

Advanced PLC Learning System (Siemens S7-1200 PLC)

Original Operating Instructions

FESTO

Electric Power Technology

User Guide



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Document Preliminaries

About this document

The operator should be familiar with the content of this document before installing and operating the equipment.

The Safety Symbols table at the beginning of this document lists safety symbols that may be present in this document or on the equipment.

This document is freely available for download from the Festo website.

Upon request, printed copies of this document are freely available. Contact your Festo Didactic sales representative.

Core documentation

The following course provides the main instructional content for the Advanced PLC Learning System (Siemens S7-1200 PLC), alongside this user guide. It describes theory and hands-on procedures students carry out using the system.

- PLC and HMI Programming – Siemens S7-1200 PLC

This course is available as a printed workbook, PDF, campus license, or web course on the Festo LX Portal.



Important. In this document, "the equipment" or "the learning system" refers specifically to the Advanced PLC Learning System (Siemens S7-1200 PLC).

Safety Symbols and Procedures

The following table lists the safety and common symbols that may be used in this document and on the equipment. Before performing procedures with the equipment, you should read all sections regarding safety in the User Guide accompanying the equipment. Additional safety procedures are given before any task requiring specific safety precautions.

Symbol	Description
	DANGER indicates a hazard with a high level of risk, which, if not avoided, will result in death or serious injury.
	WARNING indicates a hazard with a medium level of risk, which, if not avoided, could result in death or serious injury.
	CAUTION indicates a hazard with a low level of risk, which, if not avoided, could result in minor or moderate injury.
	NOTICE indicates a hazard with a potentially hazardous situation, which, if not avoided, may result in property damage.

Symbol	Description
	Caution, risk of danger. Consult the relevant user documentation.
	Caution, risk of electric shock.
	Caution, lifting hazard.
	Caution, hot surface.
	Caution, risk of fire.
	Caution, risk of explosion.
	Caution, belt drive entanglement hazard.
	Caution, chain drive entanglement hazard.
	Caution, gear entanglement hazard.
	Caution, hand crushing hazard.
	Static sensitive contents. Observe precautions for handling electrostatic discharge sensitive devices.
	Notice, non-ionizing radiation.

Symbol	Description
	Consult the relevant user documentation.
	Radio Equipment Directive (RED) geographical restrictions – consult the relevant user documentation.
	Direct current.
	Alternating current.
	Both direct and alternating current.
	Three-phase alternating current.
	Earth (ground) terminal.
	Protective conductor terminal.
	Frame or chassis terminal.
	Equipotentiality.
	On (supply).
	Off (supply).
	Equipment protected throughout by double insulation or reinforced insulation.

Symbol	Description
	In position of a bi-stable push control.
	Out position of a bi-stable push control.

General Requirements for Operating the Equipment

To safely operate electrical equipment in commercial or training environments, the following requirements apply:

- **Follow national regulations** that govern electrical systems and equipment in commercial or industrial facilities.
- **Ensure supervision.** A qualified supervisor (electrician or trained electrical engineer with documented training) must oversee the laboratory or classroom.
- **Perform correct setup.** Install and commission the equipment strictly according to the accompanying documentation before use.
- **Remove damaged equipment.** Immediately block off and remove damaged or defective devices, cables, leads, pneumatic tubing, or hydraulic hoses from the lab or classroom.
- **Ensure the room is equipped with all required safety devices.** Where local regulations apply, the room must include:
 - DC-sensitive residual current devices (RCDs), type B, ≤ 30 mA.
 - Overcurrent protection (circuit breakers or fuses).
 - One or more emergency-off devices to cut power either for the entire room or individual workstations.
 - Security features (e.g., lockable power-on switches or on-off valves) to prevent unauthorized activation of voltage or compressed air.

Use for Intended Purpose

The equipment may only be used:

- For its intended purpose in teaching and training applications.
- When its safety functions are in flawless condition.

The equipment components are designed with the latest technology and adhere to recognized safety standards. However, improper use can endanger the user and others, and may damage the equipment.

