

Name: Smart Factory 2

Product Range:

Automatics **Product Code:** AU5555

Curriculum Code: CP4902

Power Supply: 24V

Unit weight

Weight: TBC

Length: 720mm

Width: 556mm

Height: 316mm

Packed Specifications

Volume: TBC

Gross Weight: TBC

Product Description

The Smart Factory 2 system is designed to develop practical and theoretical understanding of modern manufacturing and Industry 4.0 technologies, aligning directly with BTEC Nationals Level 3 in Engineering units on Automation, PLCs, and the Industrial Internet of Things (IIoT). Learners gain experience of how real production systems are controlled, monitored, and optimised using PLCs, HMIs, and networked sensors within an automated manufacturing cell.

Students explore how DC motors, stepper drives, conveyors, and gantry systems form the mechanical foundation of an automated process, while pneumatic pick-and-place mechanisms demonstrate industrial handling and assembly. Through the integration of sensors, controllers, and visualisation tools, learners investigate how data is gathered, analysed, and used to improve production efficiency, product quality, and predictive maintenance.

The system introduces the core principles of Industry 4.0 such as interoperability, information transparency, decentralised control, and modularity, showing how smart factories connect people, machines, and digital systems through IIoT communication networks. IO-Link compatible sensors further enhance this by enabling intelligent, real-time communication between devices and the PLC, giving students practical insight into modern industrial networking. With optional RFID and vision add-ons, data logging, and web-based control, Smart Factory 2 provides a complete educational platform for teaching connected, data-driven manufacturing practices.

Target Audience

The Smart Factory 2 curriculum is designed for students aged 16–19 studying engineering, automation, or mechatronics in further and higher education. It is ideally suited to learners enrolled on T-Level, BTEC, and HNC/HND engineering programmes, as well as apprentices beginning careers in industrial automation, manufacturing, and process control.

The program is also suitable for vocational training centres and universities seeking hands-on exposure to Industry 4.0 technologies, including PLC and HMI programming, pneumatic control, robotics, and data-driven maintenance. By engaging with real industrial hardware and live fault scenarios, students develop essential skills in system design, troubleshooting, and digital manufacturing operations, preparing them for modern roles across automotive, utilities, logistics, and advanced manufacturing sectors.

Key Features

System Hardware & Design

- Siemens S7-1200 PLC providing digital and analogue I/O for complete process control.
- Siemens 7-inch Unified Basic HMI for real-time monitoring, control, and system diagnostics.
- 24 V DC conveyor drive with PWM speed control for accurate material transport.
- Stepper-driven gantry system with vacuum plunger for automated pick-and-place operations.
- Inductive, capacitive, and photoelectric sensors for material detection and sorting.
- Pneumatic manifold with 3/2 and 5/2 solenoid valves for plunger and reject mechanisms.
- IO-Link Master and smart sensors enabling plug-and-play connectivity and advanced diagnostics.
- Raspberry Pi edge processor for vision system integration and data handling.
- Modular steel and aluminium base, compact and durable for classroom or lab use.
- CE/UL compliant components and wiring, incorporating internal fusing, circuit isolation, and safe 24 V DC operation.

Curriculum & Learning Outcomes

- Factory control and automation systems
- Software design for automation
- DC motor and stepper drives
- Conveyor and gantry systems
- Vacuum pick and place systems
- Component sensing and sorting
- System design with more than one controller (some systems)
- Data collection and visualisation for process monitoring
- Networked communication between PLCs, HMIs, and robots
- Predictive maintenance using live system data
- Integration of modular add-ons such as RFID and vision systems
- Web or mobile-based control and monitoring interfaces

Core System Capabilities

- Closed-loop process: Automatic cycle ending with bay reset back to hopper.

- Gantry loading: Simple and reliable counter placement onto the conveyor.
- Vision inspection: Camera-based defect detection with configurable thresholds.
- HMI student decision: Approve-or-discard workflow for flagged counters.
- Robotic sorting: Placement into steel, aluminium, or plastic bays.
- Material identification: Deterministic routing by material type.
- Batch completion logic: Automatic transition to reset once items are processed.
- Cycle-ready reset: Paddle returns all sorted parts to hopper for next run.
- Data capture: Optional logging of decisions, defects, and throughput.
- Safety interlocks: E-stop and guarded motion zones.

