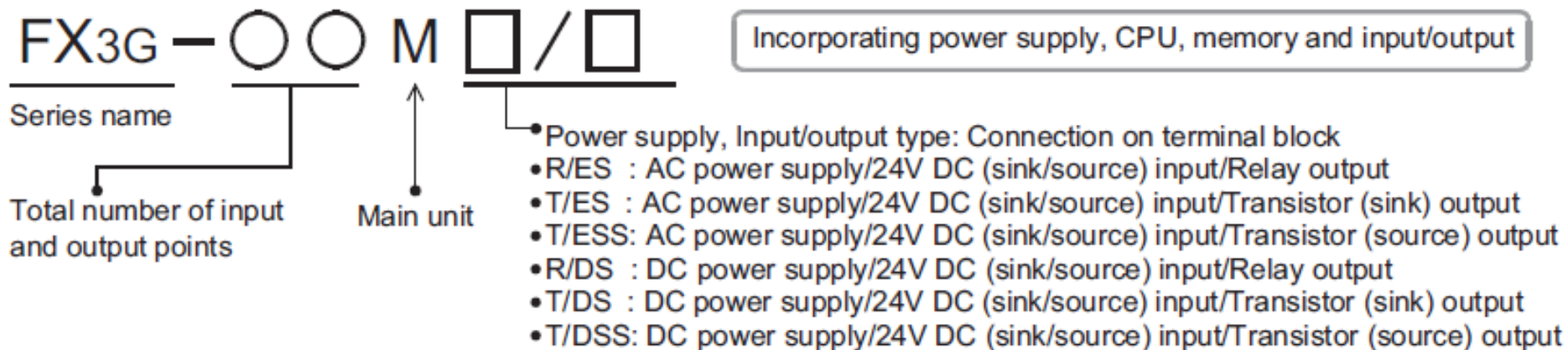
Front Panel

When the terminal block covers are open



Interpretation of Model Names

❖ Main unit



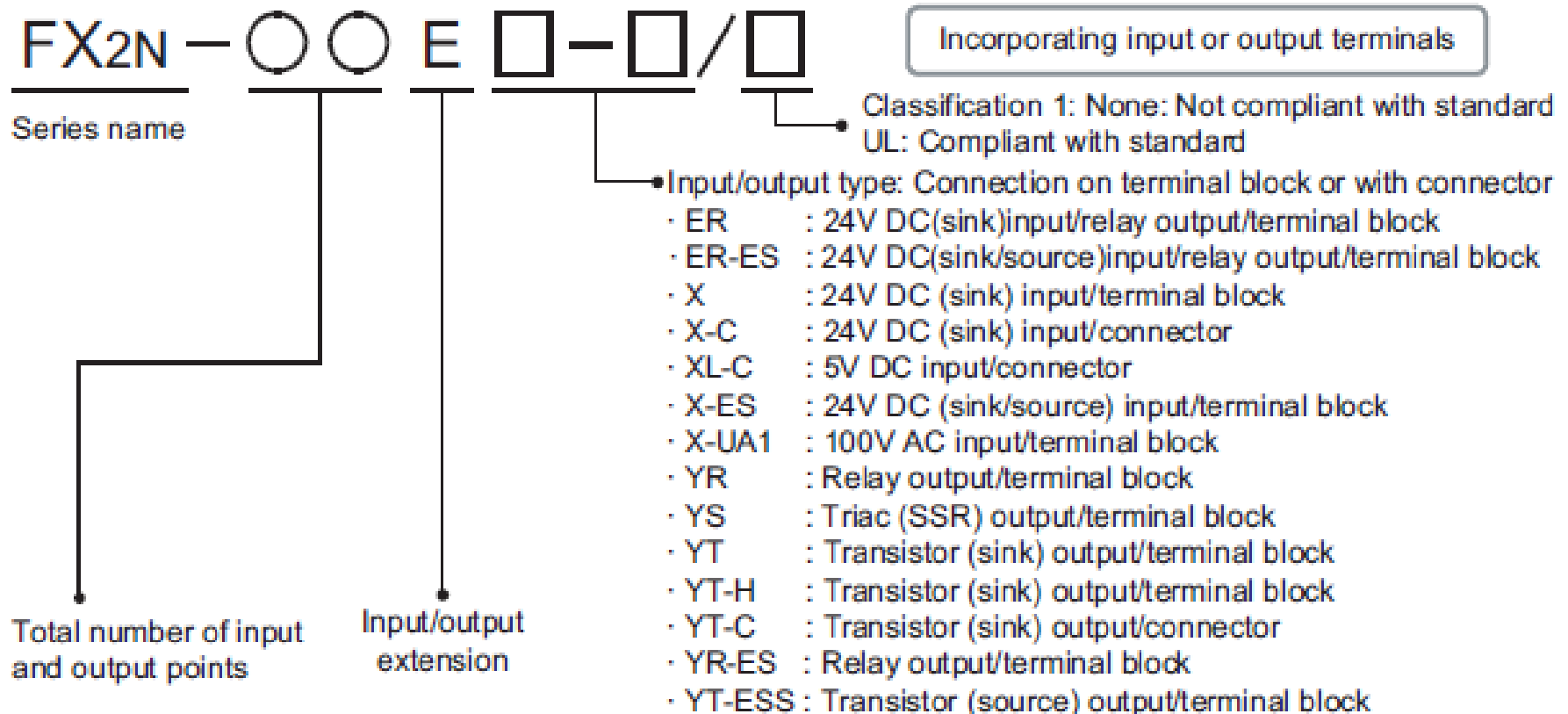
Interpretation of Model Names

Model name	Number of input/output points			Input type	Output type	Connection form
	Total number of points	Number of input points	Number of output points			
AC power supply common to 24V DC sink and source input						
FX3G-14MR/ES	14(16) ^{*1}	8	6(8) ^{*1}	24V DC(sink/source)	Relay	Terminal block
FX3G-14MT/ES	14(16) ^{*1}	8	6(8) ^{*1}	24V DC(sink/source)	Transistor(sink)	Terminal block
FX3G-14MT/ESS	14(16) ^{*1}	8	6(8) ^{*1}	24V DC(sink/source)	Transistor(source)	Terminal block
FX3G-24MR/ES	24(32) ^{*1}	14(16) ^{*1}	10(16) ^{*1}	24V DC(sink/source)	Relay	Terminal block
FX3G-24MT/ES	24(32) ^{*1}	14(16) ^{*1}	10(16) ^{*1}	24V DC(sink/source)	Transistor(sink)	Terminal block
FX3G-24MT/ESS	24(32) ^{*1}	14(16) ^{*1}	10(16) ^{*1}	24V DC(sink/source)	Transistor(source)	Terminal block
DC power supply common to 24V DC sink and source input						
FX3G-14MR/DS	14(16) ^{*1}	8	6(8) ^{*1}	24V DC(sink/source)	Relay	Terminal block
FX3G-14MT/DS	14(16) ^{*1}	8	6(8) ^{*1}	24V DC(sink/source)	Transistor(sink)	Terminal block
FX3G-14MT/DSS	14(16) ^{*1}	8	6(8) ^{*1}	24V DC(sink/source)	Transistor(source)	Terminal block
FX3G-24MR/DS	24(32) ^{*1}	14(16) ^{*1}	10(16) ^{*1}	24V DC(sink/source)	Relay	Terminal block
FX3G-24MT/DS	24(32) ^{*1}	14(16) ^{*1}	10(16) ^{*1}	24V DC(sink/source)	Transistor(sink)	Terminal block
FX3G-24MT/DSS	24(32) ^{*1}	14(16) ^{*1}	10(16) ^{*1}	24V DC(sink/source)	Transistor(source)	Terminal block