The Festo Didactic learning program is designed solely for training. To keep trainees safe, the training company or supervisors must ensure that all trainees use the equipment as instructed in the Festo Didactic courses and follow the safety guidelines in this document.

	 WARNING
	Risk of danger from using the equipment in a way other than prescribed by Festo Didactic! • Using the equipment in a way other than directed in the accompanying Festo Didactic courses, or using the equipment with equipment from other manufacturers, may increase the risk of injuries or property damage. • To minimize the risk of danger, always respect the specifications marked on the equipment as well as the specifications in the Festo Didactic data sheet of the equipment. • If the equipment includes a third-party component, consult the manufacturer's official documentation for that component—available from the manufacturer or online—to ensure safe use and compliance with all specifications and directives.

Guarantee and Liability

Our "general terms and conditions of sale and delivery" are always applicable. These are made available to the operating company no later than on conclusion of the sales contract. Guarantee and liability claims resulting from personal injury and/or property damage are excluded if they can be traced back to one or more of the following causes:

- Use of the equipment for anything other than its intended purpose.
- Improper commissioning and/or operation of the equipment.
- Use of the equipment with defective safety equipment, or with improperly attached or non-functional safety and protective equipment.
- Non-compliance with instructions included in the core documentation about commissioning and operation.
- Unauthorized modifications to the equipment.
- Improperly executed repairs.
- Disasters resulting from the influence of foreign bodies and acts of nature.

Festo Didactic hereby excludes any and all liability for damages suffered by trainees, the training company, and/or any third parties, which occur during use of the equipment in situations which serve any purpose other than training and/or vocational education, unless such damages have been caused by Festo Didactic due to malicious intent or gross negligence.

Work and Safety Instructions

Safety responsibilities

Responsibilities are divided by role as shown in the following table.

Table 1: Responsibilities by role.

Role	Responsibilities
Operating company	• Allow only qualified personnel to work with the equipment. • Ensure personnel are trained in safety regulations and have read the safety information in this document. • Periodically evaluate personnel for safe working practices.
Instructor	• Supervise trainees at all times. • Permit only harmless mistakes and prevent actions that could cause injury or damage.
Trainees	• Read the safety chapter and warnings before use. • Follow all applicable work-safety and accident-prevention rules. • Work only under the supervision of a qualified person.

General operational safety

	 CAUTION
	Ignoring basic operational safety rules may lead to accidents, injuries, or equipment damage. • Trainees must be supervised by an instructor at all times when working with the equipment. • Use the equipment only as instructed in Festo Didactic documentation. • Keep switches, buttons, and disconnectors unobstructed and easy to reach. • Repair or secure faulty equipment immediately. • Wear suitable personal protective equipment (PPE), such as safety glasses and safety shoes. • Avoid wearing loose clothing or accessories that could become entangled in equipment. • Secure long hair to prevent it from interfering with moving parts or obstructing vision. • Keep the work area clean, dry, and free of substances that could cause slips or interfere with equipment operation.
	 CAUTION
	Improper handling of heavy equipment may cause personal injury or equipment damage. • Use proper lifting techniques or assistance when moving heavy components marked with the lifting-hazard symbol.

Personal protective equipment (PPE)

Despite built-in safety features, residual risks remain due to misuse or faulty components. To reduce injury risk, always follow these PPE guidelines:

- Wear **safety shoes** when frequently moving equipment between storage and workstations.
- Wear **safety glasses** when working with polarized capacitors, which may explode unexpectedly.
- Wear **hearing protection** when using noisy equipment such as rotating machines.

- Wear **safety gloves** for mechanical handling (e.g., sharp edges, heavy parts, hot surfaces).

Equipment handling and layout

NOTICE

Cable handling

- Lay out cables without bends, pinches, or contact with hot surfaces (clearly marked if applicable).
- Always unplug by pulling the plug itself—never pull on the cable.
- Prevent continuous tension on cables to avoid damage and disconnection.

