

PLC- Overview

- Programmable Logic Controller
 - Designed for industrial processes.
 - Works under severe conditions.
 - Real time system.
 - Handles sensors and actuators (I/O).

PLC- Functions

Process control

- Collects inputs (digital, analog)
- Runs the process control
 - Basic logic functions
 - Complex algorithms (PID...)
 - Safety functions
- Produces actions (outputs)
- Provides data to the supervision layer

PLC- Strength

- Reliable. Used for safety systems.
- Robust. Resistant to electrical noise, vibration, impact, dust, heat.
- Extensive range of inputs/outputs.
- Extensive range of functionalities.
- Long term support by suppliers.
- Long service life, around 20 years.

PLC- Weak points

- Limited memory.
- Low performance.
- Dedicated programming environment.
- Different programming languages from different manufacturers.

PLC- Hardware Overview



PLC- Sensors / actuators

- Device which converts the signal from one form to another.
- Sensors
 - Analog: Temperature, pressure, humidity, level, flow, weight...
 - Digital: Level, pushbutton (emergency stop), position switch, photoelectric sensor...

Actuators

- Analog: valve, pump, heater, power supply...
- Digital: Signaling column, contactor, electro valve, switch, OnOff pump...

PLC- Hardware Overview



PLC- Periphery stations

Communication modules.

I/O Modules.

- Convert physical value into numeric value and vice versa.
- Function modules.

PLC- Communication modules

- Ethernet
- Profibus
- Profinet
- Modbus
- Ethernet IP
- CAN
- Serial, Point to Point
- AS-Interface

PLC- Input / Output modules

- Analog
 - 16-bit signed from -32768 to 32767.
 - Inputs: Resistance, Current, Voltage, thermocouple...
 - Outputs: Current, voltage.
- Digital
 - 1-bit
 - Inputs: 120v-230v AC, 24v DC
 - Outputs: Relay, 120v-230v AC, 24v-48v-125v DC.

PLC- Function modules

- PID control
- Flow
- Camera controllers
- Numerical controllers
- Counters, positioners.
- Motor VFD or Soft Starter

PLC- Hardware Overview



PLC- FieldBus. Overview

- Industrial Network System
- Provides the PLC with I/Os
- Time deterministic

PLC- FieldBus. Strength

- Controls multiple I/Os
- Saves cabling costs
- Allows distributed layouts and topologies
- Safety compliant

PLC- FieldBus. Weak points

- Sensitive to electromagnetic noise.
- Installation constraints (specific installation guidelines).
- Several different (incompatible) fieldbus standards.

PLC- FieldBus. Standards

- Profibus
 - Industry leader (56.1 million nodes)
- WorldFip
 - Robust (radiation resistant)
- CAN. CANOpen. CANBus
 - Low cost, Easy to implement
 - Used for ELMB at CERN
- Over Industrial Erthernet:
 - Profinet (16.4 million nodes)
 - EtherNet/IP
 - Powerlink
 - EtherCAT

PLC- FieldBus. Market share



PLC- Profibus. Technical data

 Standard 	PROFIBUS EN 50 170	
 Access 	Token ring . Master-Slave	
 Transmission rate 	9.6 kbit/s - 12 Mbit/s	
 Transmission technology 	electric: optic: wireless:	Shielded cooper pair twisted cable fiberoptics (cristal and plastic) infrared and radio
 Nodes 	127 maximun	
 Network lenght 	electric: optic:	9.6 km maximun 150 km maximun
 Topology 	Daisy Chain, tree, star, ring, redundant ring	
 Used for 	Process communication, data transfer	

PLC- Profibus



PLC- Hardware Overview



PLC- Supported at CERN





Siemens CERN-SIEMENS B1130A/GEN 31-12-1999

Schneider CERN-SCHNEIDER. B1129/GEN 12-11-1999

PLC- Siemens

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IEMENS



PLC- Siemens



PLC- Siemens

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SIEMENS

 S7 400 (high range)
 Redundant architecture
 Large memory
 High performance

PLC- Siemens – New CPUs



S7 1500 (medium/high range)

- Modular
- Wide range of IO
- Large memory
- High performance

PLC- Schneider

Small range (M340)



 Medium range (PREMIUM)



 High range (QUANTUM)



- 4 Mb of memory
- 1024 digital I/O
- 256 analog I/O

- 7 Mb of memory
- 2040 Digital I/O max
- 512 Analog I/O

- 8 Mb of memory
- 8 000 Digital I/O
- 2500 Analog I/O

PLC- Schneider – New CPU

High range (M580)



- Compact
- High performance
- Modular

PLC- Processor



PLC- Memory access, IO access



%MW100 := 12;

%QW0.2.3 := 16#0F00;

%Q0.7.3.6 := TRUE;

PLC- Programming languages

Languages defined in IEC 61131-3

- Textual languages
 - Instruction List (IL)
 - Structure Text (ST)
- Graphical Languages
 - Ladder (LD)
 - Functional Bloc Diagram (FBD)
- Sequence (Stepper)
 - Sequential Function Chart (SFC)

PLC- Programming languages - IL

- IL: Instruction List
- Fastest possible logic execution.
- Low level language

PLC- Programming languages - ST

- ST: Structured Text
- High level language
- Equations, table manipulation
- Complex statements and nested instructions
 - Iteration loops (REPEAT-UNTIL; WHILE-DO)
 - Conditional execution (IF-THEN-ELSE; CASE)
 - Functions (SQRT(), SIN())

PLC- Programming languages - LD

- Traditional *ladder logic* is an easy-to-use graphical programming language that implements relay-equivalent symbol.
- Intuitive.
- Limited functionalities.



PLC- Programming languages - FBD

- FBD : Function Block Diagram
- Easy way of programming (intuitive)
- Easy way of debugging
- Limited for complex algorithms



PLC- Programming languages - SFC

- SFC : Sequential Function Chart
- A graphical method of representing a sequential control system (stepper).



PLC- Programming software tools

- Siemens : Simatic Step7
 - Modular
 - Wide range of functionalities
 - Diagnostic tools
 - Network configuration
- Schneider : UNITY Pro V11.0
 - Easy to manage
 - Visualization facilities

PLC- Hardware Overview



PLC- SCADA communication

- Ethernet TCP IP.
- Big amount of data transfer.
- Non deterministic.
- Big data transfer rates.
- S7 Driver on TCP IP. Siemens.
- Modbus Driver on TCP IP. Schneider.
- OPC.