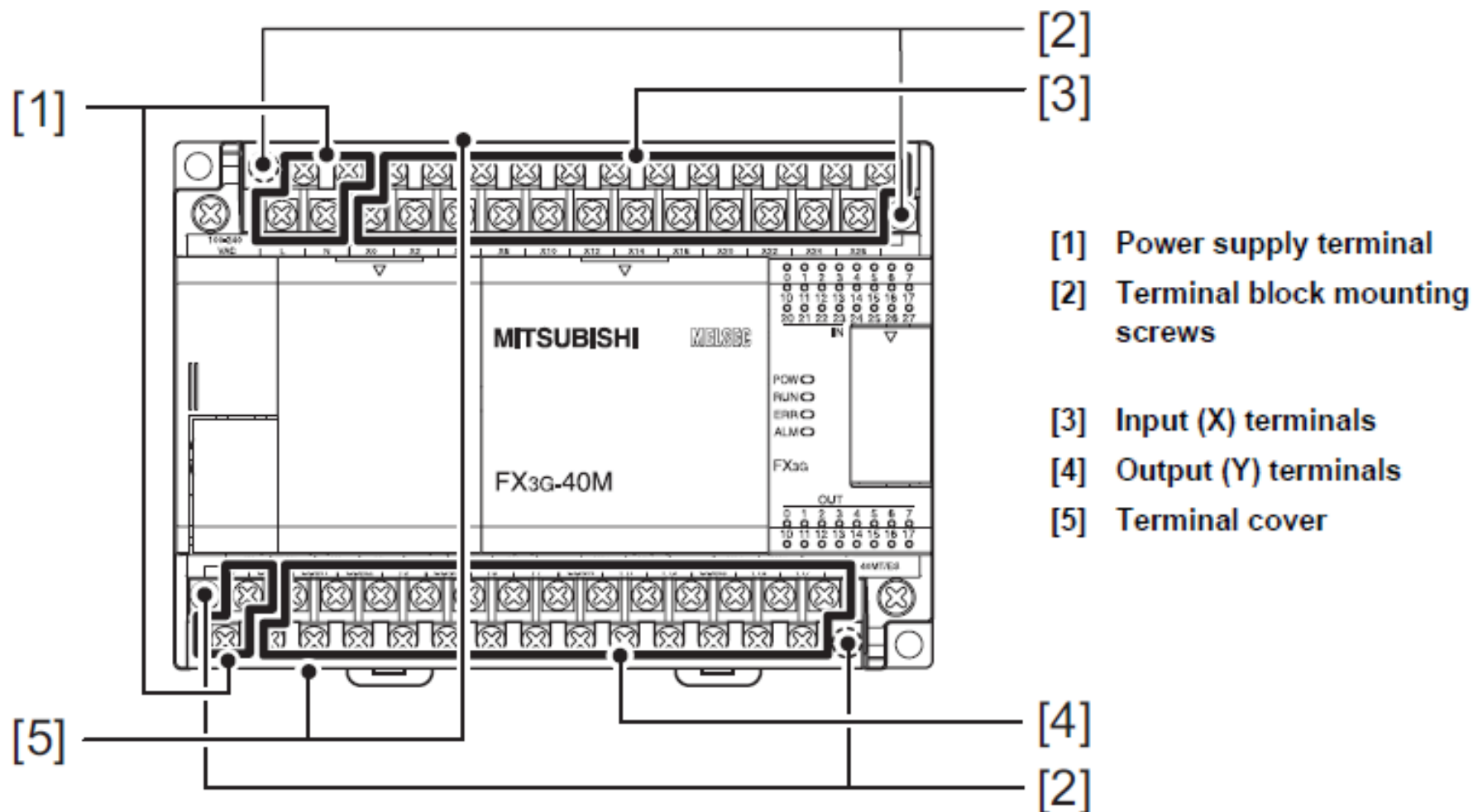
Interpretation of Model Names

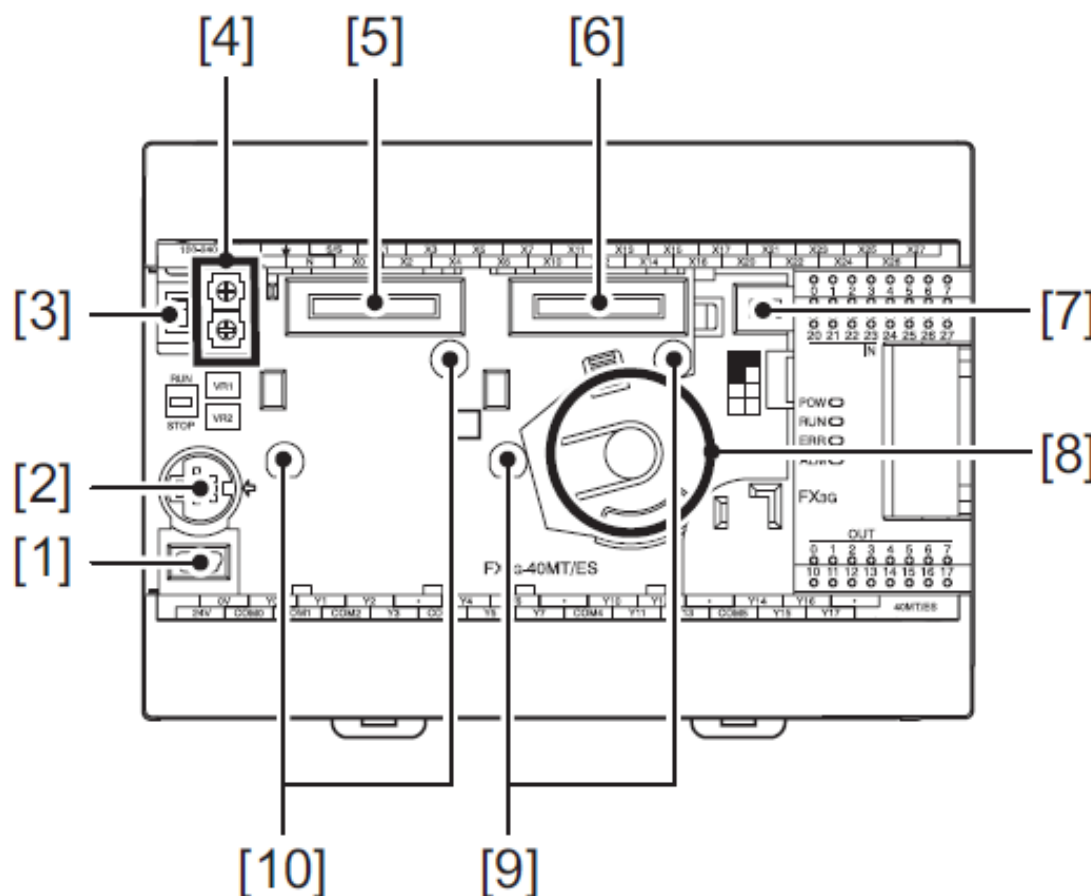
❖ External module

The input/output extension block has built-in input or output terminals to add input or output terminals. Connect the input/output extension block to the main unit or input/output powered extension unit.



FX3G-40MR/T





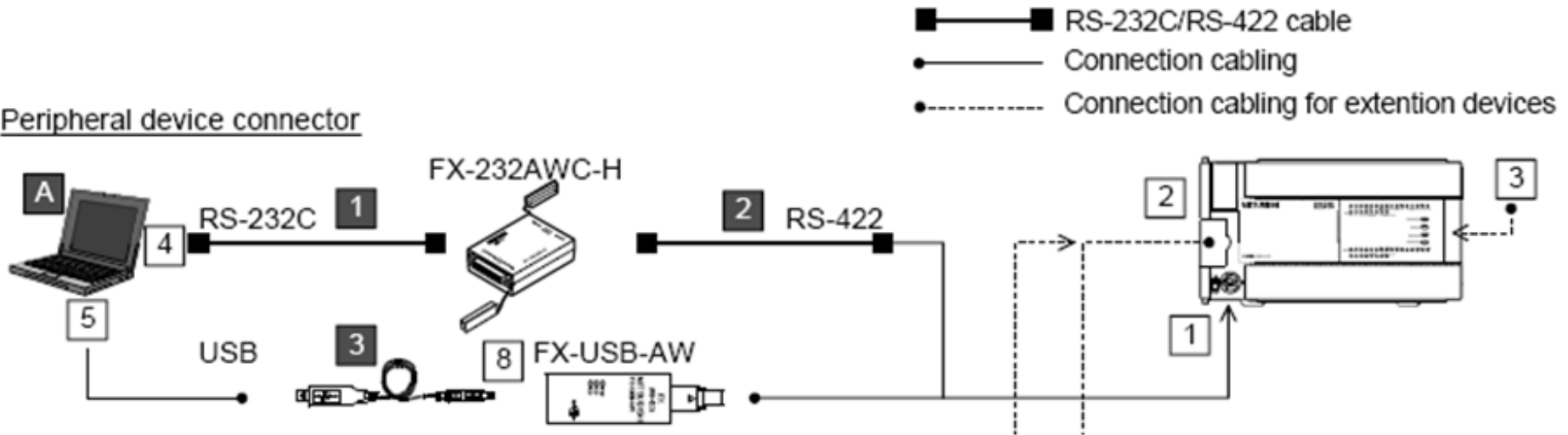
- [1] Peripheral device connecting connector (USB)
- [2] Peripheral device connecting connector (RS-422)
- [3] RUN/STOP switch
- [4] Variable analog potentiometers
- [5] Optional equipment connector1
- [6] Optional equipment connector2 (40points, 60points type only)
- [7] Battery connector
- [8] Battery holder
- [9] Optional equipment connecting screw holes2 (2 places) (40points, 60points type only)
- [10] Optional equipment connecting screw holes1 (2 places)

