

0.2 kW Electromechanical Training Systems 8001

FESTO

LabVolt Series

Datasheet



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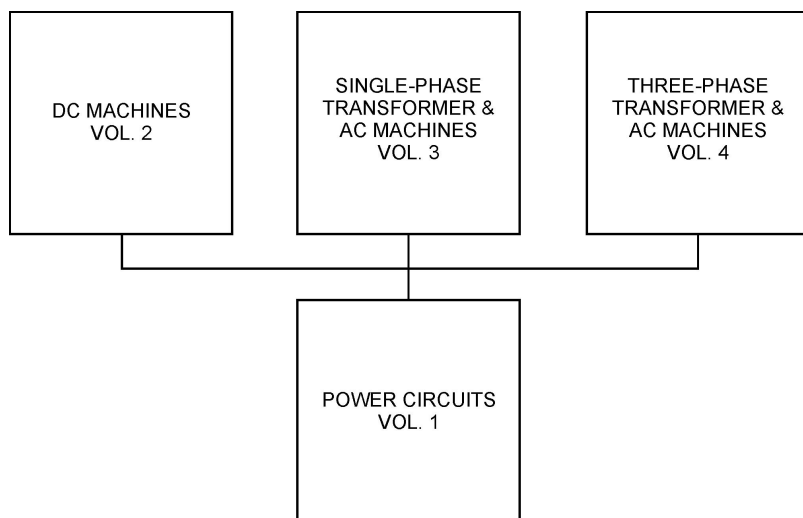
General Description

The 0.2 kW Electromechanical Training Systems (EMS) are part of a modular instructional program designed to teach electric power technology through laboratory observations. The program, divided in four subsystems, deals with the different techniques associated with the generation and use of electrical energy. The subsystems cover the common machines, and each subsystem is offered with its courseware presented in a student manual.

Each subsystem is available as a package that consists of the equipment necessary to perform the laboratory exercises presented in the correlated student manual.

0.2 kW Electromechanical Training Systems give instructors complete versatility in selecting a program adapted to students' specific career objectives. The EMS System was developed by educators to satisfy educational requirements that include industrial applications of electric power technology. The design objective was to develop a low-power (0.2 kW or ¼ hp) educational system with equipment that operates like industrial equipment.

Through careful attention to engineering detail, the EMS System meets this objective, and in so doing, provides laboratory results that are easy to understand, with data values that are easily observed. The data, when applied to formulas, provides results that verify electrical laws rather than deny them because of large operational tolerance errors.



Laboratory manuals

Laboratory manuals guide students step-by-step through the experiments and provide the necessary theoretical background to allow students to successfully complete the educational objectives. These manuals contain experiments that correlate with the training equipment for hands-on involvement with the subject matter. The instructor can select the experiments that will satisfy the objectives of technical courses or university programs. The flexibility of the training systems allows students to use their own initiative during the laboratory sessions. Under the direction of an instructor, students can gain the required competencies for successful employment.

A Modular Approach

The modular approach in designing the training systems allows new equipment to be added to existing EMS laboratories without needless duplication of equipment. There are two standard module sizes: full size, 308 mm (12.1 in) high, and half size, 154 mm (6.1 in) high. All modules can be inserted into a Mobile Workstation, Model 8110. With the exception of rotating machines, all modules have steel face plates. The modules are constructed of heavy-gauge steel, finished in baked enamel. Symbols and diagrams specific to each module are clearly silk-screened on the steel faceplates. Standard, color-coded, 4 mm safety jacks are used to interconnect all system components.

The Mobile Workstation

The mobile workstation is equipped with four swivel casters. It contains a general storage cabinet, a pull-out work surface, and spaces to insert the modules required for each experiment. Six full-size, or twelve half-size, modules plus three additional half-size modules can be used simultaneously. For applications requiring additional modules, a Three-Module Workstation, Model 8131 can easily be bolted on top of the mobile workstation. The modules are guided into position along stainless steel guide rails and are held securely in place by a holding mechanism. Front-mounted release levers allow easy removal of modules from the workstation. Safety locking devices prevent students from removing modules from the workstation during lab exercises.

Storage Cabinet

All unused modules can be placed in a Storage Cabinet, Model 8150. Only the necessary modules for a given experiment are placed in the console so that students are not distracted by unused instruments.

Accessibility



All rotating machines are mounted in standard-size modules. These modules are equipped with a clear plastic faceplate fitted with a chrome-plated piano hinge. The faceplate can be lowered for access to the machine, and when closed, it is secured by two quick-lock fasteners. Each rotating machine is provided with a safety locking device that prevents students from lowering the faceplate during lab exercises.

Visual Inspection

All rotating machines have open bell housings (front and rear) to permit visual inspection of the internal construction and observation of the machine during operation with the aid of a Stroboscope, Model 8922. Externally mounted components such as centrifugal switches, capacitors, brushes, slip rings, and commutators – in addition to the exposed squirrel cage and wound rotors – permit students to clearly determine component function as well as to understand relative position, turns, and wire sizes of the machinery.

Machine Features

The shaft of each machine has a concave slotted end to facilitate the use of tachometers, holding brakes, plugging switches, and inertia wheels. A geared pulley is fitted on each machine shaft to mechanically couple machines together using a non-slip timing belt. The Timing Belt, Model 8942, has molded teeth, which mesh with the geared machine pulleys. Tension for the timing belt is provided by the idler-tensioning ball bearings mounted on each machine module.

Loads

Resistive, inductive, and capacitive load components, housed in separate modules, are designed to provide equal load magnitudes for all three types of loads. The load impedance can be varied in equal steps of unity value by switches provided on all load modules. These characteristics simplify the calculations required in the learning process.

Metering Modules

The metering modules are designed to cover the complete range of required measurements with a minimum number of meters. The ac ammeter and voltmeter modules each contains three meters for simultaneously measuring all three currents and voltages on a three-phase system. All meters are designed to sustain starting currents even when used on a low range. Wattmeters are internally connected to read power directly when the input is connected to the source and the output to the load. Protection of vulnerable meter components is accomplished without fuses.

Power Supply

A separate power supply for each workstation provides total control of the necessary power sources. This allows the student maximum use of laboratory equipment and reduces interference with other simultaneous laboratory experiments. The power supply module provides all ac and dc power sources required at each station.

Speed Measurements

The speed of the machines can be measured with a Hand Tachometer, Model 8920, or an optional Electrical Tachometer, Model 8931, which is easily mounted on the machine.

Leads

The machines and various components of the system are connected using flexible PVC-insulated connection leads terminated with 4 mm safety plugs. These leads allow safe connection of components without danger of electrical shock, since the live parts of their plugs are concealed and insulated in such a way that they cannot be contacted accidentally. They come in three different lengths, each identified by a distinctive color. A handy rack can be attached to the workstation side for inventory and storage of these leads.

Features & Benefits

- Sturdy workstations and modules constructed of heavy-gauge steel, finished in baked enamel
- Cutaway bell housings to permit visual inspection of the internal construction and observation of the machine during operation
- The shaft of each machine has a concave and slotted end to facilitate the use of tachometers, holding brakes, plugging switches, or inertia wheels
- Metering modules are designed to cover the complete range of required measurements with a minimum number of meters
- System conception and load components simplify calculations required in the learning process
- Safe: all electrical components can be interconnected without electric shock hazard as all live parts of the plugs are concealed and insulated
- Comprehensive curriculum
- Estimated total program duration: approximately 150 hours

List of Available Training Systems

Qty	Description	Model number
1	0.2 kW Electromechanical Training System – Modular with motor starters _____	587243 (8001-10)
1	0.2 kW EMS – Power Circuits _____	587250 (8001-20)
1	0.2 kW EMS – DC Machines _____	587257 (8001-30)
1	0.2 kW EMS – Single-Phase Transformers and AC Machines _____	587264 (8001-40)
1	0.2 kW EMS – Three-Phase Transformers and AC Machines _____	587271 (8001-50)
1	0.2 kW Electromechanical Training System _____	587278 (8001-60)

Available Training Systems

0.2 kW Electromechanical Training System – Modular with motor starters 587243 (8001-10)



The Complete 0.2 kW EMS – Modular training system is complete and supported by student manuals for all four subsystems.

The subsystems – Power Circuits (Vol. 1), DC Machines (Vol. 2), Single-Phase Transformer and AC Machines (Vol. 3), Three-Phase Transformer and AC Machines (Vol. 4) – cover the common machines, and each subsystem is offered with its courseware presented in a student manual. Each subsystem is available as a package that consists of the equipment necessary to perform the laboratory exercises presented in the correlated student manual.

List of Equipment

Qty	Description	Model number
1	_____	583899 (25986-00)
1	_____	583909 (25987-00)
1	_____	583913 (25988-00)
1	_____	583917 (25989-00)
1	Investigations in Electric Power Technology (Instructor Guide) _____	583921 (25990-01)
1	Mobile Workstation _____	579755 (8110-20)
1	Storage Shelves _____	579756 (8150-10)
1	DC Motor/Generator _____	579759 (8211-00)
1	Four-Pole Squirrel-Cage Induction Motor _____	579491 (8221-00)
1	Three-Phase Wound-Rotor Induction Machine _____	586320 (8231-00)
1	Synchronous Motor/Generator _____	586351 (8241-00)
1	Capacitor-Start Motor _____	579767 (8251-00)
1	Capacitor-Run Motor _____	586390 (8253-00)
1	Universal Motor _____	579774 (8254-00)
1	Resistive Load _____	763359 (8311-00)
1	Inductive Load _____	763362 (8321-00)
1	Capacitive Load _____	763366 (8331-00)
3	Fully Protected Transformer _____	763419 (8341-20)
1	DC Voltmeter/Ammeter _____	581397 (8412-00)
1	AC Ammeter _____	581406 (8425-00)
1	AC Voltmeter _____	581413 (8426-00)
1	Single-Phase Wattmeter _____	586514 (8431-20)
1	Three-Phase Wattmeter _____	586521 (8441-20)
1	Synchronizing Module _____	586738 (8621-00)
1	Manual DC Motor Starter _____	586745 (8631-00)
1	Synchronous Motor Starter _____	586751 (8641-00)
1	Three-Phase Full-Voltage Starter _____	586758 (8651-00)

Qty	Description	Model number
1	Three-Phase Rheostat _____	586786 (8731-00)
1	Variable Three-Phase Power Supply _____	579603 (8821-20)
1	Electrodynamometer, Imperial Units _____	586856 (8911-00)
1	Digital Tachometer _____	581427 (8920-40)
1	Timing Belt _____	579637 (8942-00)
1	Digital Multimeter _____	579782 (8946-20)
1	Connection Lead Set _____	581428 (8951-00)
1	Thyristor Speed Controller _____	587007 (9017-00)

List of Manuals

Description	Manual number
Power Circuits (Workbook) _____	583899 (25986-00)
DC Machines (Workbook) _____	583909 (25987-00)
Single-Phase Transformers and AC Machines (Workbook) _____	583913 (25988-00)
Three-Phase Transformers and AC Machines (Workbook) _____	583917 (25989-00)
Investigations in Electric Power Technology (Workbook (Instructor)) _____	583921 (25990-01)
Phase-Shifting with Transformers (Workbook) _____	583981 (27082-00)
The Wound-Rotor Induction Motor and Applications (Workbook) _____	584327 (35064-00)
The Capacitor-Run Motor (Workbook) _____	584328 (35065-00)
Electric Power Technology Training Equipment (User Guide) _____	584778 (38486-E0)

Table of Contents of the Manual(s)

Power Circuits (Workbook) (583899 (25986-00))

- 1 Series and Parallel Equivalent Resistances
- 2 Resistances in Parallel
- 3 Resistances in Series and in Series-Parallel
- 4 Safety and the Power Supply
- 5 Ohm's Law
- 6 Circuit Solution – Part I
- 7 Circuit Solution – Part II
- 8 Power in DC Circuits – Part I
- 9 Power in DC Circuits – Part II
- 10 The Transmission Line
- 11 AC Voltage and Current – Part I
- 12 AC Voltage and Current – Part II
- 13 The Wattmeter
- 14 Phase Angle, Active, and Apparent Power
- 15 Capacitive Reactance
- 16 Inductive Reactance
- 17 Watt, Var, Volt-Ampere, and Power Factor
- 18 Vectors and Phasors – Series Circuit
- 19 Vectors and Phasors – Parallel Circuits
- 20 Impedance
- 21 Three-Phase Circuits
- 22 Three-Phase Watts, Vars, and Volt-Amperes
- 23 Three-Phase Power Measurement

- 24 Phase Sequence

DC Machines (Workbook) (583909 (25987-00))

- 0 Safety and the Power Supply
- 1 Prime Mover and Torque Measurement
- 2 The Direct Current Motor – Part I
- 3 The Direct Current Motor – Part II
- 4 The DC Shunt Motor
- 5 The DC Series Motor
- 6 The DC Compound Motor
- 7 The DC Separately Excited Shunt Generator
- 8 The DC Self Excited Shunt Generator
- 9 The DC Compound Generator
- 10 DC Motor Starter
- 11 Thyristor Speed Controller
- 12 Thyristor Speed Controller with Regulation

Single-Phase Transformers and AC Machines (Workbook) (583913 (25988-00))

- 0 Safety and the Power Supply
- 1 The Single-Phase Transformer
- 2 Transformer Polarity
- 3 Transformer Regulation
- 4 The Autotransformer
- 5 Transformers in Parallel
- 6 The Distribution Transformer
- 7 Prime Mover and Torque Measurement
- 8 The Split-Phase Inductor Motor – Part I
- 9 The Split-Phase Inductor Motor – Part II
- 10 The Split-Phase Inductor Motor – Part III
- 11 The Capacitor-Start Motor
- 12 The Capacitor-Run Motor
- 13 The Universal Motor – Part I
- 14 The Universal Motor – Part II

Three-Phase Transformers and AC Machines (Workbook) (583917 (25989-00))

- 0 Safety and the Power Supply
- 1 Three-Phase Transformer Connections
- 2 Prime Mover and Torque Measurement
- 3 The Wound-Rotor Induction Motor – Part I
- 4 The Wound-Rotor Induction Motor – Part II
- 5 The Wound-Rotor Induction Motor – Part III
- 6 The Squirrel-Cage Induction Motor
- 7 The Synchronous Motor – Part I
- 8 The Synchronous Motor – Part II
- 9 The Synchronous Motor – Part III
- 10 The Three-Phase Alternator
- 11 The Alternator Under Load
- 12 Alternator Synchronization
- 13 Alternator Power

- 14 Three-Phase Motor Starter
- 15 Frequency Conversion
- 16 Reactance and Frequency
- 17 Selsyn Control

Phase-Shifting with Transformers (Workbook) (583981 (27082-00))

- 1 Phase Shifting with Transformers

The Wound-Rotor Induction Motor and Applications (Workbook) (584327 (35064-00))

- 1 The Wound-Rotor Induction Motor – Part I
- 2 The Wound-Rotor Induction Motor – Part II
- 3 The Wound-Rotor Induction Motor – Part III
- 4 Frequency Conversion
- 5 Reactance and Frequency
- 6 Selsyn Control

The Capacitor-Run Motor (Workbook) (584328 (35065-00))

- 1 The Capacitor-Run Motor

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

Software

Qty	Description	Model number
1	Complete Function Set _____	581435 (8968-00) ¹
1	Standard Functions (computer-based control) Set _____	581437 (8968-20) ²
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 1 User Online, 1 year _____	586971 (8972-00) ³
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 5 Users Online, 1 year _____	586974 (8972-A0) ⁴
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 10 Users Online, 1 year _____	586977 (8972-B0) ⁵

¹ Additional firmware for the optional Four-Quadrant Dynamometer/Power Supply.

² Additional firmware for the optional Four-Quadrant Dynamometer/Power Supply.

³ Simulation software that covers these topics and more.

⁴ Simulation software that covers these topics and more.

⁵ Simulation software that covers these topics and more.

Qty	Description	Model number
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 15 Users Online, 1 year	___ 586980 (8972-C0) ⁶
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 20 Users Online, 1 year	___ 586983 (8972-D0) ⁷
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 25 Users Online, 1 year	___ 586986 (8972-E0) ⁸
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 30 Users Online, 1 year	___ 586989 (8972-F0) ⁹
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 35 Users Online, 1 year	___ 586992 (8972-G0) ¹⁰
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 40 Users Online, 1 year	___ 586995 (8972-H0) ¹¹
1	SCADA for LVDAC-EMS _____	8094377 (8973-00) ¹²
1	Complete Function Set _____	581451 (9069-00) ¹³
1	Synchroscope Function _____	579789 (9069-C0) ¹⁴

System Specifications

Parameter	Value
System Requirements	
Maximum Current	15 A
Typical Current	1.5 A per student group
AC Power Network Installation	3 phases (120/208 V – 60 Hz), star (wye) configuration including neutral and ground wires, protected by a 20 A circuit breaker
AC Power Network Connector	NEMA L21-20
Physical Characteristics	
Intended Location	On the floor (stands on casters)
Dimensions (H x W x D)	900 x 930 x 530 mm (35.4 x 36.6 x 20.9 in)
Net Weight	439 kg (966 lb)
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)

0.2 kW EMS – Power Circuits 587250 (8001-20)



The 0.2 kW EMS – Power Circuits training system is supported by the student manual Volume 1: Power Circuits.

⁶ Simulation software that covers these topics and more.

⁷ Simulation software that covers these topics and more.

⁸ Simulation software that covers these topics and more.

⁹ Simulation software that covers these topics and more.

¹⁰ Simulation software that covers these topics and more.

¹¹ Simulation software that covers these topics and more.

¹² Allows monitoring of up to 5 Stations through OPC.

¹³ Additional firmware for the optional Data Acquisition.

¹⁴ Additional firmware for the optional Data Acquisition.

List of Equipment

Qty	Description	Model number
1	_____	583899 (25986-00)
1	Mobile Workstation _____	579755 (8110-20)
1	Storage Shelves _____	579756 (8150-10)
1	Resistive Load _____	763359 (8311-00)
1	Inductive Load _____	763362 (8321-00)
1	Capacitive Load _____	763366 (8331-00)
1	DC Voltmeter/Ammeter _____	581397 (8412-00)
1	AC Ammeter _____	581406 (8425-00)
1	AC Voltmeter _____	581413 (8426-00)
1	Single-Phase Wattmeter _____	586514 (8431-20)
1	Three-Phase Wattmeter _____	586521 (8441-20)
1	Synchronizing Module _____	586738 (8621-00)
1	Variable Three-Phase Power Supply _____	579603 (8821-20)
1	Digital Multimeter _____	579782 (8946-20)
1	Connection Lead Set _____	581428 (8951-00)

List of Manuals

Description	Manual number
Power Circuits (Workbook) _____	583899 (25986-00)
Electric Power Technology Training Equipment (User Guide) _____	584778 (38486-E0)

Table of Contents of the Manual(s)

Power Circuits (Workbook) (583899 (25986-00))

- 1 Series and Parallel Equivalent Resistances
- 2 Resistances in Parallel
- 3 Resistances in Series and in Series-Parallel
- 4 Safety and the Power Supply
- 5 Ohm's Law
- 6 Circuit Solution – Part I
- 7 Circuit Solution – Part II
- 8 Power in DC Circuits – Part I
- 9 Power in DC Circuits – Part II
- 10 The Transmission Line
- 11 AC Voltage and Current – Part I
- 12 AC Voltage and Current – Part II
- 13 The Wattmeter
- 14 Phase Angle, Active, and Apparent Power
- 15 Capacitive Reactance
- 16 Inductive Reactance
- 17 Watt, Var, Volt-Ampere, and Power Factor
- 18 Vectors and Phasors – Series Circuit
- 19 Vectors and Phasors – Parallel Circuits
- 20 Impedance
- 21 Three-Phase Circuits

- 22 Three-Phase Watts, Vars, and Volt-Amperes
- 23 Three-Phase Power Measurement
- 24 Phase Sequence

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
System Requirements	
Maximum Current	15 A
Typical Current	1.5 A per student group
AC Power Network Installation	3 phases (120/208 V – 60 Hz), star (wye) configuration including neutral and ground wires, protected by a 20 A circuit breaker
AC Power Network Connector	NEMA L21-20
Physical Characteristics	
Intended Location	On the floor (stands on casters)
Dimensions (H x W x D)	900 x 930 x 530 mm (35.4 x 36.6 x 20.9 in)
Net Weight	439 kg (966 lb)
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)

0.2 kW EMS – DC Machines 587257 (8001-30)



The 0.2 kW EMS – DC Machines training system is supported by the student manual Volume 2: DC Machines.

