INDUSTRIAL MAINTENANCE

IM6930

PRODUCT SPECIFICATION

Name: PLC Fundamentals Trainer
Product Range: Industrial Maintenance
Product Code: IM6930
Curriculum Code: CP2388
Power Supply: 24V
Size: L 514mm x W466mm x D 250mm

Product Description

The PLC Fundamentals Trainer is a hands-on training platform designed specifically for those new to industrial maintenance and automation. It provides a structured, practical introduction to PLC-controlled systems using real-world components and industrial wiring standards. At the heart of the system is a Siemens S7-1214 PLC and a 7-inch Unified Basic HMI, delivering a realistic interface for observing how inputs and outputs interact in a typical automated process.

Rather than focusing on programming or diagnostics, the module helps learners build core knowledge from the ground up. It starts with how a basic control panel is laid out and how devices like push buttons, proximity sensors, and temperature inputs are wired into a PLC. The system includes clearly labelled terminals and a mix of digital and analogue devices, offering opportunities to explore normally open (NO) and normally closed (NC) contacts, signal types, and typical industrial safety features such as dual-channel emergency stops, with outputs demonstrated both directly from the PLC and via relays for isolation.

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Each component has been carefully selected to reflect what learners will encounter in real facilities. From the MCB to the red-and-white RPM feedback motors and DIN rail relays, every interaction is visible and tactile. This makes concepts like I/O mapping, contact state logic, and basic sequencing intuitive and easy to grasp.

Designed to support T-Level qualifications and foundational maintenance training, the module includes a short set of worksheets that guide users through each component's role, wiring, and interaction with the PLC. By the end of the course, learners will have a solid understanding of how signals flow through a control system and how industrial hardware works together, even if they have never touched a control panel before.

Perfect for the hands-on learner who has never opened a control panel and isn't sure if a PLC is a fuse or a fancy relay. This is the place to start building real industrial confidence.

Target Audience

This curriculum is designed for 16 to 18-year-old engineering students in further education colleges, as well as apprentices beginning their careers in industrial maintenance and automation. It is ideal for those studying T Levels, BTECs, or similar vocational qualifications where practical understanding of control systems is essential. The program focuses on giving learners their first exposure to PLC hardware, inputs and outputs, safety systems, and real industrial components, without requiring prior knowledge of programming or electrical systems. Whether the goal is to work in manufacturing, utilities, or process industries, this course lays the groundwork for understanding what is inside a control panel, how components interact, and how modern automation systems are built and maintained.

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Key Features

System Hardware and Design

- Siemens S7-1214 PLC with digital and analogue inputs and outputs
- Siemens Unified Basic HMI for monitoring I/O and displaying system status
- Range of input devices including push buttons, selector switch, proximity sensor, potentiometer, and temperature sensor
- Output devices including red and green LEDs, DIN rail-mounted relays, and two visual RPM feedback motors
- Integrated emergency stop and blue reset button wired through a dual-channel wiring
- Clearly labelled terminals, modular DIN rail layout, and MCB for power isolation
- Industrial-grade 24V components selected to reflect real control panels
- Compact desktop format suitable for classroom and bench-top use

Curriculum and Learning Outcomes

- Introduces basic concepts of PLC-controlled systems and industrial control panels
- Explains digital and analogue inputs and outputs, including NO and NC contact types
- Covers dual-channel E-stop circuits and relay logic
- Provides practical exposure to reading sensor signals and observing actuator response
- Helps learners build confidence in identifying components and understanding their roles

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Hands-On Interaction and Visual Feedback

- Visible signal indicators via LEDs and rotating motor discs for easy observation of output activity
- Use of multimeters encouraged to test voltages and continuity across terminals
- PLC and field devices include LED indicators to support signal tracing and logic understanding

Worksheets and Instructor Support

- Includes a structured set of worksheets focused on each component and concept
- Worksheets cover E-stops, push buttons, relays, terminals, indicator lights, and more
- “Over to You” sections guide learners to explore and apply concepts independently
- Full documentation with wire numbers and terminal references

Target Audience and Qualification Mapping

- Designed for students aged 16 to 18 in further education or apprenticeships
- Aligned with UK T-Level and BTEC Maintenance, Installation, and Repair units
- Suitable for learners with no prior experience in PLCs or control panels
- Ideal for classrooms, lab sessions, and vocational training programs

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Learning Objectives

By the end of the PLC Fundamentals curriculum, learners will be able to:

1. Identify and explain the function of common industrial control panel components, including push buttons, selector switches, relays, motors, indicator lights, and sensors.
2. Demonstrate correct wiring and testing of both digital and analogue input and output devices to a Siemens PLC and HMI.
3. Apply safe working practices by using isolation devices, emergency stops, and status indicators during system operation.
4. Distinguish between digital and analogue signals, explain how PLCs process each type, and apply scaling to interpret sensor values.
5. Monitor and interpret PLC and HMI feedback, including I/O activity, fault states, and process conditions, to support troubleshooting.
6. Understand how PLC logic controls outputs, including sequencing, latching, and PWM motor speed control.
7. Follow structured worksheets to build practical confidence in tracing signals, testing circuits, and verifying safe system operation.
8. Describe how a PLC processes basic on/off inputs to control outputs, using push buttons and indicator LEDs.
9. Explain sequencing and latching logic, and demonstrate how a PLC can manage multi-step processes with start/stop conditions.
10. Interpret HMI displays to monitor live I/O states, process steps, and alarms, and explain their role in operator interaction.
11. Demonstrate safe isolation using a dual-channel emergency stop and reset circuit, and explain its role in industrial safety.
12. Recognise how system status indicators show healthy, fault, and stop states, and explain their use in diagnostics.
13. Distinguish between normally open (NO) and normally closed (NC) inputs, interpret their states on the HMI, and explain why both are used in control circuits.
14. Connect and test an inductive proximity sensor, and describe its application in detecting objects and ensuring safe operation.
15. Use a potentiometer to generate a 0–10 V analogue signal, and explain how PLCs scale and process analogue inputs.
16. Measure and interpret readings from a PT100 RTD with transmitter, and explain how analogue scaling converts raw values into real temperatures.

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17. Operate PLC-driven outputs such as LEDs, relays, and motors, and explain how digital logic activates actuators.
18. Demonstrate how PWM control varies motor speed, and relate duty cycle percentage to motor performance.
19. Explain and test the function of relays in isolating PLC outputs from loads, and describe their importance in industrial control circuits.

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Worksheets

CP2388 – PLC Fundamentals for Maintenance Engineers

- **Worksheet 1 – Simple PLC Systems**
  Momentary push-button drives a basic ON/OFF output while you observe matching I/O indicators on the rig and PLC.
- **Worksheet 2 – Complex PLC Systems**
  Latched start command triggers a timed output sequence (Q0→Q5); sequence can be interrupted by Stop or E-Stop.
- **Worksheet 3 – HMIs**
  Batch-mixing HMI: select batches, adjust Mix 1–3 parameters, watch controls grey out during mixing, then resume on completion.
- **Worksheet 4 – Emergency Stops**
  Use the E-Stop during the mixing demo, then clear alarms/faults; dual-channel behaviour is implemented in PLC logic and requires twist-release plus reset.
- **Worksheet 5 – Status LED**
  Read system state in Basic, Enhanced, and Live Process modes; confirm colour/flash patterns for normal, fault, and process conditions.
- **Worksheet 6 – Normally Open vs Normally Closed**
  Hands-on with NO/NC inputs: momentary, latching push-button, and 3-position switch mapping to I4/I5 to interpret I/O states correctly.
- **Worksheet 7 – Proximity Sensor**
  Inductive proximity sensor confirms forging-press locking pins; practise simulating detection and recognising interlock/fault behaviour.
- **Worksheet 8 – Potentiometer**
  Analogue input scaling: apply offset and scalar, observe motor response (via PWM), and see how software calibration affects behaviour.
- **Worksheet 9 – Temperature Sensor**
  PT100 with transmitter to 0–10 V: convert raw values (0–27,648) to °C via a scalar, identify ~32,000 as a fault, and tune to realistic ambient.

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- **Worksheet 10 – Digital Outputs**
  Drive outputs from buttons, selector, proximity sensor, and potentiometer; finish with HMI “Dance Mode” to recognise timed output sequences.
- **Worksheet 11 – Motor PWM**
  Map potentiometer to PWM duty cycle; view live input graph and duty readout while correlating duty percentage to motor speed.
- **Worksheet 12 – Relays**
  See the PLC energise a relay coil to switch a load; test manual and auto (pot-based) activation and confirm E-Stop de-energises.

Packing List

Essentially the product will be sold as almost one complete tested unit.