PLC Mitsubishi - FX Family

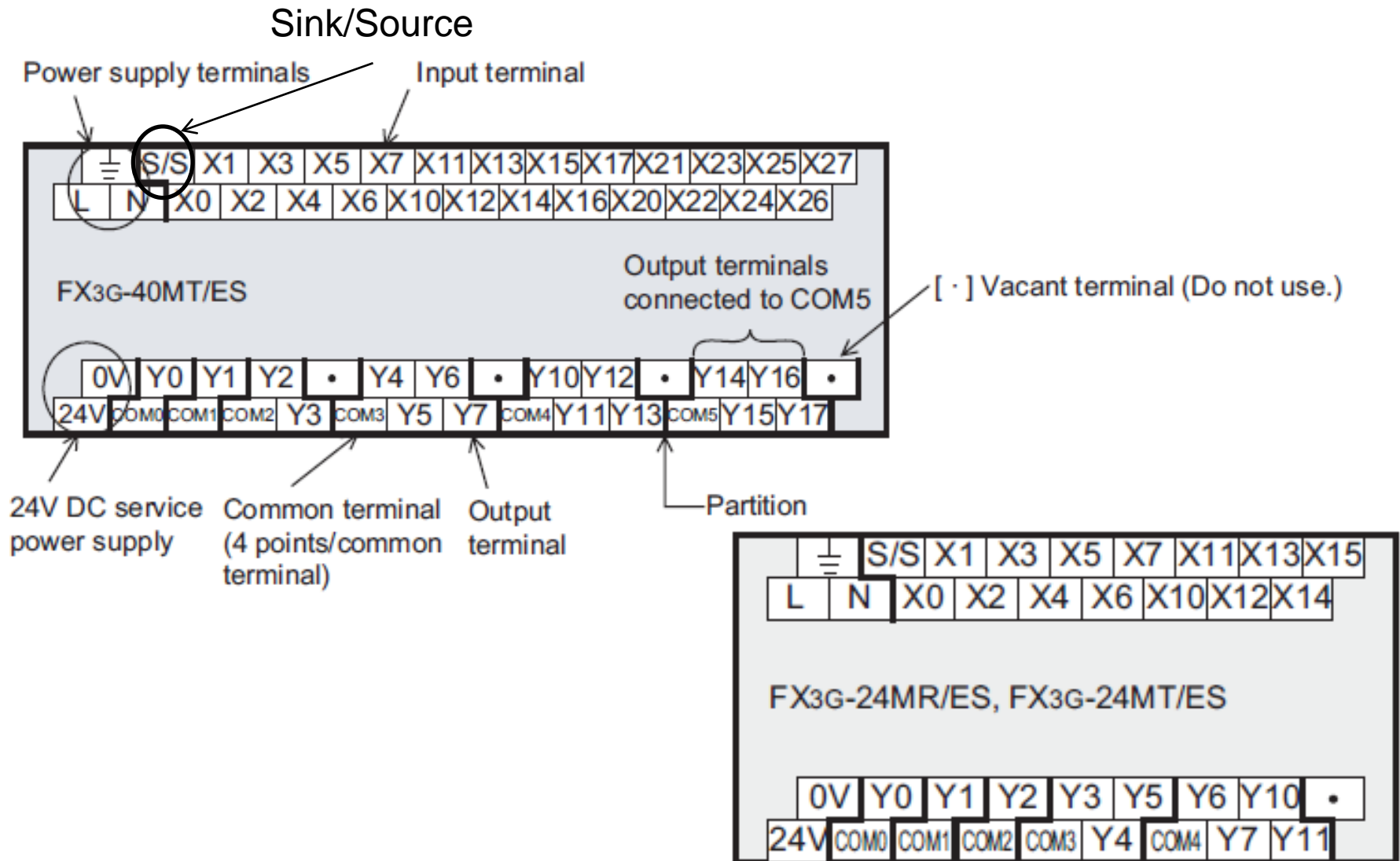
Model	FX3S	FX3G	FX3GE	FX3U	FX3UC
Power Supply	100–240 VAC, 24V DC	100–240 VAC, 24V DC	100–240 VAC 24V DC	100–240 VAC, 24V DC	24V DC
Maximum I/O	30	256 (w/CC-Link)	256 (w/CC-Link)	384 (w/CC-Link)	384 (w/CC-Link)
Digital I/O	Relay/Transistor	Relay/Transistor	Relay/Transistor	Relay/Transistor/Triac	Relay/Transistor
Cycle Period/ logical instruction	0.21μs	0.21μs	0.21μs	0.065μs	0.065μs
Memory	4k steps	32k steps	32k steps	64k steps	64k steps

Cables for Program Communication

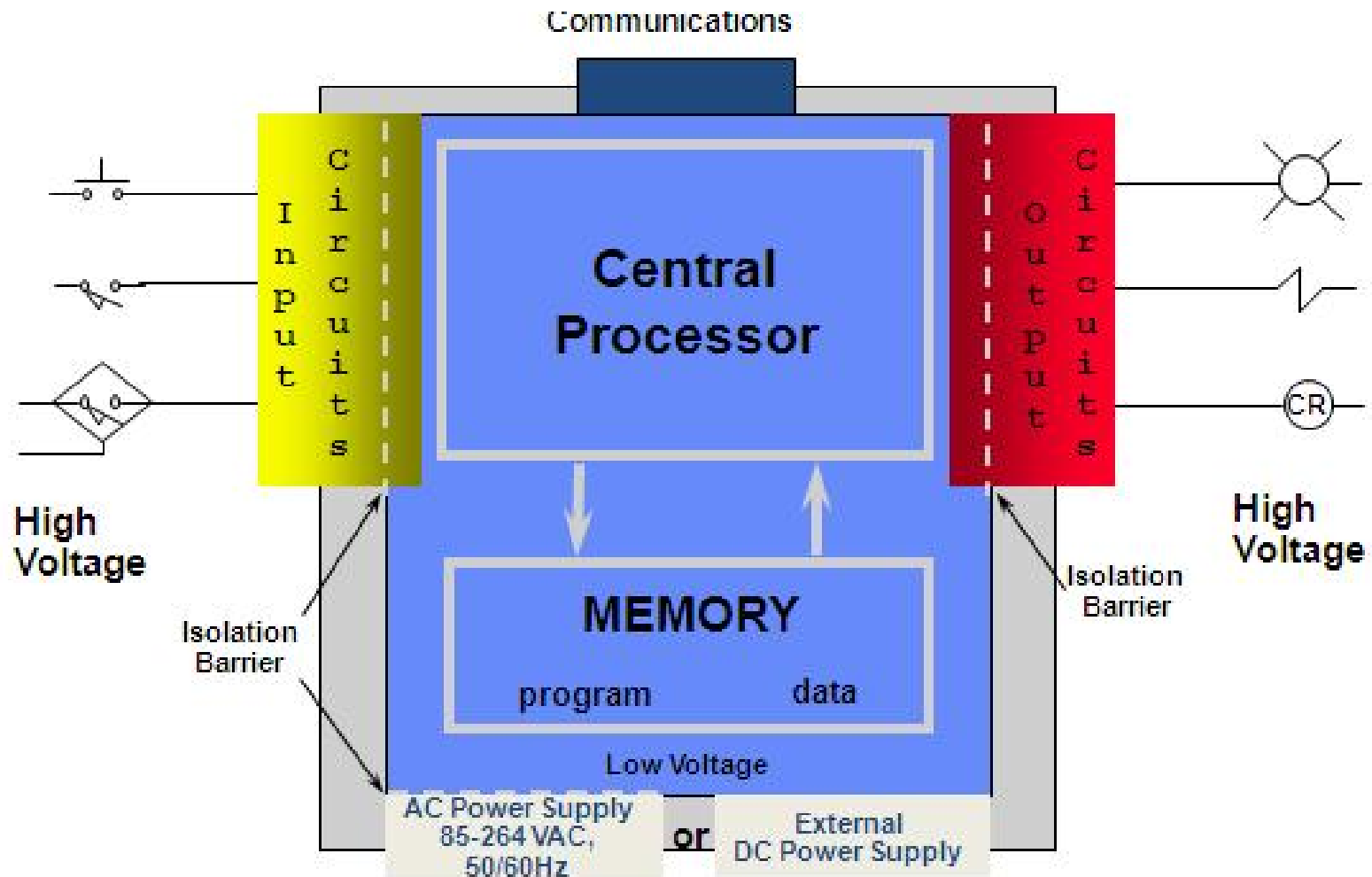
Peripheral device connector



Terminal Block Layout



PLC Hardware



- ❖ **Power Supply**: is not only to provide internal DC voltages to the system components (i.e., processor, memory, and input/output interfaces), but also to monitor and regulate the supplied voltages and warn the CPU if something is wrong.
- ❖ **System Buses**: are the paths through which the digital signal flows internally of the PLC.
 - There are four system buses.
 - **Data bus** is used by the CPU to transfer data among different elements.
 - **Control bus** transfers signals related to the action that are controlled internally.
 - **Address bus** sends the location's addresses to access the data.
 - **System bus** helps the I/O port and I/O unit to communicate with each other.