NOTICE

Ventilation and heat management

- Keep all ventilation slots unobstructed. Place equipment only on hard, flame-resistant surfaces to allow proper airflow.
- Do not install heat-generating equipment near or underneath temperature-sensitive components.

NOTICE

Workstation setup

- Check the maximum load capacity of the workstation and ensure it is not exceeded.

Electrical safety

	 WARNING
	Risk of electric shock due to dangerous voltage The equipment contains hazardous voltage that can cause death, serious injury, or major property damage if safety instructions are ignored. Protective earth (PE) • Always earth equipment fitted with a PE terminal. • Connect the PE first and disconnect it last. • Do not break or damage yellow-green PE conductors. • Equipment with high leakage current needs a separate PE lead on its extra PE terminal. Prohibited practices • Never connect power sources in series. • Never connect multiple power supplies to a single ac power wall outlet, as this can cause higher leakage currents. • Do not exceed the input voltage or current rating of any device, as this can lead to heating, shocks, and fires. Safe voltage limits • Contact with > 30 V ac rms or > 60 V dc can be fatal. • Shield power source outputs and leads from touch; use shrouded safety leads rated CAT II or higher. • Switch off all power sources and de-energize circuits before wiring changes. • Only use detachable mains supply cords, cables, and connection leads with adequate ratings. Capacitors • Large capacitors may stay charged after power-off. Wait several minutes before opening housings. Low-voltage circuits • Power low-voltage circuits only with Class II SELV or double-insulated supplies (e.g., Festo Didactic power sources).

Cyber security

Festo Didactic provides products with security functions that support the safe operation of plants, systems, machines, and networks. Protecting these assets from cyber threats, however, requires a comprehensive and regularly updated security concept. Festo's products and services form only part of such a strategy.

The customer is responsible for preventing unauthorized access to equipment and networks. Connections to company networks or the Internet should be made only when necessary and only with appropriate security measures, such as firewalls, network segmentation, defense-in-depth strategies, etc.

Without these measures, connecting products to a network can expose vulnerabilities that allow unauthorized remote access, potentially affecting the entire system. This access can be exploited for data theft, manipulation, or sabotage. Common threats include Denial-of-Service attacks, remote code execution, privilege escalation, ransomware, and other malicious activities. In industrial environments, such attacks can create unsafe conditions, endangering both people and equipment.

Customers should follow Festo's security guidelines and keep their products up to date. Festo continuously improves its products for greater security and strongly recommends installing updates promptly. Using outdated or unsupported versions increases exposure to cyber threats.

Report security issues to the Festo Product Security Incident Response Team (PSIRT) in German or English by email at psirt@festo.com or through the online form at <https://www.festo.com/psirt>.



WARNING

Unsecure operating conditions due to software tampering

- Software tampering (e.g., viruses, Trojans, malware, worms) can cause unsafe system conditions, potentially leading to serious injury or property damage.
- Keep all software up to date.
- Integrate all automation and actuator components into a comprehensive industrial security concept aligned with current technological standards.
- Ensure all installed products are included in your security concept.
- Use protective tools, such as antivirus software, to scan files on removable storage media for malware.



WARNING

Firmware Update Security

This warning applies only to products with updatable firmware. To protect the security and integrity of your system, follow these guidelines during the firmware update process:

- **Download source.** Obtain firmware updates only from the official manufacturer's website.
- **Do not tamper.** Do not modify or interfere with the firmware update process.
- **Update process.** Strictly follow the firmware update instructions provided in the user guide.

Equipment Installation and Commissioning

Environmental requirements

The equipment is designed to be installed and stored indoors and operated in the following environmental conditions:

- An altitude up to 2000 m (6560 ft).
- A temperature between 5°C and 40°C (41°F and 104°F).
- A maximum relative humidity of 80% for temperatures up to 31°C (88°F), decreasing linearly to 50% relative humidity at 40°C (104°F).
- Mains supply voltage fluctuations which do not exceed $\pm 10\%$ of the nominal voltage.
- Transient overvoltages up to the levels of overvoltage category II (1500 V for 120 V mains and 2500 V for 230 V mains).
- Temporary overvoltage occurring on the mains supply.
- A pollution degree of 2 (dry, non-conductive pollution).