Contents;

- IM6930: Base with all components installed PLC & HMI.
- Matrix 24V Power Supply

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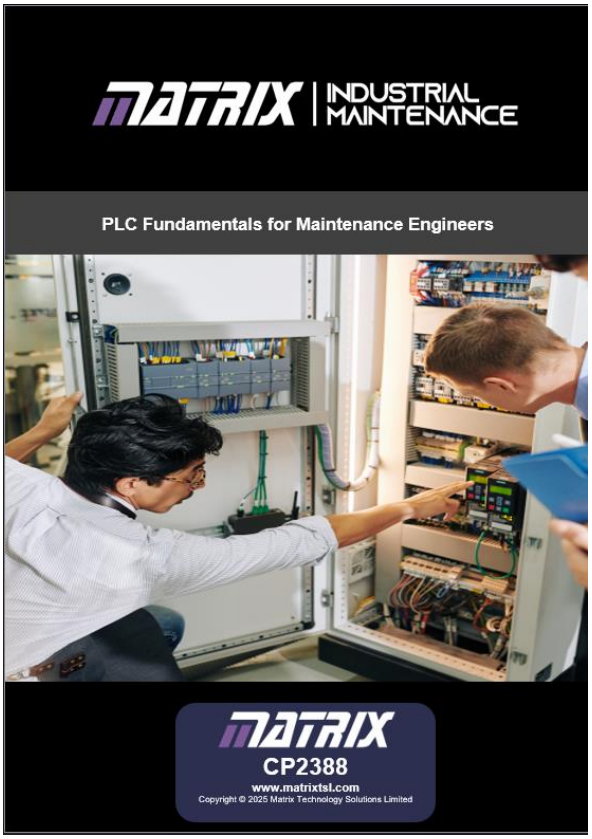
PRODUCT SPECIFICATION

Curriculum

CP2388 – PLC Fundamentals for Maintenance Engineers



Click here to download curriculum from our Learning Centre

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Main Components

Main Module

Below are the main components of the PLC Fundamentals Trainer. Each part has been carefully selected to reflect real-world industrial systems and is fully integrated for hands-on learning.

PLC – Siemens S7-1200 (CPU 1214C)
• **Purpose:** Central controller for logic, safety interlocks, and I/O processing
• **Key Features:**
  ○ 14x Digital Inputs, 10x Digital Outputs (24VDC)
  ○ 2x Analog Inputs (0–10V)
  ○ Interfaces with HMI for setpoint, alarms, and diagnostics
	

PRODUCT SPECIFICATION

Unified HMI – Siemens Unified Basic Panel (MTP700)
• **Purpose:** Operator interface for real-time monitoring, fault display, and parameter input
• **Key Features:**
  ○ 7" touch screen for flow setpoint input and system feedback
  ○ Displays alarms, I/O status, values, and temperature cutoffs.
  ○ Setup page allows editing of temperature cutout limits and viewing system state
	

Motor –Brushed DC Motor, 3 W, 24 V dc, 3700 rpm, 2.5mm Shaft Diameter
• **Purpose:** Used to visually represent output activation and rotational speed in PLC-controlled systems.
• **Key Features:**
  ○ Operates on 24 V DC via relay or PWM output from the PLC
  ○ Drives a disc to provide a clear visual indication of motor speed
  ○ Ideal for demonstrating output control, switching, and variable speed functionality in a safe, compact format
	

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Relay – WAGO Interface Relay, DIN Rail Mount, 24 V AC/DC Coil, 1-Pole
• **Purpose:** Relay – WAGO Interface Relay, DIN Rail Mount, 24 V AC/DC Coil, 1-Pole (857-358)
• **Key Features:**
  ○ 24 V AC/DC coil, compatible with standard PLC output voltage
  ○ 1-pole changeover (SPDT) contact rated up to 250 V AC / 6 A
  ○ Includes integrated status indicator for visual feedback
	

Proximity Sensor – RS PRO Inductive Threaded Barrel Proximity Sensor, M12, 8 mm Detection, PNP NO, 10 → 30 V dc • **Purpose:** Detects the presence of nearby metal objects without physical contact. Used to simulate safety interlocks or object detection in automated systems. • **Key Features:** ○ Inductive sensor with 8 mm sensing distance, ideal for general object detection	

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Temperature Transmitter – IFM TP9237 (Evaluation Unit for PT100/PT1000 Sensors)

- **Purpose:** Converts resistance signals from PT100 or PT1000 temperature sensors into a standard 0–10 V analogue output signal readable by a PLC.
- **Key Features:**
  - Compatible with both **PT100 and PT1000** RTDs
  - Provides a **0–10 V analogue output** for temperature measurement
  - Designed for use in industrial environments with robust housing and secure terminals

