Hydrogen Fuel Cell Training System
579307 (8010-80)

LabVolt Series

Datasheet

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Festo Didactic
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General Description

The Hydrogen Fuel Cell Training System provides a realistic representation of the basic functions of a 50 W hydrogen fuel cell system. It is ideal for teaching the basic engineering principles of fuel cell systems. Realistic, extensive experimenting capabilities and optimized instructional materials make this a comprehensive instruction package. Through practical experiments, students acquire a sound competence in working with fuel cell systems.

The modular design of the Hydrogen Fuel Cell Training System enables flexibility in setup complexity – from simple experiments for teaching basic principles to complex experiments for experienced students. The components and curriculum of the Hydrogen Fuel Cell Training System are offered through a partnership with Heliocentris, the world's leading authority on fuel cells used in education. The system is suitable for hands-on learning in diverse fields of study and occupations, such as:

- Electrical engineering
- Energy engineering
- Process engineering
- Mechanical engineering
- Automotive engineering

The Hydrogen Fuel Cell Training System includes numerous prepared experiments, enabling students to examine the design and functions of a real fuel cell system. It is developed especially for educational purposes, the system being designed for maximum safety and ease of use, even by inexperienced users. With this training system, students explore the engineering principles of a hydrogen fuel cell system, as well as advanced general principles related to the system, including:

- Structure and functioning principles
- Thermodynamics
- Characteristic curves and efficiency ratings
- Power electronics

The Hydrogen Fuel Cell Training System is part of the Electric Power Technology Training Systems, Series 8010. Each training system in Series 8010 is based on the Electric Power Technology Training Program and provides a turn-key solution dealing with some aspects of the wide field of electrical energy. The exhaustive courseware provided with each training system covers all the theory required to perform the laboratory exercises, while review questions and unit tests allow students to test the knowledge they have gained.

The Electric Power Technology Training Program is highly modular in both courseware and hardware. Because of this, courses and equipment from the program are available as required, either individually or in the context of a specific training system. The program covers several different subjects in the field of electrical energy, such as rotating machines, electrical power transmission, power electronics, home energy production from renewable resources (wind and sunlight), large-scale electricity production from hydropower and wind power, smart-grid technologies (SVC, STATCOM, HVDC transmission, etc.), storage of electrical energy in batteries, and drive systems for small electric vehicles and cars.

Exercises

Theory:

- Introduction to the operation of a fuel cell system
- Characteristic curve and output curve of the fuel cell
- Dependence of output on air supply and temperature
- Hydrogen/current characteristic curve of the fuel cell
- Efficiency analyses of the fuel cell stack

Safety:

The Hydrogen Fuel Cell Training System is designed for maximum technical safety. Developed especially for universities and vocational institutions, the system is designed for safe and easy operation by inexperienced and experienced users. In case of overloads or irregularities, the trainer shuts down automatically and locks the hydrogen supply. Therefore, you can take the system to its limits without the risk of safety hazards or damage.

Practice:

- Set-up and operation of an autonomous power supply
- Efficiency of the fuel cell system
- Sample application of independent power supply: How long can a fuel cell supply an autonomous consumer?
- Sample application for fuel cell car: Determination of the fuel consumption based on the load profi le

Features & Benefits

- Different test points with digital meters throughout the process for better understanding
- The training system teaches the principles of hydrogen fuel cell operation during both charge and discharge directly in the laboratory.
- The hydrogen fuel cell modules are safe to use and present no risk to system users. The modules are easy to setup by following the procedure detailed in the manuals.
- Sequential loads and fully adjustable loads allow study of hydrogen fuel cell system operation.
- A variety of test points with digital meters are included in the hydrogen fuel cell modules to observe the different processes taking place.
- The course curriculum of the Electric Power Technology Training Program is highly flexible and allows a multitude of different customized training solutions.
- The courseware includes student manuals and instructor guides with all the theory required to perform the hands-on experiments.
- All workstations, modules, and components are very sturdy to ensure a prolonged service life in a demanding environment such as a training laboratory.
- The modular design approach of the training equipment allows a large variety of courses to be performed using a small number of modules, without unnecessary duplication of equipment.
- All electrical components can be interconnected without electric shock hazard since all live parts of the connection leads are concealed and insulated.
- All electrical symbols representing the components used in a laboratory exercise are clearly silk-screened on the front panel of the modules.

