Four-Quadrant Dynamometer/Power Supply with manual control

579641 (8960-B0)

LabVolt Series

Datasheet

* The product images shown in this document are for illustration purposes; actual products may vary. Please refer to the Specifications section of each product/item for all details. Festo Didactic reserves the right to change product images and specifications at any time without notice.

Festo Didactic
en 120 V - 60 Hz
03/2025

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General Description

The Four-Quadrant Dynamometer/Power Supply is a highly versatile USB peripheral designed to be used in the Electric Power Technology Training Systems. Two operating modes are available: Dynamometer and Power Supply. A wide variety of user-selectable functions is available in each operating mode.

In the Dynamometer mode, the unit becomes a four-quadrant dynamometer that can act as either a fully configurable brake (i.e., a mechanical load) or a fully configurable prime mover (i.e., a motor drive). In the Power Supply mode, the unit becomes a four-quadrant power supply that can act as a dc voltage source, dc current source, ac power source, etc.

In each operating mode, key parameters related to the selected function are displayed. Speed, torque, mechanical power, and energy are displayed in the Dynamometer mode while voltage, current, electrical power, and energy are displayed in the Power Supply mode. Optional functions, such as a small wind-turbine emulator, a hydraulic turbine emulator, a solar panel emulator, battery chargers, an SDK (Software Development Kit) etc., can be added to the standard functions to further enhance the training possibilities of the Four-Quadrant Dynamometer/Power Supply.

Two modes are available to control the function which the Four-Quadrant Dynamometer/Power Supply performs: Manual and Computer-Based.

In the Manual control mode, the module operates as a stand-alone unit, and the function performed is selected, set, and monitored using front-panel mounted controls and display. This mode provides access to all basic functions. In the Computer-Based control mode, the function performed by the module is selected, set, and monitored using the LVDAC-EMS software. In this mode, communication between the Four-Quadrant Dynamometer/Power Supply and the host computer running the LVDAC-EMS software is achieved through a USB connection. This mode provides access to all basic functions, as well as to additional advanced functions.

Includes the Four-Quadrant Dynamometer/Power Supply, with the Standard Functions (Manual Control)

The Four-Quadrant Dynamometer/Power Supply is powered from a standard wall receptacle via a line cord that connects to the module’s front panel. The module helps energy conservation by returning the mechanical or electrical energy it receives to the ac power network while maintaining a unity power factor.

Software

Qty	Description	Model number
1	Complete Function Set	581435 (8968-00)
1	Standard Functions (computer-based control) Set	581437 (8968-20)
1	Turbine/Engine Emulator Function Set	579783 (8968-30)
1	Lead-Acid Battery Charger Function Set	581438 (8968-40)
1	Ni-MH Battery Charger Function Set	581439 (8968-50)
1	Solar Panel Emulator Function Set	581440 (8968-60)
1	SCADA for LVDAC-EMS	8094377 (8973-00) [1]

Specifications

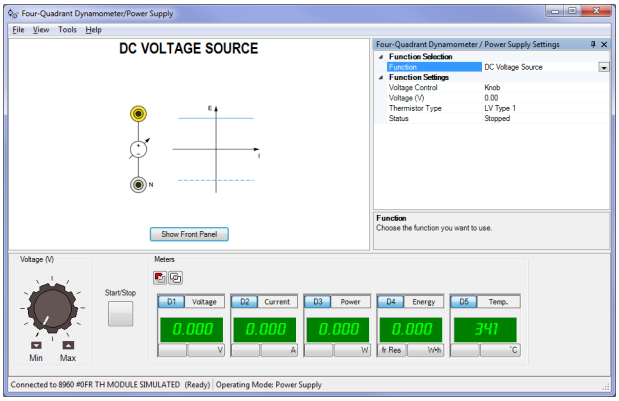
Parameter	Value
Power Requirements	
Maximum Current	6 A
AC Power Network Installation	120 V - 60 Hz, must include live, neutral, and ground wires
Maximum Leakage Current	1.8 mA
Dynamometer Mode	

[1] Software allowing the monitoring of up to 5 Stations through OPC.

