Solar Thermal Learning System

Original Operating Instructions

FESTO

Renewable Energy

User Guide

Festo Didactic
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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 Didactic website.

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

Important. In this document, "the equipment" and/or "the learning system" specifically refers to the Solar Thermal Learning System.

This document contains the information required to set up, commission, and carry out maintenance on the equipment. However, for specific instructions or information, refer to the documents listed in the following table. These documents form the core of the documentation for the equipment.

Table 1: Core documentation.

Name	P/N
Introduction to Solar Thermal Energy (workbook)	8060761
Introduction to Solar Thermal Energy (workbook for instructors)	8060760
Solar Thermal Energy Systems (workbook)	8060771
Solar Thermal Energy Systems (workbook for instructors)	8060770
Multi-Loop Systems (workbook)	8060781
Multi-Loop Systems (workbook for instructors)	8060780
Solar Thermal Learning System (user guide)	590107

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

Symbol	Description
	Caution, gear entanglement hazard.
	Caution, hand crushing hazard.
	Static sensitive contents. Observe precautions for handling electrostatic discharge sensitive devices.
	Notice, non-ionizing radiation.
	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.

Symbol	Description
	Equipotentiality.
	On (supply).
	Off (supply).
	Equipment protected throughout by double insulation or reinforced insulation.
	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 2: 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 **insulating gloves** when handling live electrical components.
- 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).

Additional safety

⚠ WARNING

Risk of electric shock

Keep water away from electrical components. In case of a leak, clean it immediately using a mop and bucket. If water contacts any electrical part, switch off the power and have the instructor inspect the system before restarting.

Electrical panel safety

Before making or modifying electrical connections, ensure no voltage is present and all components are dry.

⚠ CAUTION

Wet floor hazard

Water on the floor can cause slipping injuries. Clean any spills promptly with a mop and bucket.

⚠ CAUTION

High temperature

Do not operate the system if the liquid temperature reaches 50°C (122°F). If this occurs, turn off the system, switch off lights, or cover the solar collector.

⚠ CAUTION

Hot surface

Improper wiring can cause very hot water. Never disconnect hoses when the water temperature exceeds 50°C (122°F).

⚠ CAUTION

Solar collector rotation

Keep hands and fingers away from moving parts when rotating the solar collector. Only rotate the collector using the designated handles to avoid pinch injuries.

Work light safety

⚠ WARNING

Hot surface

Work lights can become extremely hot. Do not touch them with bare skin. Always allow them to cool before handling.

⚠ CAUTION

Fire risk

Keep lights away from flammable materials. Always turn off the power before changing bulbs.

⚠ CAUTION

Electric shock hazard

Do not use work lights near water or in wet areas. Keep connectors and outlets dry at all times.

NOTICE

Use only 500 W bulbs

Only 500 W lamp bulbs are permitted. Using other types may pose a safety risk or damage the equipment.

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

Equipment installation

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 ±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).

The word pollution used above refers to any addition of foreign matter, solid, liquid, or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity.

The learning system is shipped in wooden crates on wooden pallets. Only heat-treated wood is used, so the wooden packaging can be disposed of or reused without risk of pest proliferation. Paper and cardboard packaging should be recycled in accordance with local regulations. The components are mounted on the system workstation and secured with twist locks (see the following figure).

⚠ CAUTION

Keep the learning system upright to prevent damage to its components.

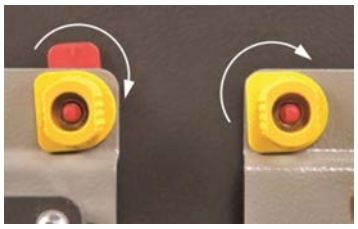

Figure 1: Twist locks.

Unpacking the learning system

When you unpack the equipment, verify that every item listed in the following table is present.

The remaining equipment is listed as consumables and is described in the following sections.

Table 3: System components.