List of Equipment

Qty	Description	Model number
1	_____	579355 (86355-00)
1	_____	579356 (86355-10)
1	Three-Module Workstation _____	579483 (8131-00)
1	Traffic Lights _____	579574 (8380-00)
1	Electronic Load _____	579575 (8381-00)
1	Hydrogen Fuel Cell _____	579593 (8803-00)
1	Hydrogen Cylinder Connection Kit _____	780548 (52863-00)
1	Hydrogen Storage Canister _____	579699 (87948-00)

List of Manuals

Description	Manual number
Hydrogen Fuel Cell (Workbook) _____	579355 (86355-00)
Hydrogen Fuel Cell (Workbook (Instructor)) _____	579356 (86355-10)
Hydrogen Fuel Cell (User Guide) _____	579357 (86355-E0)
Electric Power Technology Training Equipment (User Guide) _____	584778 (38486-E0)

Table of Contents of the Manual(s)

Hydrogen Fuel Cell (Workbook) (579355 (86355-00))

Hydrogen Fuel Cell (User Guide) (579357 (86355-E0))

- 3-6 Start-up
- 3-7 Shutting down
- 3-8 Factors affecting operation
- 3-9 Improper modes of operation
- 3-10 Error messages and causes
- 3-11 Maintenance
- 4 Electronic Load Module EL200
- 4-1 Use
- 4-2 Overview and parts list
- 4-3 Basic function
- 4-4 Technical data
- 4-5 Start-up
- 4-6 Manual operation
- 4-7 Computer-assisted operation
- 4-8 Shutting down
- 4-9 Improper modes of operation
- 4-10 Possible malfunctions
- 5 Voltage Converter Module VC100
- 5-1 Use
- 5-2 Overview and parts list
- 5-3 Basic functions
- 5-4 Technical data
- 5-5 Start-up
- 5-6 Maintenance
- 6 Traffic Light Module TL10
- 6-1 Use
- 6-2 Overview
- 6-3 Technical data
- 7 Control software
- 7-1 System requirements
- 7-2 Installation
- 7-3 Running an FC50 Program
- 7-4 Control window (left side)
- 7-5 Warm-up panel
- 7-6 User Interface program
- 7-7 Experiment programs
- 7-8 Automated Experiment programs
- 7-9 Troubleshooting
- 8 Hydrogen Supply I: Connection set for compressed gas cylinders
- 8-1 Use
- 8-2 Overview and parts list
- 8-3 Special safety considerations for handling compressed hydrogen cylinders
- 8-4 Technical data
- 8-5 Basic function
- 8-6 Installation
- 8-7 Pausing and shutting down
- 8-8 Maintenance and repair
- 9 Hydrogen Supply II: Metal hydride storage, with refilling kit

- 9-1 Use
- 9-2 Overview and parts list
- 9-3 Special safety considerations for metal hydride storage canisters
- 9-4 Special safety considerations for handling compressed hydrogen cylinders
- 9-5 In case of fire
- 9-6 Technical data
- 9-7 Basic function
- 9-8 Shipping state, installation and first use of the metal hydride canister
- 9-9 Refilling the metal hydride storage canister with hydrogen
- 9-10 Installation of the metal hydride storage canister on its panel
- 9-11 Using hydrogen from the metal hydride storage canister
- 9-12 Pausing and shutting down
- 9-13 Maintenance and repair
- 10 Hydrogen Supply III: Hydrogen generator with metal hydride storage
- 10-1 Use
- 10-2 Special safety considerations for the hydrogen generator
- 10-3 Overview, scope of supply and operation
- 11 Warranty and complaints