List of Equipment

Qty	Description	Model number
1	_____	583909 (25987-00)
1	Mobile Workstation _____	579755 (8110-20)
1	Storage Shelves _____	579756 (8150-10)
1	DC Motor/Generator _____	579759 (8211-00)
1	Synchronous Motor/Generator _____	586351 (8241-00)
1	Resistive Load _____	763359 (8311-00)

Qty	Description	Model number
1	DC Voltmeter/Ammeter _____	581397 (8412-00)
1	AC Ammeter _____	581406 (8425-00)
1	AC Voltmeter _____	581413 (8426-00)
1	Manual DC Motor Starter _____	586745 (8631-00)
1	Variable Three-Phase Power Supply _____	579603 (8821-20)
1	Electrodynamometer, Imperial Units _____	586856 (8911-00)
1	Digital Tachometer _____	581427 (8920-40)
1	Timing Belt _____	579637 (8942-00)
1	Connection Lead Set _____	581428 (8951-00)
1	Thyristor Speed Controller _____	587007 (9017-00)

List of Manuals

Description	Manual number
DC Machines (Workbook) _____	583909 (25987-00)
Electric Power Technology Training Equipment (User Guide) _____	584778 (38486-E0)

Table of Contents of the Manual(s)

DC Machines (Workbook) (583909 (25987-00))

- 0 Safety and the Power Supply
- 1 Prime Mover and Torque Measurement
- 2 The Direct Current Motor – Part I
- 3 The Direct Current Motor – Part II
- 4 The DC Shunt Motor
- 5 The DC Series Motor
- 6 The DC Compound Motor
- 7 The DC Separately Excited Shunt Generator
- 8 The DC Self Excited Shunt Generator
- 9 The DC Compound Generator
- 10 DC Motor Starter
- 11 Thyristor Speed Controller
- 12 Thyristor Speed Controller with Regulation

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
System Requirements	
Maximum Current	15 A
Typical Current	1.5 A per student group

Parameter	Value
AC Power Network Installation	3 phases (120/208 V – 60 Hz), star (wye) configuration including neutral and ground wires, protected by a 20 A circuit breaker
AC Power Network Connector	NEMA L21-20
Physical Characteristics	
Intended Location	On the floor (stands on casters)
Dimensions (H x W x D)	900 x 930 x 530 mm (35.4 x 36.6 x 20.9 in)
Net Weight	307 kg (675 lb)
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)

0.2 kW EMS – Single-Phase Transformers and AC Machines 587264 (8001-40)



The 0.2 kW EMS – Single-Phase Transformers and AC Machines training system is supported by the student manual Volume 3: Single-Phase Transformers and AC Machines.

List of Equipment

Qty	Description	Model number
1	_____	583913 (25988-00)
1	Mobile Workstation _____	579755 (8110-20)
1	Storage Shelves _____	579756 (8150-10)
1	Capacitor-Start Motor _____	579767 (8251-00)
1	Capacitor-Run Motor _____	586390 (8253-00)
1	Universal Motor _____	579774 (8254-00)
1	Resistive Load _____	763359 (8311-00)
1	Inductive Load _____	763362 (8321-00)
1	Capacitive Load _____	763366 (8331-00)
2	Fully Protected Transformer _____	763419 (8341-20)
1	DC Voltmeter/Ammeter _____	581397 (8412-00)
1	AC Ammeter _____	581406 (8425-00)
1	AC Voltmeter _____	581413 (8426-00)
1	Single-Phase Wattmeter _____	586514 (8431-20)
1	Variable Three-Phase Power Supply _____	579603 (8821-20)
1	Electrodynamometer, Imperial Units _____	586856 (8911-00)
1	Digital Tachometer _____	581427 (8920-40)
1	Timing Belt _____	579637 (8942-00)
1	Digital Multimeter _____	579782 (8946-20)
1	Connection Lead Set _____	581428 (8951-00)

List of Manuals

Description	Manual number
Single-Phase Transformers and AC Machines (Workbook)	583913 (25988-00)
The Capacitor-Run Motor (Workbook)	584328 (35065-00)
Electric Power Technology Training Equipment (User Guide)	584778 (38486-E0)

Table of Contents of the Manual(s)

Single-Phase Transformers and AC Machines (Workbook) (583913 (25988-00))

- 0 Safety and the Power Supply
- 1 The Single-Phase Transformer
- 2 Transformer Polarity
- 3 Transformer Regulation
- 4 The Autotransformer
- 5 Transformers in Parallel
- 6 The Distribution Transformer
- 7 Prime Mover and Torque Measurement
- 8 The Split-Phase Inductor Motor – Part I
- 9 The Split-Phase Inductor Motor – Part II
- 10 The Split-Phase Inductor Motor – Part III
- 11 The Capacitor-Start Motor
- 12 The Capacitor-Run Motor
- 13 The Universal Motor – Part I
- 14 The Universal Motor – Part II

The Capacitor-Run Motor (Workbook) (584328 (35065-00))

- 1 The Capacitor-Run Motor

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
System Requirements	
Maximum Current	15 A
Typical Current	1.5 A per student group
AC Power Network Installation	3 phases (120/208 V – 60 Hz), star (wye) configuration including neutral and ground wires, protected by a 20 A circuit breaker
AC Power Network Connector	NEMA L21-20
Physical Characteristics	
Intended Location	On the floor (stands on casters)
Dimensions (H x W x D)	900 x 930 x 530 mm (35.4 x 36.6 x 20.9 in)
Net Weight	332 kg (730 lb)
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)

Parameter	Value
Half-Size Dimensions (H x W x D)	154 x 287 x 440 mm (6.1 x 11.3 x 17.3 in)

0.2 kW EMS – Three-Phase Transformers and AC Machines 58271 (8001-50)



The 0.2 kW EMS – Three-Phase Transformers and AC Machines training system is supported by the student manual Volume 4: Three-Phase Transformers and AC Machines.

List of Equipment

Qty	Description	Model number
1	_____	583917 (25989-00)
1	Mobile Workstation _____	579755 (8110-20)
1	Storage Shelves _____	579756 (8150-10)
1	DC Motor/Generator _____	579759 (8211-00)
1	Four-Pole Squirrel-Cage Induction Motor _____	579491 (8221-00)
1	Three-Phase Wound-Rotor Induction Machine _____	586320 (8231-00)
1	Synchronous Motor/Generator _____	586351 (8241-00)
1	Resistive Load _____	763359 (8311-00)
1	Inductive Load _____	763362 (8321-00)
1	Capacitive Load _____	763366 (8331-00)
3	Fully Protected Transformer _____	763419 (8341-20)
1	DC Voltmeter/Ammeter _____	581397 (8412-00)
1	AC Ammeter _____	581406 (8425-00)
1	AC Voltmeter _____	581413 (8426-00)
1	Three-Phase Wattmeter _____	586521 (8441-20)
1	Synchronizing Module _____	586738 (8621-00)
1	Synchronous Motor Starter _____	586751 (8641-00)
1	Three-Phase Full-Voltage Starter _____	586758 (8651-00)
1	Three-Phase Rheostat _____	586786 (8731-00)
1	Variable Three-Phase Power Supply _____	579603 (8821-20)
1	Electrodynamometer, Imperial Units _____	586856 (8911-00)
1	Digital Tachometer _____	581427 (8920-40)
1	Timing Belt _____	579637 (8942-00)
1	Connection Lead Set _____	581428 (8951-00)

List of Manuals

Description	Manual number
Three-Phase Transformers and AC Machines (Workbook) _____	583917 (25989-00)
Phase-Shifting with Transformers (Workbook) _____	583981 (27082-00)
The Wound-Rotor Induction Motor and Applications (Workbook) _____	584327 (35064-00)

Description**Manual
number**

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

Table of Contents of the Manual(s)**Three-Phase Transformers and AC Machines (Workbook) (583917 (25989-00))**

- 0 Safety and the Power Supply
- 1 Three-Phase Transformer Connections
- 2 Prime Mover and Torque Measurement
- 3 The Wound-Rotor Induction Motor – Part I
- 4 The Wound-Rotor Induction Motor – Part II
- 5 The Wound-Rotor Induction Motor – Part III
- 6 The Squirrel-Cage Induction Motor
- 7 The Synchronous Motor – Part I
- 8 The Synchronous Motor – Part II
- 9 The Synchronous Motor – Part III
- 10 The Three-Phase Alternator
- 11 The Alternator Under Load
- 12 Alternator Synchronization
- 13 Alternator Power
- 14 Three-Phase Motor Starter
- 15 Frequency Conversion
- 16 Reactance and Frequency
- 17 Selsyn Control

Phase-Shifting with Transformers (Workbook) (583981 (27082-00))

- 1 Phase Shifting with Transformers

The Wound-Rotor Induction Motor and Applications (Workbook) (584327 (35064-00))

- 1 The Wound-Rotor Induction Motor – Part I
- 2 The Wound-Rotor Induction Motor – Part II
- 3 The Wound-Rotor Induction Motor – Part III
- 4 Frequency Conversion
- 5 Reactance and Frequency
- 6 Selsyn Control

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
System Requirements	
Maximum Current	15 A

Parameter	Value
Typical Current	1.5 A per student group
AC Power Network Installation	3 phases (120/208 V – 60 Hz), star (wye) configuration including neutral and ground wires, protected by a 20 A circuit breaker
AC Power Network Connector	NEMA L21-20
Physical Characteristics	
Intended Location	On the floor (stands on casters)
Dimensions (H x W x D)	900 x 930 x 530 mm (35.4 x 36.6 x 20.9 in)
Net Weight	371 kg (816 lb)
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)

0.2 kW Electromechanical Training System 587278 (8001-60)



The 0.2 kW Electromechanical Training System (EMS) is a modular instructional program designed to teach electric power technology through laboratory observations.

The training system is supported by a 65-experiment laboratory manual, "Investigations in Electric Power."

List of Equipment

Qty	Description	Model number
1	Investigations in Electric Power Technology (Student Manual)	583758 (11627-00)
1	Investigations in Electric Power Technology (Instructor Guide)	583759 (11627-01)
1	Mobile Workstation	579755 (8110-20)
1	Storage Shelves	579756 (8150-10)
1	DC Motor/Generator	579759 (8211-00)
1	Four-Pole Squirrel-Cage Induction Motor	579491 (8221-00)
1	Three-Phase Wound-Rotor Induction Machine	586320 (8231-00)
1	Synchronous Motor/Generator	586351 (8241-00)
1	Capacitor-Start Motor	579767 (8251-00)
1	Capacitor-Run Motor	586390 (8253-00)
1	Universal Motor	579774 (8254-00)
2	Resistive Load	763359 (8311-00)
1	Inductive Load	763362 (8321-00)
2	Capacitive Load	763366 (8331-00)
3	Fully Protected Transformer	763419 (8341-20)
1	DC Voltmeter/Ammeter	581397 (8412-00)
1	AC Ammeter	581406 (8425-00)
1	AC Voltmeter	581413 (8426-00)
1	Single-Phase Wattmeter	586514 (8431-20)
1	Three-Phase Wattmeter	586521 (8441-20)
1	Synchronizing Module	586738 (8621-00)
1	Three-Phase Rheostat	586786 (8731-00)
1	Variable Three-Phase Power Supply	579603 (8821-20)

Qty	Description	Model number
1	Electrodynamometer, Imperial Units _____	586856 (8911-00)
1	Digital Tachometer _____	581427 (8920-40)
1	Timing Belt _____	579637 (8942-00)
1	Connection Lead Set _____	581428 (8951-00)
1	Thyristor Speed Controller _____	587007 (9017-00)

List of Manuals

Description	Manual number
Investigations in Electric Power Technology (Workbook) _____	583758 (11627-00)
Investigations in Electric Power Technology (Workbook (Instructor)) _____	583759 (11627-01)
Phase-Shifting with Transformers (Workbook) _____	583981 (27082-00)
The Wound-Rotor Induction Motor and Applications (Workbook) _____	584327 (35064-00)
The Capacitor-Run Motor (Workbook) _____	584328 (35065-00)
Electric Power Technology Training Equipment (User Guide) _____	584778 (38486-E0)

Table of Contents of the Manual(s)

Investigations in Electric Power Technology (Workbook) (583758 (11627-00))

- 1 Series and Parallel Equivalent Resistances
- 2 Resistances in Parallel
- 3 Resistances in Series and in Series-Parallel
- 4 Safety and the Power Supply
- 5 Ohm's Law
- 6 Circuit Solution – Part I
- 7 Circuit Solution – Part II
- 8 Power in DC Circuits – Part I
- 9 Power in DC Circuits – Part II
- 10 The Transmission Line
- 11 The Direct Current Motor – Part I
- 12 The Direct Current Motor – Part II
- 13 AC Voltage and Current – Part I
- 14 AC Voltage and Current – Part II
- 15 The Wattmeter
- 16 Phase Angle, Active, and Apparent Power
- 17 Capacitive Reactance
- 18 Inductive Reactance
- 19 Watt, Var, Volt-Ampere, and Power Factor
- 20 Vectors and Phasors – Series Circuit
- 21 Vectors and Phasors – Parallel Circuits
- 22 Impedance
- 23 Prime Mover and Torque Measurement
- 24 The DC Shunt Motor
- 25 The DC Series Motor
- 26 The DC Compound Motor
- 27 The DC Separately Excited Shunt Generator
- 28 The DC Self-Excited Shunt Generator
- 29 The DC Compound Generator

- 30 The DC Series Generator
- 31 The Split-Phase Inductor Motor – Part I
- 32 The Split-Phase Inductor Motor – Part II
- 33 The Split-Phase Inductor Motor – Part III
- 34 The Capacitor-Start Motor
- 35 The Capacitor-Run Motor
- 36 The Universal Motor – Part I
- 37 The Universal Motor – Part II
- 38 The Repulsion Start-Induction Run Motor (optional)
- 39 The Single-Phase Transformer
- 40 Transformer Polarity
- 41 Transformer Regulation
- 42 The Autotransformer
- 43 Transformers in Parallel
- 44 The Distribution Transformer
- 45 Three-Phase Circuits
- 46 Three-Phase Watts, Vars, and Volt-Amperes
- 47 Three-Phase Power Measurement
- 48 Three-Phase Transformer Connections
- 49 The Wound-Rotor Induction Motor – Part I
- 50 The Wound-Rotor Induction Motor – Part II
- 51 The Wound-Rotor Induction Motor – Part III
- 52 The Squirrel-Cage Induction Motor
- 53 The Synchronous Motor – Part I
- 54 The Synchronous Motor – Part II
- 55 The Synchronous Motor – Part III
- 56 The Three-Phase Alternator
- 57 The Alternator Under Load
- 58 Alternator Synchronization
- 59 Alternator Power
- 60 Phase Sequence
- 61 Frequency Conversion
- 62 Reactance and Frequency
- 63 Three-Phase to Two-Phase Conversion
- 64 Selsyn Control
- 65 Thyristor Speed Controllers
- 66 Thyristor Speed Controllers with Regulation

Phase-Shifting with Transformers (Workbook) (583981 (27082-00))

- 1 Phase Shifting with Transformers

The Wound-Rotor Induction Motor and Applications (Workbook) (584327 (35064-00))

- 1 The Wound-Rotor Induction Motor – Part I
- 2 The Wound-Rotor Induction Motor – Part II
- 3 The Wound-Rotor Induction Motor – Part III
- 4 Frequency Conversion
- 5 Reactance and Frequency
- 6 Selsyn Control

The Capacitor-Run Motor (Workbook) (584328 (35065-00))

- 1 The Capacitor-Run Motor

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

Software

Qty	Description	Model number
1	Complete Function Set _____	581435 (8968-00) ¹⁵
1	Standard Functions (computer-based control) Set _____	581437 (8968-20) ¹⁶
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 1 User Online, 1 year ____	586971 (8972-00) ¹⁷
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 5 Users Online, 1 year ____	586974 (8972-A0) ¹⁸
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 10 Users Online, 1 year __	586977 (8972-B0) ¹⁹
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 15 Users Online, 1 year __	586980 (8972-C0) ²⁰
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 20 Users Online, 1 year __	586983 (8972-D0) ²¹
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 25 Users Online, 1 year __	586986 (8972-E0) ²²
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 30 Users Online, 1 year ____	586989 (8972-F0) ²³
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 35 Users Online, 1 year __	586992 (8972-G0) ²⁴
1	Electromechanical Systems Simulation Software (LVSIM [®] -EMS) - 40 Users Online, 1 year __	586995 (8972-H0) ²⁵
1	SCADA for LVDAC-EMS _____	8094377 (8973-00) ²⁶
1	Complete Function Set _____	581451 (9069-00) ²⁷
1	Synchroscope Function _____	579789 (9069-C0) ²⁸

System Specifications

Parameter	Value
System Requirements	
Maximum Current	15 A

¹⁵ Additional firmware for the optional Four-Quadrant Dynamometer/Power Supply.

¹⁶ Additional firmware for the optional Four-Quadrant Dynamometer/Power Supply.

¹⁷ Simulation software that covers these topics and more.

¹⁸ Simulation software that covers these topics and more.

¹⁹ Simulation software that covers these topics and more.

²⁰ Simulation software that covers these topics and more.

²¹ Simulation software that covers these topics and more.

²² Simulation software that covers these topics and more.

²³ Simulation software that covers these topics and more.

²⁴ Simulation software that covers these topics and more.

²⁵ Simulation software that covers these topics and more.

²⁶ Allows monitoring of up to 5 Stations through OPC.

²⁷ Additional firmware for the optional Data Acquisition.

²⁸ Additional firmware for the optional Data Acquisition.

Parameter	Value
Typical Current	1.5 A per student group
AC Power Network Installation	3 phases (120/208 V – 60 Hz), star (wye) configuration including neutral and ground wires, protected by a 20 A circuit breaker
AC Power Network Connector	NEMA L21-20
Physical Characteristics	
Intended Location	On the floor (stands on casters)
Dimensions (H x W x D)	900 x 930 x 530 mm (35.4 x 36.6 x 20.9 in)
Net Weight	440 kg (970 lb)
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

Mobile Workstation 579755 (8110-20)



The Mobile Workstation is a ready-for-use workstation that consists of two fully assembled modules: a Workstation mounted on a Mobile Storage Cabinet. Four rubber-tire swivel casters allow easy movement of the workstation in the laboratory classroom. The lower portion of the workstation serves as a storage cabinet with two hinged panels and a lock handle. Immediately above the storage cabinet is a pullout work surface with a scuff- and burn-resistant laminate finish. The upper portion of the workstation consists of three rows of compartments designed to house EMS modules. Two of these rows have full-height compartments while the other row has half-height compartments. Each row of full-height compartments can accommodate up to three full-size EMS modules or six half-size EMS modules, whereas the row of half-height compartments can accommodate up to three 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. Front-mounted push levers allow all EMS modules on a single row 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

Six 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

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

**Manual
number**

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
- 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

Specifications

Parameter	Value
Physical Characteristics	
Intended Location	On the floor (stands on casters)
Dimensions (H x W x D)	1660 x 935 x 665 mm (65.4 x 36.8 x 26.2 in)
Net Weight	77.1 kg (170 lb)

Storage Shelves 579756 (8150-10)

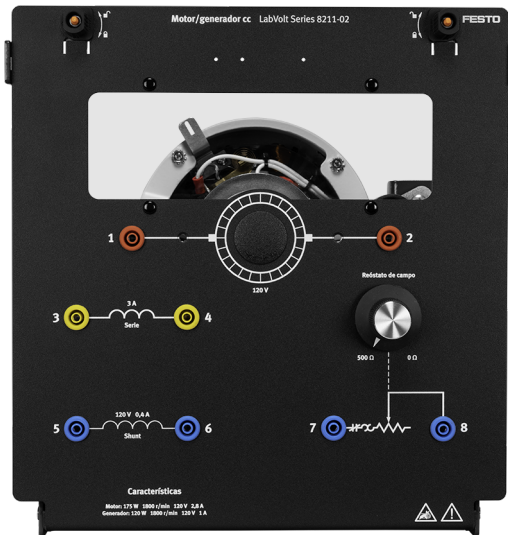


The Storage Shelves module contains five shelves, each of which can accommodate four full-size EMS modules or eight half-size EMS modules. Stainless steel rails guide the modules on the storage shelves and protect them against wear. The Storage Shelves module requires assembly. A diagram is provided to facilitate assembly. Note that this model cannot stand by itself and must be attached to a wall.