Part	Quantity	Part number
Solar collector	1	89515
Storage tank (with 2 heat exchangers)	1	87318-1
Electrical panel (with emergency switch). Includes: • Thermostat controller (with 1 sensor) • Differential controller (with 3 sensors)	1	52154
Circulator pump	2	46508-1C or -10
Plate heat exchanger	1	46505
Expansion tank	2	46510-1
Radiator (with magnetic surface thermometer)	1	6531-C, 87244
Radiant floor	1	46512
Thermometer	2	46501
Rotameter	2	6550-A
Pressure gauge	1	6553-E

Part	Quantity	Part number
Pressure relief valve	2	46503, 46504
Shutoff valve	2	6520-A
Check valve assembly (with 2 drain valves)	1	46507
Fill bowl	2	46519-1
Automatic air vent	1	46511
Digital multimeter	1	6394-B
Dual work light	1	87038-1
White case	1	52366

Moving the learning system

The learning system has sturdy swivel casters, which make it easy to move. Lock the casters whenever the system is not being moved to prevent accidents.

⚠ CAUTION

- Always lock the casters when using the learning system.
- The learning system is heavy; use and move it only on a flat floor.

Figure 2: Swivel casters.

Starting the trainer

Setup

1. Make sure the environment around the system is secure.

2. Fill the storage tank with 37.85 L of water.

3. Connect each pump to a controller (either differential controller or thermostat controller) using the 4 pin connectors mentioned in the Introduction section. Make sure both override switches are set to the Off position.

4. Connect the system to an ac outlet.

5. Notify all the people working in the area that the system is about to be energized.

6. Turn the power on by setting the circuit breaker to I.

Configuring the pumps

7. If you are using pumps model 46508-1C, press the > button (at the center of each pump) to select the III mode.

   If you are using pumps model 46508-10, rotate the speed selector to the HI position.

Configuring the differential controller

8. Check the differential controller interface. Verify that the controller is set correctly by referring to the Equipment Description unit.

   Some settings may not appear directly on the screen. Other settings may appear that are not listed in this section. These parameters do not affect system operation.

9. Use buttons on the controller to adjust parameters as needed.

   Once these steps are complete, turn the system off by setting the circuit breaker to O.

   Make sure you complete these steps before proceeding to Example of usage.