❖ Memory: is composed of two different memories

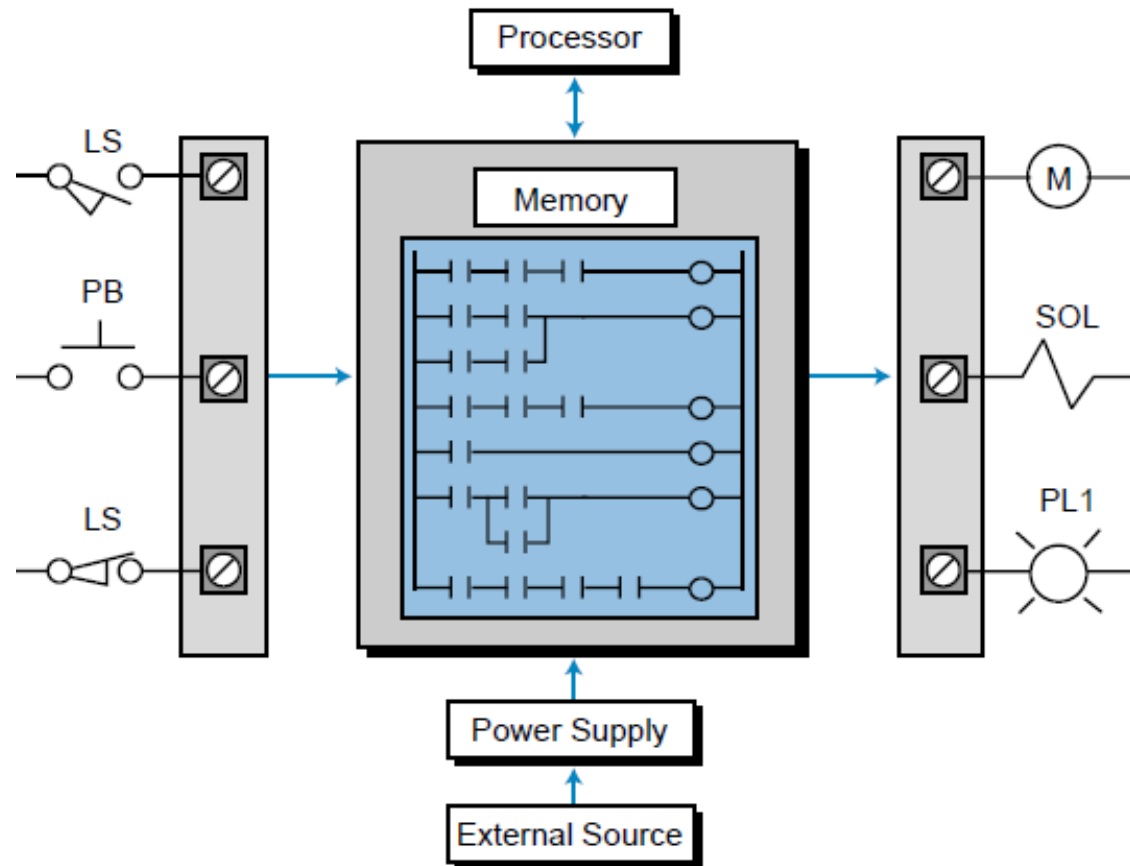
- **The executive memory**: is a collection of permanently stored programs.
 - **Read-only memory** (ROM) is designed to permanently store a fixed program that is not alterable under ordinary circumstances.
- **The application memory**: provides a storage area for the user-programmed instructions that form the application program.
 - **Random-access memory** (RAM), often referred to as read/write memory (R/W), is designed so that information can be written into or read from the memory storage area.

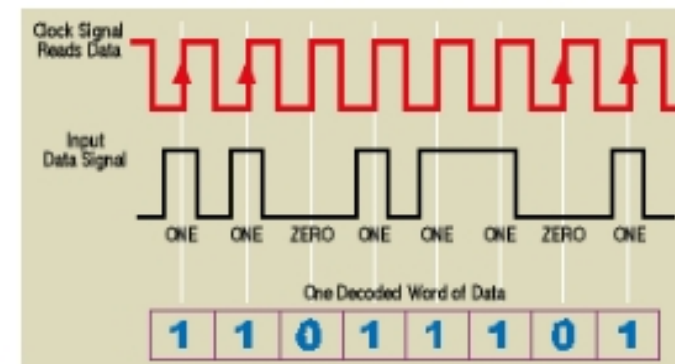
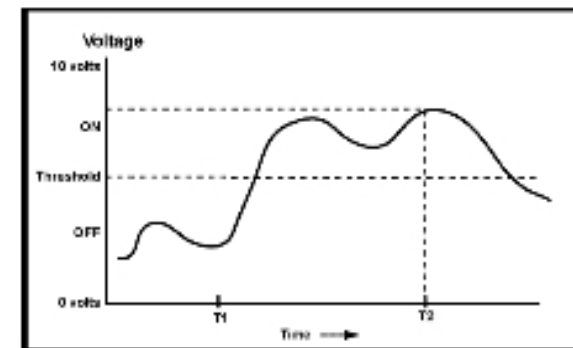
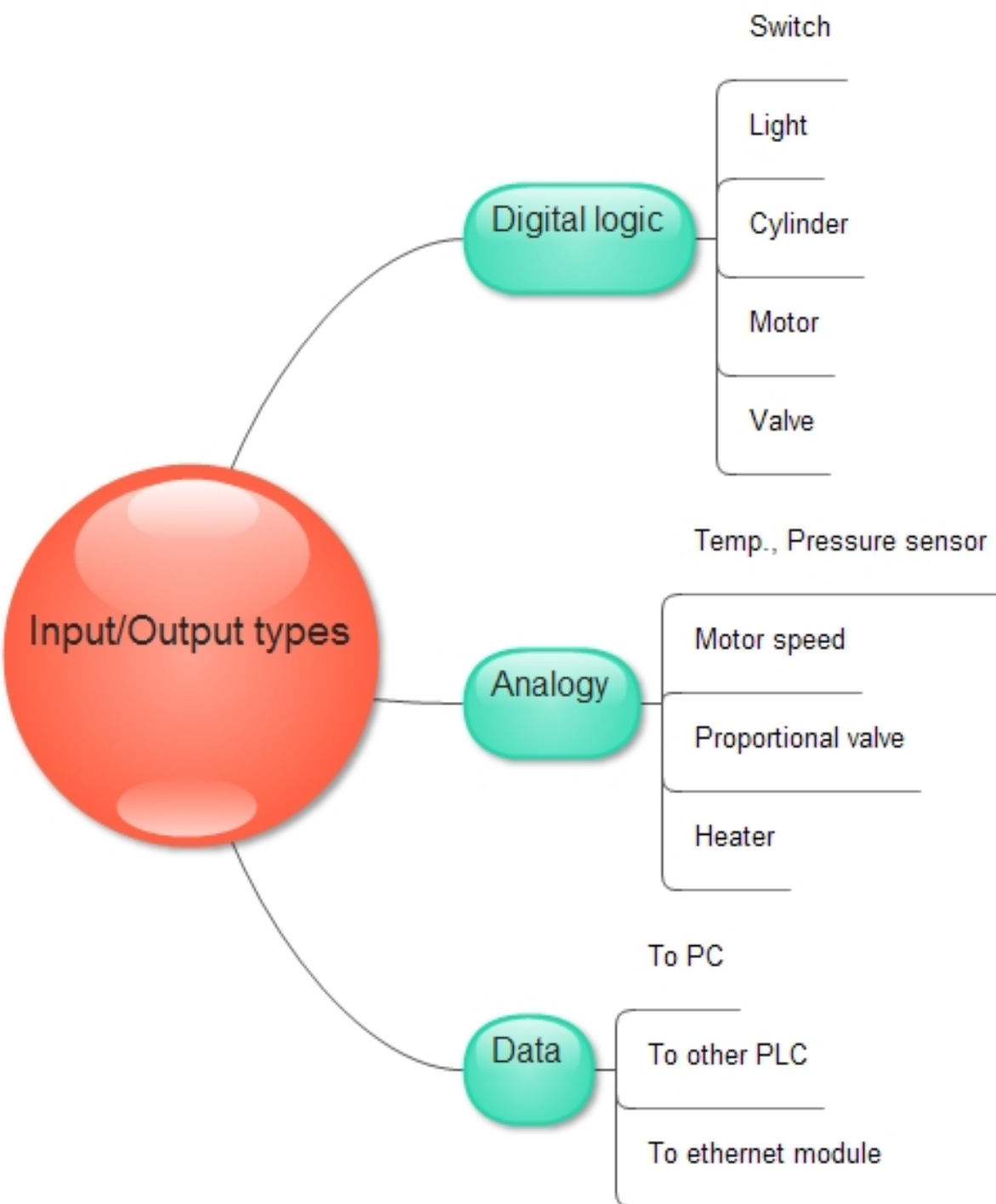
PROM (Programmable ROM): non-volatility, a permanent storage backup for some type of RAM.