Specifications

Parameter	Value
Physical Characteristics	
Intended Location	On the floor and attached to a wall
Dimensions (H x W x D)	1980 x 1225 x 510 mm (78 x 48.2 x 20.1 in)
Net Weight	TBE

DC Motor/Generator 579759 (8211-00)



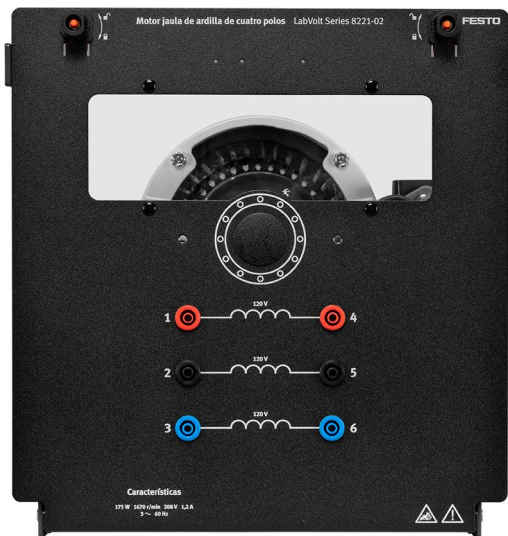
The DC Motor/Generator is a dc machine mounted in a full-size EMS module. It can operate independently as a dc motor or a dc generator. The armature, shunt field, and series field windings are terminated separately on the faceplate to permit long and short shunt as well as cumulatively and differentially compounded motor and generator connections. This machine is fitted with exposed movable brushes to allow students to study the effect of armature reaction and commutation while the machine is operating under load.

An independent, circuit-breaker protected, shunt-field rheostat is mounted on the faceplate for motor speed control or generator output voltage adjustment. The speed of the DC Motor/Generator can be controlled using the Thyristor Speed Controller in both the open-loop and closed-loop modes of control.

Specifications

Parameter	Value
Rating	
Motor Output Power	175 W
Generator Output Power	120 W
Armature Voltage	120 V dc
Shunt Field Voltage	120 V dc
Full-Load Speed	1800 r/min
Full-Load Motor Current	2.8 A
Full-Load Generator Current	1 A
Physical Characteristics	
Dimensions (H x W x D)	308 x 287 x 445 mm (12.1 x 11.3 x 17.5 in)
Net Weight	14.1 kg (31 lb)

Four-Pole Squirrel-Cage Induction Motor 579491 (8221-00)



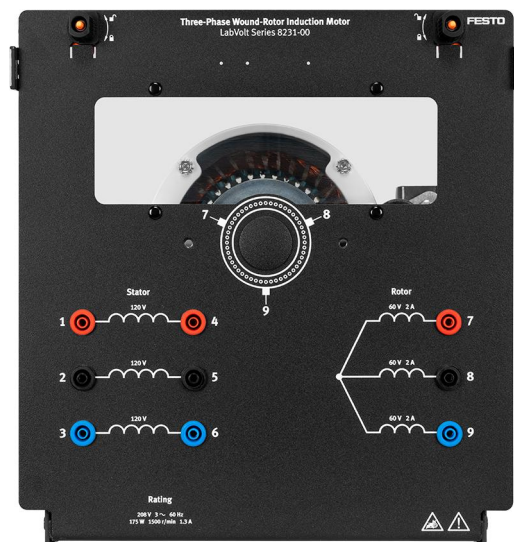
The Four-Pole Squirrel-Cage Induction Motor is a 0.2 kW squirrel-cage induction machine mounted in a full-size EMS module. The machine stator windings are independently connected (six jacks), allowing connection in either wye or delta configuration. Connections to the machine are made through color-coded safety banana jacks located on the front panel on the module.

The front panel of the Four-Pole Squirrel-Cage Induction Motor module can be opened to install a Timing Belt on the pulley of the machine shaft. This permits mechanical coupling of this machine a dynamometer or prime mover. When driven by a prime mover, the Four-Pole Squirrel-Cage Induction Motor operates as a three-phase asynchronous generator.

Specifications

Parameter	Value
Ratings	
Stator Voltage	120/208 V, 60 Hz, 3-phase
Mechanical Power	175 W
Nominal Speed	1670 r/min
Nominal Current	1.2 A
Physical Characteristics	
Dimensions (H x W x D)	308 x 287 x 420 mm (12.1 x 11.3 x 16.5 in)
Net Weight	13.5 kg (29.7 lb)

Three-Phase Wound-Rotor Induction Machine 586320 (8231-00)



The Three-Phase Wound-Rotor Induction Machine is a rotating machine mounted in a full-size EMS module. Each phase of the stator windings is independently terminated and identified on the faceplate to permit operation in either delta or star (wye) configuration. The rotor windings are brought out to the faceplate via external slip rings and brushes. This machine can be used as a wound-rotor induction motor, phase shifter, single-phase variable coupling transformer, three-phase transformer, selsyn control, frequency converter or asynchronous induction generator. The speed of the machine can be controlled through the use of the Three-Phase Rheostat.

This version has a 2:1 turn ratio on the rotor, which is optimized for using with a rotor rheostat. There is also a different version that has a higher turn ratio on the rotor, to be used as a DFIG.

List of Manuals

Description

Manual number

Phase-Shifting with Transformers (Workbook)	583981 (27082-00)
The Wound-Rotor Induction Motor and Applications (Workbook)	584327 (35064-00)

Table of Contents of the Manual(s)

Phase-Shifting with Transformers (Workbook) (583981 (27082-00))

- 1 Phase Shifting with Transformers

The Wound-Rotor Induction Motor and Applications (Workbook) (584327 (35064-00))

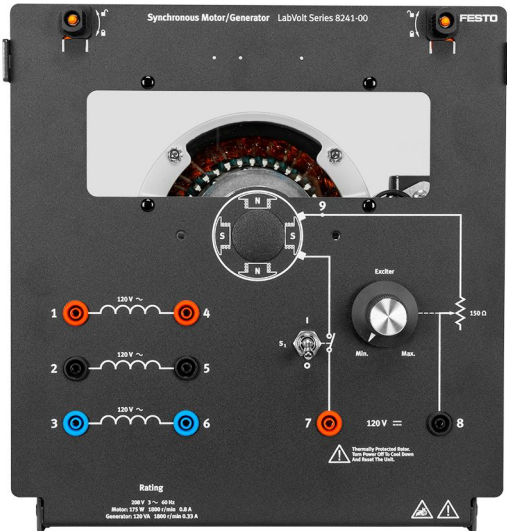
- 1 The Wound-Rotor Induction Motor – Part I
- 2 The Wound-Rotor Induction Motor – Part II
- 3 The Wound-Rotor Induction Motor – Part III
- 4 Frequency Conversion
- 5 Reactance and Frequency
- 6 Selsyn Control

Specifications

Parameter	Value
Power Requirement	120/208 V

Parameter	Value
Rating	
Output Power	175 W
Stator Voltage	120/208 V, 3-phase
Rotor Voltage	60/104 V, 3-phase
Full-Load Speed	1500 r/min
Full-Load Current	1.3 A
Physical Characteristics	
Dimensions (H x W x D)	308 x 291 x 440 mm (12.1 x 11.5 x 17.3 in)
Net Weight	14 kg (30.8 lb)

Synchronous Motor/Generator 586351 (8241-00)



The Synchronous Motor/Generator is a 0.2 kW three-phase synchronous machine mounted in a full-size EMS module. This machine can be operated either as a three-phase motor or a three-phase generator. Each phase of the machine stator windings is independently terminated and identified on the front panel to allow operation in either wye or delta configuration. The machine rotor is equipped with a squirrel-cage damper. Variable dc excitation to the rotor field windings is fed through externally mounted slip rings and brushes that are wired to a rheostat and control switch located on the front panel.

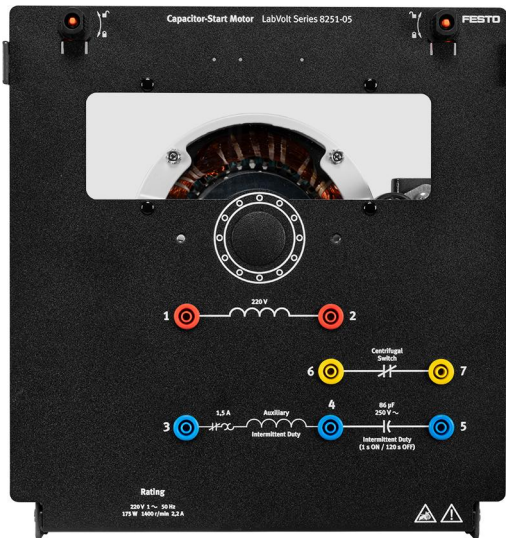
Connections to the machine are made through color-coded safety banana jacks located on the front panel of the module. This front panel can be opened to install a Timing Belt on the pulley of the machine shaft. This permits mechanical coupling of the machine to the dynamometer or prime mover.

Note that the coupling can only be done on the right side of the machine. If you require a coupling on the left side, please contact your sales representative.

Specifications

Parameter	Value
Motor	
Stator Voltage	120/208 V, 60 Hz, 3-phase
Rotor Voltage	120 V dc
Output Power	175 W
Synchronous Speed	1800 r/min
Full-Load Current	0.8 A
Generator	
Stator Voltage	120/208 V, 60 Hz, 3-phase
Rotor Voltage	120 V dc
Output Power	120 VA
Synchronous Speed	1800 r/min
Nominal Output Current	0.33 A
Physical Characteristics	
Dimensions (H x W x D)	308 x 287 x 440 mm (12.1 x 11.3 x 17.3 in)
Net Weight	14 kg (30.8 lb)

Capacitor-Start Motor 579767 (8251-00)

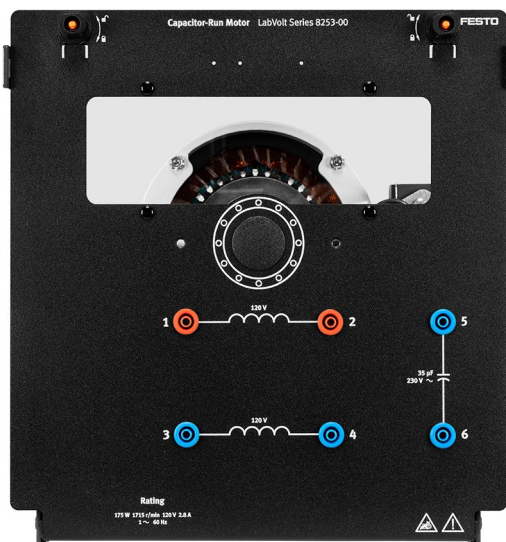


The Capacitor-Start Motor is a 0.2 kW capacitor-start machine mounted in a full-size EMS module. The centrifugal switch and contact points of the machine are mounted externally to allow students to examine their construction and observe their operation. The switch, the starting auxiliary winding, and the main running winding are all independently terminated and identified on the faceplate to facilitate experimentation of various machine connections, including open- and short-circuit fault conditions. The starting winding is circuit breaker protected against overloads. Because of the open bell housing construction, students can compare the relative size, position, and turns of the starting winding and the main running winding. An externally mounted starting capacitor is also independently terminated and identified on the faceplate to permit experimentation as a split-phase or a capacitor-start single-phase induction motor.

Specifications

Parameter	Value
Rating	
Line Voltage	120 V
Mechanical Power	175 W
Full-Load Speed	1715 r/min
Full-Load Current	4.6 A
Physical Characteristics	
Dimensions (H x W x D)	308 x 287 x 420 mm (12.1 x 11.3 x 16.5 in)
Net Weight	13.8 kg (30.4 lb)

Capacitor-Run Motor 586390 (8253-00)



The Capacitor-Run Motor is fitted with a running capacitor and running windings that are independently terminated and identified on the faceplate to facilitate experimentation of various machine connections, including operation from a two-phase source of power. The design of the machine has been optimized so that it operates like a two-phase motor at full load when connected to a single-phase source.

Manual

Description

Manual number

The Capacitor-Run Motor (Workbook) _____ 584328 (35065-00)

Table of Contents of the Manual(s)

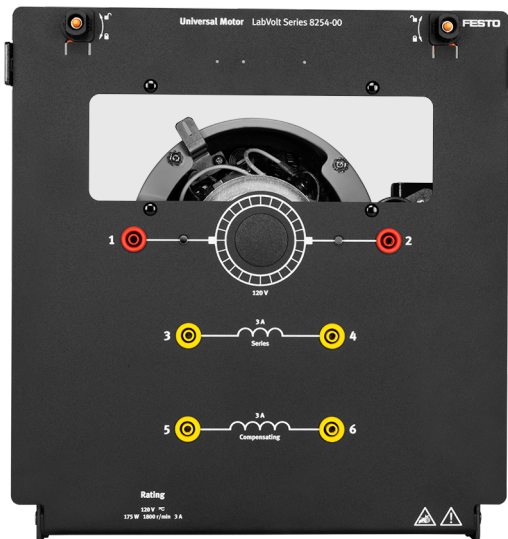
The Capacitor-Run Motor (Workbook) (584328 (35065-00))

- 1 The Capacitor-Run Motor

Specifications

Parameter	Value
Rating	
Line Voltage	120 V
Output Power	175 W
Full Load Speed	1715 r/min
Full Load Current	2.8 A
Physical Characteristics	
Dimensions (H x W x D)	308 x 291 x 440 mm (12.1 x 11.5 x 17.3 in)
Net Weight	13.6 kg (29.9 lb)

Universal Motor 579774 (8254-00)



The Universal Motor is a 0.2 kW universal machine mounted in a full-size EMS module. Its commutator bars and adjustable brushes are exposed to allow students to study the effect of armature reactions and commutation while the machine is running under load. The armature winding, the series field winding, and the compensation winding are terminated independently on the module front panel by 4 mm color-coded banana jacks. Students can observe the effects of both inductive and conductive compensation on motor speed and torque for both ac and dc input voltage sources.

Specifications

Parameter	Value
Rating	
Voltage	120 V ac/dc
Mechanical Power	175 W
Full-Load Speed	1800 r/min
Full-Load Current	3 A
Physical Characteristics	
Dimensions (H x W x D)	308 x 287 x 420 mm (12.1 x 11.3 x 16.5 in)
Net Weight	14.4 kg (31.7 lb)

Resistive Load 763359 (8311-00)



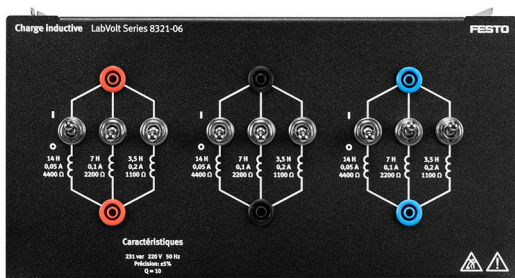
The Resistive Load consists of a module housing nine wire-wound power resistors arranged in three identical banks. Each bank consists of three resistors connected in parallel that can be switched on or off with toggle switches to obtain various resistance values. This allows the total (equivalent) resistance of each bank to be increased or decreased by steps. Six safety banana jacks on the module front panel provide access to each resistor bank. The three resistor banks can be connected separately for operation in three-phase circuits. Also, the three resistor banks can be connected together for operation in single-phase circuits.

The Resistive Load is commonly used in conjunction with other basic load modules, like the Inductive Load and the Capacitive Load to experiment with the effects of different types of loads on a circuit.

Specifications

Parameter	Value
Resistors	
Quantity	Three identical banks of three resistors
Resistance Values (Each Group)	300/600/1200 Ω
Nominal Voltage	120 V ac/dc
Resistance Value Accuracy	$\pm 5\%$
Load at Nominal Voltage (Each Bank)	
Power	12-84 W
Current	0.1-0.7 A
Steps	Seven, of equal increment
Current Increment	0.1 A
Physical Characteristics	
Dimensions (H x W x D)	154 x 287 x 410 mm (6.1 x 11.3 x 16.1 in)
Net Weight	4.5 kg (9.9 lb)
Color	
Front panel color	Black

Inductive Load 763362 (8321-00)



The Inductive Load consists of a module housing nine iron-core power inductors arranged in three identical banks. Each bank consists of three inductors connected in parallel that can be switched on or off with toggle switches to obtain various inductance values. This allows the equivalent inductance of each bank to be increased or decreased by steps. Six safety banana jacks on the module front panel provide access to each inductor bank. The three inductor banks can be connected separately for operation in three-phase circuits. Also, the three inductor banks

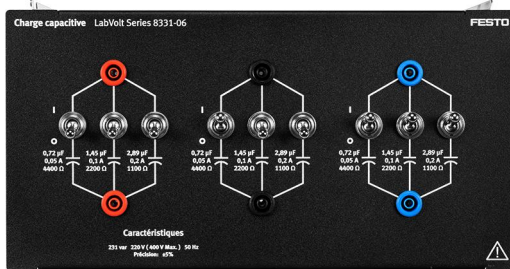
can be connected together for operation in single-phase circuits.

The Inductive Load is commonly used in conjunction with other basic load modules, like the Resistive Load and the Capacitive Load to experiment with the effects of different types of loads on a circuit.

Specifications

Parameter	Value
Inductors	
Quantity	Three identical banks of three inductors
Inductance Values (Each Bank)	0.8/1.6/3.2 H
Reactance Values (Each Bank)	300/600/1200 Ω
Nominal Voltage	120 V – 60 Hz
Inductance Value Accuracy	$\pm 5\%$
Load at Nominal Voltage (Each Bank)	
Reactive Power	12-84 var
Current	0.1-0.7 A
Steps	Seven, of equal increment
Current Increment	0.1 A
Physical Characteristics	
Dimensions (H x W x D)	154 x 287 x 410 mm (6.1 x 11.3 x 16.1 in)
Net Weight	10.1 kg (22.3 lb)

Capacitive Load 763366 (8331-00)



The Capacitive Load consists of a module housing nine capacitors arranged in three identical banks. Each bank consists of three capacitors connected in parallel that can be switched on or off with toggle switches to obtain various capacitance values. This allows the equivalent capacitance of each bank to be increased or decreased by steps. Six safety banana jacks on the module front panel provide access to each capacitor bank. The three capacitor banks can be connected separately for operation in three-phase circuits. Also, the three capacitor banks can be

connected together for operation in single-phase circuits.

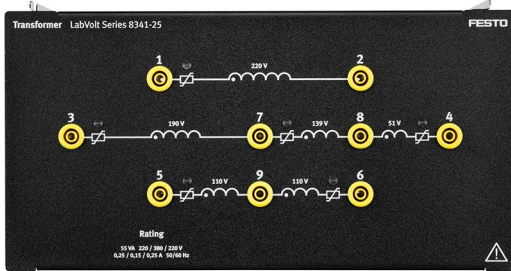
A permanently connected discharge resistor reduces the voltage across the terminals of each bank of capacitors to 5% of the applied voltage within 25 seconds after the load is disconnected from the supply. The Capacitive Load may be used with both dc and ac power.

The Capacitive Load is commonly used in conjunction with the other basic load modules, the Resistive Load and the Inductive Load to experiment with the effects of different types of loads on a circuit.

Specifications

Parameter	Value
Capacitors	
Quantity	Three identical banks of three capacitors
Capacitance Values (Each Bank)	2.2/4.4/8.8 μF
Reactance Values (Each Bank)	300/600/1200 Ω
Nominal Voltage	120 V – 60 Hz
Maximum Voltage	230 V
Capacitance Value Accuracy	$\pm 5\%$
Load at Nominal Voltage (Each Bank)	
Reactive Power	12-84 var
Current	0.1-0.7 A
Steps	Seven, of equal increment
Current Increment	0.1 A
Physical Characteristics	
Dimensions (H x W x D)	154 x 287 x 410 mm (6.1 x 11.3 x 16.1 in)
Net Weight	5.7 kg (12.6 lb)

Fully Protected Transformer 763419 (8341-20)



The Fully Protected Transformer is fitted with three discrete windings. Any winding can be used as either a primary or a secondary, which increases the number of laboratory applications. Due to its numerous taps, the Fully Protected Transformer can be used with many different input and output voltages. For this reason, it can be used for impedance matching and other transformer experiments. By using multiple Fully Protected Transformers, students can explore transformer phasing, distribution transformers, open- and closed-delta

transformer configurations, delta-wye, wye-delta, wye-wye, and delta-delta connections. Other specialized transformer connections, such as Scott (three-phase to two-phase), three-phase to six-phase, and zig-zag connections are also possible. Furthermore, resettable fuses are used to protect the windings.

The Fully Protected Transformer is mounted in a half-size EMS module. The primaries and secondaries are terminated on the module faceplate to 4 mm color-coded safety sockets and are identified by schematic symbol, terminal number, voltage and current.

Specifications

Parameter	Value
Rating (Coil 1)	
Voltage	120 V ac
Current	0.5 A
Rating (Coil 2)	
Voltage	208 V ac
Current	0.3 A
Taps	50% and 86.6%
Rating (Coil 3)	
Voltage	120 V ac
Current	0.5 A
Tap	50%
Circuit-Protection Type	6 resettable fuses
Physical Characteristics	
Dimensions (H x W x D)	154 x 287 x 410 mm (6.1 x 11.3 x 16.1 in)
Net Weight	6.5 kg (14.3 lb)

DC Voltmeter/Ammeter 581397 (8412-00)



The DC Voltmeter/Ammeter module is an EMS metering module. It is fitted with one dc voltmeter, one dc milliammeter, and one dc ammeter. Meter ranges and scalar values of each instrument have been carefully selected for compatibility and are appropriate for the electrical values to be measured. All meter readings are direct indications and do not require the indicated value to be mentally multiplied by a constant.