Example of usage

Setup

1. Mount the parts as shown in the following figure. Use the hoses to connect the components.

2. Wire the components properly (you can refer to the Equipment Description unit if needed).

3. Connect the training system to an ac power source.

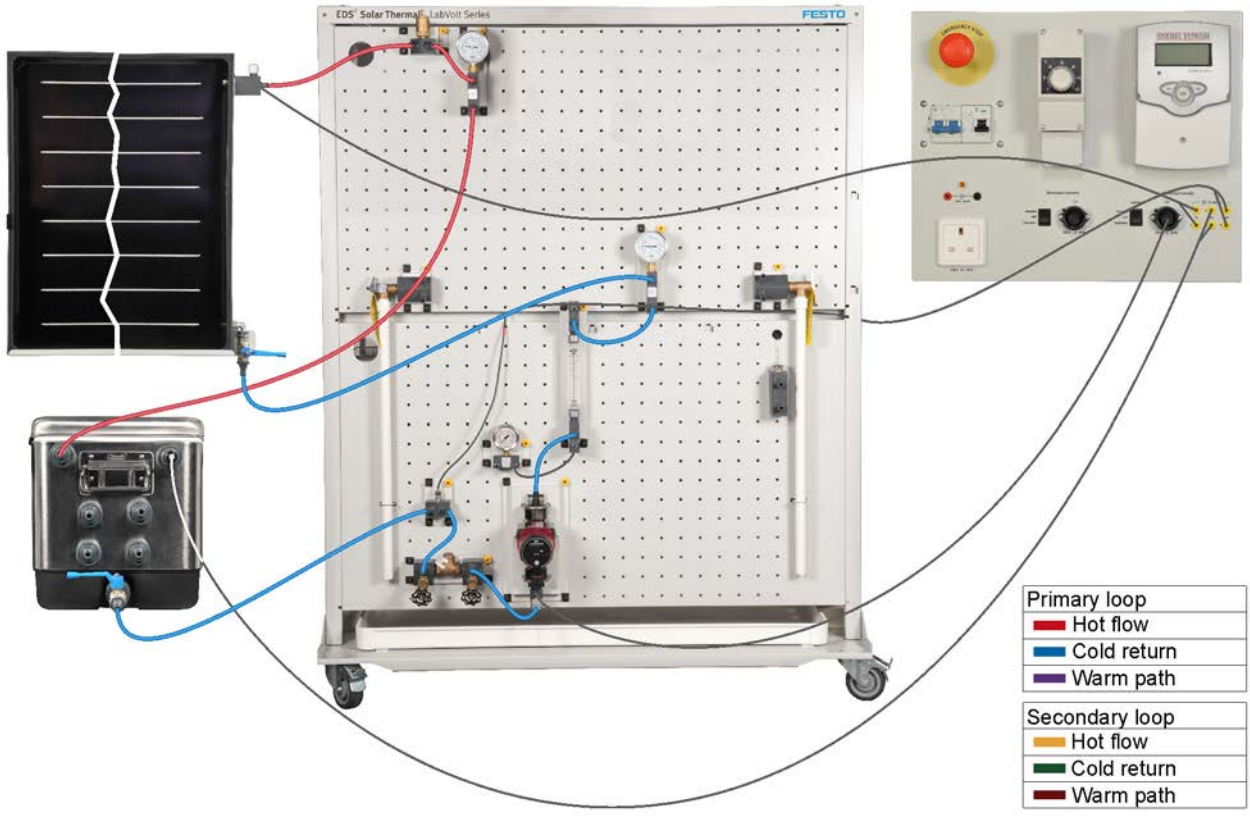

Figure 3: Example of usage system configuration.

Priming the system

4. Set the valves of the solar collector to Open.

5. Disconnect the hose at the output of the pump and wait until you see a small flow of water.

6. Reconnect the hose at the output of the pump.

7. Turn the power on by setting the circuit breaker to I.

8. Start the pump by setting the differential controller override switch to Override. Wait at least 30 seconds.

   Make sure the pump is still set to III or HI. If not, use the > button at the center of pump model 46508-1C or rotate the speed selector on model 46508-10 to adjust.

9. Check the rotameter. If the value is greater than or equal to 1.9 LPM, proceed to the Commissioning section. If the value is 0, turn the pump off using the override switch and wait at least 5 seconds.

10. Restart the pump by setting the differential controller override switch to Override. Wait at least 30 seconds.

11. Check the rotameter. If there is no flow, turn the pump off. Then perform the following steps.

12. Disconnect the hose at the rotameter inlet. Allow all trapped air to escape. Air is no longer present when the water flow from the hose is steady. Then reconnect the hose.

13. Disconnect the hose at the thermometer inlet. Allow all trapped air to escape. Air is no longer present when the water flow from the hose is steady. Then reconnect the hose.

14. Restart the pump.

15. Repeat Step 9 to Step 14 until the water flow is steady and greater than or equal to 1.9 LPM.

Once these steps are complete, the system is primed. Proceed to the next section.

Commissioning

16. Set the valves as shown in the following table.

Table 4: State of the different valves.

Valves	State
Automatic air vent	closed
Solar collector ball valve	open
Storage tank ball valve	open
Check valve assembly (fill) drain valve	closed
Check valve assembly (purge) drain valve	closed

17. Set the differential controller override switch to the Controller position.

18. Use the differential controller (TDIC) to set the pump to AUTO mode.

    - **DeltaSol SL controller.** Slide down the housing cover and press the [HAND] micro button to enter the menu. Press the [CHECK] button, select AUTO with the adjustment dial, and confirm by pressing [CHECK]. Exit the menu with the [BACK] button.

    - **Stiebel Eltron SOM 6 Plus controller.** Press and hold the "+" (right) button until a menu appears. Use the "+" button to select the MAN-1 menu. Press the "ok" (center) button and use the "+" and "–" buttons to select auto mode. Press the "ok" (center) button to confirm.

19. Use the electrical panel's ac outlet to connect two 500 W work lights and turn them on.

    You can now measure the parameters under normal operating conditions.

Turning the system off

20. Turn off the system by setting the circuit breaker to O.

21. Turn off the work lights.

When the system is no longer in use, the water must be drained. To do so, refer to the Water draining procedure section.

Water draining procedure

Draining a loop

1. Connect a hose to the purge drain valve, or to a trainer hose at the lowest point in the system, or at a pump inlet, and route the hose to a large bucket or nearby drain.

