Equipment set TP 8012-5 Solar Power (Complete)
596088 (8012-5C)

LabVolt Series

Datasheet

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Festo Didactic
en 230 V - 50 Hz
04/2025

Table of Contents

General Description

Solar Power Production

As solar power production becomes more and more affordable for residential applications, no wonder the number of installations worldwide is blooming. So comes the need to train qualified technicians in understanding and maintaining these systems.

Our solar power learning solutions come in modular packages that will fit your training needs starting with the fundamentals of photovoltaic panels and how they work all the way to actual photovoltaic energy production systems operating in stand-alone or grid-tied operation.

Computerized tools made for learning

To guide students through their learning path, Festo Didactic provides state-of-the-art data acquisition tools for easy, safe and fast measurements in order to speed up the setup time but also reduce the downtime of using standard measuring instruments. The Data Acquisition and Control Interface comes also with an oscilloscope, a phasor analyser, a data table and a graph on specifically designed software optimized for learning purposes.

Features

- Flexible packages for specific training and budget needs
- A4 form factors
- Modular approach giving opportunity to combine these packages with other topics
- New and safer grounding methods between the modules
- Solar Panel Emulator for experiments requiring more power
- Two types of inverters: PWM and MPPT
- Top of the line data acquisition and control interface designed for learning purposes

Training Content:

- The Diode
- The Solar Panel (Photovoltaic Panel)
- Effect of Temperature on Solar
- Panel Performance
- Storing Energy from Solar Panels into Batteries (optional)
- Effect of Shading on Solar Panel Operation
- Solar Panel Orientation
- Solar Panel Performance versus Insolation
- Stand-Alone PV Systems for DC Loads
- Use of an MPPT Charge Controller in Stand-Alone PV Systems
- Stand-Alone PV Systems for AC Loads
- Grid-Tied PV Systems

List of components:

- 1x 12 V Lead-Acid Batteries
- 1x Solar Panel Test Bench

- 1x Monocrystalline Silicon Solar Panel
- 1x DC 48 V Lamps
- 1x AC 230 V Lamps
- 2x 1 AC Energy Meter
- 1x 48 V Lead-Acid Battery Pack
- 1x DC 48 V PWM Charge Controller
- 1x DC 48 V MPPT Charge Controller
- 1x Single-Phase Power Supply
- 1x AC 24 V Power Supply
- 1x 1 AC 230 V Stand-Alone Inverter
- 1x 1 AC 230 V Grid-Tied Inverter
- 1x 4-Quadrant Power Supply and Dynamometer Controller (including Manual and Computer-Based Control)
- 1x Firmware Function (4Q Dynamometer/Power Supply): Pb-Acid Battery Charger
- 1x Data Acquisition and Control Interface (including computer-based instrumentation for 2x current inputs and 2x voltage inputs)

Equipment set TP 8012-5 Solar Power (Complete)The training system in Solar Power shall be a modular system that provide fundamentals training on photovoltaic panels, solar power production, stand-alone networks and grid-tied applications.

It shall include the following features:

- Complete tabletop test bench for solar panels with irradiance control, temperature monitoring, shading capabilities for complete understanding of solar panel operation
- Modular in design to allow new equipment to be added to existing laboratories without any needless duplication of equipment also share equipment between workstations
- All modules able to be inserted into a standard workstation
- Symbols and diagrams specific to each module shall be clearly silk-screened on the faceplates.
- Standard color-coded 4 mm safety sockets shall be used to interconnect all system components
- Grounding method between modules that prevents connection with live voltage
- Complete computer data acquisition (including multiple meters, oscilloscope, data table and graph) connected to the same software as the flexible power supply
- Realistic solar panel emulator integrated in flexible power supply with easy configuration of irradiance and number of PV cells in series and parallel

The accompanying teachware shall cover the following topics both theoritically and experimentally:

- Solar panel construction, photovoltaic cells, diodes, series and parallel
- Effects of orientation, temperature, insulation, shading on solar power production
- Store energy in batteries from solar panels
- Stand-alone photovoltaic installations for DC Loads
- Stand-alone photovoltaic installations for AC loads
- PWM vs MPPT charge controllers and their benefits
- Grid-tied installations and metering methods

All workbooks shall be available as PDF files on a CD-ROM for an unlimited license.

Consisting of:

- 1x Batteries
- 1x Monocristallin Solar Panel
- 1x Solar Panel Test Bench
- 1x Set of DC lamps
- 1x Set of AC lamps
- 1x Stand-alone inverter
- 1x Grid-Tied Inverter
- 2x Single-Phase Energy Meter
- 1x PWM Charge Controller
- 1x MPPT Charge Controller
- 1x Data Acquisition for measurements
- 1x Flexible Power Supply with Solar Panel Emulator
- 1x Single-Phase Power Supply

Features & Benefits

- Flexible packages to match specific training needs and budget

- Top of the line data acquisition and control interface designed for learning purposes
- Solar panel emulator for experiments requiring more power
- Two types of charge controllers: PWM and MPPT
- Safe grounding methods between the modules
- Modular approach allowing for expansion to other topics, such as wind power
- Courseware available as eLab courses on Festo LX or in print or PDF format