In this context, pollution means any foreign matter—solid, liquid, or gas, including ionized gas—that may reduce dielectric strength or surface resistivity.

Equipment handling

Before handling equipment, ensure the following:

- You know where to install or relocate the equipment.
- The path is clear—no obstacles, bumps, or slippery surfaces.
- You can safely lift and carry the equipment. Check its weight beforehand if needed.

While carrying equipment, make sure to:

- Maintain a firm grip.
- Hold the equipment close to your waist, with level shoulders. Do not extend your arms.
- Move slowly and maintain stable footing.
- Turn by moving your feet, not by twisting your back.

	 CAUTION
	Physical stress likely to occur when handling heavy equipment. • Take extra care when lifting or moving heavy equipment. • Equipment heavier than 5 kg (10 lb) is marked with a lifting hazard symbol where not otherwise obvious.

Connection to ac power outlets

Power the equipment from an ac wall outlet. When several units are installed in the same laboratory classroom, connect each unit to a separate ac wall outlet.

	 CAUTION
	If the earth conductor of an ac wall outlet is interrupted, failing to comply with this requirement can increase the severity of electric shocks caused by leakage current from the equipment.

Regulations in some countries require laboratory ac outlets to include overcurrent protection (fuses or circuit breakers) and residual current protection (type B residual current devices). Verify that the ac outlets in your laboratory meet local regulatory requirements before using the equipment.

If the laboratory outlets lack the required protection features, use a Festo Didactic power supply equipped with a safety unit at each workstation.

Opening the system case

1. Release the four latches securing the cover of the system case—two at the front and two on the side.

2. Open the case.

If you cannot open the case due to air travel or pressure changes, turn the air pressure release knob on the front of the case. You should then be able to lift the cover.

3. To remove the top cover, lift it to a 45° angle and slide it out to the right.



The top cover contains additional equipment, along with the necessary power and connection cables for the system.

Initial setup

1. Verify that no faults are inserted in the training system.

2. Plug the power cord into a compatible power source, then turn on the power switch.
3. Connect an Ethernet cable from the host computer to the PLC.
4. Make all required connections for your laboratory exercise according to the available setup photos, electrical diagrams, pneumatic diagrams, tag lists, and related documentation.
5. Turn on the host computer and the S7-1200 PLC.
 - On the S7-1200 CPU, a green RUN/STOP LED should be on and a red ERROR LED should flash. This indicates that an error is detected.
 - On the analog I/O module, a red DIAG LED should flash and red I/O status LEDs should flash. This indicates that the field-side power is turned off.
6. Press the green start button under the red emergency stop button to activate the PLC outputs.
 - On the S7-1200 CPU, the green RUN/STOP LED remains on and the red ERROR LED no longer flashes. This indicates that the CPU is running.
 - On the analog I/O module, a green DIAG LED is on and green I/O status LEDs are on. This indicates that the module is configured with no errors.
7. Start the TIA Portal software.

You can now perform your exercise.

Equipment Description

The system includes industrial components: a Siemens S7-1200 controller, a 7" widescreen TP700 Comfort Panel with PROFINET, MPI/PROFIBUS DP, and USB interfaces, and a SCALANCE XB005 unmanaged industrial Ethernet switch. It provides several accessible inputs (16 digital, including 6 high-speed counters, and 4 universal analog) and outputs (14 digital, including 4 high-speed, and 2 configurable analog) from the front panel via 2-mm test leads. Controls and indicator lights can also be connected. Eight switches enable the insertion of electrical faults for troubleshooting exercises. A SysLink interface allows connection to Festo's Modular Production System (MPS) stations.