All meters are diode-protected against burnout, should the students miswire a meter by range or function. This permits the greatest latitude of student involvement without fear of damaging equipment. All meters are terminated by 4 mm color-coded safety sockets.

Specifications

Parameter	Value
Voltmeter Ranges	
Low	0-20 V
High	200 V
Milliammeter Range	0-500 mA
Ammeter Ranges	
Low	0-2.5 A
High	5 A
Accuracy	2%
Type of Instrument	Panel meter - 65 mm (2.5 in)
Type of Movement	d'Arsonval
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	3.5 kg (7.7 lb)
Shipping Weight	5.1 kg (11.2 lb)

AC Ammeter 581406 (8425-00)



The AC Ammeter module is fitted with three separate multi-range ac ammeters for simultaneous measurement of three-phase currents. Two of the three meters have identical ranges while the third instrument has one additional higher range for measurement of the starting current of single-phase motors. Meter ranges and scalar values of each instrument have been carefully selected for compatibility and are appropriate for the electrical values to be measured. All meter readings are direct indications and do not require the indicated value to be mentally multiplied by a constant.

All meters are diode-protected against burnout, should the students miswire a meter by range or function. This permits the greatest latitude of student involvement without fear of damaging equipment. All meters are terminated by 4 mm color-coded safety sockets.

Specifications

Parameter	Value
Ammeter Ranges	
High (Two Meters)	0-0.5 A / 2.5 A / 8 A
Low (One Meter)	0-0.5 A / 2.5 A / 8 A / 25 A
Accuracy	3%
Type of Instrument	Panel meter - 65 mm (2.5 in)
Type of Movement	Moving vane and current transformer
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	4.8 kg (10.6 lb)
Shipping Weight	6.4 kg (14.1 lb)

AC Voltmeter 581413 (8426-00)



The AC Voltmeter module is fitted with three separate multi-range ac voltmeters for simultaneous measurement of three-phase voltages. Meter ranges and scalar values of each instrument have been carefully selected for compatibility and are appropriate for the electrical values to be measured. All meter readings are direct indications and do not require the indicated value to be mentally multiplied by a constant.

All meters are diode-protected against burnout, should the students miswire a meter by range or function. This permits the greatest latitude of student involvement without fear of damaging equipment. All meters are terminated by 4 mm color-

coded safety sockets.

Specifications

Parameter	Value
Voltmeter Ranges	
Low	0-100 V ac
High	250 V ac
Accuracy	2%
Type of Instrument	Panel meter - 65 mm (2.5 in)
Type of Movement	d'Arsonval, 1000 Ω /V, and rectifier current
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	3.6 kg (7.9 lb)
Shipping Weight	5.2 kg (11.4 lb)

Single-Phase Wattmeter 586514 (8431-20)



The Single-Phase Wattmeter is used to indicate active power in single-phase circuits. Its electronic design uses voltage and current sensors to sample line voltage and current. Voltage and current circuits are internally connected so that students only have to connect the “line” and “load” terminals of the module.

Specifications

Parameter	Value
Rating	
Range	0-750 W
Maximum Voltage	150 V
Maximum Current	10 A
AC Power Input	24 V
Accuracy	2%
Type of Instrument	Panel Type – 100 mm (4 in)
Type of Movement	d'Arsonval

Parameter	Value
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	Net: 3.6 kg (7.9 lb)

Three-Phase Wattmeter 586521 (8441-20)



The Three-Phase Wattmeter module is fitted with two separate wattmeters, each of which is equipped with a polarity switch. Its electronic design uses voltage and current sensors to sample line voltage and current. Voltage and current circuits are internally connected so that students only have to connect the “line” and “load” terminals of the module. The three-phase active power is the algebraic sum of the two meter indications. When used independently, each meter will indicate active power in single-phase circuits.

Specifications

Parameter	Value
Rating	
Range (2 Meters)	0-300 W
Maximum Voltage	300 V
Maximum Current	2 A
AC Power Input	24 V
Accuracy	2%
Type of Instrument	Panel Type – 100 mm (4 in)
Type of Movement	d'Arsonval
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	3.9 kg (8.6 lb)

Synchronizing Module 586738 (8621-00)



The Synchronizing Module is a power control device enclosed in a half-size EMS module. The Synchronizing Module is mainly used to synchronize two ac generators. It can also be used to determine the phase sequence in three-phase circuits. The synchronizing Module has three indicator lamps indicating the relative voltage difference between two circuits. The brightness of the indicator lamps increases with the voltage difference between the two circuits. The Synchronizing Module has a three-phase switch mounted on the module front panel. This three-phase switch is a triple-pole, single-throw switch. Each phase

leg of the three-phase switch is protected against overcurrents and short-circuits by a thermal-magnetic circuit breaker.

Specifications

Parameter	Value
Rating	
Each Phase	240 V – 2 A ac
Light Bulbs	130 V – 2.6 W – BA9S
Circuit Breakers	2 A

Parameter	Value
Physical Characteristics	
Dimensions (H x W x D)	154 x 287 x 410 mm (6.1 x 11.3 x 16.1 in)
Net Weight	3.6 kg (7.9 lb)

Manual DC Motor Starter 586745 (8631-00)



The Manual DC Motor Starter can be wired as either a three or four point dc starter to be used in conjunction with the DC Motor/Generator, Model 8211. The module has a fitted, manually operated handle for variable resistance starting. When it is in the full-run position, the handle is held in place by an electromagnet. In the event of field loss, the holding electromagnet is de-energized and the starting handle is returned to the off position by a stiff spring.

Specifications

Parameter	Value
Rating	
Motor Power	0.2 kW
Line Voltage	120 V dc
Armature Starting Current	3 A
Full Load Current	3 A
Maximum Field Current	0.4 A
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	5.9 kg (13 lb)
Shipping Weight	7.5 kg (16.5 lb)

Synchronous Motor Starter 586751 (8641-00)



The Synchronous Motor Starter is designed to start the Three-Phase Synchronous Motor/Generator directly from the ac power network. The module consists of a three-pole magnetic contactor and a built-in dc power source which applies dc voltage to the field winding when the rotor speed reaches approximately 90% of the machine synchronous speed. A pilot lamp indicates that the motor is synchronized with the ac power network when dc voltage is applied to the machine. Industrial push-button controls are mounted on the front panel of the module. The I button must be depressed and held until the Motor Synchronized indicator lights up (releasing the I push-

button before the machine is synchronized prevents three-phase ac current from flowing into the synchronous machine). The Synchronous Motor Starter contains an overload protection to prevent damage to the machine. Connections are made through 4 mm color-coded jacks.

Specifications

Parameter	Value
Rating	
Motor Power	0.2 kW
Line Voltage	208 V ac, 3-Phase
Full Load Current	1 A
Maximum Field Current	0.8 A
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	5.8 kg (12.8 lb)
Shipping Weight	7.4 kg (16.3 lb)

Three-Phase Full-Voltage Starter 586758 (8651-00)



The Three-Phase Full-Voltage Starter is designed to start the Four-Pole Squirrel-Cage Induction Motor and Three-Phase Wound-Rotor Induction Motor directly from the ac power network. The module consists of a three-pole magnetic contactor with a variable overload relay. The components are interconnected to the line and load terminals. A power-on pilot lamp and I and O push-buttons are also mounted on the module faceplate. The auxiliary contacts of the main contactor can be accessed for use as an interlock in control circuits. Connections are made through 4 mm color-coded jacks.

Specifications

Parameter	Value
Rating	
Motor Power	0.2 kW
Line Voltage	208 V ac, 3-Phase
Full Load Current	1.1 A
Reduced Voltage Starting Time	20 s
Physical Characteristics	
Dimensions (H x W x D)	156 x 287 x 440 mm (6.1 x 11.3 x 17.3 in)
Net Weight	4.4 kg (9.7 lb)
Shipping Weight	6 kg (13.2 lb)

Three-Phase Rheostat 586786 (8731-00)



The Three-Phase Rheostat module consists of three rheostats mounted on a common shaft directly controlled by a single knob on the module faceplate. The rheostats are electrically interconnected in a four-wire wye configuration and each leg is protected from over-current conditions by a thermal-magnetic circuit breaker.

The module is mainly used for speed control of a Three-Phase Wound-Rotor Induction Motor., Model 8231. This module can also be used for other applications where a variable power resistor is needed.

Specifications

Parameter	Value
Rating	
Resistance (line-neutral)	16 Ω
Total Power	192 W
Maximum Current (per phase)	2 A
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	4.9 kg (10.8 lb)
Shipping Weight	6.5 kg (14.3 lb)

Variable Three-Phase Power Supply 579603 (8821-20)



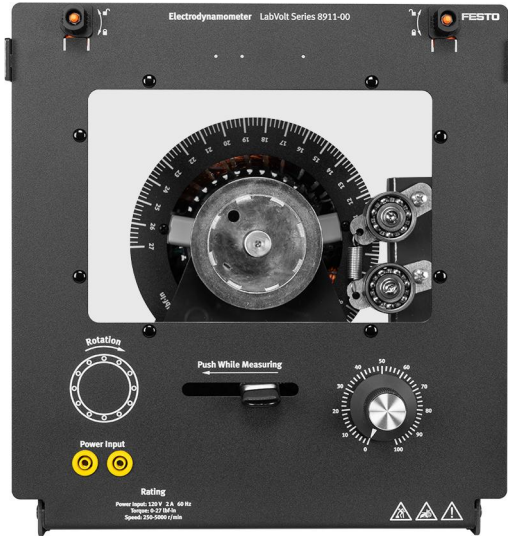
The Power Supply is enclosed in a full-size EMS module. It can be used to power most of the EMS modules of the Electricity and New Energy Training Equipment. This Power Supply provides dc power and ac power, both fixed and variable, single-phase and three-phase. Color-coded safety banana jacks provide access to all the power sources in the Power Supply. All these power sources can be used simultaneously, provided that the total current drawn does not exceed the maximum current rating. A built-in voltmeter with selector switch and liquid crystal display (LCD) indicates the voltage provided by any of the power sources. The input and outputs of the Power Supply are protected by independent circuit breakers.

Specifications

Parameter	Value
Module Requirements	
AC Power Network Installation	3 phases (120/208 V – 60 Hz), star (wye) configuration including neutral and ground wires, protected by a 20 A circuit breaker
AC Power Network Connector	NEMA L21-20
Maximum Current	15 A
Outputs (*see note)	
Three-Phase Fixed AC	120/208 V – 15 A - 60 Hz
Three-Phase Variable AC	0-120/208 V – 5 A - 60 Hz
Variable DC	0-120 V – 8 A (three-phase half-wave rectified without filtering capacitor)
Fixed DC	120 V – 2 A (three-phase half-wave rectified with 94 μ F capacitor)
Low Power AC	24 V – 3 A - 60 Hz
Included Accessories	
	3 m (10 ft) AC power cord (1)
	Padlock (1)
Physical Characteristics	
Dimensions (H x W x D)	308 x 287 x 495 mm (12.1 x 11.3 x 19.5 in)
Net Weight	18.4 kg (40.5 lb)
*Note	The Power Supply cannot supply all the amounts of current indicated by the current ratings on its front panel at the same time. The current indicated for the fixed ac three-phase output section can only be obtained if no current is drawn from any other section, because this section is protected by the main circuit breaker common to every section. If currents flow in other sections, the available current for the fixed ac three-phase output section decreases. The variable ac output section and the variable dc output section are protected by a common set of circuit breakers placed after the fixed ac three-phase output section, which means that the current capacity has

Parameter	Value
	to be shared between the two sections. For instance, if current of the variable dc output section is at 70% of its nominal value, current drawn from the variable ac output section should not exceed 30% of its nominal value. The fixed dc output section is also protected by circuit breakers placed after the fixed ac three-phase output section.

Electrodynamometer, Imperial Units 586856 (8911-00)



The Electrodynamometer is made of a squirrel-cage rotor fitted in a dc-excited stator. Mechanical loading is achieved by increasing the stator field current, which generates eddy currents in the driven rotor. The stator is trunnion-mounted on ball bearings and rotates against a helicoidal spring to oppose braking torque.

The front-end bell is provided with a circular scale that indicates the torque developed. The circular scale is graduated in Imperial units (lb·in). A damper lever is located underneath the dynamometer to prevent oscillation if the power supply is applied while the dynamometer is turning. To measure the torque, this lever can be pushed to adjust and read the torque. The Electrodynamometer is electrically powered from standard fixed ac line supply.

The Electrodynamometer can be coupled to a 0.2 kW drive motor through the use of the Timing Belt, Model 8942. The faceplate can be lowered to provide access to the inside for coupling the Electrodynamometer to the drive motor. When closed, the faceplate is secured by two quick-lock fasteners.

A variant of the model expressing values in the International System of Units (SI) is also available (see Model 8911-1).

Specifications

Parameter	Value
Rating	
Torque Range (8911)	-3 to +27 lbf·in
Speed	250 to 3000 r/min
Accuracy	2%
Input Voltage	120 V – AC
Input Current	2 A
Physical Characteristics	
Dimensions (H x W x D)	308 x 291 x 490 mm (12.1 x 11.5 x 19.3 in)
Net Weight	17.4 kg (38.3 lb)

Digital Tachometer 581427 (8920-40)



The Digital Tachometer indicates motor rotation speed either in a clockwise or counterclockwise direction. The measured speed is automatically indicated on a five-digit display and is updated every second to enable measurement of acceleration and deceleration.

Coupling to the shaft of a motor is accomplished through a rubber tip attached to the Digital Tachometer. The optical sensor can also be used with a reflective tape to read motor speed. Designed to fit comfortably in either the right or left hand, the tachometer is constructed to withstand years of rugged use.

Specifications

Parameter	Value
Direction of Rotation	CW and CCW
Speed Range	0.5-19 999 r/min (Contact Tacho) / 5-99999 r/min (Photo Tacho)
Accuracy	0.05% + 1 digit
Resolution (up to 999.9 r/min)	0.1 r/min
Resolution (1000 r/min and above)	1 r/min
Sampling Time	1 s (for speeds > 60 r/min)
Display	5 digits
Memory Hold Time	5 minutes after measurement
Power	Four 1.5 V AA cells
Accessories Included	Rubber contact tip, rubber contact ring, instruction manual, storage case, reflective tape, and batteries
Physical Characteristics	
Dimensions (H x W x D)	80 x 250 x 120 mm (3.1 x 9.8 x 4.7 in)
Net Weight	0.61 kg (1.34 lb)

Timing Belt 579637 (8942-00)



The Timing Belt is a high-quality industrial synchro-cog timing belt made of rubber whose teeth exactly mesh with the geared pulley fitted on the shaft of all 0.2 kW EMS machines. The Timing Belt is supplied in a fixed length appropriate for coupling two adjacent EMS machines together without slippage between them.

Specifications

Parameter	Value
Physical Characteristics	
Pitch	9.5 mm (0.375 in)
Pitch Length	819 mm (32.25 in)
Number of Teeth	86
Dimensions (Width)	12.7 mm (0.5 in)
Net Weight	0.1 kg (0.2 lb)

Digital Multimeter 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	
Range	0-10 A ac/dc
Resistance	
Range	0-40 M Ω
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 581428 (8951-00)

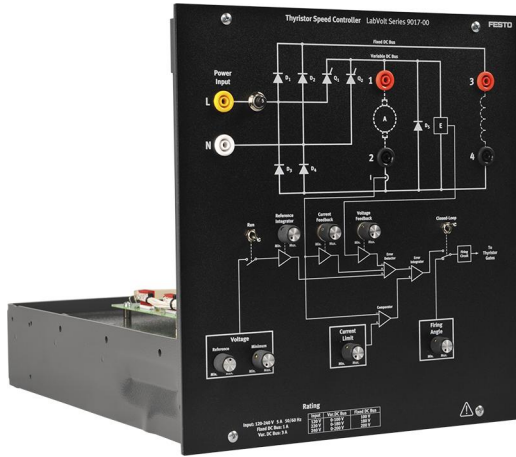
This Connection Lead Set consists of extra-flexible leads terminated with stacking 4 mm safety banana plugs. The leads are supplied in different lengths and are color-coded according to length.

4mm: 10 x 30 cm yellow, 15 x 60 cm red, 6 x 90 cm blue.

Specifications

Parameter	Value
4 mm Safety Banana Plug Leads Characteristics	
Cross Section	1 mm ² (1974 cmil)
Rated Current	19 A
Rated Voltage	600 V, CAT II
4 mm Safety Banana Plug Leads Quantities	
Yellow, 30 cm (12 in)	10
Red, 60 cm (24 in)	15
Blue, 90 cm (36 in)	6

Thyristor Speed Controller 587007 (9017-00)



The Thyristor Speed Controller is designed to control the speed of the DC Motor/Generator in both the open-loop and closed-loop modes of control.

The Thyristor Speed Controller module contains a thyristor single-phase bridge rectifier installed in a full-height EMS module. Speed control of the dc motor is achieved by varying the firing angle of the thyristors. In the open-loop mode of control, the firing angle is set manually using a potentiometer, while, in the closed-loop mode, it is set by a controller which compares the motor armature voltage to a voltage reference set by the user. The mode of control is selectable using a toggle switch. Other parameters that can be controlled using the Thyristor Speed Controller include ramp control, IR compensation, and current limit. These controls are accessible directly on the faceplate of the module.

These controls are accessible directly on the faceplate of the module.

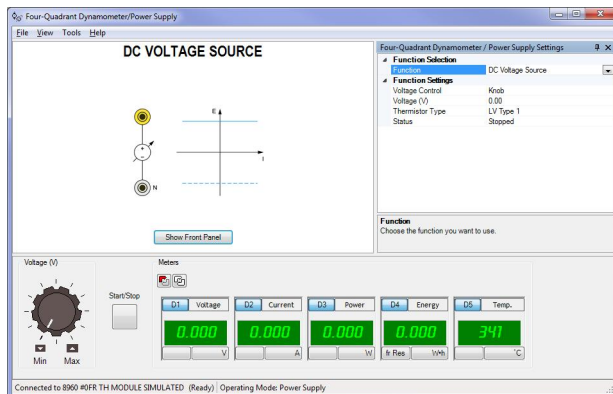
Schematic symbols and their electrical interconnections are silk-screened on the faceplate of the module. Components are terminated by 4 mm color-coded safety sockets where student access is required.

Specifications

Parameter	Value
Power Requirements	120-240 V – 5 A – 50/60 Hz
Variable DC Bus	
Voltage	0-100 V
Current	3 A
Fixed DC Bus	
Voltage	100 V
Current	1 A
Physical Characteristics	
Dimensions (H x W x D)	308 x 287 x 450 mm (12.1 x 11.3 x 17.7 in)
Net Weight	5 kg (2.2 lb)

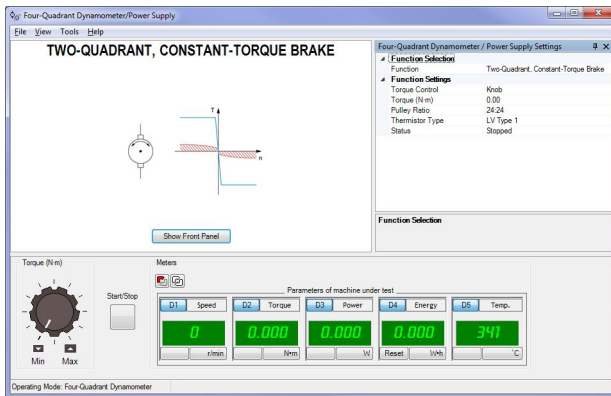
Optional Equipment Description

Complete Function Set (Optional) 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 (Optional) 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

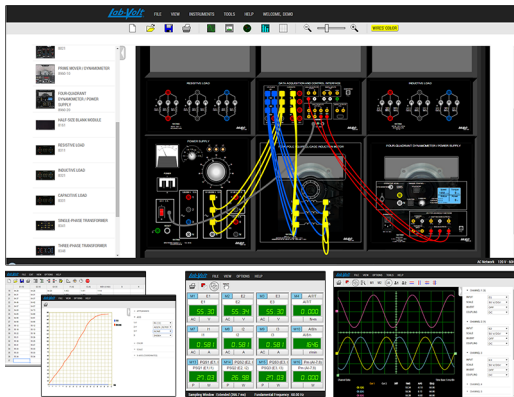
Specifications

Parameter	Value
Control Functions	
Control Functions	Two-Quadrant, Constant-Torque Brake

Parameter	Value
	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·m ² (0.119-23.73 lb·ft ²)
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	

Parameter	Value
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

Electromechanical Systems Simulation Software (LVSIM[®]-EMS) - 1 User Online, 1 year (Optional) 586971 (8972-00)



The Electromechanical Systems Simulation Software (LVSIM[®]-EMS) is a simulation software that covers the same courseware as the following systems:

Computer-Assisted 0.2 kW Electromechanical Training System, Model 8006-1

DC and AC Power Circuits Training System, Model 8010-1
Electromechanical Training System, Model 8010-9

AC Power Transmission Training System, Model 8010-B

All workbooks parts of the systems above are available in the navigation menu of LVSIM-EMS for online consultation. To obtain the printing rights, Campus Licenses for each are

available and must be ordered separately.