Educational Focus

- Aligned to UK T-Level & BTEC qualifications (Maintenance, Installation & Repair)
- Designed for Further Education students and apprentices aged 16–18.
- Teaches control system integration: sensors, PLC, HMI, actuators.
- Suitable for classroom teaching, self-guided labs, and assessment

Learning Objectives

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

- Describe how PLCs, HMIs, sensors, and actuators work together in an automated control system.
- Write and test simple PLC programs to control motors, conveyors, and pneumatic devices.
- Configure and tune DC motor and stepper drives for precise motion control.
- Build and operate a conveyor and gantry sequence to move and sort components.
- Set up a vacuum pick-and-place system and explain its pneumatic operation.
- Use inductive, capacitive, and optical sensors to detect and sort different materials.
- Create a multi-controller setup where a robot, PLC, and HMI exchange control signals.
- Record live data from the Smart Factory and plot it on an HMI or dashboard.
- Establish communication between devices using Ethernet, Modbus, or TCP/IP.
- Monitor system parameters and identify early signs of faults or maintenance needs.
- Integrate add-on modules such as RFID readers or vision cameras into the control system.
- Develop a basic web or mobile interface to monitor and control Smart Factory operations remotely.

Worksheets

CP4902

Smart Factory 2

Worksheet 1 – Understanding Sensors
Worksheet 2 – Reject Mechanisms
Worksheet 3 – Understanding the Conveyor
Worksheet 4 – Sorting Counters
Worksheet 5 – Driving the Stepper Motor
Worksheet 6 – Understanding the Plunger
Worksheet 7 – Delivering Counters
Worksheet 8 – Robot Arm
Worksheet 9 – Commissioning the Cell
Worksheet 10 – Completing the Smart Factory
Worksheet 11 – Defects & Reset Sequence
Worksheet 12 – Vision System
Worksheet 13 – RFID
Worksheet 14 – Network & Communications
Worksheet 15 – Data Logging
Worksheet 16 – Analytics
Worksheet 17 – IO-Link
Worksheet 18 – Predictive Maintenance

Packing List

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

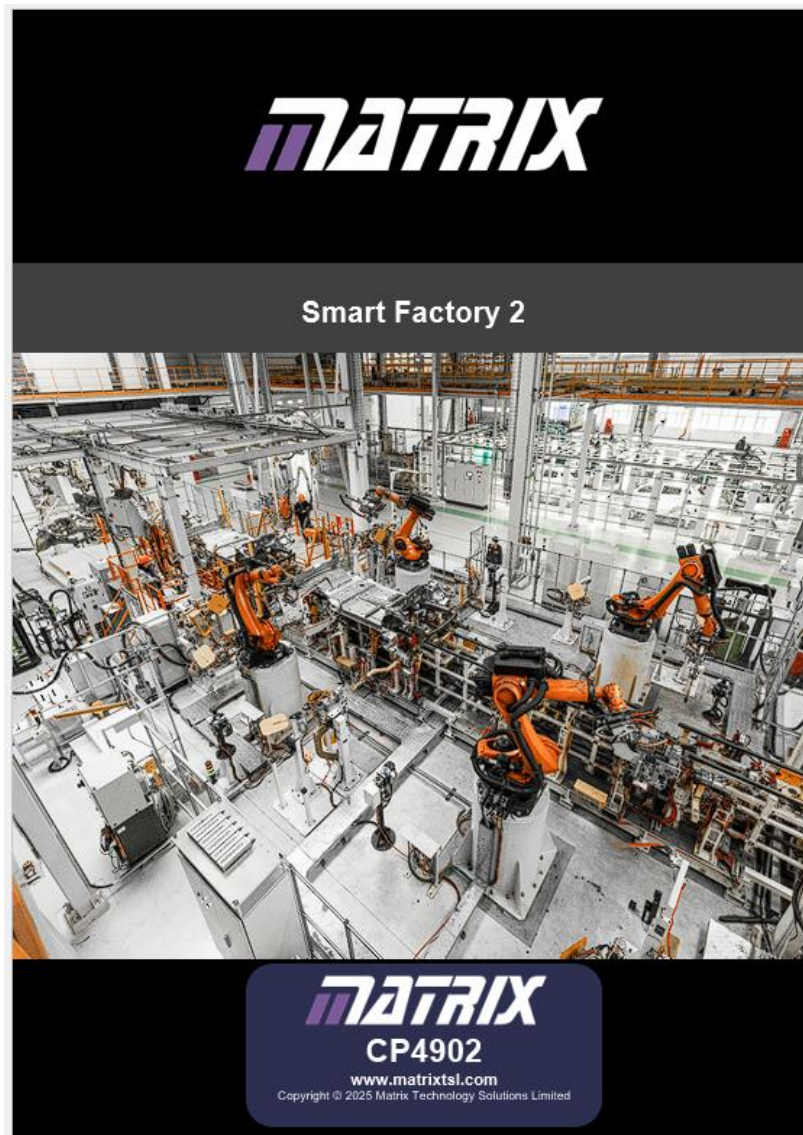
Contents;