2. If present, open the purge drain valve by turning its knob counterclockwise.

3. Open the storage tank ball valve.

4. Let the water drain from the system until the bucket is nearly full or all water has drained from the trainer.

   If necessary, remove the hose from the top of the rotameter to allow draining.

5. If present, close the purge drain valve by turning its knob clockwise.

6. Disconnect the garden hose from the purge drain valve, if present.

7. Close the ball valve at the solar collector inlet or drain the solar collector at this point.

   When draining the solar collector, allow air to enter at the outlet port (or attach the vacuum breaker valve).

Draining the storage tank

8. Connect a garden hose to the purge drain valve, or connect a trainer hose to the drain at the bottom of the storage tank, and route the hose to a large bucket or nearby drain.

9. Open the purge drain valve by turning its knob counterclockwise and/or open the ball valve at the base of the storage tank.

10. Let the water drain from the system until the bucket is nearly full or all water has drained from the trainer.

11. Close the purge drain valve by turning its knob clockwise and/or close the ball valve at the base of the storage tank.

12. Empty the bucket and repeat Step 8 if necessary.

13. Disconnect the hose.

Equipment Description

The Solar Thermal Learning System (shown in the following figure) is a solar hot-water heating system that teaches students the basic principles of thermal energy, and how it can be collected, stored, and supplied. It focuses on operation, troubleshooting, and maintenance of the equipment.