Parameter	Value
Magnetic Torque	0 to 3 N·m (0 to 27 lbf·in)
Direction of Rotation	CW / CCW
Speed	0 to 2500 r/min
Nominal Power	350 W
Power Supply Mode	
DC Voltage	0 to ± 150 V
AC Voltage (RMS)	0 to 105 V (no-load)
DC Current	0 to ± 5 A
AC Current (RMS)	0 to 3.5 A
Maximum Output Power	500 W
AC Frequency	10 to 120 Hz
Control Functions	
Activated Set	Standard Functions (Manual Control), Model 8968-1
Liquid-Crystal Display (LCD)	76 mm (3 in), monochrome, background-illuminated, 240 x 160 dots
Control Inputs	
Command Input	0 to ± 10 V
Thermistor Input	10 kΩ, type 1
Control Outputs	
Shaft Encoder	Quadrature encoder (A-B) - 360 pulses/revolution - TTL compatible
Torque Output Sensitivity	0.3 N·m/V (2.655 lbf·in/V)
Speed Output Sensitivity	500 r/min/V
Communication Port	
Type	USB 2.0
Physical Characteristics	
Dimensions (H x W x D)	308 x 287 x 437 mm (12.1 x 11.3 x 17.2 in)
Net Weight	19.5 kg (43.0 lb)

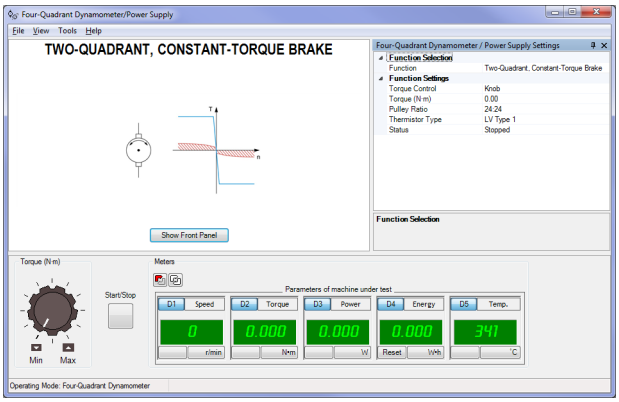
Module Options Description

Complete Function Set 581435 (8968-00)



This Model activates all currently available control function sets for the Four-Quadrant Dynamometer/ Power Supply, Model 8960-3. See individual control functions sets, Model 8968-X, for more information on the included functions.

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

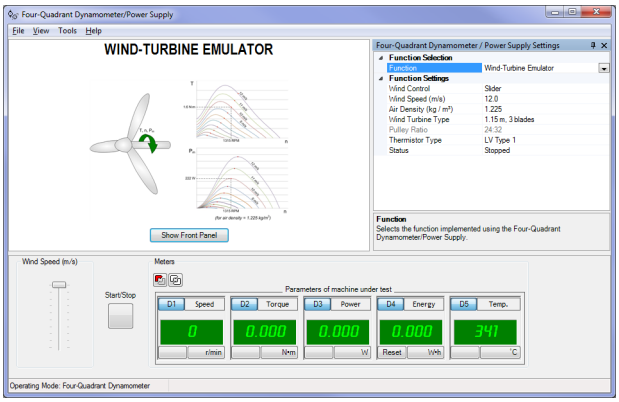
- Positive Voltage Source
- Negative Voltage Source
- DC Voltage Source
- Positive Current Source
- Negative Current Source
- DC Current Source
- 50 Hz Power Source
- 60 Hz Power Source
- AC Power Source
- Lead-Acid Battery Float Charger

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
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

Parameter	Value
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

Turbine/Engine Emulator Function Set 579783 (8968-30)



The Turbine/Engine Emulator Function Set is a package of control functions that can be activated in the Four-Quadrant Dynamometer/Power Supply, enabling the module to emulate the operation of various types of turbines and engines.