List of Equipment

Qty	Description	Model number
1	DC 48V Lamps	595055 (8313-PC)
1	AC 230 V Lamps	8165858 (8314-QC)
2	1AC Energy Meter	594904 (8432-PC)
1	AC 230 V Power Supply	595930 (8622-PC)
1	12V Lead-Acid Batteries	595060 (8801-PC)
1	48 V Lead-Acid Battery Pack	8174051 (8802-QC)
1	Solar Panel Test Bench	595057 (8805-PC)
1	Monocrystalline Silicon Solar Panel	595058 (8806-PC)
1	DC 48V PWM Charge Controller	595051 (8807-PC)
1	DC 48V MPPT Charge Controller	595050 (8808-PC)
1	AC 24V Power Supply	772050 (8826-PC)
1	1AC 230V Stand-Alone Inverter	595052 (8833-PC)
1	1AC 230V Grid-Tied Inverter	595053 (8834-PC)
1	4 Quadrant Power Supply and Dynamometer Controller (including Manual and Computer-Based Control)	595028 (8960-SC)
1	Solar Panel Emulator Function Set	581440 (8968-60)
1	Data Acquisition and Control Interface	595912 (9063-QC)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [1]
1	Digital Multimeter	579782 (8946-20) [2]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [3]
1	Digital Multimeter	579782 (8946-20) [4]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

[1] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[2] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

[3] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[4] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [5]
1	Digital Multimeter	579782 (8946-20) [6]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [7]
1	Digital Multimeter	579782 (8946-20) [8]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [9]
1	Digital Multimeter	579782 (8946-20) [10]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [11]
1	Digital Multimeter	579782 (8946-20) [12]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)

[5] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[6] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

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[11] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[12] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

Qty	Description	Model number
1	Communications Gateway	595054 (8849-PC) [13]
1	Digital Multimeter	579782 (8946-20) [14]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [15]
1	Digital Multimeter	579782 (8946-20) [16]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [17]
1	Digital Multimeter	579782 (8946-20) [18]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [19]
1	Digital Multimeter	579782 (8946-20) [20]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [21]

[13] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[14] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

[15] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

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[17] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[18] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

[19] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[20] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

Qty	Description	Model number
1	Digital Multimeter	579782 (8946-20) [22]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [23]
1	Digital Multimeter	579782 (8946-20) [24]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [25]
1	Digital Multimeter	579782 (8946-20) [26]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [27]
1	Digital Multimeter	579782 (8946-20) [28]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [29]
1	Digital Multimeter	579782 (8946-20) [30]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

[22] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

[23] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[24] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

[25] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

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[27] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[28] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

[29] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

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Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [31]
1	Digital Multimeter	579782 (8946-20) [32]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [33]
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Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [35]
1	Digital Multimeter	579782 (8946-20) [36]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [37]
1	Digital Multimeter	579782 (8946-20) [38]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)

[31] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

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Qty	Description	Model number
1	Communications Gateway	595054 (8849-PC) [39]
1	Digital Multimeter	579782 (8946-20) [40]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [41]
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Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [43]
1	Digital Multimeter	579782 (8946-20) [44]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [45]
1	Digital Multimeter	579782 (8946-20) [46]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [47]

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[46] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

Qty	Description	Model number
1	Digital Multimeter	579782 (8946-20) [48]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Tabletop Workstation (DIN A4)	8153360 (8180-00)
1	Communications Gateway	595054 (8849-PC) [49]
1	Digital Multimeter	579782 (8946-20) [50]
1	Connection Lead Set and Grounding Kit	595916 (8951-R0)

Equipment Description

DC 48V Lamps 595055 (8313-PC)

The DC 48V Lamps module allows the user to compare two types of loads on a stand-alone dc network.

Specifications

Parameter	Value
Lamps	
Types	LED and incandescent
Voltage	48 V dc
Current	1.5 A
Protections	
Power Input	Reverse polarity and overvoltage (60 V)
Physical Characteristics	
Dimensions (H x W x D)	297 x 133 x 140 mm

[48] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

[49] Only one Communications Gateway per laboratory is required. If the country's voltage is rather stable, this unit is optional. It is meant to configure the Grid-Tied Inverter if needed.

[50] The data acquisition already includes this function and many more, but the DC Circuits manual references using multimeters.

Parameter	Value
Weight	2.1 kg

AC 230 V Lamps 8165858 (8314-QC)

The AC 230 V lamps is an A4 module that provides two different 230 V lamps. An incandescent lamp and a LED lamp are included which allows comparing these different loads.

1AC Energy Meter 594904 (8432-PC)

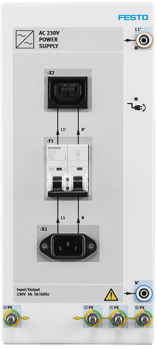
The 1AC Energy Meter is a power monitoring tool. It allows the user to monitor the power flowing from left to right as well as from right to left by switching a switch.

Specifications

Parameter	Value
AC Network	
Voltage	230 V – 50Hz

Parameter	Value
Current	16 A
Monitored Values	Voltage, current, energy, power
Physical Characteristics	
Dimensions (H x W x D)	297 x 133 x 140 mm
Weight	1.7 kg

AC 230 V Power Supply 595930 (8622-PC)



The AC 230 V Power Supply consists of a single-phase power supply which, connected to the AC line voltage, supplies the necessary power for single-phase experiments. This power supply is mounted in an A4 module. The power supply is connected to the AC line voltage with a standard C13 power cord and is then protected with a built-in circuit breaker. Then, the output comes in two forms, one is through a C14 socket and the second is via two 4 mm output jacks.

