

PLC Automation Fundamentals – Hardware, Programming and Troubleshooting

1. PLC Hardware Architecture

A PLC (Programmable Logic Controller) is composed of:

CPU: Executes the control program and manages communication.

Power Supply: Converts AC to 24VDC for internal electronics.

I/O Modules: Interface between field devices and PLC.

Typical scan cycle:

Read Inputs → Execute Program → Update Outputs

Example:

Input I0.0 ON → CPU processes logic → Output Q0.0 activated.

2. PLC Programming Languages (IEC 61131-3)

- 1 Ladder Diagram (LD): relay-based graphical logic.
- 2 Structured Text (ST): high-level programming (IF, WHILE, variables).
- 3 Function Block Diagram (FBD): blocks connected by signals.

ST Example:

IF Sensor = TRUE THEN Motor := TRUE; END_IF;

3. Digital and Analog I/O Handling

Digital Inputs: ON/OFF signals (pushbuttons, sensors).

Digital Outputs: control relays, motors, valves.

Analog Inputs: 0–10V or 4–20mA (temperature, pressure).

Analog Outputs: speed or position control.

Scaling formula:

Engineering Value = (Raw × MaxValue) / MaxCounts

Example:

0–10V = 0–27648 counts → 13824 = 5V.

4. Timers, Counters, Comparators and Basic Logic

Timers: TON (On-delay), TOF (Off-delay).

Counters: CTU (Up), CTD (Down).

Comparators: >, <, = for analog values.

Logic gates: AND, OR, NOT, XOR.

Example:

If Sensor ON for 5 seconds → Motor ON (TON timer).

5. Debugging, Online Monitoring and Fault Finding

Online monitoring: view real-time I/O status.

Forcing I/O: temporary activation for testing.

Common faults:

- No power supply
- Broken sensor cable
- Incorrect addressing
- Program logic errors

Basic troubleshooting steps:

1. Check power LEDs
2. Verify inputs
3. Monitor program online
4. Test outputs manually

Educational document for PLC students and industrial automation technicians.