The control functions in the set are 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 following control functions are available in the set:

Dynamometer operating mode

- Small Wind-Turbine Emulator: this function makes the permanent-magnet dc motor of the Four-Quadrant Dynamometer/Power Supply faithfully reproduce the effect of wind on the bladed rotor of a small-scale wind turbine. The torque-speed characteristic at the shaft of the machine coupled to the Four-Quadrant Dynamometer/Power Supply is the same as the one that is obtained when wind blows at a certain speed on the rotor of the actual wind turbine. The user has control over the wind speed and air density.

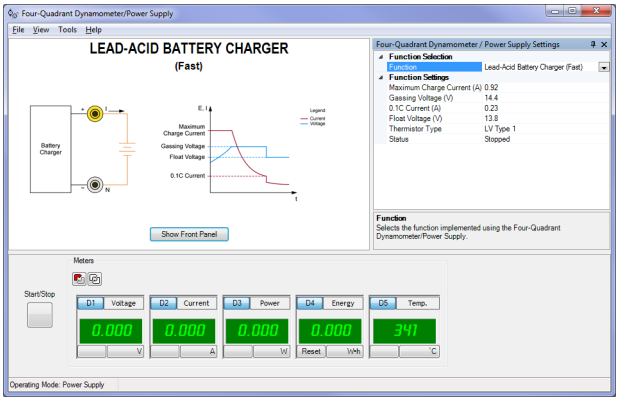
- Hydraulic Turbine Emulator: this function uses the permanent-magnet dc motor of the Four-Quadrant Dynamometer/Power Supply to recreate the behavior of an hydraulic turbine with a synchronous generator. The torque-speed characteristics at the shaft of the machine coupled to the Four-Quadrant Dynamometer/Power Supply is the same as that of a Francis-type hydraulic turbine. The user has control over the vane angle (manually or through the module analog input), the vane variation speed, and the inertia.

- Engine Emulator: this function uses the permanent-magnet dc motor of the Four-Quadrant Dynamometer/Power Supply to recreate the behavior of a diesel engine with a synchronous generator. The torque-speed characteristics at the shaft of the machine coupled to the Four-Quadrant Dynamometer/Power Supply is the same as a diesel generator. The user has control over the fuel rack position (%) (manually or through the module analog input) and the inertia.

Specifications

Parameter	Value
Control Functions	
Control Functions	Wind-Turbine Emulator
	Hydraulic-Turbine Emulator
	Engine Emulator
Wind-Turbine Emulator	
Wind Control	Software slider or 8960 command input
Wind Speed	3-12 m/s (6.7-26.8 mph)
Air Density	1.12-1.44 kg/m³ (0.07-0.09 lb/ft³)
Wind Turbine Type	1.15 m with 3 blades, 1.15 m with 3 blades and gearbox, 0.72 m with 3 blades and passive stall
Inertia J	0.02-0.4 kg·m² (0.475-9.492 lb·ft²) (only available for certain wind turbine types)
Gear Ratio R	0.5-2 (only available for certain wind turbine types)
Hydraulic-Turbine Emulator	
Vane Control	Software slider or 8960 command input
Turbine Type	300 W Francis
Vane Maximal Speed	0-100%/s
Runner Inertia	0.005-1 kg·m² (7.119 lb·ft²)
Engine Emulator	
Fuel Rack Position Control	Software slider or 8960 command input
Engine Type	300 W Diesel
Fuel Rack Position	0-100%
Engine Inertia	0.005-1 kg·m² (7.119 lb·ft²)

Lead-Acid Battery Charger Function Set 581438 (8968-40)



The Lead-Acid Battery Charger Function Set is a package of control functions that can be activated in the Four-Quadrant Dynamometer/Power Supply, enabling the module to implement a lead-acid battery charger, as well as a battery discharger.