Description

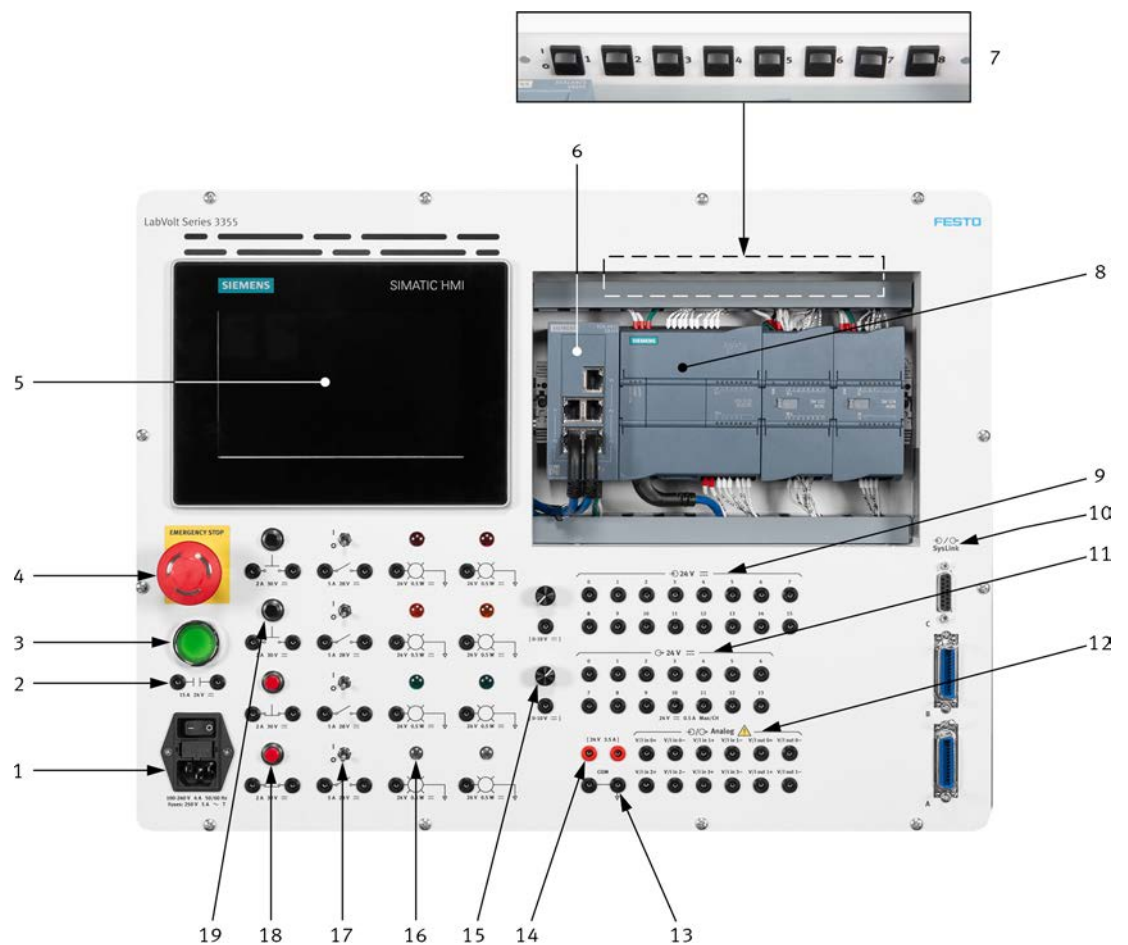


Figure 1: Advanced PLC Learning System (front view).