Features

- Easy way to get AC line voltage over two types of connections

- Includes a phase sequence indicator as some country specific plugs can be inverted

- LED indicated the presence of output voltage

- Protective conductor connection, 4 mm² minimum diameter and deliberately unmistakable with 4 mm safety plug connections to prevent mix-up

AC 230 V Power Supply

The Single-Phase Power Supply shall consists of a fixed single-phase power supply connected to the AC line voltage by a standard power cord. Protected with a circuit breaker, it shall provide voltage for a power cord connection and also through 4 mm safety jacks to other equipment.

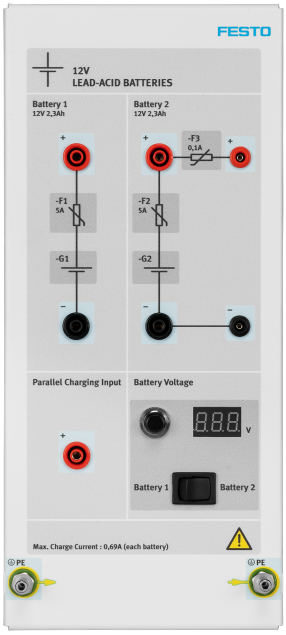
It shall include the following features:

- A phase sequence inducator as some country specific plugs can be inverted
- A LED indicating the presence of output voltage
- Grounding shall be done via Potential Equalization Sockets using vertically mounted pins for higher safety and avoid connections with live voltage

Technical Specifications:

- Nominal current output of at least 3 A

12V Lead-Acid Batteries
595060 (8801-PC)

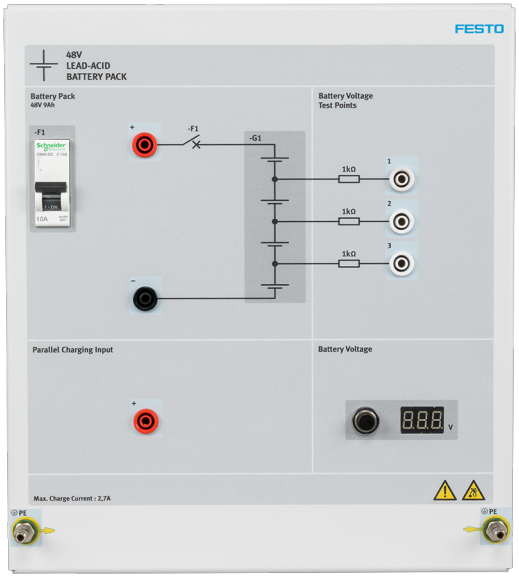


The 12V Lead-Acid Batteries module consists of two 12 V valve-regulated, lead-acid (VRLA) batteries enclosed in an A4 size housing. These batteries are part of the Electric Power Technology Training Program and are used to study lead-acid battery characteristics as well as the storage of electrical energy in various applications, such as solar power and wind power electricity generation. They can easily be charged using the Four-Quadrant Dynamometer/Power Supply. The batteries can be connected in series or parallel. Connection to the batteries is through 4 mm safety banana jacks mounted on the front panel of the module. These jacks are used when large amounts of power are supplied to the batteries or drawn from the batteries. A pair of miniature (2 mm) banana jacks mounted on the front panel of the module provides access to one of the two batteries via a low-capacity auto-reset fuse. These miniature jacks are used to connect the battery to the Solar Panel when performing lab exercises dealing with the storage of electrical energy produced from solar power. A digital meter allows the user to check independently both batteries voltage by selecting a battery and pressing the test button.

Specifications

Parameter	Value
Batteries	
Quantity	2
Type	Valve-regulated lead-acid
Voltage	12 V
Capacity	2.3 Ah
Maximum Charge Current	0.69 A
Maximum Discharge Current	5 A
Auto-Reset Protective Fuse	
Battery	5 A (hold current), 10 A (trip current)
Test Point	0.1 A (hold current), 0.2 A (trip current)
Physical Characteristics	
Dimensions (H x W x D)	297 x 133 x 140 mm
Weight	3.5 kg

48 V Lead-Acid Battery Pack 8174051 (8802-QC)



The 48 V Lead-Acid Battery Pack consists of four 12 V lead accumulators mounted in series. The voltage of each individual battery can be measured via 4 mm safety jacks on the front panel. The batteries have a power switch, common charging input, a battery selector switch and a battery voltage indicator.