The Lead-Acid Battery Charger 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 following control functions are available in the set:

Power Supply operating mode

- Lead-Acid Battery Charger (Fast):

This function uses the four-quadrant power supply to implement a battery charger that is able to rapidly charge lead-acid batteries of various capacities (typically in less than two hours). A three-step charge algorithm is used. Battery charging starts with a constant current corresponding to the battery maximum charge current until the battery gassing voltage is reached. At this point, battery charging continues with a constant voltage (close to gassing voltage) until the charge current decreases to 0.1 C. Then, constant-voltage charging continues but at a lower voltage (float charging voltage). The user has to specify the following four battery characteristics for the charger to achieve proper charge control: maximum charge current, gassing voltage, 0.1C current (10% of battery capacity), and float charging voltage. The function indicates the voltage, current, electrical power, and energy at the charger output. The function can also indicate battery temperature when the temperature sensor of the battery (if so equipped) is connected to the Thermistor Input of the Four-Quadrant Dynamometer/Power Supply. The function can also indicate battery temperature when the temperature sensor of the battery (if so equipped) is connected to the Thermistor Input of the Four-Quadrant Dynamometer/Power

Supply. The license for the Lead-Acid Battery Charger, is required to activate the Lead-Acid Battery Charger (Fast) function in the Four-Quadrant Dynamometer/Power Supply.

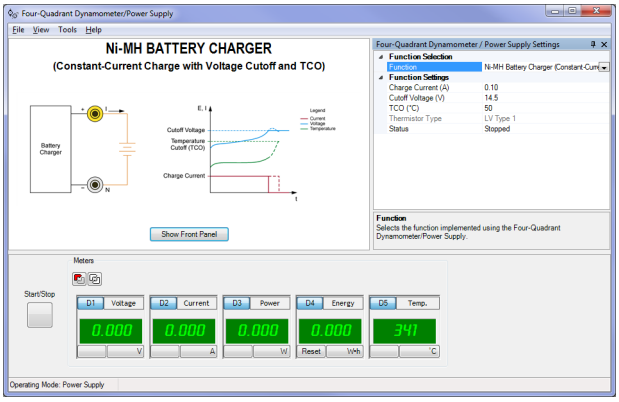
- Battery Discharger (Constant-Current Timed Discharge with Voltage Cutoff):

This function uses the four-quadrant power supply to sink a constant current from a battery, thereby discharging the battery at a specific rate, during a specific period. The discharger also monitors the battery voltage during discharge. Battery discharging terminates immediately when the battery voltage decreases to a specific cutoff voltage. The user has to specify the discharge current, discharge duration, and cutoff voltage for the discharger to achieve proper discharge control. The function indicates the voltage, current, electrical power, and energy at the discharger output. The function can also indicate battery temperature when the temperature sensor of the battery (if so equipped) is connected to the Thermistor Input of the Four-Quadrant Dynamometer/Power Supply. The Battery Discharger function is perfectly suited to measure discharge characteristics of batteries at various rates as well as to bring a battery to a specific depth of discharge before a battery charging experiment. The license for the Lead-Acid Battery Charger, or the license for the Ni-MH Battery Chargers, is required to activate the Battery Discharger (Constant-Current Timed Discharge with Voltage Cutoff) function in the Four-Quadrant Dynamometer/Power Supply.

Specifications

Parameter	Value
Control Functions	
Control Functions	Lead-Acid Battery Charger (Fast)
	Battery Discharger (Constant-Current Timed Discharge with Voltage Cutoff)
Lead-Acid Battery Charger (Fast)	
Maximum Charge Current	0-5 A
Gassing Voltage	0-150 V
0.1C Current	0-5 A
Float Voltage	0-150 V
Battery Configuration	48V 3.4Ah (13S1P) or 10.2Ah (13S3P) auto detected
Battery Discharger (Constant-Current Timed Discharge with Voltage Cutoff)	
Discharge Current	0-5 A
Discharge Duration	0-2000 min
Cutoff Voltage	0-150 V

Ni-MH Battery Charger Function Set 581439 (8968-50)



The Ni-MH Battery Charger Function Set is a package of control functions that can be activated in the Four-Quadrant Dynamometer/Power Supply, enabling the module to operate as different types of Ni-MH battery chargers, as well as a battery discharger.