EPROM (Erasable PROM): special PROM, erased by an ultraviolet light source.

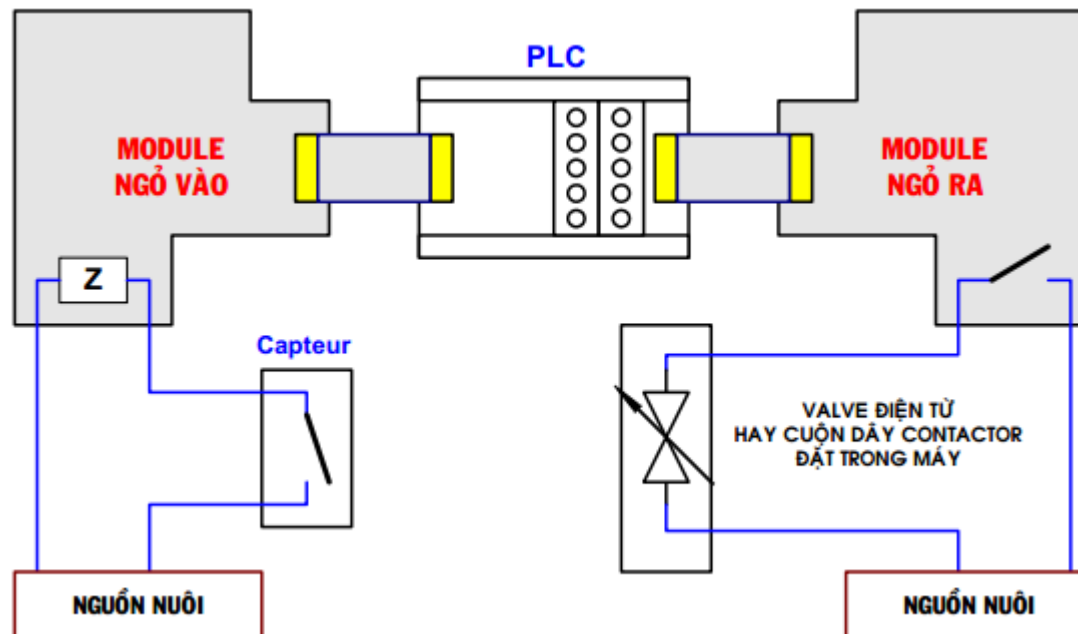
EEPROM (Electrically EPROM): provides permanent storage for the program and can be easily changed with the use of a programming device.

- ❖ Central Processing Unit (CPU - Processor): performs mathematical operations, data handling, and diagnostic routines.

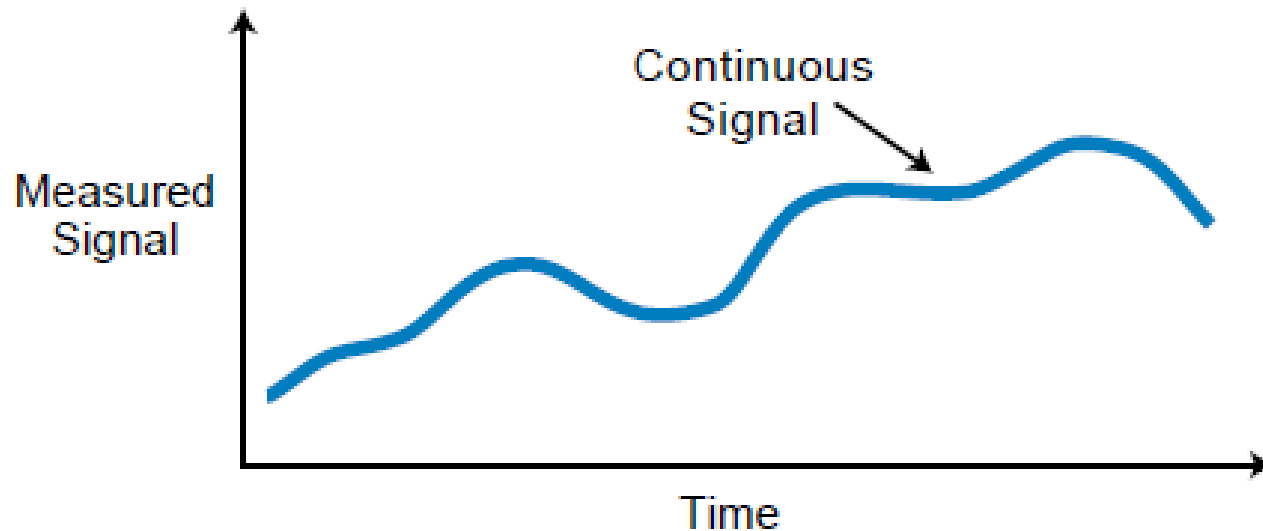




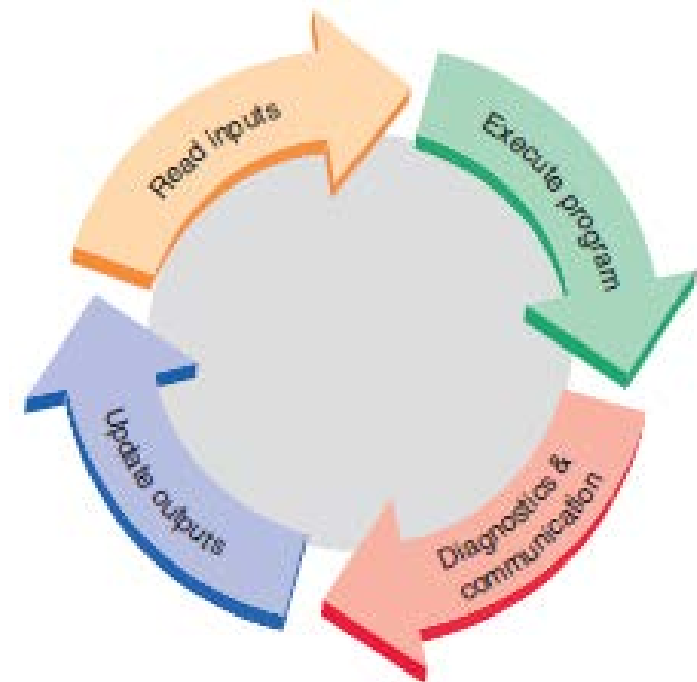
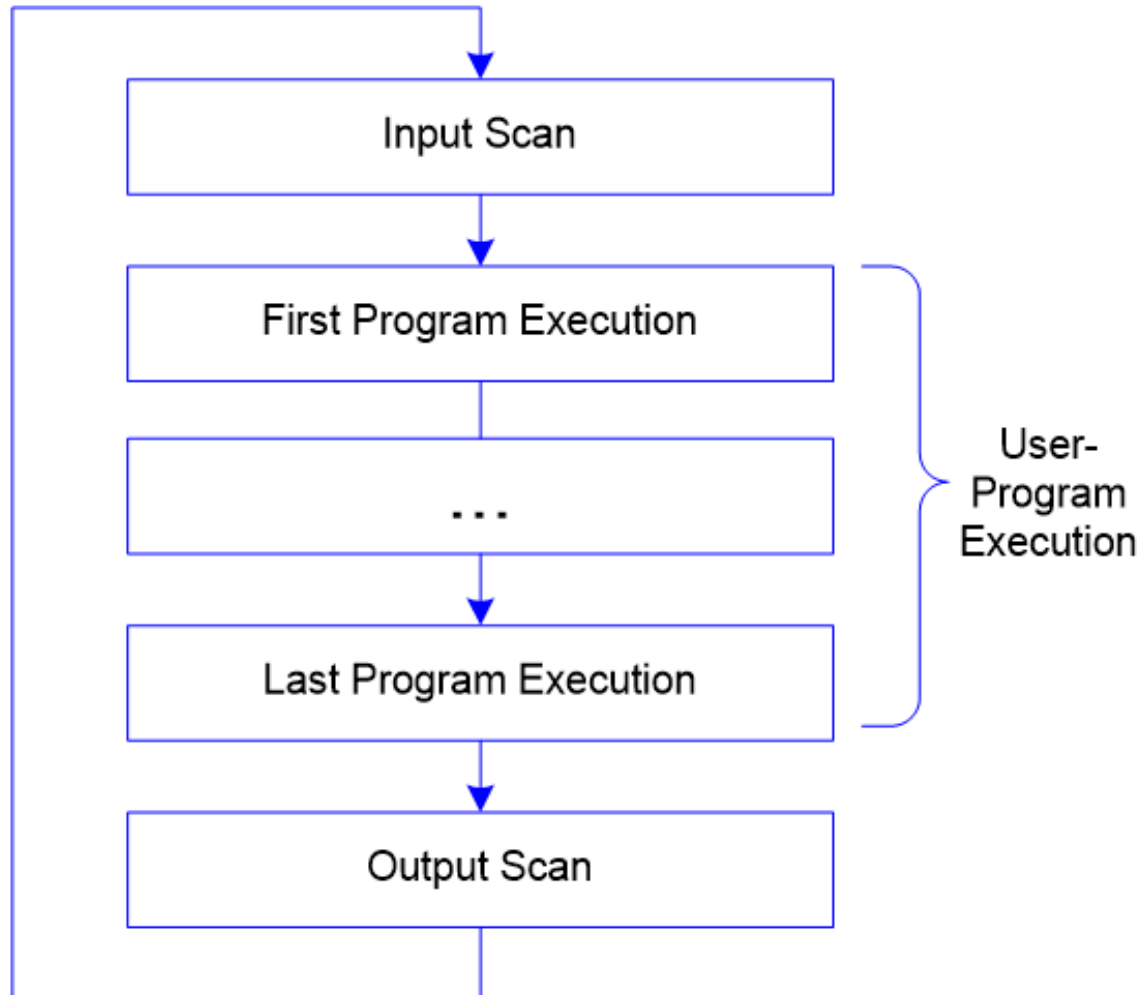
- ❖ The **discrete input/output (I/O)** system provides the physical connection between the central processing unit and field devices that transmit and accept digital signals.
- ❖ **Digital signals** are non-continuous signals that have only two states—ON and OFF.