With LVSIM-EMS, all the standard EMS laboratory equipment is replaced by images of the actual EMS modules that students can manipulate on the computer screen. Students can identify and set up equipment for a given exercise, make the necessary connections between the virtual EMS modules, and verify the connections made without the need for actual EMS equipment.

Sophisticated mathematical models fully simulate the electrical and mechanical characteristics of all the actual EMS modules: power supplies, motors, generators, transformers, electrical and mechanical loads, etc. All modules simulated in the LVSIM-EMS software feature the same front panel information as the actual EMS modules. Short-circuit connections in the virtual equipment setup cause the virtual circuit-breaker protection to trip. This trip condition is clearly indicated on the virtual EMS modules.

Used either as a complement to the actual EMS laboratory equipment, or as a stand-alone product, LVSIM-EMS is a cost-effective tool that enables students to perform the same exercises as in the courseware of the above-mentioned training systems. When used as a stand-alone package, the LVSIM-EMS software allows students to perform hands-on activities related to electrical power and machines, including active, reactive, and apparent power, phasors, ac/dc motors and generators, three-phase circuits, and transformers.

LVSIM-EMS is a web-browser based application **available in three different configurations**. The simulation software can either be installed locally on a Windows[®] personal computer (local version), on a Windows server (network version), or accessed directly online through the labvolt.com website at lvsim.labvolt.com (online

version). Both network and local versions are delivered with perpetual license for the current version. The online version is delivered as a annual license with possibility to expand for more years.

Please visit <https://lvsim.labvolt.com> and try the online version!

Virtual Instrumentation

LVSIM-EMS comprises a set of conventional and specialized instruments that can be used for measuring, observing, and analyzing electrical and mechanical parameters in electric power systems and power electronic circuits. Each instrument appears as a window on the computer screen. The conventional instruments include ac/dc voltmeters and ammeters, power meters, and an eight-channel oscilloscope. The specialized instruments include a six-channel phasor analyzer, a harmonic analyzer, torque, speed, and mechanical power meters, and user-programmable meters. The software is also provided with data-recording and graph-plotting capabilities. The various instruments are briefly described in the next section of this datasheet.

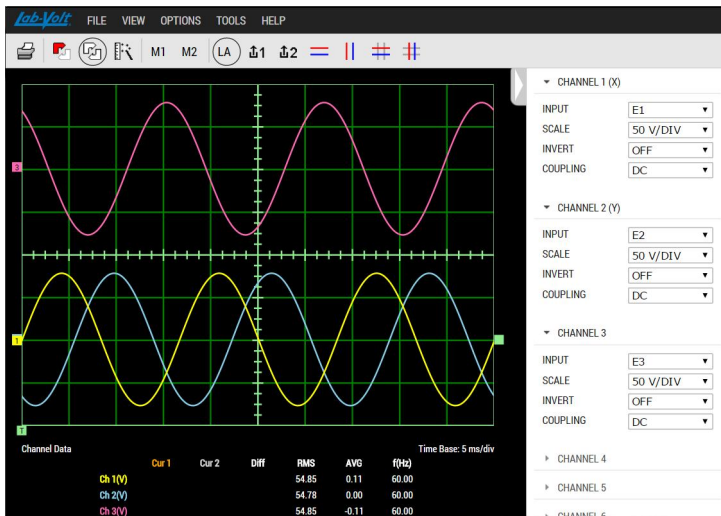
Metering Window



The Metering window displays up to eighteen meters, which can be configured individually for measuring ac/dc voltage and current, electrical power (active, reactive, and apparent), torque, speed, mechanical power, etc. The voltage and current meters have several modes of operation that allow measurement of the mean (dc) value, RMS value, crest factor, RMS value of a particular harmonic (up to the 15th

value), RMS value of the harmonics, and total harmonic distortion (THD). Six of the eighteen meters are user-programmable and give access to a larger variety of functions for measurement of power factor, efficiency, impedance, frequency, energy, phase shift, etc. The layout of the meters in the Metering window is user-customizable.

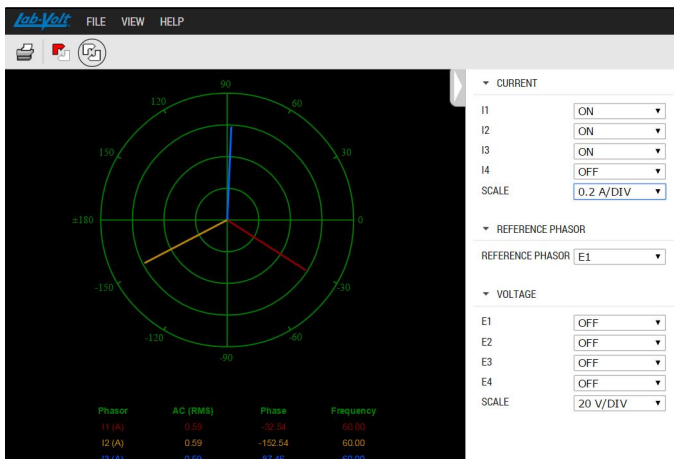
Oscilloscope



The Oscilloscope displays up to eight waveforms simultaneously, each of a different color for easy identification. Each channel has independent vertical controls similar to those found on conventional oscilloscopes. An automatic scale-setting function allows the sensitivity of each channel to be set automatically according to the magnitude of the observed parameter. The time base and trigger controls are similar to those found on most oscilloscopes. The RMS value, average value, and frequency of each observed parameter can be displayed

in the Oscilloscope window. Two vertical cursors can be activated to perform precise measurements at particular points on the displayed waveforms. The Oscilloscope toolbar includes two memory buttons for saving displayed waveforms.

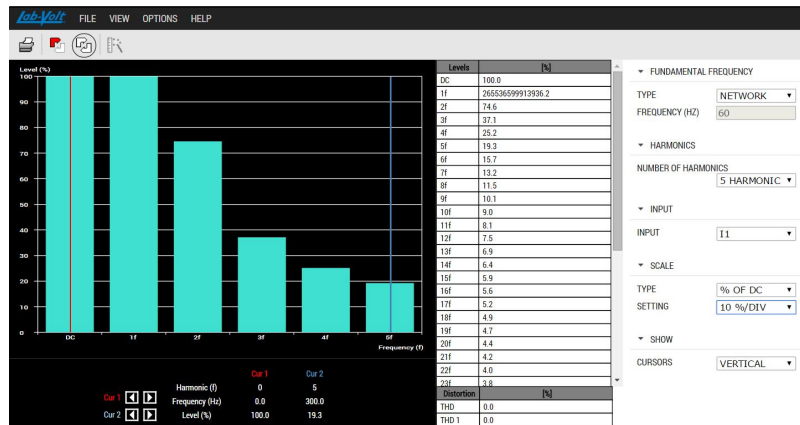
Phasor Analyzer



The Phasor Analyzer displays the phasors related to the measured voltages and currents. The amplitude and phase angle of each voltage and current is clearly represented by the orientation and length of their corresponding phasors, allowing easy comparison between the displayed parameters. This produces a unique and dynamic display of the voltages and currents in a circuit (especially in three-phase circuits) that cannot be obtained with conventional

instruments. The RMS value, phase angle, and frequency of the voltage or current related to each phasor is displayed in the Phasor Analyzer window.

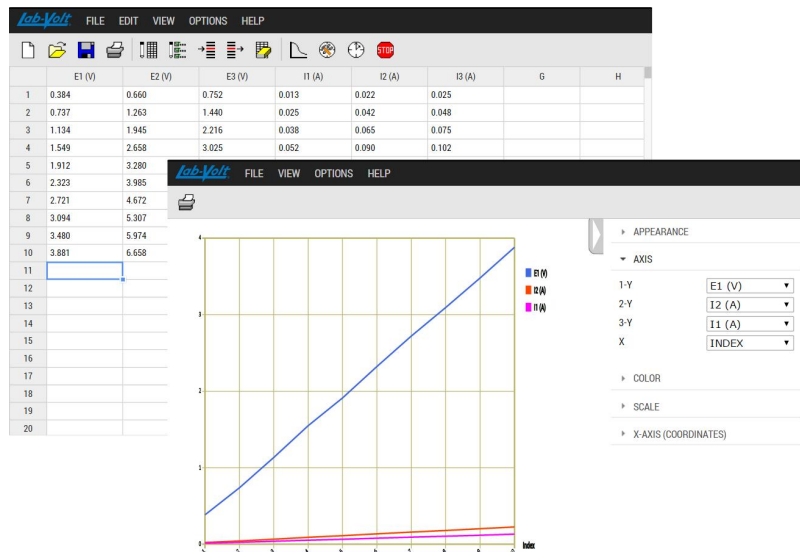
Harmonic Analyzer



The Harmonic Analyzer allows observation and analysis of the harmonic components in the measured voltages and currents. The fundamental frequency can be manually set to the ac power network frequency or automatically set to the frequency of the fundamental component of the selected voltage or current. The harmonic components of the selected voltage or current can be displayed using a vertical scale

graduated in either absolute or relative values. A group of data displays in the Harmonic Analyzer indicates the values of the dc component of the selected voltage or current, as well as the total harmonic distortion (THD). Vertical and horizontal cursors can be displayed to perform precise measurements at particular points on the display. Since the equipment simulated by LVSIM-EMS produces only dc and sinusoidal ac signals (without harmonics), the Harmonic Analyzer, which is intended for use with devices that produce harmonics, is not often used with LVSIM-EMS.

Data Table and Graph Windows



The values indicated by the various meters in the Metering window, as well as values measured by the other instruments, can be recorded in the Data Table window with a click of the mouse. The values recorded in the Data Table can be saved to a file (ASCII-formatted file). The recorded data can also be used to plot graphs by selecting which parameter(s) to plot in the Graph window. This allows lab results to be plotted quickly and easily. More sophisticated graphs can be created by exporting the contents of the Data Table window to any spreadsheet program, such as

Microsoft Excel[®], directly through the Windows Clipboard.

Software Protection and Licensing

The local and network version provides a perpetual licence and the online access version provides a annual licence (additional years can be purchased when ordering).

The local and network version of LVSIM-EMS are copy-protected by means of a hardlock security device. When LVSIM-EMS detects the security device, students have complete access to all measuring functions of the virtual instruments and other protected features of LVSIM-EMS, as well as to the student manuals included with the simulation software. Note that students are allowed to copy the software onto their personal computer to allow them to prepare laboratories in advance.

Two different security devices are available for LVSIM-EMS: a single-user hardlock key, which can be inserted in the USB port of the user's computer, and a multiple-user hardlock key, which can be inserted in the USB port of the network server or any computer in the same network. Once the hardlock key is active on the network, the other computer will see the available licences. Alternately, the multiple-user hardlock key can be inserted in a USB port inside the server using a circuit board with edge-type connector (provided with the key) that can be installed in a PCI expansion slot of the server.

The multiple-user hardlock key can be installed in servers running under one of the following Microsoft® operating systems: Windows 7, Windows 8, Windows 10, Windows 2008 Server, and Windows 2013 Server. As its name indicates, the multiple-user hardlock key allows several users of a network to run LVSIM-EMS simultaneously. Different versions of LVSIM-EMS are available, each allowing a particular number of users.

Online Edition

The online version of LVSIM-EMS is accessible directly via the internet, and requires no software installation nor any update since the latest version of the software is always available. The online version of LVSIM-EMS also includes a demo mode that allows students to prepare laboratories in advance by familiarizing with the equipment and connections. The demo mode does not require any login.

Computer Requirements

Local and Network Versions:

- One (1) USB 2.0 port for the security dongle, Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8), basic dual core CPU, Google Chrome web browser installed (for better experience)

Online Version:

- Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8 but not fully compatible with mobile devices), basic dual core CPU, internet access (bandwidth usage of 50 KB/s maximum), Google Chrome web browser installed (for better experience)

List of Manuals

Description	Manual number
Electromechanical Systems Simulation Software (User Guide) _____	583879 (20858-E0)
Computer-Based Instruments for EMS (User Guide) _____	584396 (36221-E0)

Table of Contents of the Manual(s)

Electromechanical Systems Simulation Software (User Guide) (583879 (20858-E0))

- 1 Overview of LVSIM-EMS
- 2 Installing the Security Device
- 3 Installing and Running LVSIM-EMS

Computer-Based Instruments for EMS (User Guide) (584396 (36221-E0))

- 1 Familiarization with the Metering Window and the Data Table
- 2 Familiarization with the Oscilloscope
- 3 Familiarization with the Phasor Analyzer
- 4 Familiarization with the Harmonic Analyzer
- 5 Measuring Three-Phase Power Using the Metering Window

Topic Coverage

- Fundamentals for Electric Power Technology
- Alternating Current
- Capacitors in AC Circuits
- Inductors in AC Circuits
- Power, Phasors, and Impedance in AC Circuits
- Three-Phase Circuits
- Special Transformer Connections
- Single- and three-Phase Transformers
- Fundamentals for Rotating Machines
- DC Motors and Generators
- Special Characteristics of DC Motors
- AC Induction and Synchronous Motors
- Three-Phase Synchronous Generators

Features & Benefits

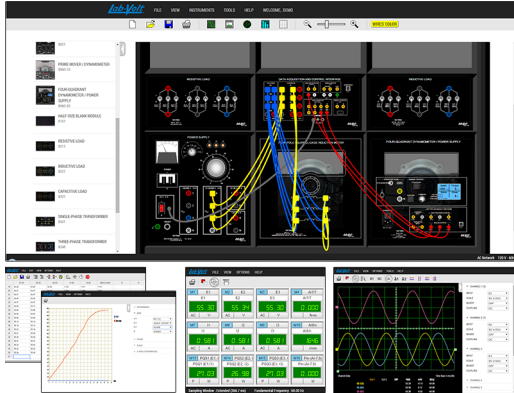
- Replicates the Electromechanical Training System, enabling students to perform actual experiments using virtual equipment
 - Install, move, and remove EMS modules in and from the workstation
 - Modify module connections at any time and change the color of wires
 - Install a timing belt between two EMS machines
 - Verify module connections using a tool that highlights all wires connected to a same circuit point
 - Perform measurements of voltage, current, power, speed, torque, impedance, resistance, reactance, and frequency and display the values on digital or analog meters
 - Record measurements in a data table and plot graphs using the recorded data
 - Display waveforms on a multi-channel oscilloscope and ac voltages and currents as phasors
- Students prepare for laboratories in advance using virtual equipment, thereby decreasing the time they require to perform the exercises using actual equipment
- Decreases the quantity of actual equipment required per student
- Allows students to practice with EMS equipment operation and connection at home on a personal computer

Specifications

Parameter	Value
Computer Requirements	

Parameter	Value
Local and Network versions	One (1) USB 2.0 port for the security dongle, Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8), basic dual core CPU, Google Chrome web browser installed (for better experience)
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Electromechanical Systems Simulation Software (LVSIM[®]-EMS) - 5 Users Online, 1 year (Optional) 586974 (8972-A0)



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Computer-Assisted 0.2 kW Electromechanical Training System, Model 8006-1

DC and AC Power Circuits Training System, Model 8010-1

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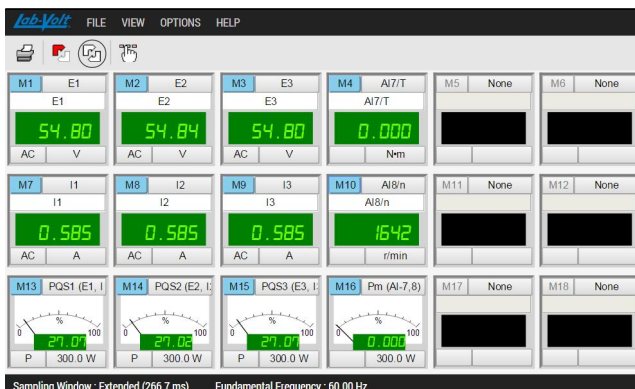
LVSIM-EMS is a web-browser based application **available in three different configurations**. The simulation software can either be installed locally on a Windows[®] personal computer (local version), on a Windows server (network version), or accessed directly online through the labvolt.com website at lvsim.labvolt.com (online version). Both network and local versions are delivered with perpetual license for the current version. The online version is delivered as an annual license with possibility to expand for more years.

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Virtual Instrumentation

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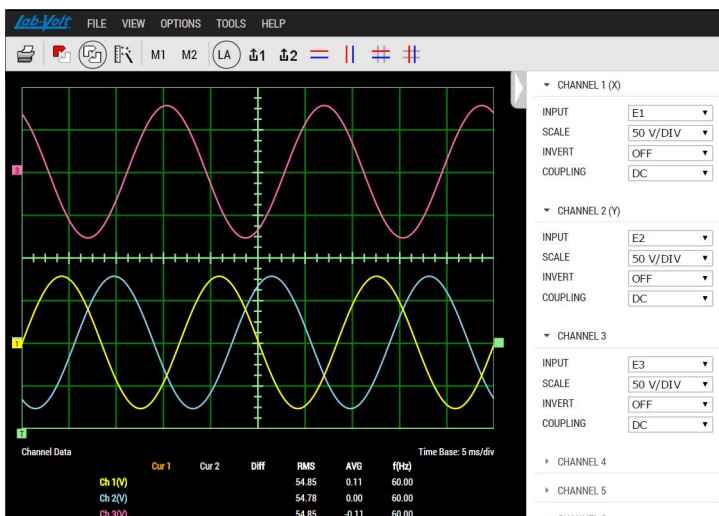
Metering Window



The Metering window displays up to eighteen meters, which can be configured individually for measuring ac/dc voltage and current, electrical power (active, reactive, and apparent), torque, speed, mechanical power, etc. The voltage and current meters have several modes of operation that allow measurement of the mean (dc) value, RMS value, crest factor, RMS value of a particular harmonic (up to the 15th

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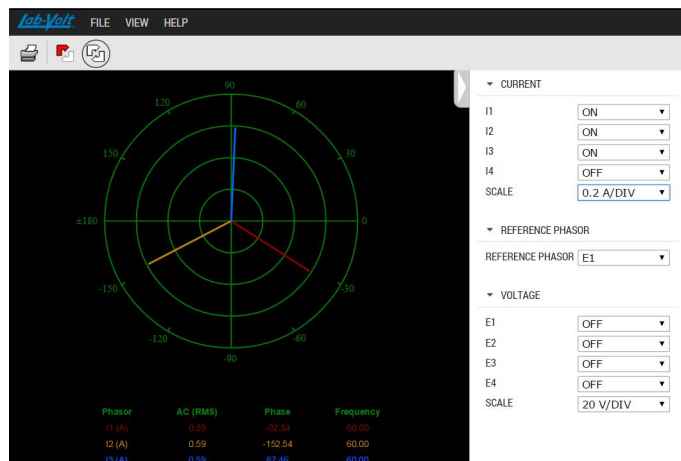
Oscilloscope



The Oscilloscope displays up to eight waveforms simultaneously, each of a different color for easy identification. Each channel has independent vertical controls similar to those found on conventional oscilloscopes. An automatic scale-setting function allows the sensitivity of each channel to be set automatically according to the magnitude of the observed parameter. The time base and trigger controls are similar to those found on most oscilloscopes. The RMS value, average value, and frequency of each observed parameter can be displayed

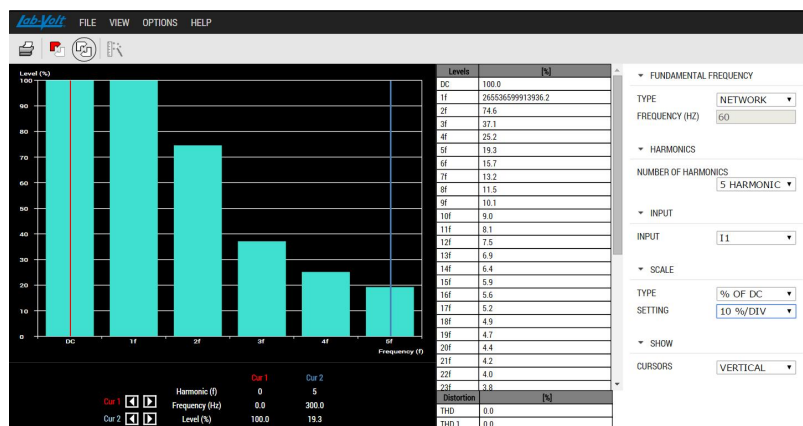
in the Oscilloscope window. Two vertical cursors can be activated to perform precise measurements at particular points on the displayed waveforms. The Oscilloscope toolbar includes two memory buttons for saving displayed waveforms.