The control functions in the set are 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 following control functions are available in the set:

Power Supply operating mode

- Ni-MH Battery Charger (Constant-Current Charge with Voltage Cutoff and TCO): this function implements a basic Ni-MH battery charger. This charger forces a constant charge in the battery until the battery voltage

reaches a certain value at which the charge terminates. The charger also monitors the battery temperature during charge. Battery charging is terminated immediately when the battery temperature reaches a specific cutoff temperature. The user has control over the charge current, cutoff voltage, and cutoff temperature.

- Ni-MH Battery Charger (Constant-Current Timed Charge with TCO): this function implements a time-controlled Ni-MH battery charger. This charger forces a constant charge current in the battery during a specific period of time and then turns off. The charger also monitors the battery temperature during charge. Battery charging is terminated immediately when the battery temperature reaches a specific cutoff temperature. The user has control over the charge current, charge duration, and cutoff temperature.

- Ni-MH Battery Charger (Constant-Current Charge with -dV and TCO): this function implements an advanced Ni-MH battery charger. This charger forces a constant charge current in the battery until the battery voltage, which increases steadily from the beginning of charge, reaches a plateau and decreases by a certain amount (-dV), at which point the charge terminates. The charger also monitors the battery temperature during charge. Battery charging is terminated immediately when the battery temperature reaches a specific cutoff temperature. The user has control over the charge current, voltage drop (-dV), and cutoff temperature.

- Ni-MH Battery Charger (Constant-Current Charge with dT°/dt and TCO): this function implements an advanced Ni-MH battery charger. This charger monitors the battery temperature and forces a constant charge current in the battery until the rate of increase of the battery temperature (dT°/dt) reaches a specific value, at which point the charge terminates. Battery charging can also terminate when the battery temperature reaches a specific cutoff temperature. The user has control over the charge current, maximum rate of temperature increase (dT°/dt), and cutoff temperature.

- Ni-MH Battery Charger (Three-Step Charge with TCO): this function implements a fast Ni-MH battery charger (three-step charge algorithm). Battery charging begins by forcing a constant charge current in the battery until the rate of increase of the battery temperature (dT°/dt) reaches a specific value. At this point, the charger enters the second phase of the charge process and continues battery charging with a constant current having a lower value for a specific period. After this period, battery charging continues with a constant current of very low value. The charger monitors the battery temperature during charge. Battery charging can also terminate when the battery temperature reaches a specific cutoff temperature. The user has control over the charge current for each of the three phases of the charging process, maximum rate of temperature increase (dT°/dt) used during the first phase of charge, duration of the second phase of charge, and cutoff temperature.

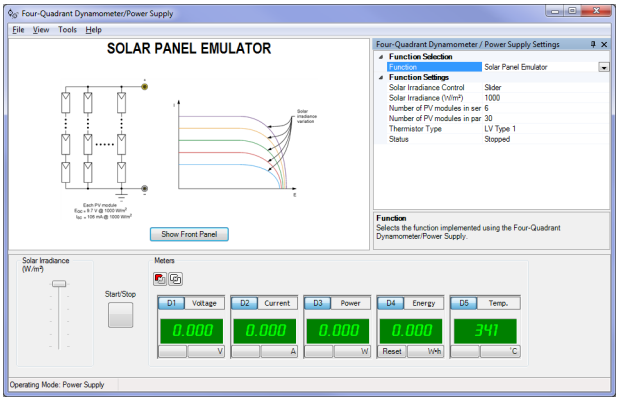
- Battery Discharger (Constant-Current Timed Discharge with Voltage Cutoff): this function sinks a constant current from a battery, thereby discharging the battery at a specific rate, during a specific period. The discharger also monitors the battery voltage during discharge. Battery discharging terminates immediately when the battery voltage decreases to a specific cutoff voltage. The user has control over the discharge current, discharge duration, and cutoff voltage.