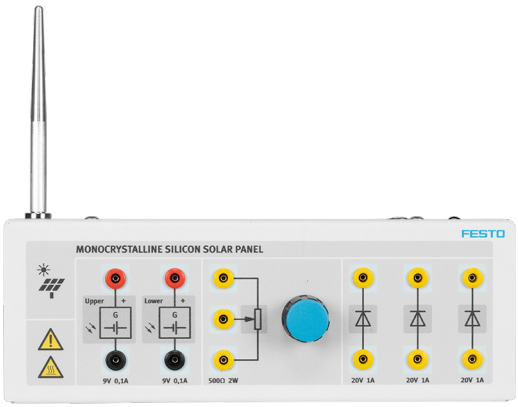
Solar Panel Test Bench 595057 (8805-PC)

The Solar Panel Test Bench is a table-top module in which a Solar Panel can be installed to perform a wide variety of tests and experiments. A powerful halogen lamp is used to illuminate the solar panel under test. The dimmer knob can be set to adjust the irradiance. A ventilation system is provided in the Solar Panel Test Bench to keep the solar panel at near room temperature and study the effects of temperature. The halogen lamp and ventilation system can be turned on and off through switches mounted on the front panel of the test bench.

Specifications

Parameter	Value
Power Requirements	
Current	1.5 A
Service Installation	Standard single-phase outlet
Physical Characteristics	
Dimensions (H x W x D)	392 x 250 x 370 mm
Weight	6.5 kg

Monocrystalline Silicon Solar Panel 595058 (8806-PC)



The Monocrystalline Silicon Solar Panel consists of two independent photovoltaic (PV) modules mounted on a common metal chassis that can be installed in the Solar Panel Test Bench when performing exercises indoors, or on a tripod when performing exercises outdoors. Both photovoltaic modules are made of high-quality monocrystalline silicon cells and protected by a coat of clear glass epoxy. Independent access to the output of each PV module is provided via a pair of miniature (2 mm) banana jacks mounted on the solar panel chassis to allow either series or parallel connection of the photovoltaic modules.

Indoor Operation in the Solar Panel Test Bench

A digital thermometer attached to the solar panel chassis allows the temperature of the photovoltaic modules to be monitored. A transparent window in the front panel of the Solar Panel Test Bench allows temperature monitoring even when the solar panel is installed in the test bench.

Outdoor Operation On a Tripod

The surface of the metal chassis on which the photovoltaic modules lie is provided with a perpendicularly mounted metal pin and silk-screened angular markers. When performing exercises outdoors, the metal pin allows the orientation to be adjusted so that the solar panel is perfectly aimed at the Sun. The angular markers allow the solar panel orientation to be offset a certain angle with respect to the Sun direction when experimenting with solar panel orientation.

The Monocrystalline Silicon Solar Panel includes a potentiometer and a set of diodes. The potentiometer is used to apply a variable electrical load to the output of the solar panel. The diodes can be connected to the solar panel to serve as either bypass diodes or blocking diodes. These components are used when performing solar panel exercises outdoors (i.e., without the Solar Panel Test Bench). Access to the potentiometer and diodes is through miniature (2 mm) banana jacks mounted on the solar panel chassis.

Specifications

Parameter	Value
PV Module	
Quantity	2
Type	Monocrystalline Silicon
Number of Cells	18
Open-Circuit Voltage (VOC)	9 V @ STC
Short-Circuit Current (ISC)	100 mA @ STC
Potentiometer	Single Turn - 500 Ω - 2 W
Diodes	
Quantity	3
Peak Inverse Voltage	1000 V
Maximum Current	1 A
Thermometer	
Range	-50°C to +150°C (-58°F to +302°F)
Resolution	±0.1° from -19.9° to +199.9°, otherwise 1°
Accuracy	±0.1°C from -30°C to +150°C (±1.8°F from -22°F to +302°F)
Battery Voltage	1.5 V

Parameter	Value
Battery Type	A76 (LR44, G13) size or equivalent, 1 required
Angular Markers	
Range	65°
Interval	5°
Physical Characteristics	
Dimensions (H x W x D)	240 x 237 x 58 mm (9.4 x 9.3 x 2.3 in)
Net Weight	2.5 kg

DC 48V PWM Charge Controller 595051 (8807-PC)

The DC 48V PWM Charge Controller is one of the most popular charge controller types. Although it is not the most efficient controller type, it is attractive to consumers due to its low price. The DC 48V PWM Charge Controller must be used in conjunction with the 48V Lead-Acid Battery Pack and solar panel emulator.

Specifications

Parameter	Value
Controller	
Type	PWM
Battery Output	
Maximum Current	7 A
Absorption Voltage	56.8 V
Float Voltage	55.2 V
Recommended Battery Pack Voltage	48 V
Photovoltaic Panel Input	
Current	7 A
Voltage	48 V dc
Protections	
Photovoltaic Panel Input	Reverse polarity and overvoltage (100 V)
Battery Output	Reverse polarity and overvoltage (64 V)
Load Output	Reverse polarity and overvoltage (64 V)
Physical Characteristics	
Dimensions (H x W x D)	297 x 266 x 180 mm
Weight	2.4 kg

DC 48V MPPT Charge Controller 595050 (8808-PC)

The DC 48V MPPT Charge Controller highlights the benefits of charge control when used in conjunction with a 48V Lead-Acid Battery Pack and a solar panel array or a solar panel emulator.