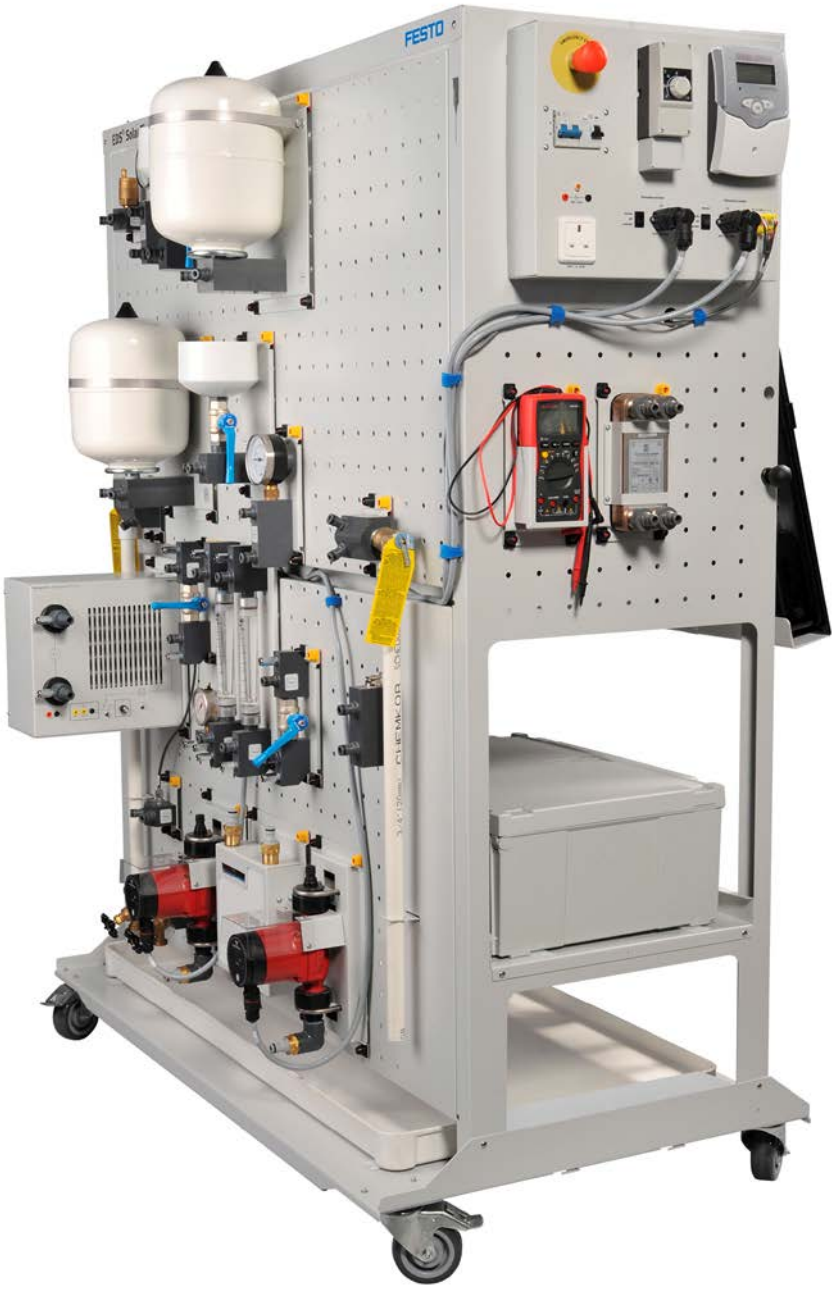

Figure 4: Solar Thermal Learning System.

Electrical panel

The electrical panel is used to power the system, the work lights and the radiator. It is also used to control the pumps using the differential controller and the thermostat controller. The electrical panel components are shown in the following figure and described as follows.

1. Emergency stop push button

2. Thermostat controller

3. Residual current device
4. 2-pole circuit breaker switch (10 A)
5. 4-pin connector (to connect to the secondary loop's circulator pump)
6. Thermostat controller override switch
7. DC power source connector rated at 24 V, 2.4 A (to connect to the radiator)
8. AC outlet (to connect the work lights)
9. Differential controller override switch
10. 2 mm yellow terminals to connect the solar collector outlet temperature sensor
11. 2 mm yellow terminals to connect the storage tank temperature sensor
12. 2 mm yellow terminals to connect the remote temperature sensor
13. AC power input
14. 4 pin connector (to connect to the primary loop's circulator pump)
15. Differential controller

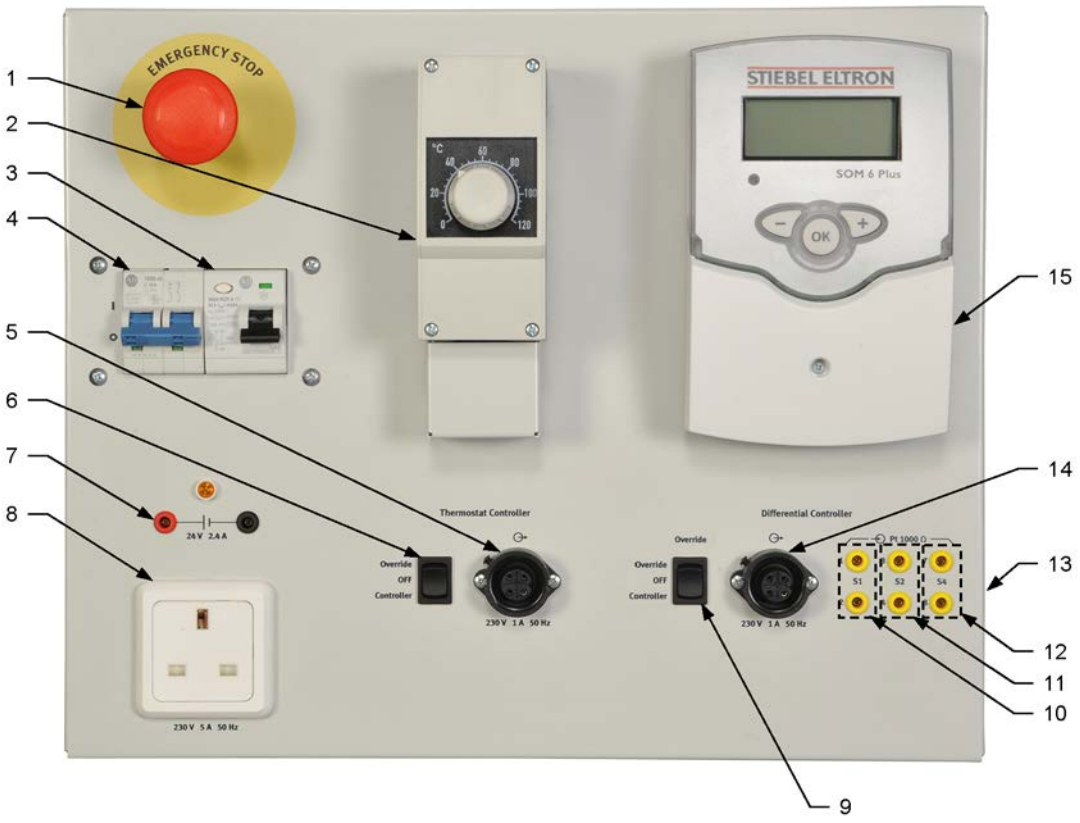

Figure 5: Electrical panel.