- AU5555: Base with PLC, IO-Link Master and HMI installed.
- Robot Arm

Curriculum

This product comes with a curriculum;

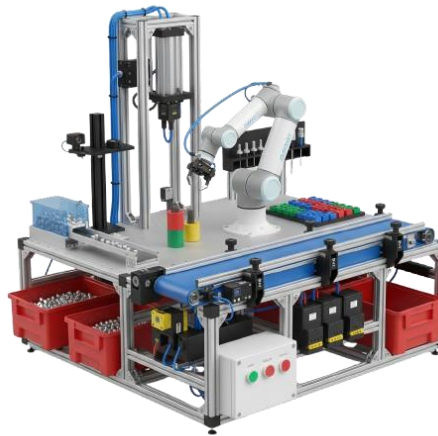
CP4902 – Smart Factory 2



Click [here](#) to download curriculum from our Learning Centre

Main Components

Main Module



PLC – Siemens S7-1200 (CPU 1214C)

- **Purpose:** Central controller for logic, PID control, safety interlocks, and I/O processing
- **Key Features:**
 - 14x Digital Inputs, 10x Digital Outputs (24VDC)
 - 2x Analog Inputs (0–10V)
 - Handles PID algorithm for flow regulation.
 - Interfaces with HMI for setpoint, alarms, and diagnostics



IO-Link Master Module (ifm AL1350)

- **Purpose:** Acts as the communication gateway between the PLC and multiple IO-Link sensors or actuators, enabling advanced data exchange and device parameterisation.
- **Key Features:**
 - Connects up to 8 IO-Link sensors or actuators via M12 ports
 - Transfers detailed sensor data and diagnostics to the PLC
 - Enables fast setup and automatic device parameter loading
 - Provides real-time process monitoring of sensor health and status
 - Integrates with the Raspberry Pi for extended data logging and analysis
 - Supports both standard digital I/O and IO-Link communication on each port



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 user control of Smart Factory
 - Displays alarms, I/O status
 - Setup page allows editing of temperature cutout limits and viewing system state



Edge – Raspberry Pi 5 8GB

- **Purpose:** Serves as the local processing and communication hub for vision, data logging, and networked control tasks within the Smart Factory.
- **Key Features:**
 - Processes live camera images for part and defect detection
 - Communicates inspection results to the PLC via Ethernet
 - Logs production data such as cycle time and reject count
 - Hosts local web dashboard for live monitoring and control
 - Interfaces with IO-Link master for advanced sensor data
 - Acts as Industry 4.0 gateway for data exchange and visualisation



Capacitive Sensor – RS PRO M18, 8 mm Detection, IO-Link




- **Purpose:** Detects non-metallic and metallic counters on the conveyor to distinguish between material types.
- **Key Features:**
 - Inductive sensor with 16 mm sensing distance, ideal for general object detection



Proximity Sensor – Omron E2E-X16MB1T12 2M (Inductive, M12, PNP, NO)