Electric Power Technology Training Equipment (User Guide) (584778 (38486-E0))

- 1 General Safety Recommendations
- 2 System Power Requirements
- 3 Quick Start Installation Guide
- 4 Equipment Installation
- 5 Modules Handling, Installation, and Removal
- 6 Equipment Maintenance
- A Connection of the Power Supply to the AC Power Network
- B Description, Specifications, and Operation of the EMS Modules

System Specifications

Parameter	Value
Power Requirements	
Service Installation	A standard single-phase ac outlet
Physical Characteristics	
Intended Location	On a table able to support the weight of the workstation and installed equipment
Dimensions (H x W x D)	900 x 930 x 530 mm (35.4 x 36.6 x 20.9 in)
Net Weight	TBE
EMS Modules	
Full-Size Dimensions (H x W x D)	308 x 287 x 440 mm (12.1 x 11.3 x 17.3 in)
Half-Size Dimensions (H x W x D)	154 x 287 x 440 mm (6.1 x 11.3 x 17.3 in)

Equipment Description

Three-Module Workstation 579483 (8131-00)

The Three-Module Workstation is a fully assembled workstation that serves the same purpose as the Mobile Workstation, Model 8110, but without any storage cabinet or pull-out work surface. This workstation is intended for use on a bench (not supplied) and is fitted with wooden feet to protect the bench top.

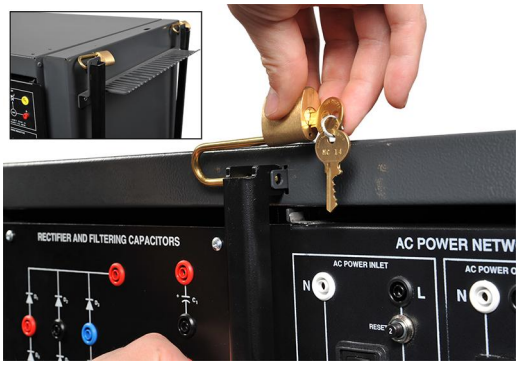
The Three-Module Workstation consists of a single row of three full-height compartments that can accommodate up to three full-size EMS modules or six half-size EMS modules.

Module Installation

The EMS modules are guided into position along stainless steel guide rails. Separators between each bay of the workstation ensure perfect alignment of the EMS modules and allow their easy insertion in the workstation. A holding mechanism ensures that each EMS module stays in place once it is installed in a compartment of the workstation. A front-mounted push lever allows all EMS modules on the workstation to be released for easy removal.

Safety Padlock Bars

Two safety padlock bars on the front of the workstation prevent students from removing EMS modules during laboratory exercises. The bars can be removed and locked to the side of the workstation when the safety lock is not necessary.



Additional Information

Three holes in the rear panel of the workstation allow connection to a power supply, as well as the connection of 2 kW machines to their interconnection modules. Assembly of the workstation before painting ensures that each EMS module in the workstation is correctly grounded.

Manual

Description	Manual number
Electric Power Technology Training Equipment (User Guide)	584778 (38486-E0)

Table of Contents of the Manual(s)

Electric Power Technology Training Equipment (User Guide) (584778 (38486-E0))

- 1 General Safety Recommendations
- 2 System Power Requirements
- 3 Quick Start Installation Guide
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Specifications

Parameter	Value
Physical Characteristics	
Intended Location	On a table able to support the weight of the workstation and installed equipment
Dimensions (H x W x D)	375 x 930 x 530 mm (14.8 x 36.6 x 20.9 in)
Net Weight	TBE

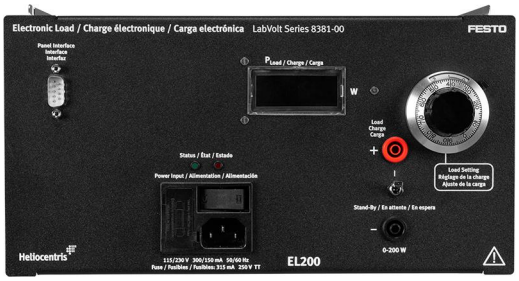
Traffic Lights 579574 (8380-00)

The Traffic Lights module simulates a real-world traffic light application that can be used as a load for a fuel cell system.