Emergency Stop – Siemens SIRIUS ACT, dual-channel, twist-release

- **Purpose:** Provides a rapid stop function for training use. Two NC channels feed the PLC; when pressed, the PLC immediately disables outputs, raises a safety fault on the HMI, and requires a manual reset before operation can resume.
- **Key Features:**
  - Dual NC contact modules wired to separate PLC inputs for channel monitoring and fault detection

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Status Indicator – Banner K50L Multi-Colour LED Beacon

- **Purpose:** Provides a clear, visible indication of system state during training. The beacon changes colour to reflect normal operation, fault conditions, or emergency stop activation, allowing learners to quickly interpret system status at a glance.
- **Key Features:**
    - Sealed RGB LED beacon with full-surface illumination for high visibility
    - Displays green for normal operation, yellow for faults, and red for emergency stop or system lockout
    - Compact base-mount design with M30 thread, suitable for bench-top training environments
    - IP67/IP69 protection rating, robust housing for industrial-style durability
    - Operates from 18–30 V DC, directly driven by PLC outputs for real-time indication

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Frequently asked questions

What software is needed to run the system?

None. The system runs entirely self-contained using the onboard Siemens PLC and Unified HMI.

Optionally, Siemens TIA Portal (v20 and above recommended) can be used to modify or create your own PLC logic.

Does the kit come with curriculum materials?

Yes. A full curriculum is included, complete with guided student worksheets and detailed teacher notes, available through the Matrix Learning Centre.

What age group is this kit aimed at?

It's designed for further and higher education students aged 16–20 studying engineering, automation, or maintenance.

How many students can use the kit at once?

It's ideal for 1 or 2 students working collaboratively. Two learners can comfortably work side-by-side during practical sessions.

How is the system powered?

The system uses a 24V DC power supply and comes with UK, EU, and US adapters. No mains wiring is required.

Is post-use maintenance required?

Very little. The system is fully electrical and requires no cleaning or servicing beyond occasional checks for loose wires or damaged cables.

Can I reprogram the PLC?

Yes. You may load your own program using TIA Portal. The system is delivered with default training code, which is editable.

How is the system stored?

The compact design allows it to be stored on a shelf or under a bench. The carry handles make it easy to move. All components are securely mounted for transport.

Is the system portable?

Yes. The system is manageable by one person and designed for easy transport between classrooms or benches.

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Do I need a PC to operate it?

No PC is needed for normal operation. The HMI provides all necessary control and diagnostics.

Is technical training required to use the kit?

No prior experience is needed. The worksheets walk students through system operation, faults, and diagnostics step-by-step.

What is the warranty or support included?

The product includes a standard 12-month warranty with full technical support from Matrix TSL.

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Tender Specification

Matrix Technology Solutions Ltd shall supply the **PLC Fundamentals Trainer** with the following features, capabilities, and performance assurances:

Hardware Specification

- The system shall be a desktop-format, fully electrical industrial training kit designed for beginner-level maintenance training in PLC-controlled systems.
- The system shall feature a steel or composite baseplate with industrial DIN rail components securely mounted and clearly labelled.
- The system shall include the following input devices:
    - Four push buttons with a mix of normally open and normally closed contact types
    - One 2-position selector switch
    - One potentiometer (0–10 V)
    - One inductive proximity sensor (Omron E2E-X16MB1T12)
    - One IFM temperature transmitter (TP9237) for PT100/1000 sensors
    - One simulated dual-channel emergency stop push button
    - One blue reset button
- The system shall include the following output devices:
    - Six indicator LEDs (three green, three red)
    - Two DC motors with red-and-white RPM discs for visual feedback
    - DIN rail-mounted relays (WAGO 857-358 or equivalent)
- The system shall include electrical protection and distribution components:
    - One miniature circuit breaker (MCB) for system power isolation
    - Touch-safe 24 V DC power supply
    - DIN rail-mounted terminal blocks for I/O and power wiring

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- The system shall be supplied with carry handles for portability and a compact footprint suitable for benches and desks.

Control & Communication Features

- The system shall include a Siemens S7-1200 CPU 1214C PLC, providing 14 digital inputs, 10 digital outputs, and 2 analogue inputs.
- The system shall include a Siemens Unified Basic HMI (7"), offering real-time I/O display and user interaction through a capacitive touchscreen.
- Communication interfaces shall include:
    - Ethernet for PLC programming and PLC-HMI communication
    - USB port for firmware updates to the HMI
- The system shall operate from a 24 V DC input, with UK, EU, and US-compatible plug adapters supplied.