- **Purpose:** Detects both metallic counters (steel and aluminium) to distinguish them from non-metallic materials such as plastic.
- **Key Features:**
 - Differentiates metal counters from plastic for multi-stage material sorting
 - Works alongside the inductive sensor to separate steel from aluminium and plastic
 - IO-Link connectivity provides live status, signal quality, and diagnostic feedback to the PLC



<p>Photoelectric Sensor – Banner Background Suppression (IO-Link, 30–250 mm)</p> <ul style="list-style-type: none"> • Purpose: Detects the presence and position of objects on the conveyor without being affected by background surfaces or lighting conditions. • Key Features: <ul style="list-style-type: none"> ○ Provides precise detection of counters on the moving conveyor without interference from background reflections ○ Communicates detection status and diagnostic data to the PLC via the IO-Link master ○ Adjustable sensing range allows tuning for different counter materials and colours ○ Supports consistent part detection for reliable reject and sorting operations ○ Enables live monitoring and parameter adjustments through the Raspberry Pi or HMI 	
<p>Status Indicator – Banner K50L Multi-Colour LED Beacon</p> <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> ○ 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 ○ IP67/IP69 protection rating, robust housing for industrial-style durability 	
<p>Emergency Stop – Siemens SIRIUS ACT, dual-channel, twist-release</p> <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> ○ Dual NC contact modules wired to separate PLC inputs for channel monitoring and fault detection 	

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



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.

There is also an additional web app available via the product's onboard web server. This can be accessed by typing in the products IP address; 192.168.7.1.

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 2-4 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.

The included air compressor is powered separately via a standard mains connection using a 3-pin plug.

Does the system need mains water or drainage?

No. The system operates using a pneumatic air compressor, no external plumbing is required.

To run the system, simply connect and power the air compressor.

Can other compressors be used with the system?

It is not recommended. The system is designed to operate with the specific mains-powered compressor supplied. Using a different compressor may result in excessive pressure, which can be dangerous and may damage pneumatic components. If an alternative compressor is used, ensure it matches the pressure rating and specifications stated in the user manual.

Is post-use maintenance required?

Very little. After use, ensure all air lines are securely connected and free from leaks, check that the pneumatic system is depressurised, and inspect sensors and moving parts for dust or debris buildup.

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.

Does the system simulate faults?

Yes. The Smart Factory includes some standard faults, as you would expect with any machinery. These help users develop real-world troubleshooting skills. For details on the specific fault conditions and how to resolve them, please refer to the user manual.

How is the system stored?

The entire kit, including all cables and accessories, can be stored safely on a shelf or under a workbench. For short-term storage, we recommend disconnecting the compressor. For long-term storage or transport, the kit can be placed back into its original shipping box for added protection.

Is the system portable?

No. The Smart Factory is designed to remain in one location during use. When fully assembled, it requires at least two people to lift and move safely.

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.

Tender Specification

Matrix Technology Solutions Ltd shall supply the **Smart Factory V2** Industrial Automation and Industry 4.0 Training System with the following features, capabilities, and performance assurances.

Hardware Specification

- The system shall consist of a single integrated base platform, manufactured from precision laser-cut sheet metal and aluminium profile framework, providing a robust, durable, and educationally accessible structure.
- All airlines, wiring, and electronic subsystems shall be concealed within the base for improved reliability, safety, and aesthetic appeal.
- The base shall include dedicated operational zones, including:
 - Material Sorting and Sensing Zone
 - Pneumatic Rejection Zone
 - Gantry Pick-and-Place Zone
 - Robotic Cell and Inspection Zone
- The system shall include the following key mechanical modules:
 - Conveyor Unit with 24 V DC variable-speed motor drive
 - Gantry Linear Actuator with stepper motor and vacuum plunger assembly
 - Counter Hopper and Rack Assembly with multiple counter types (metallic and plastic)
 - Pneumatic System comprising 5/2 and 3/2 valves, manifold, vacuum generator, and adjustable restrictors
 - Reject Mechanisms using dual pneumatic paddles for automatic sorting
- The system shall include a robot interface registration plate for precise repeatable mounting of an optional collaborative robot arm.
- The system shall include a traffic-light indicator tower and emergency stop with dual-channel safety relay for industrial realism.
- The pneumatic system shall operate from a regulated clean air compressor, typically 3–4 bar. Users shall ensure compatible pressure per the Smart Factory manual.