Differential controller

The system is supplied with either a DeltaSol SL controller or a Stiebel Eltron SOM 6 controller. You can perform the exercises with either controller.

The DeltaSol SL controller is programmed in a basic operating mode that limits the display to selected measured temperatures, output percentages, control signals, and the current time and date. These parameters are sufficient to perform the exercises. You can switch between this basic mode and the complete mode using the CODE parameter on the controller:

- 0000: basic operating mode
- 0262: complete operating mode

For more information on the parameters in either mode, consult the manufacturer's documentation.

Radiator

The radiator acts like a heat exchanger and transfers heat from water to air. The radiator components are shown in the following figure and described as follows.

1. Hose connectors
2. DC power input terminals rated at 24 V, 2.4 A for connection to the electrical panel's dc power source
3. 2 mm terminals rated at 0–5 V or 4–20 mA (used to receive the analog signals necessary for controlling the manual blower speed)
4. Toggle switch (used to select the control mode of the manual blower-speed)
5. Rotating knob (used for manual blower-speed control with built-in adjustment)
6. Toggle switch (used to select the relation between the input and the output)

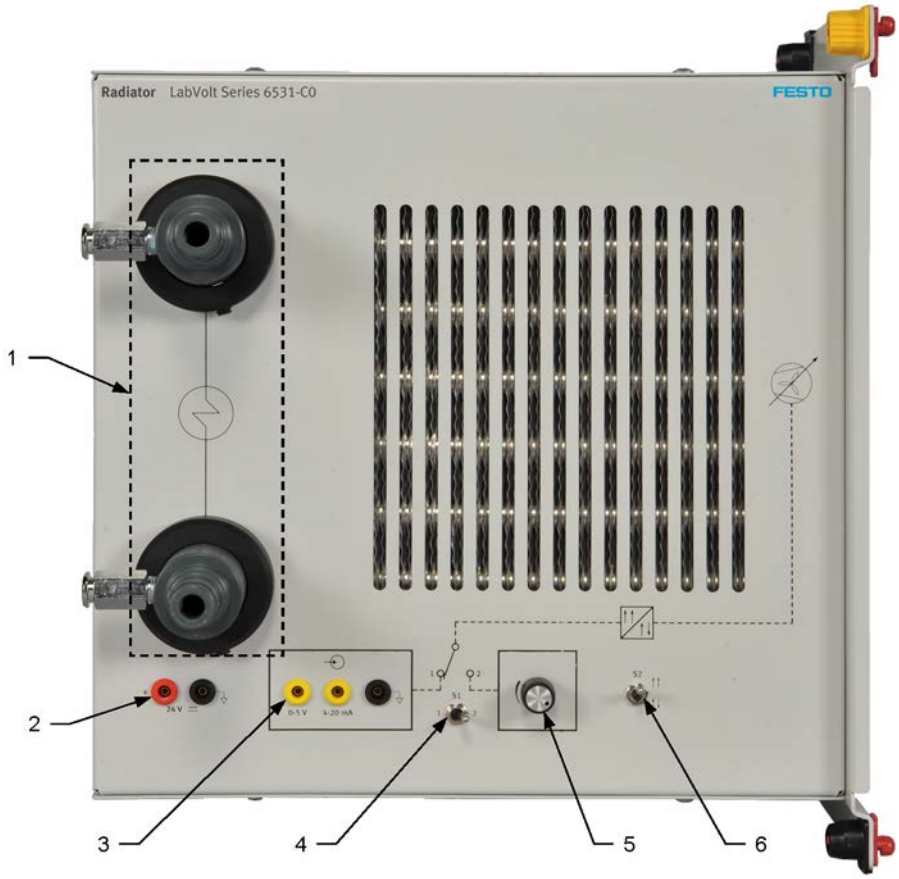

Figure 6: Radiator.