Specifications

Parameter	Value
Input Voltage	12 V dc
Power Consumption Max.	10 W
Physical Characteristics	
Dimensions (H x W x D)	154 x 287 x 440 mm (6.1 x 11.3 x 17.3 in)
Net Weight	TBE

Electronic Load 579575 (8381-00)



The Electronic Load provides manual or computer-assisted adjustment of constant rated currents that can be used to record the characteristic curves of a fuel cell system, allowing users to monitor the effects of different parameters.

Specifications

Parameter	Value
Maximum continuous power output	200 W
Load voltage	1.2 – 20 V dc
Load current	0 – 10 A
Mains connection	120 – 240 V (50 – 60 Hz)
Physical Characteristics	
Dimensions (H x W x D)	154 x 287 x 440 mm (6.1 x 11.3 x 17.3 in)
Net Weight	TBE

Hydrogen Fuel Cell 579593 (8803-00)

The Hydrogen Fuel Cell module is a fuel cell stack comprising a fuel cell controller, a hydrogen flow meter, a dc-to-dc converter (required to obtain a regulated dc output from the fuel cell stack), an air supply, and seven LED displays for visualizing all essential system parameters (e.g., current, voltage, temperature, fuel, air supply).

A USB port on the front panel enables use of the included data acquisition software to perform further analysis on the fuel cell stack. This software provides support for the experiments (visualization, data logging, fully automated experiments) in the manual.

Specifications

Parameter	Value
Rated Output	40 W
Maximum Output	50 W
No-Load Voltage	9 V
Current at Rated Output	8 A
Hydrogen Consumption at Rated Output	580 sml/min
Hydrogen Purity for Operation	A minimum of 4.0 (99.99%)
Permissible Hydrogen Pressure	0.4 – 0.8 bar

Parameter	Value
Permissible Ambient Temperature during Operation	5–35°C (41-95°F)
Communication Port	USB
Pressure Regulator	
Description	Two-stage, hydrogen
Inlet Pressure	Max. 19 bar
Outlet Pressure	0.6 ± 0.1 bar
Accessories	
	Leak detection kit
	Safety connection leads
	Software
Physical Characteristics	
Dimensions (H x W x D)	307 x 579 x 533 mm (12.1 x 22.8 x 21 in)
Net Weight	TBE

Hydrogen Cylinder Connection Kit 780548 (52863-00)

The Hydrogen Cylinder Connection Kit allows easy and quick connection of hydrogen cylinders to the quick coupling of a metal hydride canister. A pressure reducer ensures that the system's maximum inlet pressure is not exceeded.

Specifications

Parameter	Value
Hydrogen Cylinder Connection Kit	
Description	One-stage hydrogen pressure regulator
Max. Inlet Pressure	200 bar
Max. Outlet Pressure	17 bar
Connection	CGA, DIN, or BS

Hydrogen Storage Canister 579699 (87948-00)

The Metal Hydride Storage Canister can store enough hydrogen to be used for multiple experiments without requiring a compressed hydrogen cylinder for recharge. The canister is supplied empty and must be refilled from a compressed hydrogen gas canister or hydrogen generator before use.

Specifications

Parameter	Value
Storage Capacity (at a Charge Pressure of 17 bar)	250 Nl
Output	1.7 sl/min
Charge Pressure	10-17 bar
Charge Time	One hour at normal ambient temperature and with active cooling

Reflecting the commitment of Festo Didactic to high quality standards in product, design, development, production, installation, and service, our manufacturing and distribution facility has received the ISO 9001 certification.

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