Sensors and Actuators

- The Smart Factory shall include four primary sensors mounted over the conveyor:
 - Light Gate Sensors (entry and exit) for object detection and conveyor tracking
 - Inductive Sensor for ferrous material detection
 - Capacitive Sensor for non-ferrous and plastic differentiation
- All sensors shall output to the PLC as 24 V DC digital signals.
- Additional IO-Link-compatible versions of these sensors may be optionally supplied for Industry 4.0 demonstration.
- The gantry plunger shall include an electronic homing switch for calibration and a vacuum cup actuator with PLC-controlled solenoid operation.
- The pneumatic paddles shall be powered by electronically controlled 3/2 valves enabling high-speed part rejection.

Control and Communication Features

- The system shall include a Siemens S7-1200 PLC (AU0205 or equivalent) with integrated 7-inch Unified Basic HMI (MTP700) and Ethernet communication.

- The PLC shall provide at minimum 14 digital inputs, 10 digital outputs, and 2 analogue inputs.
- The system shall be pre-wired with a 30-way industrial connector harness between the Smart Factory base and the PLC/HMI assembly to simplify setup and servicing.
- All internal wiring shall use 24 V DC SELV circuits for educational safety compliance.
- Supported communication interfaces: Ethernet (Profinet) for PLC–HMI and robot communications; USB for firmware and software update; Optional RS-485/Modbus TCP for future expandability.
- The system shall support connection to a Matrix collaborative robot or third-party robot arm via wired or Wi-Fi interface for integrated pick-and-place operation.
- The system shall operate from a 24 V DC power supply provided with global plug adapters (UK/EU/US).

Performance and Operation

- The Smart Factory shall simulate a complete automated production line, where components are picked from a hopper, placed onto the conveyor, inspected, sorted, and packaged by pneumatic and robotic subsystems.
- The process shall run in Single, Batch, or Continuous modes selectable via key switch.
- The PLC program shall manage motion synchronisation, reject timing, and safety interlocks automatically.
- The HMI shall provide a graphical overview of the factory layout, sensor status, process mode selection, and live production data.
- The system shall demonstrate real-time fault detection and visual alarm indication through the HMI and tower light.

Software and Curriculum

- The Smart Factory shall be supplied with preloaded Siemens TIA Portal projects (PLC and HMI), allowing immediate use.
- All project files shall be open and editable by users for advanced programming tasks.
- The system shall include a comprehensive educational curriculum aligned with BTEC National and Higher National Engineering units covering PLC Programming, Pneumatics, Mechatronics, and Industry 4.0.
- Additional optional worksheets shall cover predictive maintenance, KPI monitoring, energy efficiency, IO-Link, and RFID concepts.
- Digital versions of all teacher notes, HMI screenshots, wiring diagrams, and curriculum updates shall be available via the Matrix Learning Centre.

Quantity and Scope of Delivery

- Each system shall be supplied fully assembled, wired, and tested.
- The following shall be included as standard: Siemens S7-1200 PLC + Unified HMI, all sensors, valves, gantry, and conveyor modules pre-installed, storage tray, and global 24 V DC power supply.
- Each Smart Factory shall support 1–2 students working simultaneously.
- The product shall be supplied ready for immediate use, with minimal assembly required and no user wiring necessary.
- A one-year warranty and lifetime technical support via the Matrix TSL helpdesk shall be provided.

Number of Experiments / Worksheets

The Smart Factory V2 (DP0056) updates, the full curriculum now includes both the original operational exercises and new Industry 4.0 expansions.