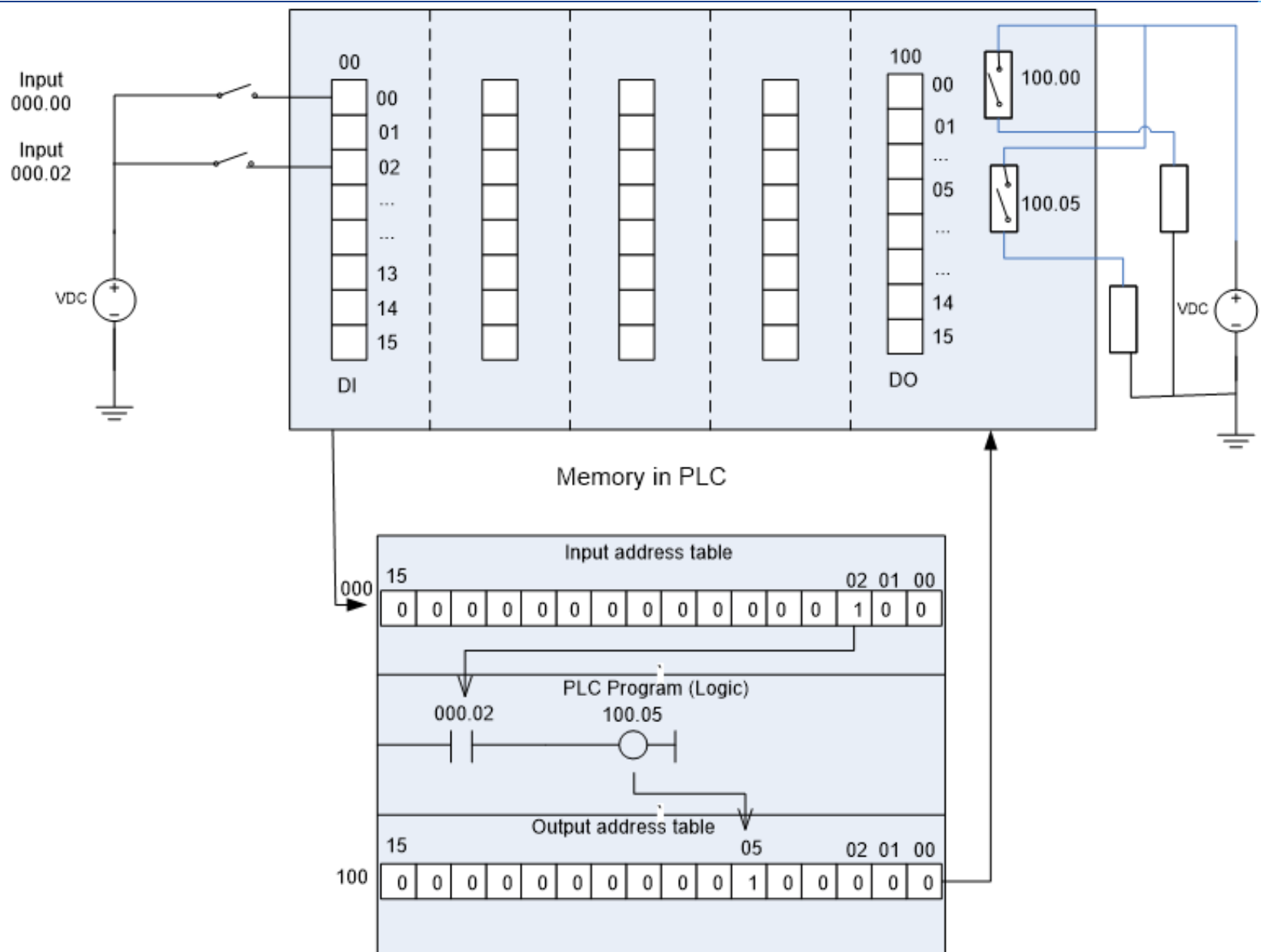
- ❖ Dislike discrete signals, analog signals have an infinite number of states.



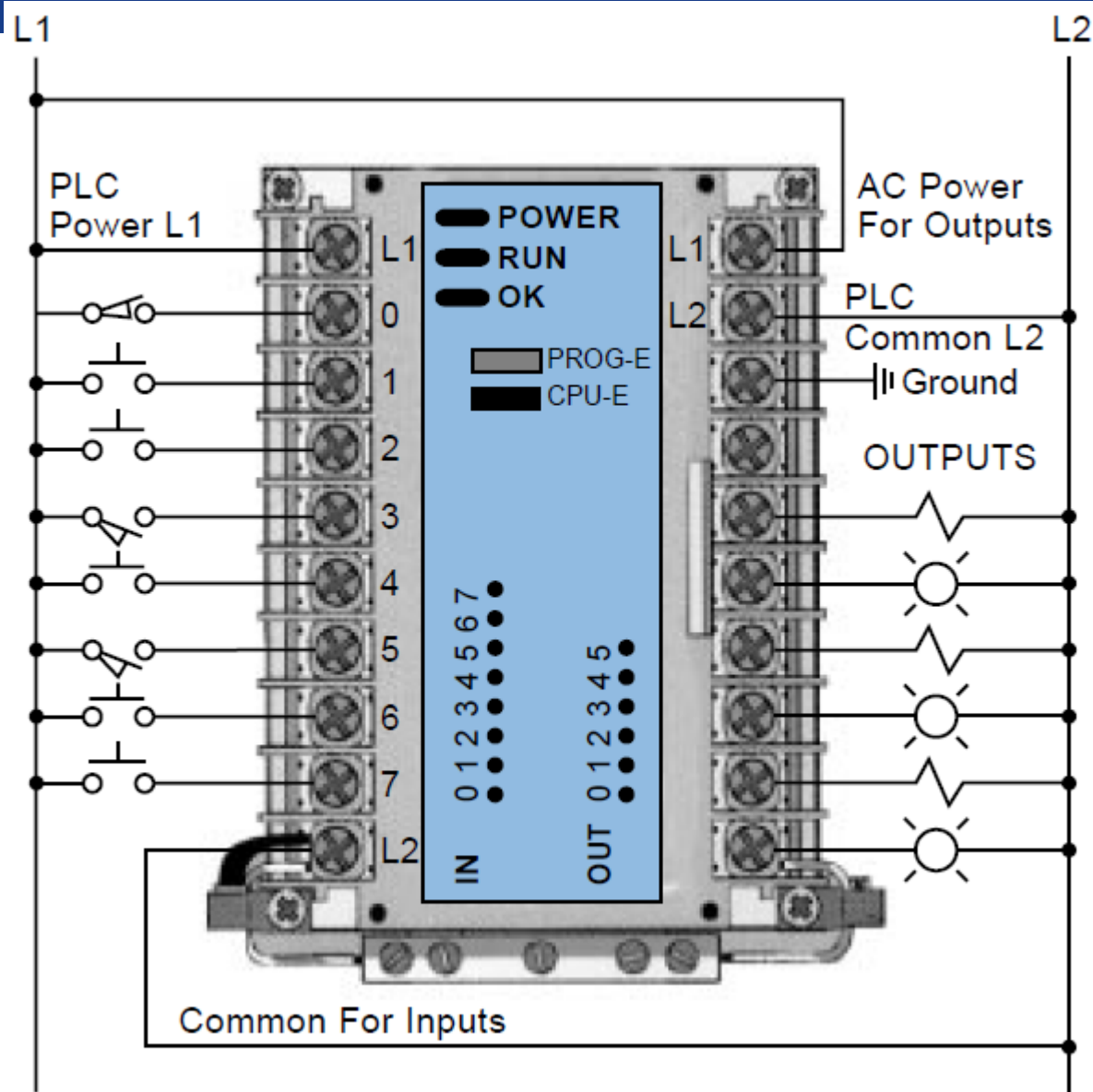
❖ Processor scan:



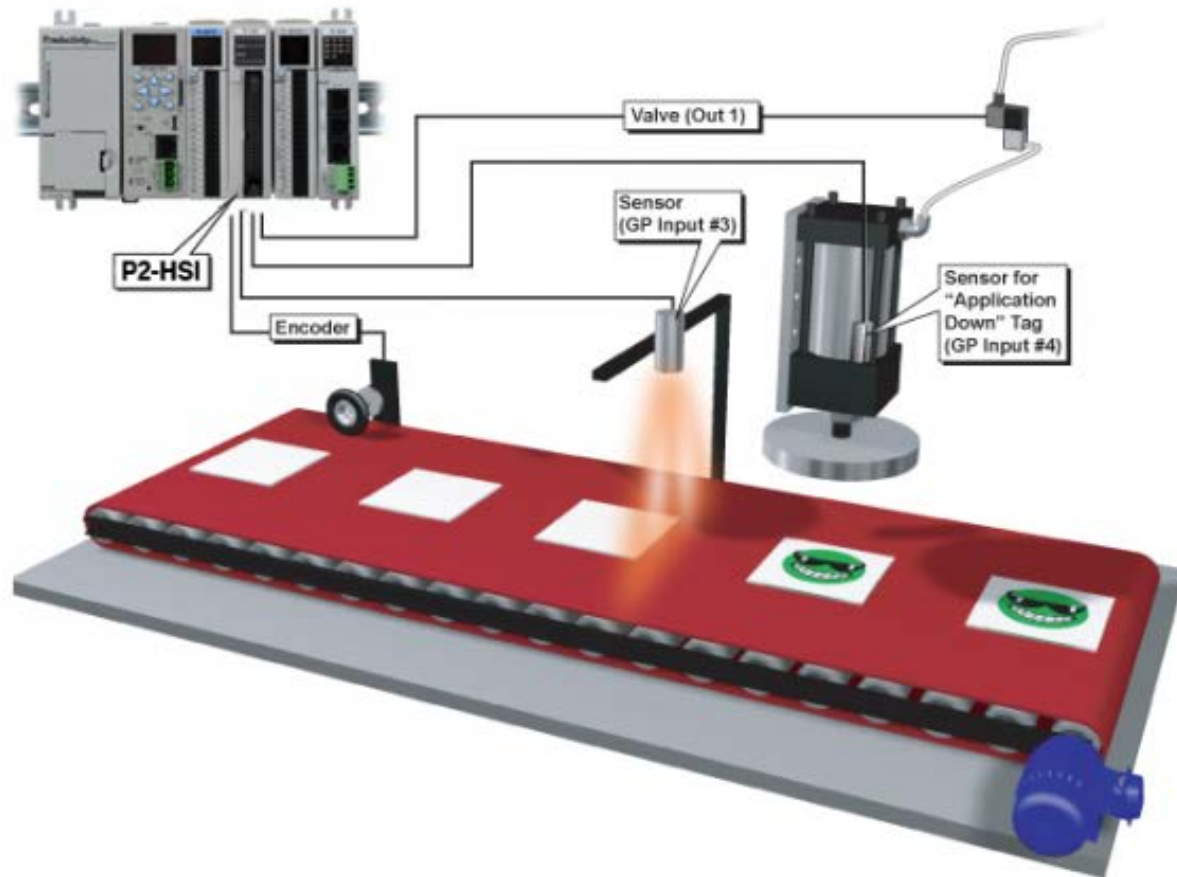
PLC Hardware



PLC Hardware

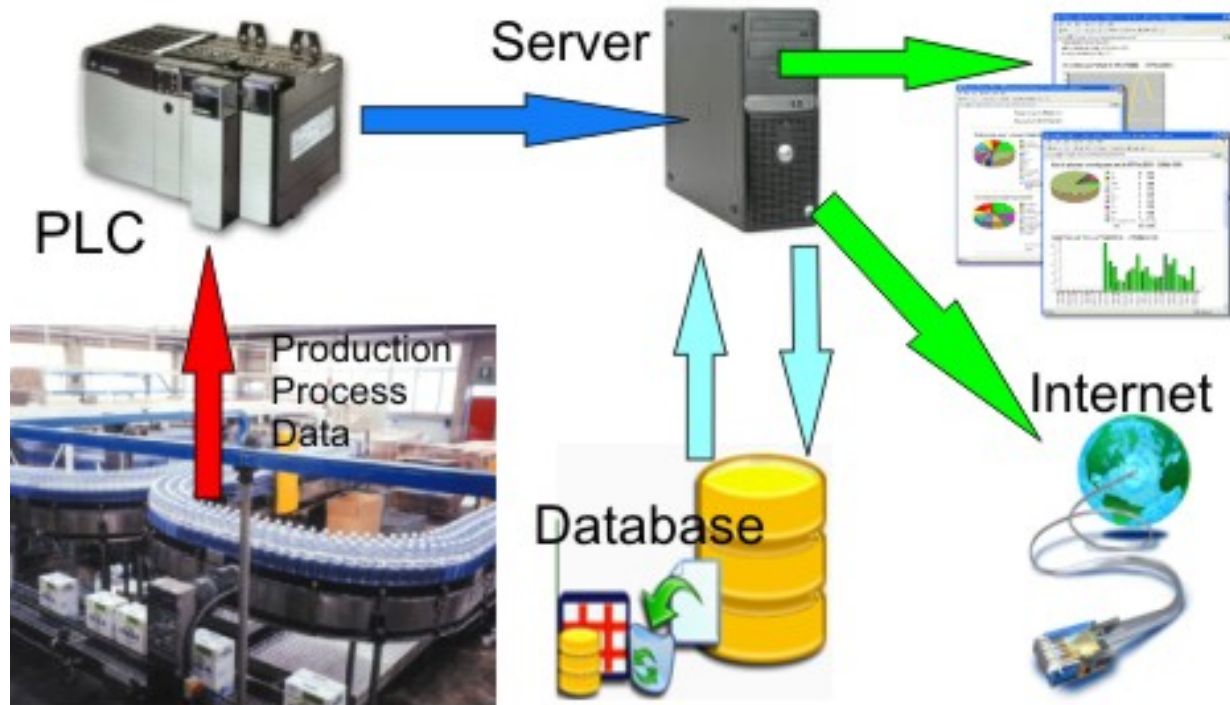


❖ Relationship between PLC and other devices in the system



PCL-based Motion control system

❖ Relationship between PLC and other devices in the system



PLC-based SCADA system

SCADA (supervisory control and data acquisition)



Physical factors

Temperature, moisture, vibration, dust, ...



Electrical factors

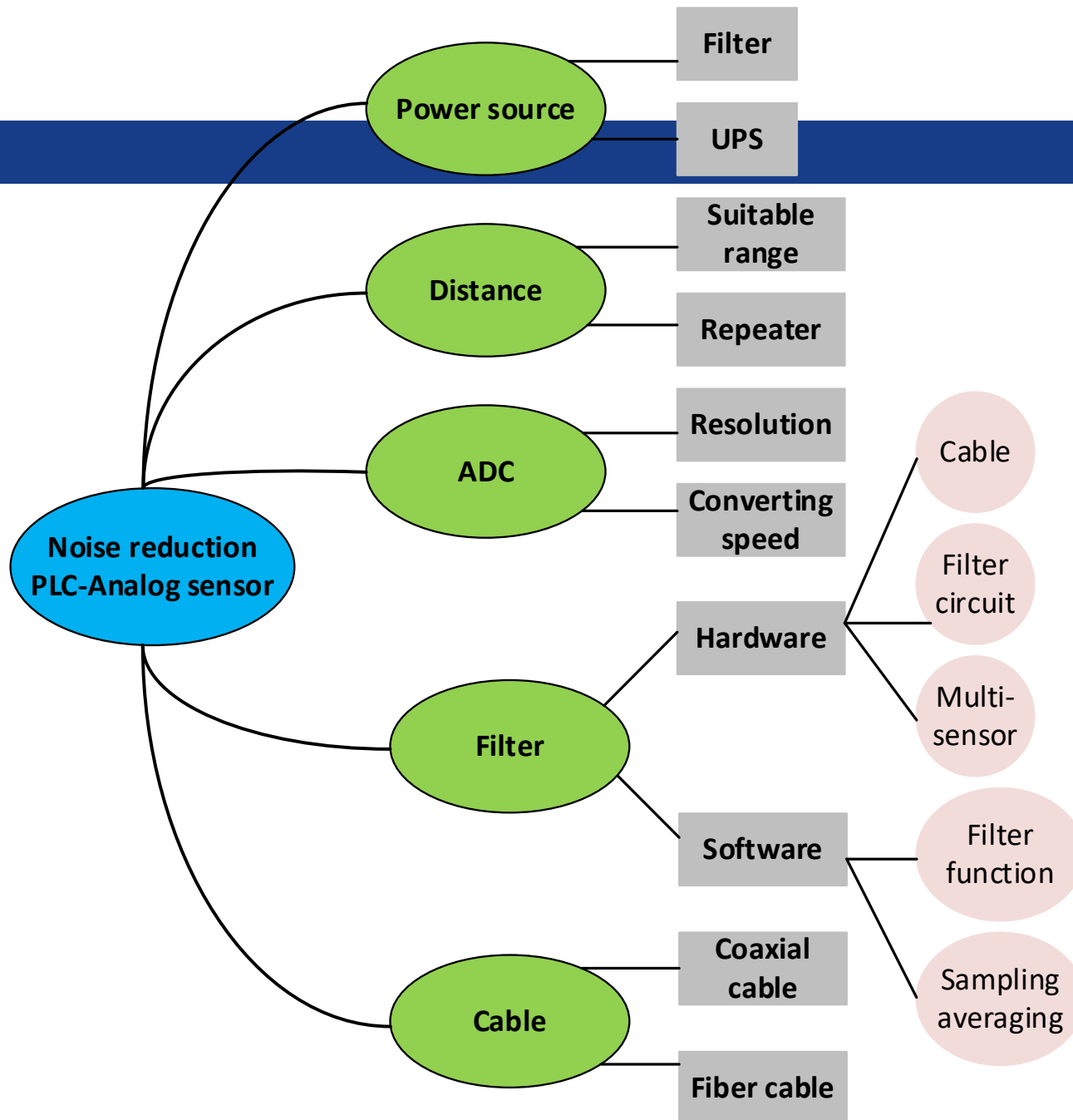
Electromagnetic waves, electric field, transmission line noise, ...