Specifications

The Solar Thermal Learning System comes in two variants: **8046647 (120 V – 60 Hz)** and **8046646 (230 V – 50 Hz)**. The specifications for both are provided in the following table.

Table 5: Technical specifications.

Parameter	Value
Power requirements	
Nominal voltage	8046647: 120 V, 12 A, 60 Hz, 1.44 kW 8046646: 230 V, 6 A, 50 Hz, 1.84 kW
Service installation	Standard single-phase outlet
Physical characteristics	

Parameter	Value
Intended location	On the floor (stands on casters)
Degree of protection	IP20
Electromagnetic compatibility	Group 1, Class A (industrial environment, EN 55011)
Dimensions	1400 × 760 × 1760 mm
Weight	188 kg (once filled with water)
CE and UKCA markings	• Low-Voltage Directive • EMC Directive • RoHS Directive
Solar collector	
Dimensions	1200 × 800 mm
Volume	0.6 L
Content	Polycarbonate frame, 70 mm-thick mineral wool insulation, aluminum-copper absorb-er, solar glass ESG.
Composition	Collector inlet (with shutoff valve) and collector outlet (capped or attached to a vacuum breaker)
Circulator pumps	
Operating modes	Mode I or LO: Fixed to slow speed. In this mode, the pump runs at a constant speed, following a constant curve (the minimum curve) under all operating conditions.
	Mode II or MED: Fixed to medium speed. In this mode, the pump runs at a constant speed, following a constant curve (the medium curve) under all operating conditions.
	Mode III or HI: Fixed to high speed. In this mode, the pump runs at a constant speed, following a constant curve (the maximum curve) under all operating conditions.
Additional operating modes for model 46508-1C	Constant pressure I: The duty point of the pump moves left and right along the lowest constant-pressure curve depending on the water demand in the system, keeping the head constant.

Parameter	Value
	Constant pressure II: The duty point of the pump moves left and right along the middle constant-pressure curve depending on the water demand in the system, keeping the head constant.
	Constant pressure III: The duty point of the pump moves left and right along the highest constant-pressure curve depending on the water demand in the system, keeping the head constant.
	AUTO adapt: In this mode, the control of the pump performance is automatic, within the defined performance range. The pump performance is automatically adjusted to the system demands over time.
Maximum flow rate	8046647: 95.0 LPM (at 0 m) 8046646: 79.5 LPM (at 0 m)
Maximum head	8046647: 5.50 m (0 LPM) 8046646: 5.80 m (0 LPM)
Power operating range	8046647: 58 W to 87 W 8046646: 5 W to 45 W
Storage tank	
Composition	Stainless steel, thermally insulated vessel, two internal heat exchangers, temperature sensor
Ports	Drain port with shutoff valve, return port
Volume	Capacity of 51.10 L but filled to 37.95 L
Coil types (heat exchangers)	Copper
Plate heat exchanger	
Plate type	Copper, brazed
Area	0.12 m²
Volume	0.11 L
Electrical panel	

Parameter	Value
Content	Circuit breakers, dc power supply, emergency button, override switches, pump connectors, temperature sensor connector's ac outlet, thermostat controller, differential controller
DC power supply rating	24 V, 2.4 A
Override switches operation modes	"Override" mode: The pump works independently from the controller's settings.
	"Off" mode: The pump is turned off.
	"Controller" mode: The pump works using the controller's settings.
Pump connectors type	4-pin connector
Pump connectors rating	8046647: 120 V, 0.75 A, 60 Hz 8046646: 230 V, 1 A, 50 Hz
Temperature sensor connectors type	1000 Ω (1 kΩ) platinum (Pt) resistance temperature detector (RTD) sensors
AC outlet rating	8046647: 120 V, 10 A, 60 Hz 8046646: 230 V, 5 A, 50 Hz
Differential controller	
Type	Digital
Model	DeltaSol SL or Stiebel Eltron SOM 6
Composition	DeltaSol SL controller: digital display screen, two buttons (BACK, CHECK), one adjustment dial, two microbuttons (MANUAL, HOLIDAY) Stiebel Eltron SOM 6 controller: digital display screen and three push-button switches
Differential temperature setting range	DeltaSol SL controller: 2°R (0.5 K) to 100°R (50 K) Stiebel Eltron SOM 6 controller: between 1.1°C and 22.22°C