Performance Expectations

- The system shall allow learners to monitor and control input and output states through physical devices and a visual HMI interface.
- Each component shall be mounted and prewired to allow practical testing and observation through the HMI.
- The system shall include a **simulated dual-channel emergency stop system**, controlled in PLC logic to disable outputs and reflect industrial safety principles.
- The motors shall visually represent PLC output control, with rotation speed reflecting either relay control or PWM drive depending on configuration.
- Analogue inputs (potentiometer and temperature sensor) shall be accessible for signal variation and HMI monitoring exercises.

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Software & Curriculum

- The system shall be delivered with default Siemens PLC and HMI programs, ready for training use.
- Logic and HMI screens shall be editable using Siemens **TIA Portal (v20 or later)**. Project files shall be made available on request.
- The system shall include a set of **12 guided worksheets**, focusing on:
  - Understanding PLC I/O basics
  - Simulated emergency stop and reset functionality
  - Contact types (NO/NC) and input signal types
  - Digital vs analogue I/O
  - Output devices including LEDs, motors, and relays
  - Power supply and isolation components
- Worksheets shall be accompanied by instructor notes, wiring schematics, and expected learning outcomes.
- Curriculum shall align with UK **T-Level** and **BTEC** standards in Maintenance, Installation, and Repair.

Quantity & Scope of Delivery

- Each unit shall be delivered fully assembled and ready to operate, including:
  - Siemens PLC and HMI
  - Prewired components and labelled terminals
  - Power supply with global plug set
  - Cable storage tray or compartment
- Each kit shall support one or two learners working simultaneously.
- The system shall be factory tested and provided with access to ongoing support and updates through the Matrix Learning Centre.

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Electrical Safety Information

The PLC Fundamentals Trainer is designed with safety in mind and complies with relevant low-voltage and EMC standards. Users must adhere to the following safety guidance to ensure safe and correct operation.

Key Safety Notes

- Low Voltage Operation:
  The system operates at 24V DC only. It does not require or tolerate direct connection to mains voltage. Doing so will result in damage and void the warranty.
- Power Supply:
  Use only the supplied 24V power adapter with approved plug heads (UK, EU, US). The power supply is a Class II, CE-marked unit with overvoltage and short-circuit protection.
- Enclosure and Wiring:
  All electrical components are mounted in a protective enclosure or DIN rail panel with finger-safe terminals. No exposed live connections are present under normal use.
- Fuse and Circuit Protection:
  The system is internally protected by a 3A fuse on the power input, alongside a Siemens 5SY MCB (3A, Curve B) to prevent overload or short-circuit damage.

Maintenance and Inspection

- Only qualified personnel should service or inspect internal wiring.
- Regularly inspect external cables for damage or wear.
- Do not modify wiring without referring to the system schematic and isolating power first.
- Always isolate power before performing any hardware fault insertion or removal of connectors.

Emergency and Fault Handling

- **Simulated Emergency Stop:**
  The system includes a dual-channel E-Stop for educational and simulation purposes only. It is not connected to a certified safety relay or safety-rated PLC. Pressing the button will halt outputs via PLC logic,

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but should not be relied on for personal protection in real emergency scenarios.

- **Reset Logic:**
  After the E-Stop is pressed, it must be manually reset (twist to release), followed by pressing the reset button on the front panel or HMI.
- **Recommended Emergency Action:**
  In a real emergency, the most effective method to isolate the system is to switch off the rear-mounted circuit breaker or unplug the 24V DC barrel connector. This fully cuts power to all components.
- **Fault LED Indicator:**
  A red system LED indicates a fault or simulated safety event. The system should not be operated until the issue is resolved.

Standards Compliance

This system is designed for educational and training use and incorporates industrial-grade components and wiring practices. While it follows best practices in system layout and electrical safety, it is not intended for use in operational industrial environments.

The system aligns with the following standards where applicable:

- **EN 60204-1** – Electrical equipment of machines (informative compliance in wiring and protection practices)
- **EN 61010-1** – Safety requirements for electrical equipment for measurement, control, and laboratory use
- **Low Voltage Directive 2014/35/EU** – Applicable to included power supply and components
- **RoHS Directive 2011/65/EU** – Restriction of hazardous substances compliance for electronic components

Note: This product does not fall under the scope of the Machinery Directive (2006/42/EC), as it is a non-functional teaching aid and does not include certified safety control circuits.

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Revisions

01 07 25 – First revision

05 09 25 – Updated learning objectives

27 01 26 – Updated proximity sensor

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