Specifications

Parameter	Value
Control Functions	
Control Functions	Ni-MH Battery Charger (Constant-Current Charge with Voltage Cutoff and TCO)
	Ni-MH Battery Charger (Constant-Current Timed Charge with TCO)
	Ni-MH Battery Charger (Constant-Current Charge with -dV and TCO)
	Ni-MH Battery Charger (Constant-Current Charge with dT°/dt and TCO)
	Ni-MH Battery Charger (Three-Step Charge with TCO)
	Battery Discharger (Constant-Current Timed Discharge with Voltage Cutoff)
Ni-MH Battery Charger (Constant-Current Charge with Voltage Cutoff and TCO)	
Charge Current	0-5 A
Cutoff Voltage	0-150 V
TCO	20-60°C (68-140°F)

Parameter	Value
Ni-MH Battery Charger (Constant-Current Timed Charge with TCO)	
Charge Current	0-5 A
Charge Duration	0-100 h
TCO	20-60°C (68-140°F)
Ni-MH Battery Charger (Constant-Current Charge with -dV and TCO)	
Charge Current	0-5 A
-dV	0-10 V
TCO	20-60°C (68-140°F)
Ni-MH Battery Charger (Constant-Current Charge with dT°/dt and TCO)	
Charge Current	0-5 A
dT°/dt	0-10°C/min (0-18°F/min)
TCO	20-60°C (68-140°F)
Ni-MH Battery Charger (Three-Step Charge with TCO)	
TCO	20-60°C (68-140°F)
Step-1 Current	0-5 A
Step-1 dT°/dt	0-10°C/min (0-18°F/min)
Step-2 Current	0-5 A
Step-2 Duration	0-100 min
Step-3 Current	0-5 A
Battery Discharger (Constant-Current Timed Discharge with Voltage Cutoff)	
Discharge Current	0-5 A
Discharge Duration	0-2000 min
Cutoff 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

SCADA for LVDAC-EMS 8094377 (8973-00)

Education in electrical engineering at Festo Didactic is largely based on our unique electric power technology training platform, which combines hardware, software, and courseware to allow study of electrical energy.

At the heart of the systems are the data acquisition and control interface (DACI) and the four-quadrant dynamometer/power supply. When used in combination with LVDAC-EMS software program, students have access to a complete set of computer-based instruments to measure, observe, analyze, and control electrical and mechanical parameters of a workstation on their computers.

Our state-of-the-art training platform has just been enhanced through the integration of a new SCADA-EMS feature, a software program designed to run in combination with LVDAC-EMS. SCADA-EMS transforms LVDAC-EMS and the workstation's computer into a local workstation that can be monitored and controlled over a local network from a supervisory computer. Using the OPC Server protocol, SCADA-EMS enables users to design their own interface by calling the different applications running on the local workstations.

SCADA-EMS enhances LVDAC-EMS by adding several new features. You will be able to:

- Collect data from local workstations.

- Observe and control one or more stations from one or more supervisory stations.

- Remotely control several applications in your lab.

- Use a workstation in a different room to make real demonstrations over the network in your classroom without having to bring your workstation to class.

- Introduce students to the fundamentals of SCADA in a smart grid context.

- Recreate a complete grid with several different applications running.

The SCADA-EMS software program can be downloaded from our website. This locked version can be unlocked by a USB dongle. A dongle unlocks five workstations; order as many dongles as required.

Before ordering the dongles, please install:

- LVDAC-EMS (version 3.19 or later) on all your workstation computers.

- SCADA-EMS (1.01 or later) on the workstation computers you want to use to build up your SCADA application.

Contact your sales representative about order details and options.

Features & Benefits

- Monitor and control several workstations from one (or more) supervisory computer(s)

- Use OPC server protocol to communicate between the different workstations
- Include your own pictures and schematics
- Introduce SCADA in existing EMS laboratories

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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