Parameter	Value
Default set points	DeltaSol SL controller • To turn the pump on: 12°R (6 K) • To turn the pump off: 8°R (4 K) Stiebel Eltron SOM 6 controller • To turn the pump on: 6.67°C • To turn the pump off: 4.45°C
Thermostat	
Switch type	Electromechanical
Composition	Remote sensing bulb with a fluid-filled capillary tube, internal single-pole, double-throw (SPDT) switch
Temperature set point adjustment	From 0°C to 40°C with a rotating knob
Temperature sensors	
Types	3 electrical and 1 mechanical
Expansion tanks	
Composition	Flexible diaphragm, fluids
Fluid types	Primary (water) and secondary (air)
Capacity	7.95 L
Radiator	
Composition	152.4 mm² radiator element, a dual blower that consists of two electric motors with fan blades, magnetic surface thermometer
Magnetic thermometer measurement range	-17.8°C to 65.6°C
Maximum air flow rate	106 CFM (3060 LPM)
Radiant floor	

Parameter	Value
Type	Hydronic
Composition	203.2 mm² flooring constructed with copper tubing bonded to a ceramic tile 6.81 mm thick
Thermal mass volume	0.04 m³ dimensionally or 0.53 kg by weight
Digital multimeter	
Measurement	AC/DC voltage and current, dc resistance, circuit continuity
Thermometers	
Type	Analog
Measurement type	Degrees Celsius (°C) and degrees Fahrenheit (°F)
Measurement range	0–120°C
Indicator type	Coiled bimetallic strip sensed in a brass immersion
Rotameters	
Type	Analog
Measurement types	Liters per minute (LPM) or gallons per minute (GPM)
Measurement range	0.76–7.6 LPM
Indicator type	Clear tapered tube with a floating indicator
Pressure gauge	
Type	Analog
Measurement type	Pounds per square inch (psi) and kilopascals (kPa)
Measurement range	0–103.4 kPa
Fill Bowls	
Composition	Funnel and ball valve

Parameter	Value
Hoses	
Composition	Pre-fabricated vinyl
Included accessories	Pitcher, white case for the hoses, vacuum breaker, end cap, magnetic surface thermometer

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.

⚠ 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

It is possible to replace consumable pieces or damageable equipment. Use only Festo accessories to ensure compatibility and sustainability of the equipment. The pieces are listed below with their respective part numbers:

Table 6: List of consumable pieces and damageable equipment.

Part	Type	Note	Part number
Power cord	EF-C	90° angle	86331-5
Fuse	Slow blow	0.375 A	92337
Lamp bulb	Halogen lamp bulb	500 W, 220 V	87039-5
Multimeter	Digital multimeter	cULus CE	6394-B0
Valve	Ball valve	15 mm, brass	52199
Hose	Water hose	1.8 m	87042-10
Hose	Water hose	0.9 m/0.6 m/0.3 m	87042-11/-12/-13
Cap	Thread	0.3 m	1.91 cm
Vacuum breaker			87448
Thermomagnetic surface			87244
Hose connector	Water stop connector		52356
Cable	2 mm 300		52369
Pitcher	Clear	1 L	52220
Velcro	Cut blue	12.70 cm	64851

⚠ DANGER

Fuse replacement requires the opening of the electrical panel. This can only be performed by Festo authorized personnel.

Water maintenance procedure

Equipment that uses water requires special care. Follow these guidelines:

- Use potable tap water for long-term, maintenance-free operation.

- Keep the system in a well-ventilated, dry area to prevent mildew. Do not store it in damp locations.
- Do not let the pump run dry. Do not use it with seawater, contaminated liquids, or viscous substances.
- Follow the draining procedure to empty the system.
- Check the liquid weekly and replace it weekly or immediately if it is contaminated.

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 7: 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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User Guide

Solar Thermal Learning System

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