Phasor Analyzer



The Phasor Analyzer displays the phasors related to the measured voltages and currents. The amplitude and phase angle of each voltage and current is clearly represented by the orientation and length of their corresponding phasors, allowing easy comparison between the displayed parameters. This produces a unique and dynamic display of the voltages and currents in a circuit (especially in three-phase circuits) that cannot be obtained with conventional instruments. The RMS value, phase angle, and frequency of the voltage or current related to each phasor is displayed in the Phasor Analyzer window.

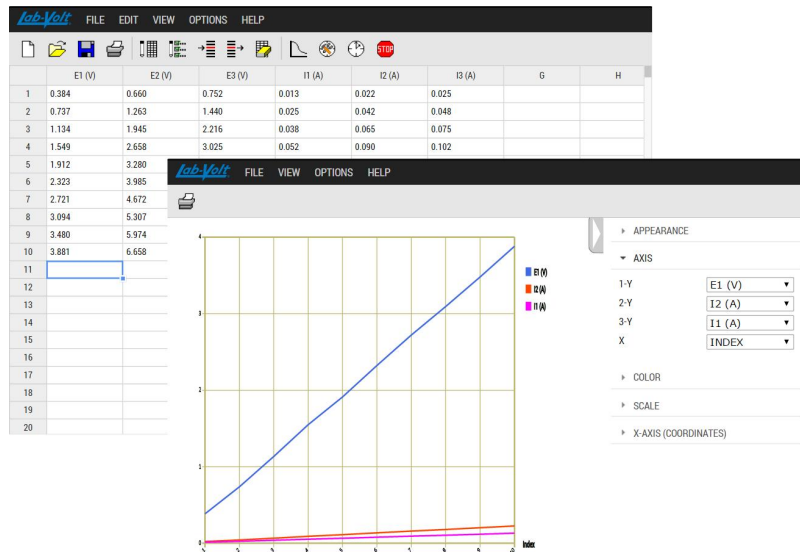
Harmonic Analyzer



The Harmonic Analyzer allows observation and analysis of the harmonic components in the measured voltages and currents. The fundamental frequency can be manually set to the ac power network frequency or automatically set to the frequency of the fundamental component of the selected voltage or current. The harmonic components of the selected voltage or current can be displayed using a vertical scale

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Data Table and Graph Windows



The values indicated by the various meters in the Metering window, as well as values measured by the other instruments, can be recorded in the Data Table window with a click of the mouse. The values recorded in the Data Table can be saved to a file (ASCII-formatted file). The recorded data can also be used to plot graphs by selecting which parameter(s) to plot in the Graph window. This allows lab results to be plotted quickly and easily. More sophisticated graphs can be created by exporting the contents of the Data Table window to any spreadsheet program, such as

Microsoft Excel[®], directly through the Windows Clipboard.

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Online Edition

The online version of LVSIM-EMS is accessible directly via the internet, and requires no software installation nor any update since the latest version of the software is always available. The online version of LVSIM-EMS also includes a demo mode that allows students to prepare laboratories in advance by familiarizing with the equipment and connections. The demo mode does not require any login.

Computer Requirements

Local and Network Versions:

- One (1) USB 2.0 port for the security dongle, Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8), basic dual core CPU, Google Chrome web browser installed (for better experience)

Online Version:

- Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8 but not fully compatible with mobile devices), basic dual core CPU, internet access (bandwidth usage of 50 KB/s maximum), Google Chrome web browser installed (for better experience)

List of Manuals

Description	Manual number
Electromechanical Systems Simulation Software (User Guide) _____	583879 (20858-E0)
Computer-Based Instruments for EMS (User Guide) _____	584396 (36221-E0)

Table of Contents of the Manual(s)

Electromechanical Systems Simulation Software (User Guide) (583879 (20858-E0))

- 1 Overview of LVSIM-EMS
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- 3 Installing and Running LVSIM-EMS

Computer-Based Instruments for EMS (User Guide) (584396 (36221-E0))

- 1 Familiarization with the Metering Window and the Data Table
- 2 Familiarization with the Oscilloscope
- 3 Familiarization with the Phasor Analyzer
- 4 Familiarization with the Harmonic Analyzer
- 5 Measuring Three-Phase Power Using the Metering Window

Topic Coverage

- Fundamentals for Electric Power Technology
- Alternating Current
- Capacitors in AC Circuits
- Inductors in AC Circuits
- Power, Phasors, and Impedance in AC Circuits
- Three-Phase Circuits
- Special Transformer Connections
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- DC Motors and Generators
- Special Characteristics of DC Motors
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- Three-Phase Synchronous Generators

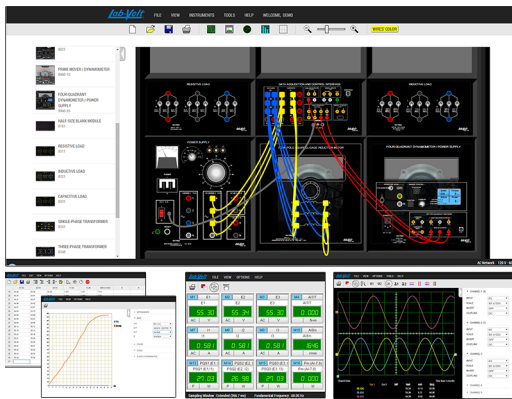
Features & Benefits

- Replicates the Electromechanical Training System, enabling students to perform actual experiments using virtual equipment
 - Install, move, and remove EMS modules in and from the workstation
 - Modify module connections at any time and change the color of wires
 - Install a timing belt between two EMS machines
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 - Record measurements in a data table and plot graphs using the recorded data
 - Display waveforms on a multi-channel oscilloscope and ac voltages and currents as phasors
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Electromechanical Systems Simulation Software (LVSIM[®]-EMS) - 10 Users Online, 1 year (Optional) 586977 (8972-B0)



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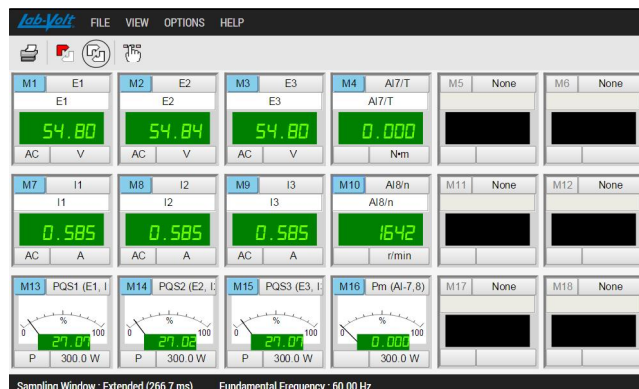
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Virtual Instrumentation

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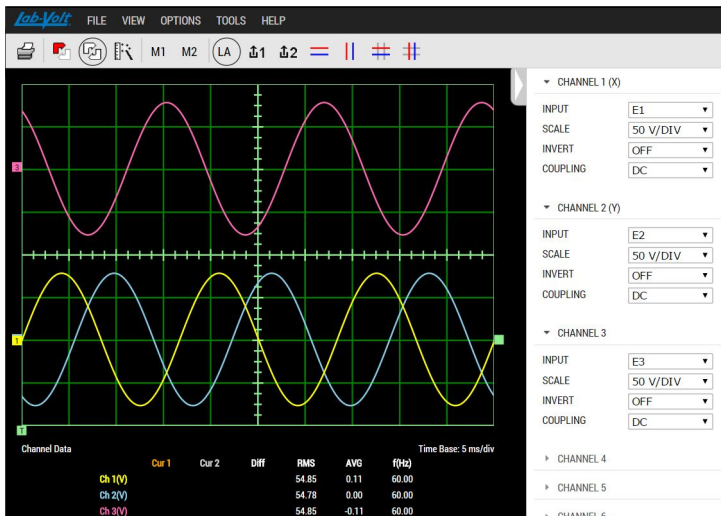
Metering Window



The Metering window displays up to eighteen meters, which can be configured individually for measuring ac/dc voltage and current, electrical power (active, reactive, and apparent), torque, speed, mechanical power, etc. The voltage and current meters have several modes of operation that allow measurement of the mean (dc) value, RMS value, crest factor, RMS value of a particular harmonic (up to the 15th

value), RMS value of the harmonics, and total harmonic distortion (THD). Six of the eighteen meters are user-programmable and give access to a larger variety of functions for measurement of power factor, efficiency, impedance, frequency, energy, phase shift, etc. The layout of the meters in the Metering window is user-customizable.

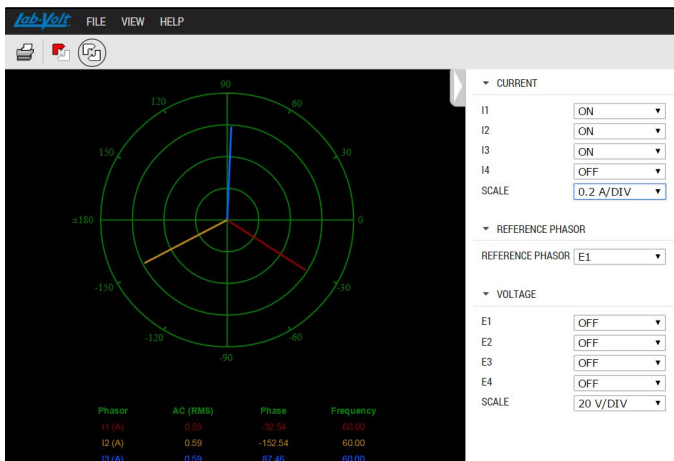
Oscilloscope



The Oscilloscope displays up to eight waveforms simultaneously, each of a different color for easy identification. Each channel has independent vertical controls similar to those found on conventional oscilloscopes. An automatic scale-setting function allows the sensitivity of each channel to be set automatically according to the magnitude of the observed parameter. The time base and trigger controls are similar to those found on most oscilloscopes. The RMS value, average value, and frequency of each observed parameter can be displayed

in the Oscilloscope window. Two vertical cursors can be activated to perform precise measurements at particular points on the displayed waveforms. The Oscilloscope toolbar includes two memory buttons for saving displayed waveforms.

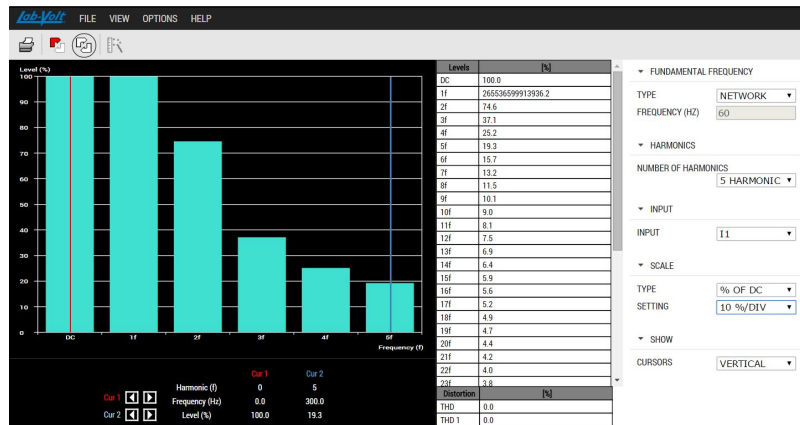
Phasor Analyzer



The Phasor Analyzer displays the phasors related to the measured voltages and currents. The amplitude and phase angle of each voltage and current is clearly represented by the orientation and length of their corresponding phasors, allowing easy comparison between the displayed parameters. This produces a unique and dynamic display of the voltages and currents in a circuit (especially in three-phase circuits) that cannot be obtained with conventional

instruments. The RMS value, phase angle, and frequency of the voltage or current related to each phasor is displayed in the Phasor Analyzer window.

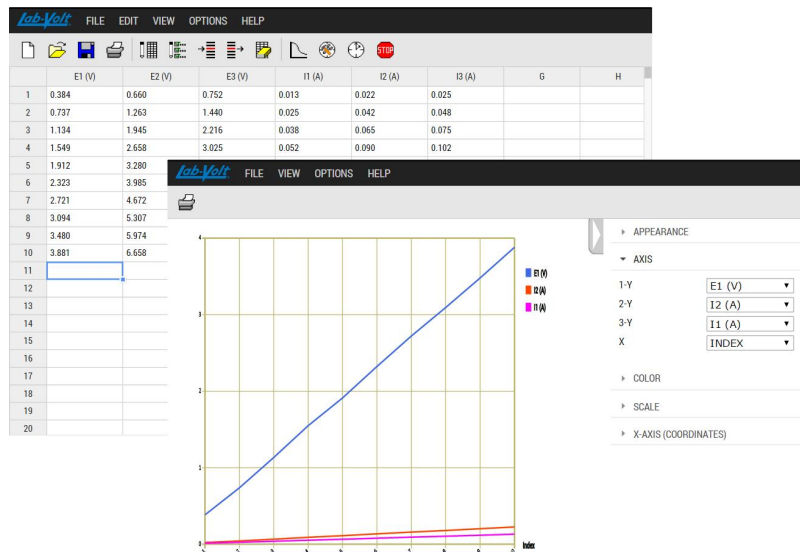
Harmonic Analyzer



The Harmonic Analyzer allows observation and analysis of the harmonic components in the measured voltages and currents. The fundamental frequency can be manually set to the ac power network frequency or automatically set to the frequency of the fundamental component of the selected voltage or current. The harmonic components of the selected voltage or current can be displayed using a vertical scale

graduated in either absolute or relative values. A group of data displays in the Harmonic Analyzer indicates the values of the dc component of the selected voltage or current, as well as the total harmonic distortion (THD). Vertical and horizontal cursors can be displayed to perform precise measurements at particular points on the display. Since the equipment simulated by LVSIM-EMS produces only dc and sinusoidal ac signals (without harmonics), the Harmonic Analyzer, which is intended for use with devices that produce harmonics, is not often used with LVSIM-EMS.

Data Table and Graph Windows



The values indicated by the various meters in the Metering window, as well as values measured by the other instruments, can be recorded in the Data Table window with a click of the mouse. The values recorded in the Data Table can be saved to a file (ASCII-formatted file). The recorded data can also be used to plot graphs by selecting which parameter(s) to plot in the Graph window. This allows lab results to be plotted quickly and easily. More sophisticated graphs can be created by exporting the contents of the Data Table window to any spreadsheet program, such as

Microsoft Excel[®], directly through the Windows Clipboard.

Software Protection and Licensing

The local and network version provides a perpetual licence and the online access version provides a annual licence (additional years can be purchased when ordering).

The local and network version of LVSIM-EMS are copy-protected by means of a hardlock security device. When LVSIM-EMS detects the security device, students have complete access to all measuring functions of the virtual instruments and other protected features of LVSIM-EMS, as well as to the student manuals included with the simulation software. Note that students are allowed to copy the software onto their personal computer to allow them to prepare laboratories in advance.

Two different security devices are available for LVSIM-EMS: a single-user hardlock key, which can be inserted in the USB port of the user's computer, and a multiple-user hardlock key, which can be inserted in the USB port of the network server or any computer in the same network. Once the hardlock key is active on the network, the other computer will see the available licences. Alternately, the multiple-user hardlock key can be inserted in a USB port inside the server using a circuit board with edge-type connector (provided with the key) that can be installed in a PCI expansion slot of the server.

The multiple-user hardlock key can be installed in servers running under one of the following Microsoft® operating systems: Windows 7, Windows 8, Windows 10, Windows 2008 Server, and Windows 2013 Server. As its name indicates, the multiple-user hardlock key allows several users of a network to run LVSIM-EMS simultaneously. Different versions of LVSIM-EMS are available, each allowing a particular number of users.

Online Edition

The online version of LVSIM-EMS is accessible directly via the internet, and requires no software installation nor any update since the latest version of the software is always available. The online version of LVSIM-EMS also includes a demo mode that allows students to prepare laboratories in advance by familiarizing with the equipment and connections. The demo mode does not require any login.

Computer Requirements

Local and Network Versions:

- One (1) USB 2.0 port for the security dongle, Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8), basic dual core CPU, Google Chrome web browser installed (for better experience)

Online Version:

- Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8 but not fully compatible with mobile devices), basic dual core CPU, internet access (bandwidth usage of 50 KB/s maximum), Google Chrome web browser installed (for better experience)

List of Manuals

Description	Manual number
Electromechanical Systems Simulation Software (User Guide) _____	583879 (20858-E0)
Computer-Based Instruments for EMS (User Guide) _____	584396 (36221-E0)

Table of Contents of the Manual(s)

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- 2 Installing the Security Device
- 3 Installing and Running LVSIM-EMS

Computer-Based Instruments for EMS (User Guide) (584396 (36221-E0))

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- 3 Familiarization with the Phasor Analyzer
- 4 Familiarization with the Harmonic Analyzer
- 5 Measuring Three-Phase Power Using the Metering Window

Topic Coverage

- Fundamentals for Electric Power Technology
- Alternating Current
- Capacitors in AC Circuits
- Inductors in AC Circuits
- Power, Phasors, and Impedance in AC Circuits
- Three-Phase Circuits
- Special Transformer Connections
- Single- and three-Phase Transformers
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- DC Motors and Generators
- Special Characteristics of DC Motors
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- Three-Phase Synchronous Generators

Features & Benefits

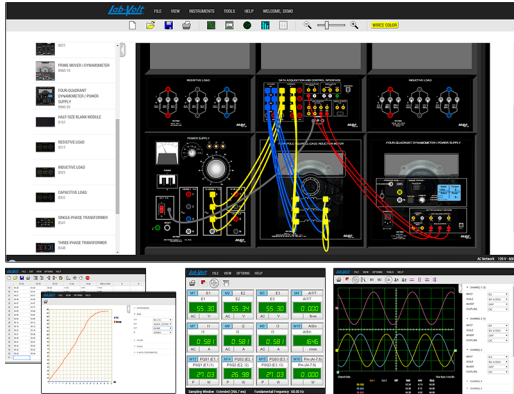
- Replicates the Electromechanical Training System, enabling students to perform actual experiments using virtual equipment
 - Install, move, and remove EMS modules in and from the workstation
 - Modify module connections at any time and change the color of wires
 - Install a timing belt between two EMS machines
 - Verify module connections using a tool that highlights all wires connected to a same circuit point
 - Perform measurements of voltage, current, power, speed, torque, impedance, resistance, reactance, and frequency and display the values on digital or analog meters
 - Record measurements in a data table and plot graphs using the recorded data
 - Display waveforms on a multi-channel oscilloscope and ac voltages and currents as phasors
- Students prepare for laboratories in advance using virtual equipment, thereby decreasing the time they require to perform the exercises using actual equipment
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Electromechanical Systems Simulation Software (LVSIM[®]-EMS) - 15 Users Online, 1 year (Optional) 586980 (8972-C0)



The Electromechanical Systems Simulation Software (LVSIM[®]-EMS) is a simulation software that covers the same courseware as the following systems:

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Electromechanical Training System, Model 8010-9

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All workbooks parts of the systems above are available in the navigation menu of LVSIM-EMS for online consultation. To obtain the printing rights, Campus Licenses for each are

available and must be ordered separately.

With LVSIM-EMS, all the standard EMS laboratory equipment is replaced by images of the actual EMS modules that students can manipulate on the computer screen. Students can identify and set up equipment for a given exercise, make the necessary connections between the virtual EMS modules, and verify the connections made without the need for actual EMS equipment.

Sophisticated mathematical models fully simulate the electrical and mechanical characteristics of all the actual EMS modules: power supplies, motors, generators, transformers, electrical and mechanical loads, etc. All modules simulated in the LVSIM-EMS software feature the same front panel information as the actual EMS modules. Short-circuit connections in the virtual equipment setup cause the virtual circuit-breaker protection to trip. This trip condition is clearly indicated on the virtual EMS modules.

Used either as a complement to the actual EMS laboratory equipment, or as a stand-alone product, LVSIM-EMS is a cost-effective tool that enables students to perform the same exercises as in the courseware of the above-mentioned training systems. When used as a stand-alone package, the LVSIM-EMS software allows students to perform hands-on activities related to electrical power and machines, including active, reactive, and apparent power, phasors, ac/dc motors and generators, three-phase circuits, and transformers.

LVSIM-EMS is a web-browser based application **available in three different configurations**. The simulation software can either be installed locally on a Windows[®] personal computer (local version), on a Windows server (network version), or accessed directly online through the labvolt.com website at lvsim.labvolt.com (online version). Both network and local versions are delivered with perpetual license for the current version. The online version is delivered as an annual license with possibility to expand for more years.

Please visit <https://lvsim.labvolt.com> and try the online version!