1. **Power inlet and switch.** Connect the PLC Trainer from this inlet to a standard wall ac outlet using the supplied power cord. Use the power switch to turn the trainer on or off.
2. **Contactor feedback terminals.** The contact closes when the contactor linked to the start button is energized.
3. **Start button.** Controls a contactor that activates the PLC outputs when the trainer is on.
4. **Emergency stop.** Deactivates the PLC outputs when pressed, while keeping the PLC and its inputs powered to maintain feedback.
5. **Touch screen.** Stores and displays HMI programs.
6. **Unmanaged Ethernet switch.** The five ports provide Ethernet connectivity between the PLC, touch screen, computer, and other compatible devices.
7. **System faults.** Eight fault switches above the PLC simulate electrical connection problems for troubleshooting practice. Ensure all switches are set to “0” before starting each exercise.
8. **SIMATIC S7-1200 PLC.** Includes three I/O modules. The CPU provides eight digital inputs, six digital outputs, two analog inputs, four counters, four alarm inputs, and four pulse outputs. Four digital inputs are usable for high-speed counting (HSC), and four outputs can generate pulse train outputs. The second module has eight digital inputs and eight digital outputs. The third module has four configurable analog inputs and two analog outputs. Communication uses TCP/IP, SNMP, DCP, and LLDP Ethernet protocols. A removable memory card allows backup storage. Status LEDs show controller and I/O states.
9. **PLC inputs.** Activated by applying 24 V dc to the input terminal from the front-panel push buttons or toggle switches, or from external devices.
10. **SysLink connectors.** Allow connection to other Festo equipment. Connectors A and B carry eight digital inputs and eight digital outputs each. Connector C carries four analog inputs and two analog outputs.
11. **PLC outputs.** When activated, a 24 V dc signal is applied to the corresponding output jack.
12. **Analog inputs/outputs.** Four configurable analog inputs connect through “in” jacks, using the positive voltage/current jack and corresponding negative jack. Two voltage or current outputs connect through “out” jacks.
13. **Common.** Two terminals provide reference voltage for connected devices.
14. **24 V dc power supply.** Two jacks provide 24 V dc to power push buttons, toggle switches, or external devices.
15. **Potentiometers.** Adjust the output voltage of the terminals below between 0 and 10 V dc.
16. **Indicator lamps.** Eight lamps illuminate when 24 V dc is applied to their respective jacks, such as when the connected PLC output is active.

- 17. Toggle switches.** Four switches can be connected on one side to the 24 V dc supply to send voltage to PLC inputs.
- 18. Normally closed push-buttons.** Two NC push buttons connect on one side to the 24 V dc supply and can apply voltage to PLC inputs.
- 19. Normally open push-buttons.** Two NO push buttons connect on one side to the 24 V dc supply and can apply voltage to PLC inputs.

Specifications

Table 2: Specifications of the Advanced PLC Learning System (Siemens S7-1200 PLC).

Parameter	Rating
AC power network voltage and frequency	230 V – 50 Hz (594513) 120 V – 60 Hz (594512)
Maximum current	4 A
Electrical installation	1 phase, including line, neutral, and earth wires, protected by a circuit breaker in accordance with local regulations.
Installation location	Tabletop
Ingress protection rating	IP20
Electromagnetic compatibility	Group 1, Class A (industrial environment, EN 55011)
Dimensions (H × W × D)	460 mm × 610 mm × 290 mm (18" × 24" × 11.5")
Weight	20.7 kg (45.6 lb)
CE and UKCA markings	● Low-Voltage Directive ● EMC Directive ● RoHS Directive

Equipment Maintenance

The equipment is designed for user safety, reliability, and effective learning. To maintain safety and performance, it must be kept in good condition.

The learning system requires regular maintenance. Students perform some tasks as part of their training, while qualified personnel handle periodic maintenance.

Because trainees may not yet detect issues, a technician or instructor should inspect the system before and after each use.

Replace defective or missing components immediately. Contact our service department for replacement parts and instructions.

	 DANGER Always turn off, disconnect, and secure the power supply before performing maintenance.
	 CAUTION • Instructors and laboratory personnel must communicate these directions and guidelines to students, as they are essential for maintaining equipment safety and functionality. • Do not operate the equipment with missing or damaged parts.

General maintenance

The equipment requires no special maintenance, but a visual inspection must be performed before each laboratory exercise. If any component appears damaged or worn, replace it to ensure user safety and prevent further damage.

There are no user-serviceable parts inside the equipment, other than items such as fuses, button cells, and batteries. Opening or removing the housing to replace parts may expose you to dangerous voltages. Do not open the housing; have a qualified technician replace internal parts.