Specifications

Parameter	Value
Charge Controller	
Type	Maximum power point tracking
Battery Output	
Power	700 W
Maximum Output Current	7 A
Absorption Voltage	57.6 V
Float Voltage	55.2 V
Equalization	OFF
Recommended Battery Pack Voltage	48 V
Photovoltaic Panel Input	
Current	7 A
Voltage	100 V max
Protections	
Photovoltaic panel Input	Reverse polarity and overvoltage (100V)
Battery Output	Reverse polarity and overvoltage (64V)
Physical Characteristics	
Dimensions (H x W x D)	297 x 266 x 218 mm
Weight	3.9 kg

AC 24V Power Supply 772050 (8826-PC)

The AC 24 V power supply is an A4 module that provides auxiliary power for various system components.

Features

- Auxiliary power supply, 24 V AC, max. 2.5 A

- Thermal overload protection included in main switch

- Case for use in the A4 frame or as standing tabletop device on the attached rubber feet

- Protective conductor connection, 4 mm² minimum diameter and deliberately unmistakable with 4 mm safety plug connections to prevent mix-up

- All connections with safety plug connections, 4 mm size for power connections, 2 mm size for safety voltage signals

Specifications

Parameter	Value
Module Requirements	
Maximum Current	0,3 A
AC Power Network Installation	230 V – 50/60 Hz, must include live, neutral, and ground wires
Outputs	
Fixed AC 1-Phase	24 V – 2,5 A
Conformity/Directives	CE and RoHS
Physical Characteristics	
Dimensions (H x W x D)	297 x 133 x 140 mm
Net Weight	2,8 kg

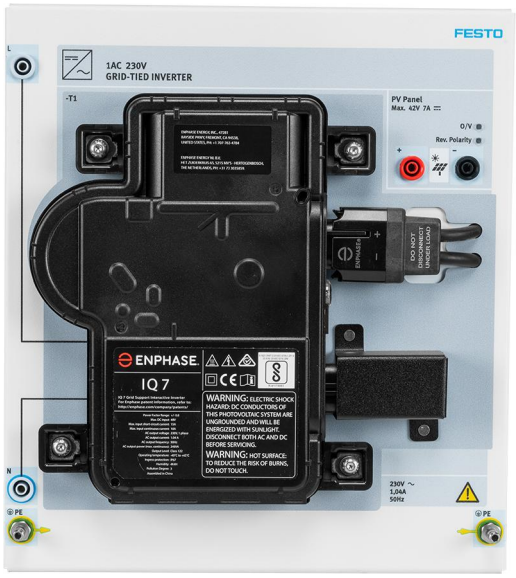
1AC 230V Stand-Alone Inverter 595052 (8833-PC)

The 1AC 230V Stand-Alone Inverter is a pure sine wave inverter. It uses a Mean Well TS-400 inverter with a protective circuit on its battery input.

Specifications

Parameter	Value
Inverter	
Type	Stand alone pure sine wave
AC Output	
Power	300 W
Voltage	230 V – 50 Hz
Current	1.4 A
Battery Input	
Recommended Battery Pack Voltage	48 V
Protections	
Battery Input	Reverse polarity and overvoltage (64 V)
AC Output	Inverter built-in short-circuit and overload protection
Physical Characteristics	
Dimensions (H x W x D)	297 x 266 x 212 mm
Weight	4.0 kg

1AC 230V Grid-Tied Inverter 595053 (8834-PC)



The 1AC 230V Grid-Tied Inverter module converts power generated by a solar panel array to AC power that can be injected into the AC local network.

Specifications

Parameter	Value
Inverter	
Type	Grid tied MPPT
AC Output	
Rated Power	235 W
Nominal Grid Voltage	230 V
Nominal Frequency	50 Hz
Max. Output Current	1.04 A
Photovoltaic Panel Input	
Maximum voltage	42 V
MPPT voltage range	27-42 V
Rated current	7 A
Protections	
Photovoltaic Panel Input	Reverse polarity and overvoltage (42 V)
AC Output	Inverter built-in protections
Physical Characteristics	
Dimensions (H x W x D)	297 x 266 x 140 mm
Weight	4 kg

4 Quadrant Power Supply and Dynamometer Controller (including Manual and Computer-Based Control) 595028 (8960-SC)

The 4-Quadrant Power Supply and Dynamometer Controller can perform a wide variety of functions, like DC voltage or current source, AC source, battery charger, solar panel emulator, constant speed or torque brake and wind or hydraulic turbine emulator.

The module is powered from a single phase outlet and acts as a green device, feeding back mechanical or electrical energy it receives to the power network with unity power factor. All inputs and outputs are protected against improper connections and overvoltage/overcurrent conditions.

For the operation of the 4-Quadrant Power Supply and Dynamometer Controller different sets of functions can be enabled by purchasing the respective firmware. Although these firmware functions can be bought individually, we have bundled the most popular ones in several packages.

Standard Functions (manual control) Set 581436 (8968-10)

The Standard Functions (manual control) Set is a package of control functions that can be activated in the Four-Quadrant Dynamometer/Power Supply, enabling the module to perform a wide variety of functions in each of its two operating modes (Dynamometer and Power Supply).