Virtual Instrumentation

LVSIM-EMS comprises a set of conventional and specialized instruments that can be used for measuring, observing, and analyzing electrical and mechanical parameters in electric power systems and power electronic circuits. Each instrument appears as a window on the computer screen. The conventional instruments include ac/dc voltmeters and ammeters, power meters, and an eight-channel oscilloscope. The specialized instruments include a six-channel phasor analyzer, a harmonic analyzer, torque, speed, and mechanical power meters, and user-programmable meters. The software is also provided with data-recording and graph-plotting capabilities. The various instruments are briefly described in the next section of this datasheet.

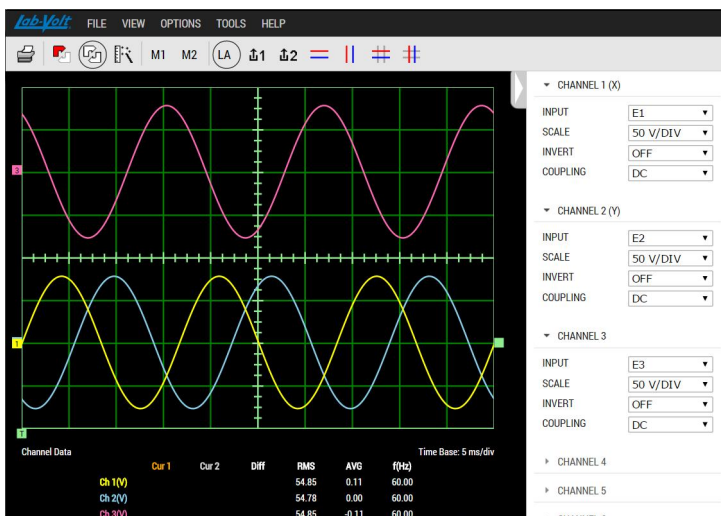
Metering Window



The Metering window displays up to eighteen meters, which can be configured individually for measuring ac/dc voltage and current, electrical power (active, reactive, and apparent), torque, speed, mechanical power, etc. The voltage and current meters have several modes of operation that allow measurement of the mean (dc) value, RMS value, crest factor, RMS value of a particular harmonic (up to the 15th

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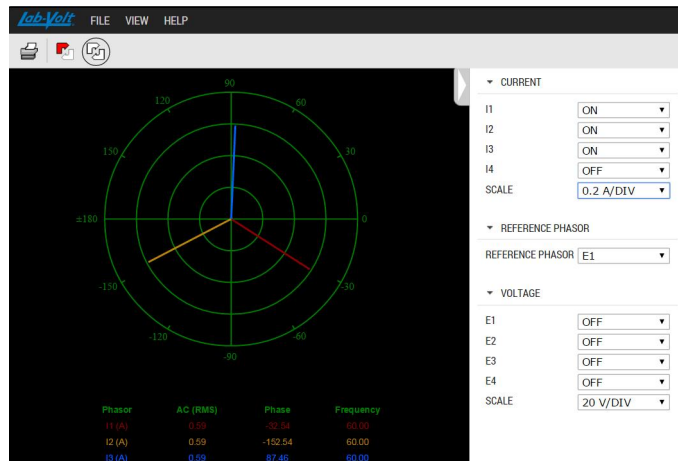
Oscilloscope



The Oscilloscope displays up to eight waveforms simultaneously, each of a different color for easy identification. Each channel has independent vertical controls similar to those found on conventional oscilloscopes. An automatic scale-setting function allows the sensitivity of each channel to be set automatically according to the magnitude of the observed parameter. The time base and trigger controls are similar to those found on most oscilloscopes. The RMS value, average value, and frequency of each observed parameter can be displayed

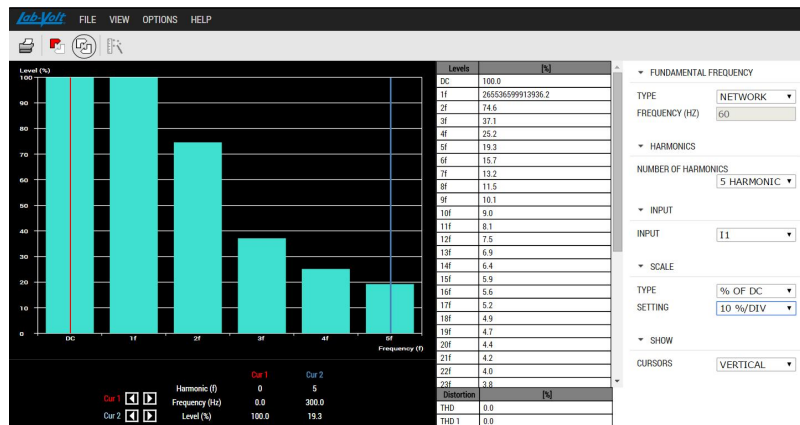
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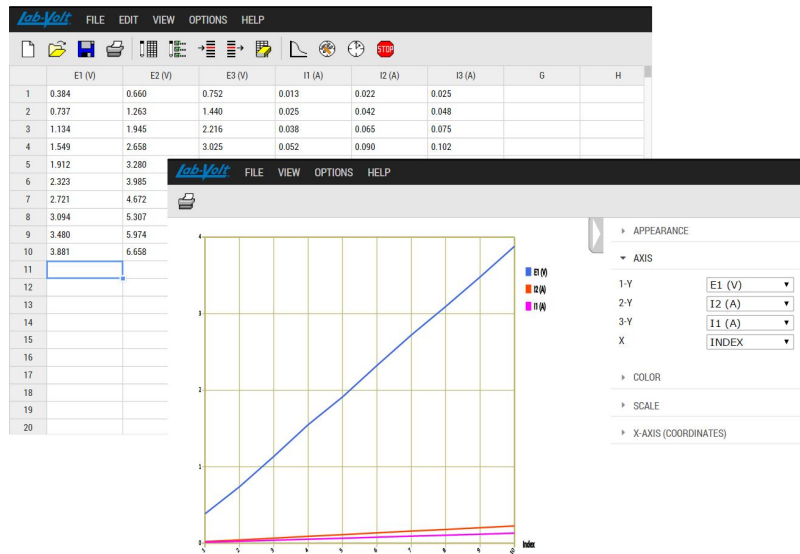
Harmonic Analyzer



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Online Edition

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List of Manuals

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- 1 Familiarization with the Metering Window and the Data Table
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- 3 Familiarization with the Phasor Analyzer
- 4 Familiarization with the Harmonic Analyzer
- 5 Measuring Three-Phase Power Using the Metering Window

Topic Coverage

- Fundamentals for Electric Power Technology
- Alternating Current
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- Power, Phasors, and Impedance in AC Circuits
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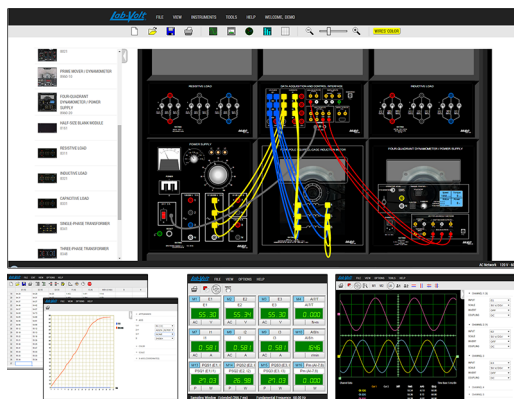
Features & Benefits

- Replicates the Electromechanical Training System, enabling students to perform actual experiments using virtual equipment
 - Install, move, and remove EMS modules in and from the workstation
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Electromechanical Systems Simulation Software (LVSIM[®]-EMS) - 20 Users Online, 1 year (Optional) 586983 (8972-D0)



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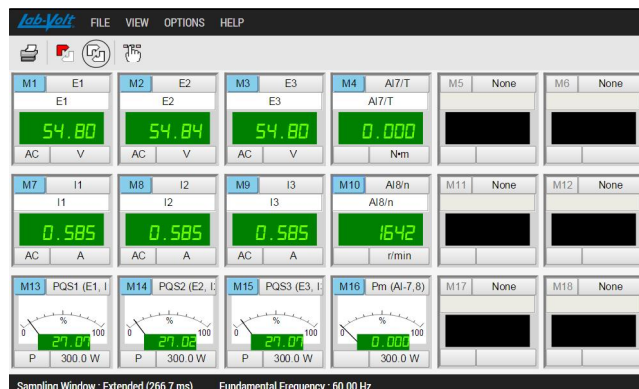
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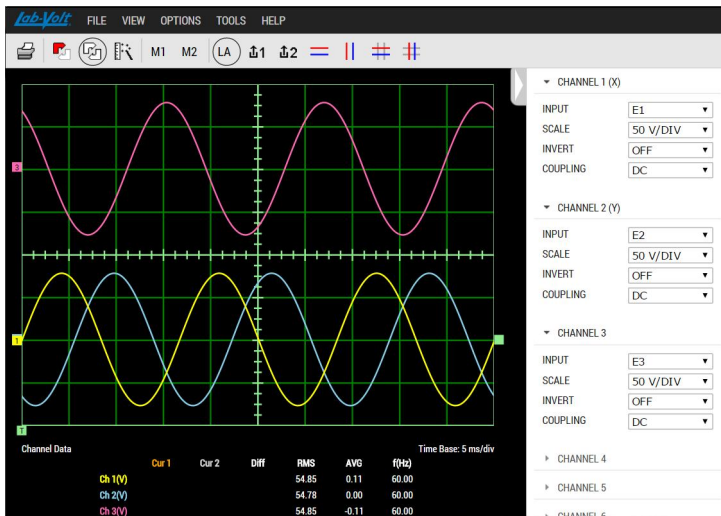
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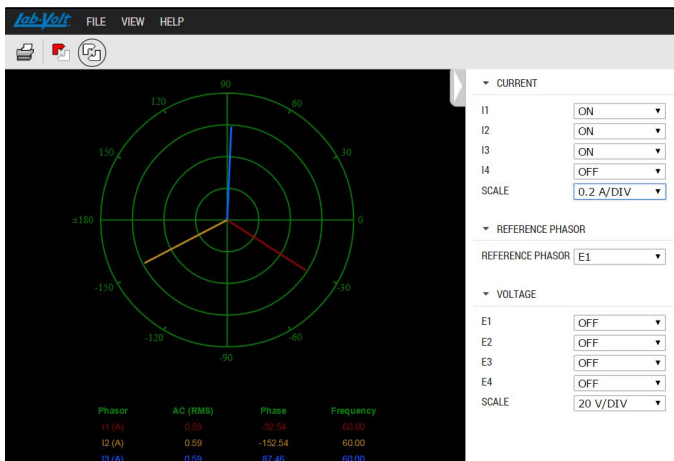
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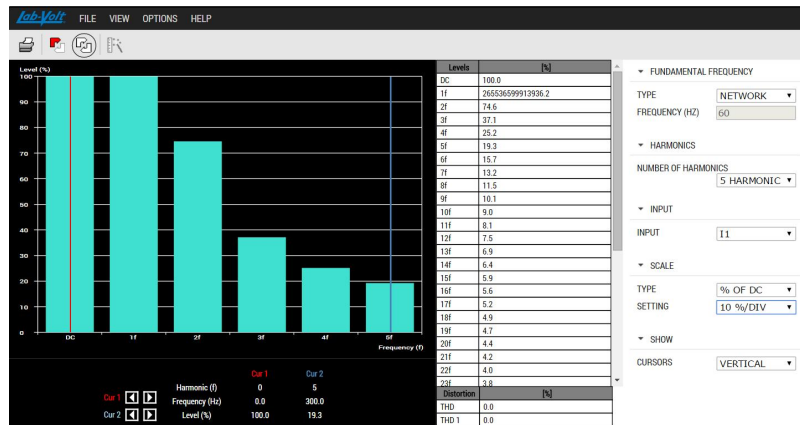
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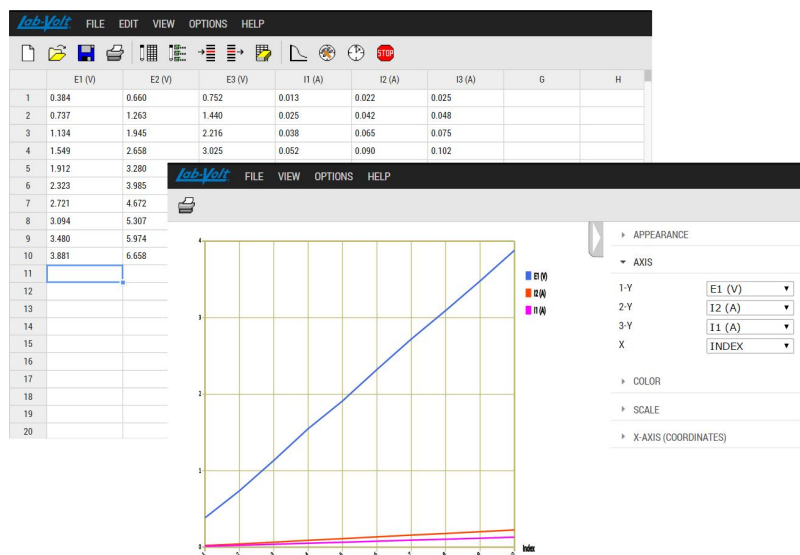
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Online Version:

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- 3 Installing and Running LVSIM-EMS

Computer-Based Instruments for EMS (User Guide) (584396 (36221-E0))

- 1 Familiarization with the Metering Window and the Data Table
- 2 Familiarization with the Oscilloscope
- 3 Familiarization with the Phasor Analyzer
- 4 Familiarization with the Harmonic Analyzer
- 5 Measuring Three-Phase Power Using the Metering Window

Topic Coverage

- Fundamentals for Electric Power Technology
- Alternating Current
- Capacitors in AC Circuits
- Inductors in AC Circuits
- Power, Phasors, and Impedance in AC Circuits
- Three-Phase Circuits
- Special Transformer Connections
- Single- and three-Phase Transformers
- Fundamentals for Rotating Machines
- DC Motors and Generators
- Special Characteristics of DC Motors
- AC Induction and Synchronous Motors
- Three-Phase Synchronous Generators

Features & Benefits

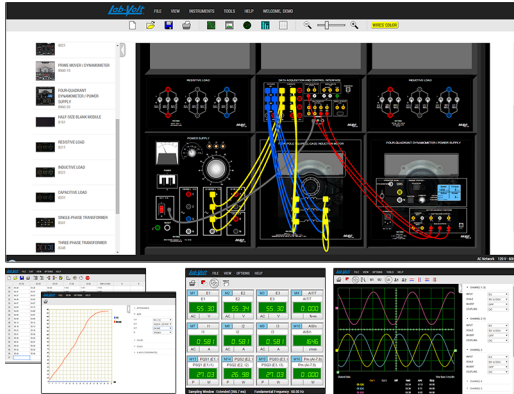
- Replicates the Electromechanical Training System, enabling students to perform actual experiments using virtual equipment
 - Install, move, and remove EMS modules in and from the workstation
 - Modify module connections at any time and change the color of wires
 - Install a timing belt between two EMS machines
 - Verify module connections using a tool that highlights all wires connected to a same circuit point
 - Perform measurements of voltage, current, power, speed, torque, impedance, resistance, reactance, and frequency and display the values on digital or analog meters
 - Record measurements in a data table and plot graphs using the recorded data
 - Display waveforms on a multi-channel oscilloscope and ac voltages and currents as phasors
- Students prepare for laboratories in advance using virtual equipment, thereby decreasing the time they require to perform the exercises using actual equipment
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Specifications

Parameter	Value
Computer Requirements	

Parameter	Value
Local and Network versions	One (1) USB 2.0 port for the security dongle, Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8), basic dual core CPU, Google Chrome web browser installed (for better experience)
Online version	Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8 but not fully compatible with mobile devices), basic dual core CPU, internet access (bandwidth usage of 50 KB/s maximum), Google Chrome web browser installed (for better experience)

Electromechanical Systems Simulation Software (LVSIM[®]-EMS) - 25 Users Online, 1 year (Optional) 586986 (8972-E0)



The Electromechanical Systems Simulation Software (LVSIM[®]-EMS) is a simulation software that covers the same courseware as the following systems:

Computer-Assisted 0.2 kW Electromechanical Training System, Model 8006-1

DC and AC Power Circuits Training System, Model 8010-1

Electromechanical Training System, Model 8010-9

AC Power Transmission Training System, Model 8010-B

All workbooks parts of the systems above are available in the navigation menu of LVSIM-EMS for online consultation. To obtain the printing rights, Campus Licenses for each are

available and must be ordered separately.

With LVSIM-EMS, all the standard EMS laboratory equipment is replaced by images of the actual EMS modules that students can manipulate on the computer screen. Students can identify and set up equipment for a given exercise, make the necessary connections between the virtual EMS modules, and verify the connections made without the need for actual EMS equipment.

Sophisticated mathematical models fully simulate the electrical and mechanical characteristics of all the actual EMS modules: power supplies, motors, generators, transformers, electrical and mechanical loads, etc. All modules simulated in the LVSIM-EMS software feature the same front panel information as the actual EMS modules. Short-circuit connections in the virtual equipment setup cause the virtual circuit-breaker protection to trip. This trip condition is clearly indicated on the virtual EMS modules.

Used either as a complement to the actual EMS laboratory equipment, or as a stand-alone product, LVSIM-EMS is a cost-effective tool that enables students to perform the same exercises as in the courseware of the above-mentioned training systems. When used as a stand-alone package, the LVSIM-EMS software allows students to perform hands-on activities related to electrical power and machines, including active, reactive, and apparent power, phasors, ac/dc motors and generators, three-phase circuits, and transformers.

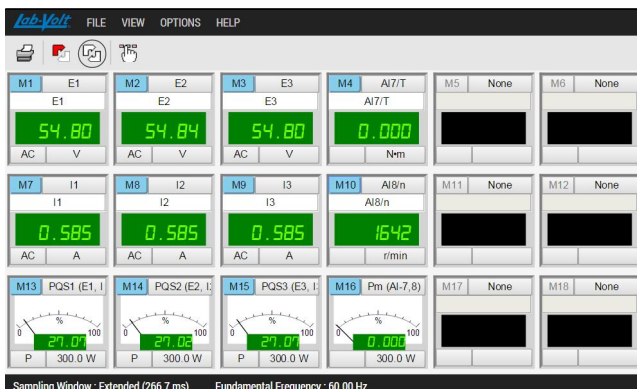
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Please visit <https://lvsim.labvolt.com> and try the online version!

Virtual Instrumentation

LVSIM-EMS comprises a set of conventional and specialized instruments that can be used for measuring, observing, and analyzing electrical and mechanical parameters in electric power systems and power electronic circuits. Each instrument appears as a window on the computer screen. The conventional instruments include ac/dc voltmeters and ammeters, power meters, and an eight-channel oscilloscope. The specialized instruments include a six-channel phasor analyzer, a harmonic analyzer, torque, speed, and mechanical power meters, and user-programmable meters. The software is also provided with data-recording and graph-plotting capabilities. The various instruments are briefly described in the next section of this datasheet.

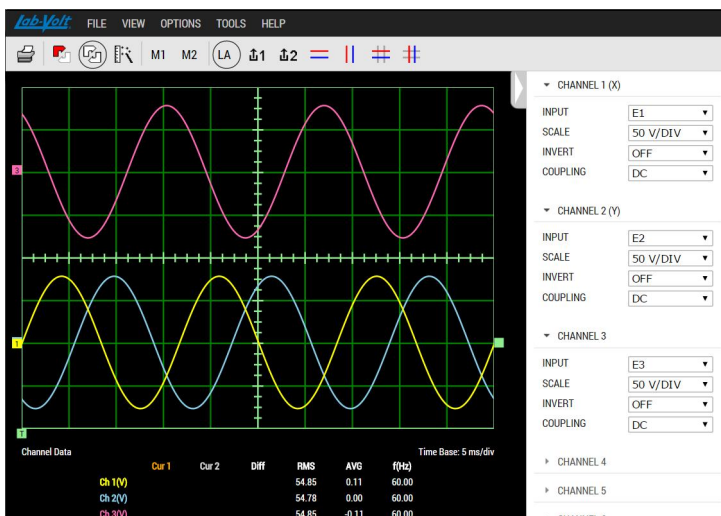
Metering Window



The Metering window displays up to eighteen meters, which can be configured individually for measuring ac/dc voltage and current, electrical power (active, reactive, and apparent), torque, speed, mechanical power, etc. The voltage and current meters have several modes of operation that allow measurement of the mean (dc) value, RMS value, crest factor, RMS value of a particular harmonic (up to the 15th

value), RMS value of the harmonics, and total harmonic distortion (THD). Six of the eighteen meters are user-programmable and give access to a larger variety of functions for measurement of power factor, efficiency, impedance, frequency, energy, phase shift, etc. The layout of the meters in the Metering window is user-customizable.