Consumables and replacement parts

Consumable or damaged components can be replaced. To ensure compatibility and long service life, use only Festo Didactic replacement parts and accessories. The following table lists the available consumable and damageable components.

Table 3: Available consumable and damageable components.

Component	Order no.
Connection lead, width: 2 mm, length: 45 cm	769119
Ethernet cable, RJ45, length: 150 cm	787843
Power cord, type A/B, 120 V	789405
Power cord, type E/F, 230 V	789182
Power cord, type D, 230 V	775500
Power cord, type G, 230 V	789407
Power cord, type H, 230 V	789408
Power cord, type I, 230 V	789406
Power cord, type J, 230 V	789409
Power cord, type L, 230 V	789410
Power cord, type M, 230 V	8115563
Digital multimeter	8239726
Fuse, slow blow, 5 A	8115201

NOTICE

- Before replacing a blown fuse, identify and correct the cause of the overcurrent.
- Always replace a blown fuse with one of the exact same type. Using an incorrect fuse type can damage the equipment or cause injury.

Equipment modification

Do not modify the equipment without prior written permission from Festo Didactic. The equipment is designed to meet safety, electromagnetic compatibility, and other regulations; modifications can compromise product integrity and safety.

Use or installation of spare parts by unqualified persons, and any repairs or modifications that do not comply with the product's original specifications and manufacturing methods, can cause material damage, serious injury, or death, and may void any warranty or product approval.

Equipment disposal

Do not discard the equipment with normal waste: it contains electrical and electronic components. A specialist must dismantle the product. Each component must be recycled or disposed of according to your local legislation.

It is the owner's responsibility to make provisions for the equipment recycling and safe disposal.

Waste from Electrical and Electronic Equipment (WEEE) directive:

- In accordance with European regulations, used electrical and electronics devices cannot be disposed of in unsorted municipal waste. The symbol of the waste bin on wheels indicates the necessity for separate collection. For environmental protection, make sure the equipment is disposed of in the waste sorting processes designed for this purpose. DIRECTIVE 2012/19/EU of the EUROPEAN PARLIAMENT AND OF the COUNCIL of 4 July 2012 on waste electrical and electronic equipment (WEEE).



The presence of this symbol on the equipment indicates the necessity of separate collection.

Cleaning

To clean the equipment front panel(s) and housing(s), use a soft cloth with a mild detergent-and-water solution. Do not apply the solution directly to the equipment; apply it to the cloth.

NOTICE

Unless specifically stated otherwise, do not use abrasive cleaners or solvents on any part of the equipment.

Indications of conformity

Directives and declarations of conformity

The directives applicable to each piece of equipment in the learning system are specified in the corresponding Equipment Description section.

You can download declarations of conformity for all available equipment using the following link:

1. Enter your equipment name in the search field.
2. Click the "Didactic Products" tab.
3. Select your equipment from the search results.
4. Open the "Downloads" tab.
5. Go to the "Certificates" section.
6. Download the required documents.



Festo website.

<https://www.festo.com>

Electromagnetic compatibility (EMC)

The following table outlines international electromagnetic compatibility (EMC) compliance requirements, specifying applicable standards, equipment classifications, and usage limitations.

Table 4: Electromagnetic compatibility (EMC) compliance.

Europe	EN IEC 61326-1: Basic Electromagnetic Environment CISPR 11: Group 1 or 2 (see the Equipment Description section for precision on each piece of equipment), Class A ● Group 1: Equipment covered by this standard that is not classified as Group 2. Group 2: Industrial, scientific, and medical radio-frequency (ISM RF) equipment that intentionally generates or uses radio-frequency energy (9 kHz to 400 GHz), locally applied via electromagnetic radiation, inductive or capacitive coupling, for purposes such as material treatment, inspection, analysis, or energy transfer. ● Class A: Equipment is suitable for use in all establishments other than domestic and those directly connected to a low-voltage power supply network that supplies buildings used for domestic purposes. There may be potential difficulties in ensuring electromagnetic compatibility in other environments due to conducted and radiated disturbances. ● Caution: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.
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