The set allows only manual control of the functions. This means that the Four-Quadrant Dynamometer/Power Supply operates as a stand-alone unit, and the function performed is selected, set, and monitored using front-panel mounted controls and display. The following control functions are available in the set:

Dynamometer operating mode

- Two-Quadrant, Constant-Torque Brake
- Clockwise Prime Mover/Brake
- Counterclockwise Prime Mover/Brake
- Clockwise Constant-Speed Prime Mover/Brake
- Counterclockwise Constant-Speed Prime Mover/Brake
- Positive Constant-Torque Prime Mover/Brake
- Negative Constant-Torque Prime Mover/Brake

Power Supply operating mode

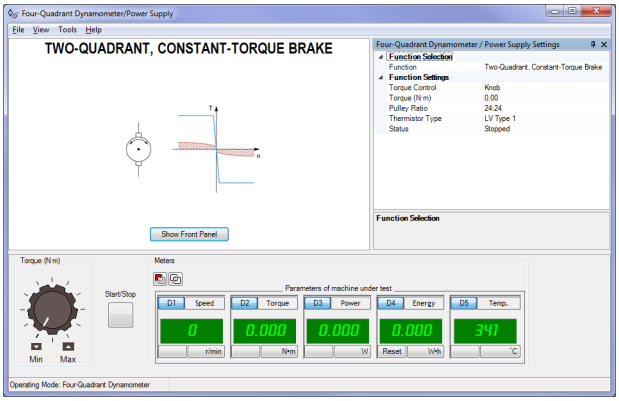
- Positive Voltage Source
- Negative Voltage Source
- 200 V DC Bus
- Positive Current Source
- Negative Current Source
- 50 Hz Power Source
- 60 Hz Power Source
- Lead-Acid Battery Float Charger

Specifications

Parameter	Value
Control Functions	
Control Functions	Two-Quadrant, Constant-Torque Brake
	Clockwise Prime Mover/Brake
	Counterclockwise Prime Mover/Brake
	Clockwise Constant-Speed Prime Mover/Brake
	Counterclockwise Constant-Speed Prime Mover/Brake
	Positive Constant-Torque Prime Mover/Brake
	Negative Constant-Torque Prime Mover/Brake
	Positive Voltage Source
	Negative Voltage Source
	Positive Current Source
	Negative Current Source
	50 Hz Power Source
	60 Hz Power Source
	200 V DC Bus
	Lead-Acid Battery Float Charger

Parameter	Value
Two-Quadrant, Constant-Torque Brake	
Torque	0-3 N·m (26.55 lbf·in)
Clockwise/Counterclockwise Prime Mover/Brake	
Speed	0-2500 r/min
Clockwise/Counterclockwise Constant-Speed Prime Mover/Brake	
Speed	0-2500 r/min
Positive/Negative Constant-Torque Prime Mover/Brake	
Torque	0-3 N·m (26.55 lbf·in)
Positive/Negative Voltage Source	
Voltage	0 to ±150 V
Positive/Negative Current Source	
Current	0 to ±5 A
50 Hz/60 Hz Power Source	
No-Load Voltage	0-140 V
200 V DC Bus	
Status	On or off
Lead-Acid Battery Float Charger	
Float Voltage	0-150 V

Standard Functions (computer-based control) Set 581437 (8968-20)



The Standard Functions (computer-based control) Set is a package of control functions that can be activated in the Four-Quadrant Dynamometer/Power Supply, enabling the module to perform a wide variety of functions in each of its two operating modes (Dynamometer and Power Supply).

The set allows only computer-based control of the functions. This means that the function performed by the Four-Quadrant Dynamometer/Power Supply is selected, set, and monitored using the LVDAC-EMS software. The following control functions are available in the set:

Dynamometer operating mode

- Two-Quadrant, Constant-Torque Brake
- Clockwise Prime Mover/Brake
- Counterclockwise Prime Mover/Brake
- Clockwise Constant-Speed Prime Mover/Brake
- Counterclockwise Constant-Speed Prime Mover/Brake
- Positive Constant-Torque Prime Mover/Brake
- Negative Constant-Torque Prime Mover/Brake
- Four-Quadrant Constant-Speed Prime Mover/Brake
- Speed Sweep

Power Supply operating mode

- Positive Voltage Source

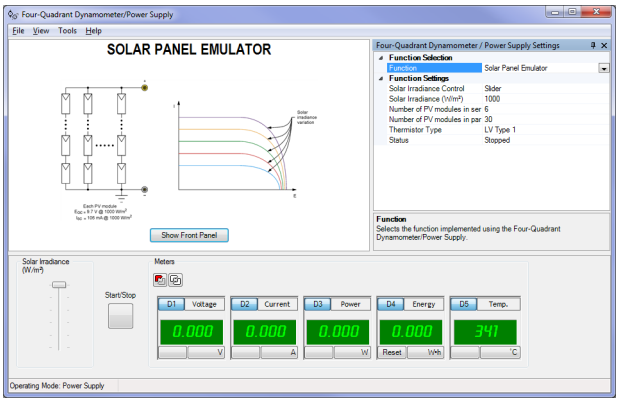
- Negative Voltage Source
- DC Voltage Source
- Positive Current Source
- Negative Current Source
- DC Current Source
- 50 Hz Power Source
- 60 Hz Power Source
- AC Power Source
- Lead-Acid Battery Float Charger