Section	Worksheet Titles	Count
Conveyor	Understanding sensors, Reject mechanisms, Understanding the conveyor, Sorting counters	4
Gantry	Driving the stepper motor, Understanding the plunger, Delivering counters	3
Robot Arm / Integration	Robot I/O setup, Commissioning, Completing the Smart Factory	3
Faults and Maintenance	Fault simulation and diagnostics, Predictive maintenance and condition monitoring	2
Data and Connectivity	KPI/OEE monitoring and analysis, IO-Link communication and setup, RFID identification and tracking	3
Vision and Sustainability	Vision/Camera quality inspection	1

Total Worksheets / Experiments: 16

Number of Components

System Area	Main Components	Count / Breakdown
Base & Frame	Steel/aluminium base with fixtures	1 complete assembly
Conveyor System	Conveyor unit with 24 V DC motor	1
Gantry Assembly	Stepper motor, plunger, vacuum generator	1 complete gantry
Pneumatic System	Manifold, 3 × 3/2 valves, 1 × 5/2 valve, restrictors, fittings	1 set (≈ 6 parts)
Sensors	2 × light gates, 1 × inductive, 1 × capacitive, 1 × limit switch	5 sensors total
Reject Mechanism	2 × paddles + hardware	2
Counters & Hoppers	3 × hopper lanes, 12 × counters (metal + plastic)	15 total
PLC & HMI	Siemens S7-1200 CPU + 7" Unified HMI (MTP700)	1 PLC + 1 HMI
Electrical Hardware	24 V PSU, MCB/isolator, E-Stop + relay, light stack	4 major items
Robot Integration	Registration plate, interface cable	1 set
Accessories	Bins, cables, fixings, tubing	1 set
Documentation & Curriculum	User manual + worksheets	1 set

Approximate total distinct hardware items: ≈ 35–40 (excluding consumables, cables, and fixings).

Modules included: Gantry, Conveyor, Sensor unit, Pneumatics block, Control unit, and optional Robot cell.

Electrical Safety Information

The Smart Factory 2 (Model DP0056) has been designed with safety and educational use in mind. It complies with applicable Low Voltage and EMC directives and uses only extra-low-voltage control systems. Users must follow the guidance below to ensure safe operation.

Key Safety Notes

- **Low-Voltage Operation:** All electrical systems operate at 24 V DC. The product must never be connected directly to mains voltage. Doing so will permanently damage the equipment and void the warranty.
- **Power Supply:** Use only the supplied 24 V DC power adapter or equivalent Matrix-approved PSU. The supply is a Class II CE-marked unit incorporating short-circuit, over-temperature, and over-voltage protection.
- **Embedded PLC and HMI:** The Siemens S7-1200 PLC and Unified HMI are enclosed within the Smart Factory base or control module. All terminations are SELV rated and finger-safe. Access to internal wiring should only be carried out by qualified personnel.
- **Circuit and Fuse Protection:** The Smart Factory includes an MCB/isolator (3 A, Curve B) on the 24 V input and additional internal fusing for individual subsystems such as the conveyor, gantry, and pneumatics.
- **Wiring and Connectors:** All wiring is routed internally beneath the base with fully shrouded connectors. External interconnections use low-voltage signal and power cables only. There are no exposed live conductors under normal operation.

Emergency and Fault Handling

- **Emergency Stop:** The Smart Factory 2 includes a dual-channel E-Stop switch and a reset push-button. These provide simulated emergency functionality via the PLC. The circuit is not safety-rated and must not be relied upon for personnel protection in real industrial applications.
- **Reset Logic:** After an E-Stop, twist to release the switch and press the Reset button on the front panel or HMI to restore operation.
- **System Isolation:** In any actual emergency, isolate the system using the front-mounted circuit breaker or by unplugging the 24 V DC supply. This action disconnects all internal and external loads.
- **Fault Indication:** A red fault indicator LED or HMI alarm will show when a simulated fault or stop condition occurs.

Standards Compliance

The Smart Factory 2 is an educational training system that uses industrial-grade components, wiring, and protective devices but is not intended for industrial production environments. It aligns with the following standards and directives:

- EN 60204-1: Electrical equipment of machines – applied informatively for wiring and protection practices
- EN 61010-1: Safety requirements for laboratory and training equipment
- Low Voltage Directive 2014/35/EU: Applies to included power supply components
- EMC Directive 2014/30/EU: Applies to PLC, HMI, and electronic subsystems
- RoHS Directive 2011/65/EU: Compliance for all electrical and electronic assemblies

Note: This product is designed for training and demonstration. The emergency-stop function is simulated in software and does not meet BS EN 60204-1 Clause 9.2.2 for industrial safety circuits. It must not be relied upon for personnel protection in real-world industrial settings.