Power supply factors

Voltage drop/rise, power turn off-on suddenly

❖ **Noise reduction for analog devices:**

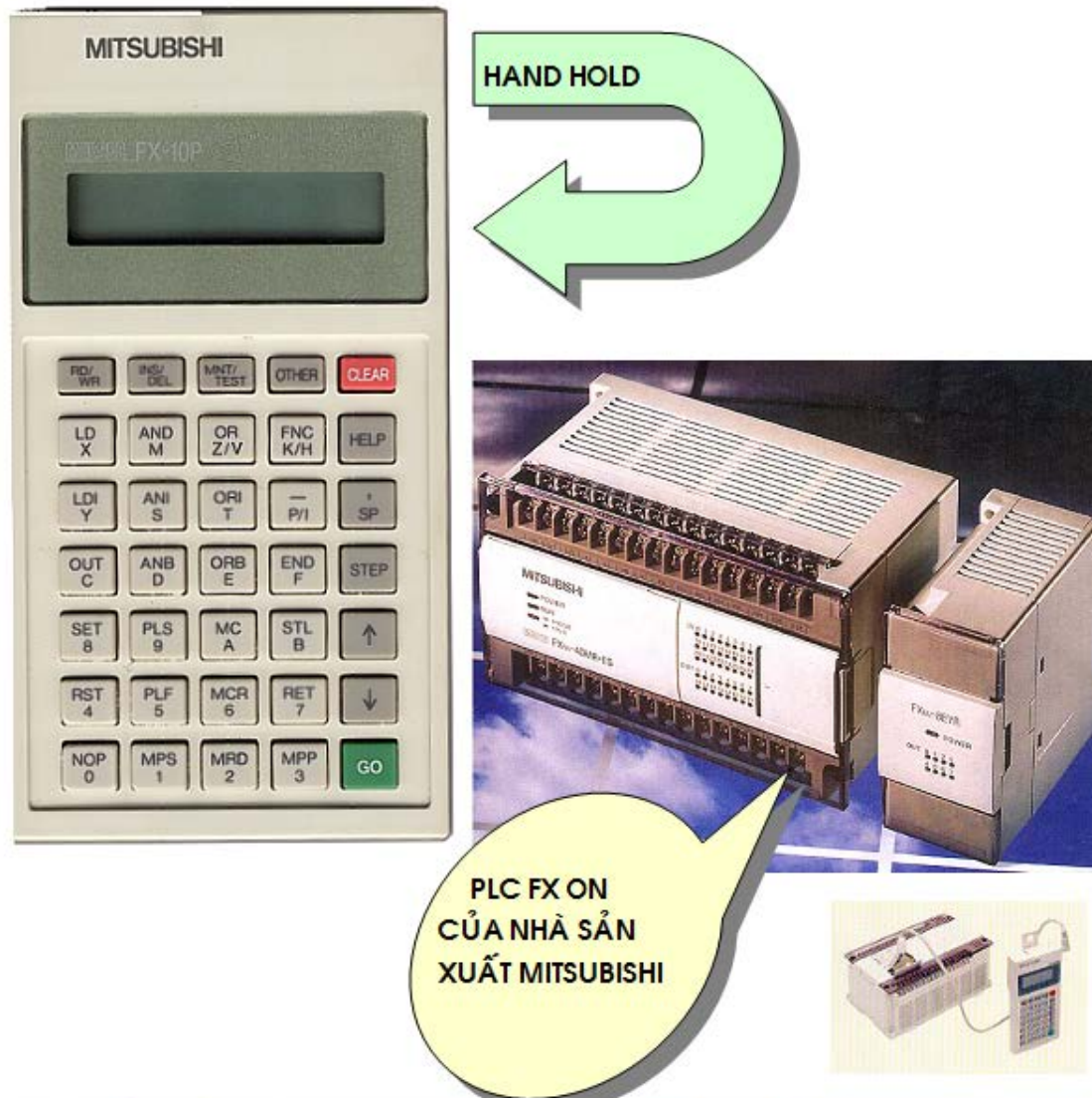


Programming for PLC
using Handheld
(Mini-programmer)

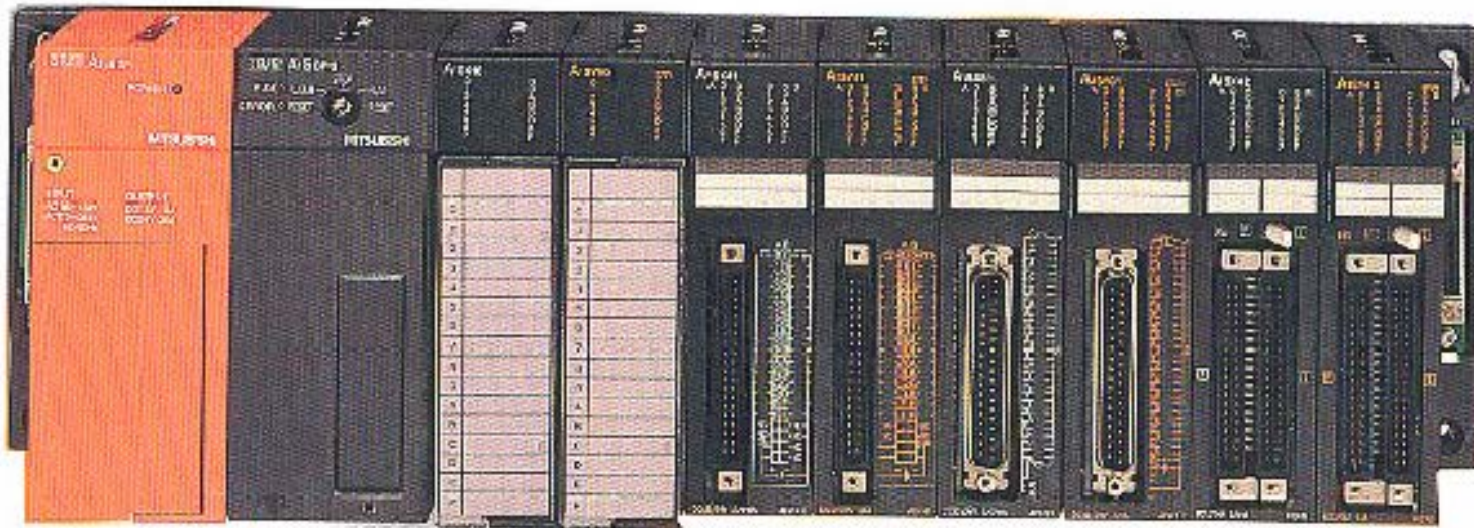


Programming for
PLC using PC

PLC Hardware



PLC Hardware



PLC MELSEC - AnS

PLC Hardware

SIEMENS



PLC Hardware



PLC Hardware



**Rockwell
Automation**

PLC Hardware



List of PLC Manufacturers



AMERICAN

1. Allen Bradley
2. Gould Modicon
3. Texas Instruments
4. General Electric
5. Westinghouse
6. Cutter Hammer
7. Square D
8. Rockwell Automation

JAPANESE

1. Toshiba
2. Omron
3. Fanuc
4. Mitsubishi

EUROPEAN

1. Siemens
2. Klockner & Mouller
3. Festo
4. Telemecanique