Specifications

Parameter	Value
Control Functions	
Control Functions	Two-Quadrant, Constant-Torque Brake
	Clockwise Prime Mover/Brake
	Counterclockwise Prime Mover/Brake
	Clockwise Constant-Speed Prime Mover/Brake
	Counterclockwise Constant-Speed Prime Mover/Brake
	Positive Constant-Torque Prime Mover/Brake
	Negative Constant-Torque Prime Mover/Brake
	Four-Quadrant, Constant-Speed Prime Mover/Brake
	Speed Sweep
	Mechanical Load
	Positive Voltage Source
	Negative Voltage Source
	DC Voltage Source
	Positive Current Source
	Negative Current Source
	DC Current Source
	50 Hz Power Source
	60 Hz Power Source
	AC Power Source
	Lead-Acid Battery Float Charger
Two-Quadrant, Constant-Torque Brake	
Torque Control	Software knob, 8960 module knob, or 8960 command input
Torque	0-3 N·m (26.55 lbf·in)
Pulley Ratio	24:24, 24:12, or 24:32
Clockwise/Counterclockwise Prime Mover/Brake	
Speed Control	Software knob, 8960 module knob, or 8960 command input
Speed	0-2500 r/min
Pulley Ratio	24:24, 24:12, or 24:32
Clockwise/Counterclockwise Constant-Speed Prime Mover/Brake	
Speed Control	Software knob, 8960 module knob, or 8960 command input
Speed	0-2500 r/min
Pulley Ratio	24:24, 24:12, or 24:32
Positive/Negative Constant-Torque Prime Mover/Brake	
Torque Control	Software knob, 8960 module knob, or 8960 command input
Torque	0-3 N·m (26.55 lbf·in)
Pulley Ratio	24:24, 24:12, or 24:32
Four-Quadrant, Constant-Speed Prime Mover/Brake	
Speed Control	Software knob, 8960 module knob, or 8960 command input
Speed	0-2500 r/min

Parameter	Value
Pulley Ratio	24:24, 24:12, or 24:32
Speed Sweep	
Start Speed	-3000 r/min to 3000 r/min
Finish Speed	-3000 r/min to 3000 r/min
Number of Steps	0-50 steps
Step Duration	2-10 s
Record Data to Table	Yes or no
Pulley Ratio	24:24, 24:12, or 24:32
Mechanical Load	
Load Type	Flywheel, fan, grinder, conveyor, calender, crane, user defined
Inertia	0.005-1 kg·m² (0.119-23.73 lb·ft²)
Friction Torque	0.05-3 N·m (0.44-26.55 lbf·in)
Pulley Ratio	24:24, 24:12, or 24:32
Positive/Negative Voltage Source	
Voltage Control	Software knob, 8960 module knob, or 8960 command input
Voltage	0 V to 147 V / -147 V to 0 V
DC Voltage Source	
Voltage Control	Software knob, 8960 module knob, or 8960 command input
Voltage	-147 V to 147 V
Positive/Negative Current Source	
Current Control	Software knob, 8960 module knob, or 8960 command input
Current	0 A to 5 A / -5 A to 0 A
DC Current Source	
Current Control	Software knob, 8960 module knob, or 8960 command input
Current	-5 A to 5 A
50 Hz/60 Hz Power Source	
Voltage Control	Software knob, 8960 module knob, or 8960 command input
No-Load Voltage	0-140 V
AC Power Source	
No-Load Voltage	0-140 V
DC Offset Correction	-1000 to 1000
Frequency	10-100 Hz
Lead-Acid Battery Float Charger	
Float Voltage	0-150 V

Solar Panel Emulator Function Set 581440 (8968-60)



The Solar Panel Emulator Function Set is a function that can be activated in the Four-Quadrant Dynamometer/ Power Supply enabling the module to emulate a solar panel.

The Solar Panel Emulator control function is only available in computer-based mode. This means that the function performed by the Four-Quadrant Dynamometer/Power Supply is selected, set, and monitored using the LVDAC-EMS software. The function emulates a solar panel consisting of an array of photovoltaic (PV) modules. The current-voltage characteristic of each PV module emulated is the same as that of the PV module used in the Monocrystalline Silicon Solar Panel. The function allows the user to determine the size of the PV module array emulated, by selecting the number of PV modules connected in series and in parallel. A sliding control in the Solar Panel Emulator interface provides the user full control of solar irradiance.

Specifications

Parameter	Value
Control Functions	Solar Panel Emulator
Solar Panel Emulator	
Solar Irradiance Control	Software slider or 8960 command input
Solar Irradiance	1-1000 W/m²
Number of PV Modules in Series	1-7 modules
Number of PV Modules in Parallel	5-45 modules

Data Acquisition and Control Interface 595912 (9063-QC)

The Data Acquisition and Control Interface (DACI) is versatile and complete device in an A4 module used for measuring, observing, and analyzing electrical and mechanical parameters in electric power systems and power electronics circuits. For these purposes, a set of computer-based instruments are available. All measurements require a USB connection to a PC running the accompanying data acquisition and control software. This software, as well as all available upgrades, is free and can be downloaded anytime on the Festo Didactic website.

Optional Equipment Description

Tabletop Workstation (DIN A4) (Optional) 8153360 (8180-00)

This tabletop workstation is designed to safely house the DIN A4 modules. It consists of a mounting frame with 3 rows and lead holder on the side. The bottom row can be removed to place other laboratory equipment without compromising stability.

The workstation is designed to be quickly assembled on-site. Rails can be assembled without further adjustments thanks to threaded holes. The base part of the workstation is equipped with proper grounding and rubber feet, but it can also be screwed to any surface.

Features:

- The bottom row can be removed without losing any structural strength if required

- Assembly of the workstation does not need precise alignment of the rows and uses preset holes in the vertical profile side bars to ease up assembly

- Lead holder on the side for safety laboratory cables

Tabletop Workstation (DIN A4)The Tabletop Workstation shall consists of a basic mounting frame with 3 DIN A4 rows for laboratory installations.

The following features shall be included:

- The bottom row can be removed without losing any structural strength if required
- Assembly of the workstation does not need precise alignment of the rows and uses preset holes in the vertical profile side bars to ease up assembly
- Lead holder on the side for safety laboratory cables

The following minimum technical requirements shall be met:

- Number of rows: 3
- Overall width smaller than 1550 mm
- Length available per row longer than 1150 mm

Communications Gateway (Optional) 595054 (8849-PC)

The communications gateway is an A4 module that is used to communicate and set grid-tied inverters over the AC line voltage direclty. The gateway is connected on the AC line voltage just like the inverters it needs to communicate with. Using that line voltage, the gateway monitors the grid-tied inverters operation and enables the user to program them with specific operating parameters.

Features

- Industrial type communications gateway and up-to-date communication technology

- Provides programming, monitoring, and troubleshooting features for the inverters

- Ethernet port, Wi-Fi or mobile for network integration

- IEC C14 power network connector including protection

- Case for use in the A4 frame or as standing tabletop device on the attached rubber feet

- Protective conductor connection, 4 mm² minimum diameter and deliberately unmistakable with 4 mm safety plug connections to prevent mix-up

- All connections with safety plug connections, 4 mm size for power connections, 2 mm size for safety voltage signals

Communications Gateway

The inverter programming device shall consist of a module that is used to communicate and set grid-tied inverters over the AC line voltage directly. The device is connected on the AC line voltage just like the inverters it needs to communicate with. Using that line voltage, the device shall monitor the grid-tied inverters operation and enables the user to program them with specific operating parameters.

It shall include the following features:

- Industrial type communications gateway and up-to-date communication technology
- Provides programming, monitoring, and troubleshooting features for the inverters
- Ethernet port for network integration
- IEC C14 power network connector including protection
- Grounding shall be done via a Potential Equalization Sockets using vertically mounted pin for higher safety and avoid connections with live voltage ,

Specifications

Parameter	Value
Gateway	
Voltage	230 V – 50 Hz
Current	0.11 A
Communication	
With inverters	Through ac power line
With user	Through Wi-Fi, Ethernet or mobile
Protection	
Power Input	Fuse, 0.5 A
Physical Characteristics	
Dimensions (H x W x D)	297 x 266 x 180 mm
Weight	2.8 kg

Digital Multimeter (Optional) 579782 (8946-20)

The Digital Multimeter consists of an Extech EX350 Digital Multimeter. It is ideal to perform voltage, current, and resistance measurements in exercises.

Specifications

Parameter	Value
Voltage	
Ranges	0-600 V ac/dc
Current	

Parameter	Value
Range	0-10 A ac/dc
Resistance	
Range	0-40 MΩ
Physical Characteristics	
Dimensions (H x W x D)	182 x 90 x 45 mm (7.17 x 3.54 x 1.77 in)
Net Weight	354 g (0.78 lb)

Connection Lead Set and Grounding Kit (Optional) 595916 (8951-R0)

The Connection Lead Set and Grounding Kit contains the necessary leads to build up the necessary circuits and also ground adequately all the equipment for a safe working environment. It includes different lengths of 4mm safety connection leads and jumpers (for short connections) coded with different colors to find out easily which lead to use depending on the distance between the connections. It also includes the necessary grounding leads which comes with a different type of safe connector to avoid misconnections.

Features

- Length color-coded leads with 4 mm safety banana plugs

- Length color-coded leads with 2 mm banana plugs

- Innovative grounding approach with external pins instead of standard 4 mm sockets to avoid misconnections

- Long-lasting and extra-flexible leads

- Protective conductor connection, 4 mm² cross section and deliberately unmistakable with 4 mm safety plug connections to prevent mix-up

- Safest grounding approach in a didactical/educational environment

- All connections with safety plug connections, 4mm size for power connections, 2 mm size for safety voltage signals

Specifications:

- 4 mm Safety Banana Plug Leads: 1 mm² cross section, 19 A max., 600 V, CAT II

- 2 mm Banana Plug Leads: 0.5 mm², 10 A max., 30 V AC, 60 V DC

- Grounding leads: 4 mm² cross section, 19 A max., 600 V, CAT II

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.

Festo Didactic SE

Rechbergstrasse 3
73770 Denkendorf
Germany

P. +49(0)711/3467-0
F. +49(0)711/347-54-88500

Festo Didactic Inc.

607 Industrial Way West
Eatontown, NJ 07724
United States

P. +1-732-938-2000
F. +1-732-774-8573

Festo Didactic Ltée/Ltd

675 rue du Carbone
Québec QC G2N 2K7
Canada

P. +1-418-849-1000
F. +1-418-849-1666

www.labvolt.com

www.festo-didactic.com