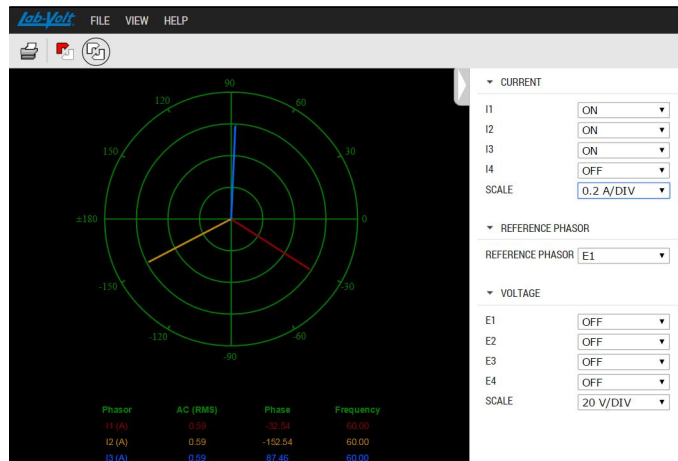
Oscilloscope



The Oscilloscope displays up to eight waveforms simultaneously, each of a different color for easy identification. Each channel has independent vertical controls similar to those found on conventional oscilloscopes. An automatic scale-setting function allows the sensitivity of each channel to be set automatically according to the magnitude of the observed parameter. The time base and trigger controls are similar to those found on most oscilloscopes. The RMS value, average value, and frequency of each observed parameter can be displayed

in the Oscilloscope window. Two vertical cursors can be activated to perform precise measurements at particular points on the displayed waveforms. The Oscilloscope toolbar includes two memory buttons for saving displayed waveforms.

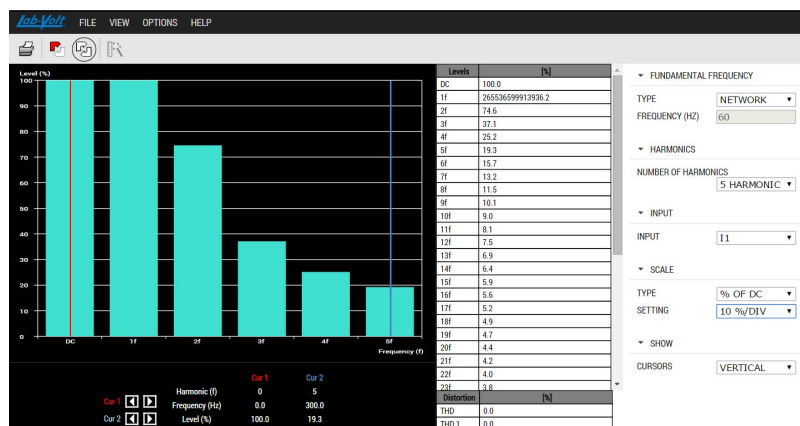
Phasor Analyzer



The Phasor Analyzer displays the phasors related to the measured voltages and currents. The amplitude and phase angle of each voltage and current is clearly represented by the orientation and length of their corresponding phasors, allowing easy comparison between the displayed parameters. This produces a unique and dynamic display of the voltages and currents in a circuit (especially in three-phase circuits) that cannot be obtained with conventional

instruments. The RMS value, phase angle, and frequency of the voltage or current related to each phasor is displayed in the Phasor Analyzer window.

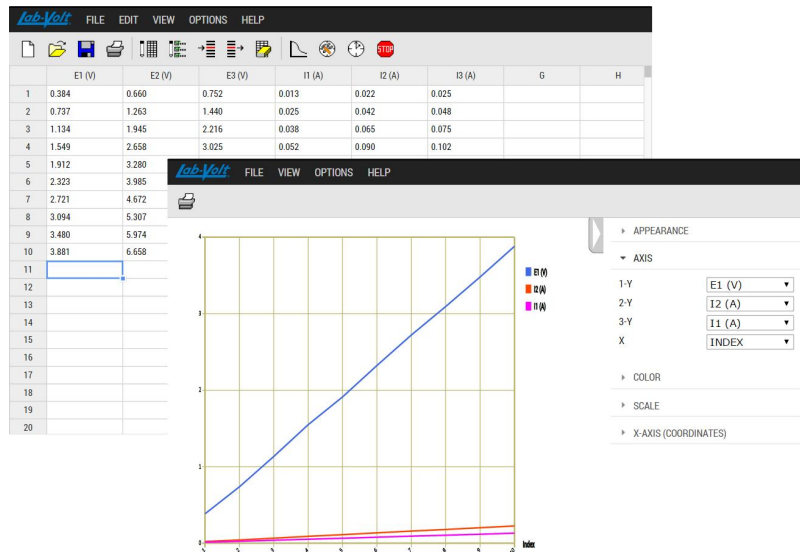
Harmonic Analyzer



The Harmonic Analyzer allows observation and analysis of the harmonic components in the measured voltages and currents. The fundamental frequency can be manually set to the ac power network frequency or automatically set to the frequency of the fundamental component of the selected voltage or current. The harmonic components of the selected voltage or current can be displayed using a vertical scale

graduated in either absolute or relative values. A group of data displays in the Harmonic Analyzer indicates the values of the dc component of the selected voltage or current, as well as the total harmonic distortion (THD). Vertical and horizontal cursors can be displayed to perform precise measurements at particular points on the display. Since the equipment simulated by LVSIM-EMS produces only dc and sinusoidal ac signals (without harmonics), the Harmonic Analyzer, which is intended for use with devices that produce harmonics, is not often used with LVSIM-EMS.

Data Table and Graph Windows



The values indicated by the various meters in the Metering window, as well as values measured by the other instruments, can be recorded in the Data Table window with a click of the mouse. The values recorded in the Data Table can be saved to a file (ASCII-formatted file). The recorded data can also be used to plot graphs by selecting which parameter(s) to plot in the Graph window. This allows lab results to be plotted quickly and easily. More sophisticated graphs can be created by exporting the contents of the Data Table window to any spreadsheet program, such as

Microsoft Excel[®], directly through the Windows Clipboard.

Software Protection and Licensing

The local and network version provides a perpetual licence and the online access version provides a annual licence (additional years can be purchased when ordering).

The local and network version of LVSIM-EMS are copy-protected by means of a hardlock security device. When LVSIM-EMS detects the security device, students have complete access to all measuring functions of the virtual instruments and other protected features of LVSIM-EMS, as well as to the student manuals included with the simulation software. Note that students are allowed to copy the software onto their personal computer to allow them to prepare laboratories in advance.

Two different security devices are available for LVSIM-EMS: a single-user hardlock key, which can be inserted in the USB port of the user's computer, and a multiple-user hardlock key, which can be inserted in the USB port of the network server or any computer in the same network. Once the hardlock key is active on the network, the other computer will see the available licences. Alternately, the multiple-user hardlock key can be inserted in a USB port inside the server using a circuit board with edge-type connector (provided with the key) that can be installed in a PCI expansion slot of the server.

The multiple-user hardlock key can be installed in servers running under one of the following Microsoft[®] operating systems: Windows 7, Windows 8, Windows 10, Windows 2008 Server, and Windows 2013 Server. As its name indicates, the multiple-user hardlock key allows several users of a network to run LVSIM-EMS simultaneously. Different versions of LVSIM-EMS are available, each allowing a particular number of users.

Online Edition

The online version of LVSIM-EMS is accessible directly via the internet, and requires no software installation nor any update since the latest version of the software is always available. The online version of LVSIM-EMS also includes a demo mode that allows students to prepare laboratories in advance by familiarizing with the equipment and connections. The demo mode does not require any login.

Computer Requirements

Local and Network Versions:

- One (1) USB 2.0 port for the security dongle, Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8), basic dual core CPU, Google Chrome web browser installed (for better experience)

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List of Manuals

Description	Manual number
Electromechanical Systems Simulation Software (User Guide) _____	583879 (20858-E0)
Computer-Based Instruments for EMS (User Guide) _____	584396 (36221-E0)

Table of Contents of the Manual(s)

Electromechanical Systems Simulation Software (User Guide) (583879 (20858-E0))

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Topic Coverage

- Fundamentals for Electric Power Technology
- Alternating Current
- Capacitors in AC Circuits
- Inductors in AC Circuits
- Power, Phasors, and Impedance in AC Circuits
- Three-Phase Circuits
- Special Transformer Connections
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- Fundamentals for Rotating Machines
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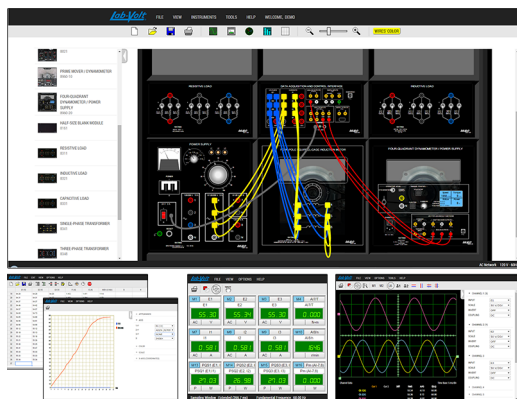
Features & Benefits

- Replicates the Electromechanical Training System, enabling students to perform actual experiments using virtual equipment
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 - Modify module connections at any time and change the color of wires
 - Install a timing belt between two EMS machines
 - Verify module connections using a tool that highlights all wires connected to a same circuit point
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Electromechanical Systems Simulation Software (LVSIM[®]-EMS) - 30 Users Online, 1 year (Optional) 586989 (8972-F0)



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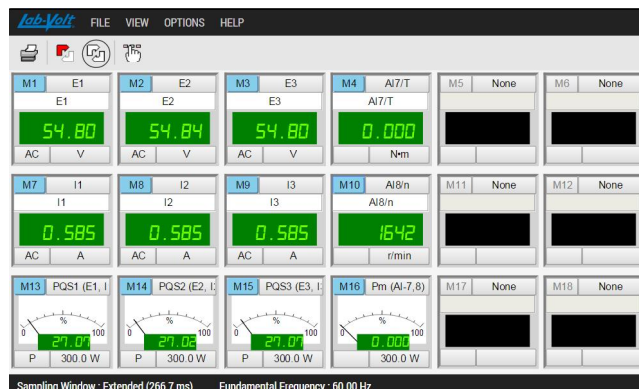
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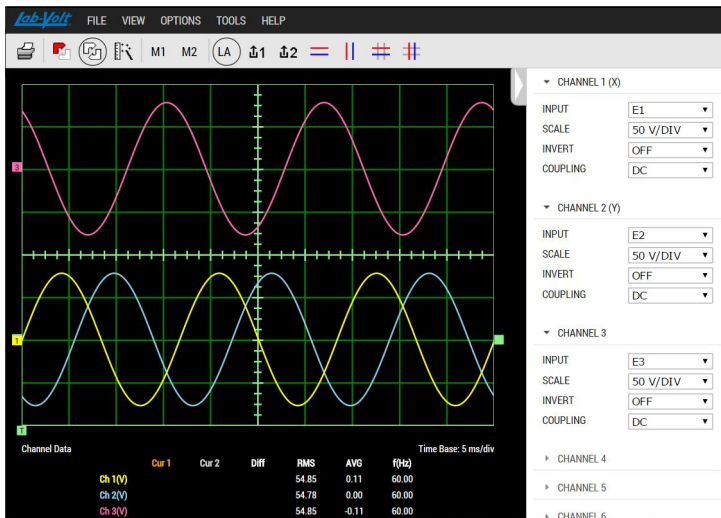
Metering Window



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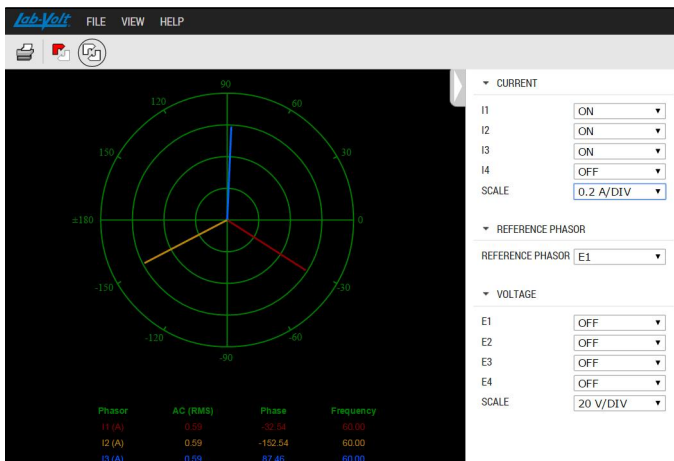
Oscilloscope



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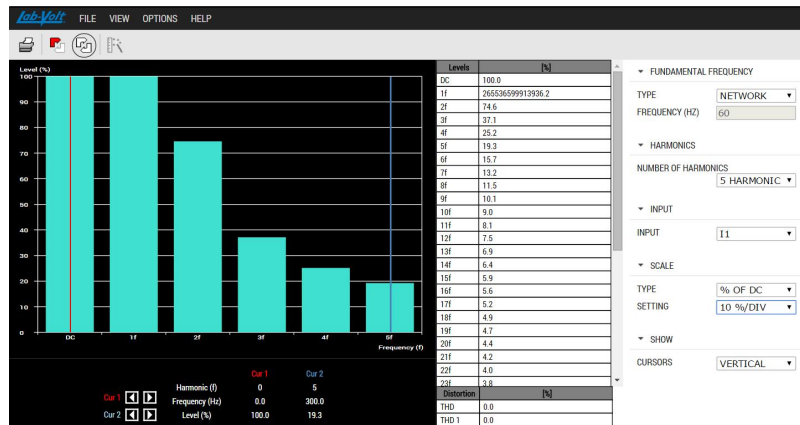
Phasor Analyzer



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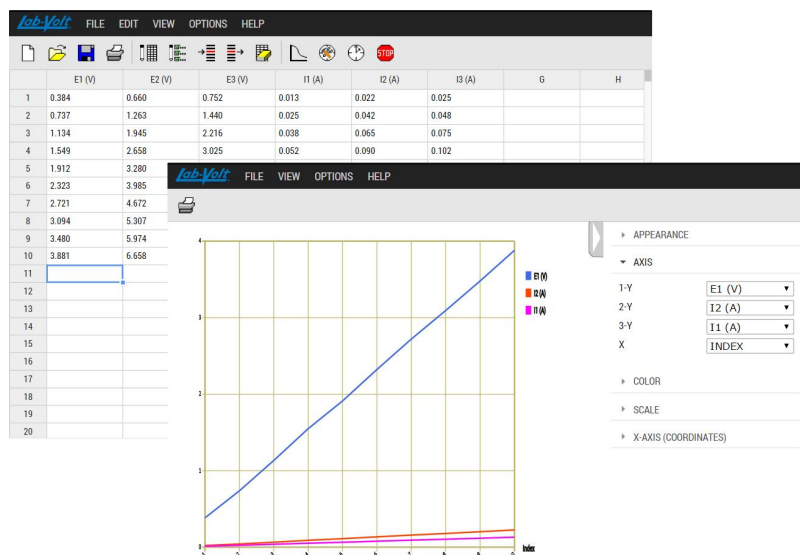
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Topic Coverage

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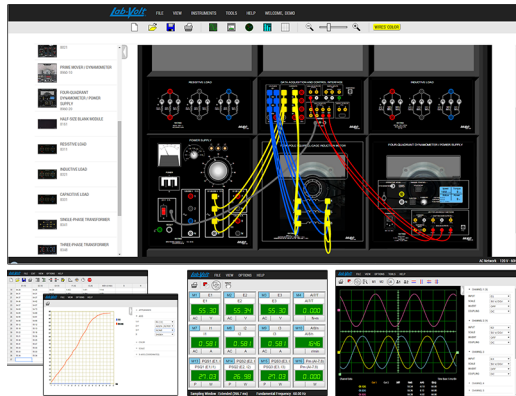
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Electromechanical Systems Simulation Software (LVSIM[®]-EMS) - 35 Users Online, 1 year (Optional) 586992 (8972-G0)



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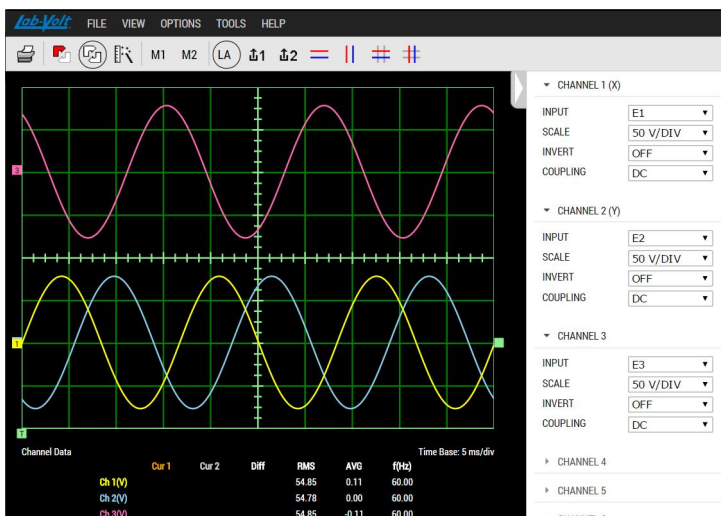
Metering Window



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value), RMS value of the harmonics, and total harmonic distortion (THD). Six of the eighteen meters are user-programmable and give access to a larger variety of functions for measurement of power factor, efficiency, impedance, frequency, energy, phase shift, etc. The layout of the meters in the Metering window is user-customizable.

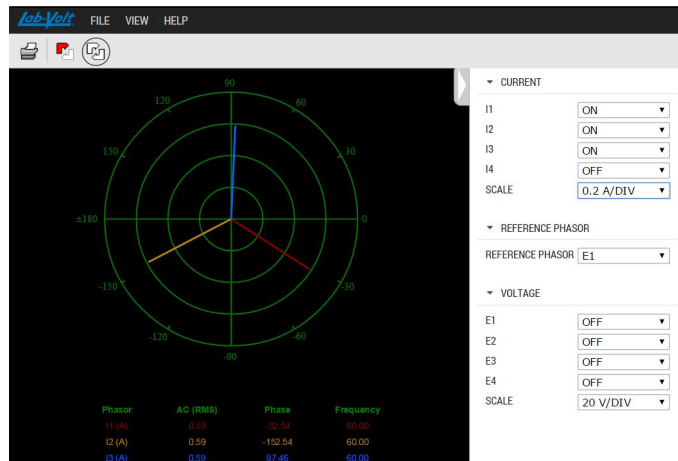
Oscilloscope



The Oscilloscope displays up to eight waveforms simultaneously, each of a different color for easy identification. Each channel has independent vertical controls similar to those found on conventional oscilloscopes. An automatic scale-setting function allows the sensitivity of each channel to be set automatically according to the magnitude of the observed parameter. The time base and trigger controls are similar to those found on most oscilloscopes. The RMS value, average value, and frequency of each observed parameter can be displayed

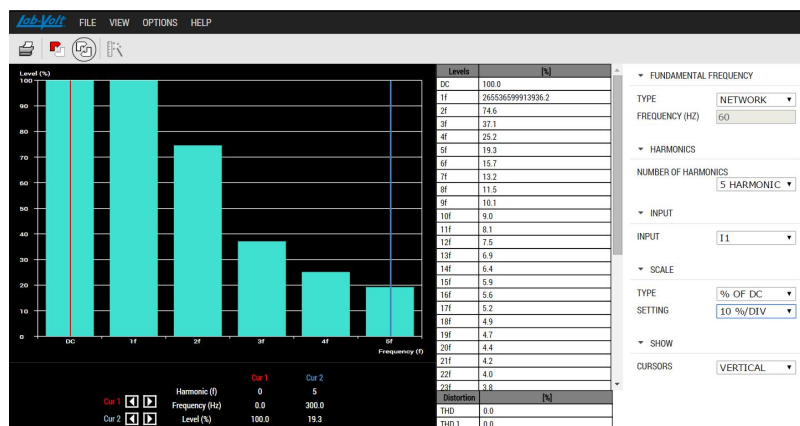
in the Oscilloscope window. Two vertical cursors can be activated to perform precise measurements at particular points on the displayed waveforms. The Oscilloscope toolbar includes two memory buttons for saving displayed waveforms.

Phasor Analyzer



The Phasor Analyzer displays the phasors related to the measured voltages and currents. The amplitude and phase angle of each voltage and current is clearly represented by the orientation and length of their corresponding phasors, allowing easy comparison between the displayed parameters. This produces a unique and dynamic display of the voltages and currents in a circuit (especially in three-phase circuits) that cannot be obtained with conventional instruments. The RMS value, phase angle, and frequency of the voltage or current related to each phasor is displayed in the Phasor Analyzer window.

Harmonic Analyzer

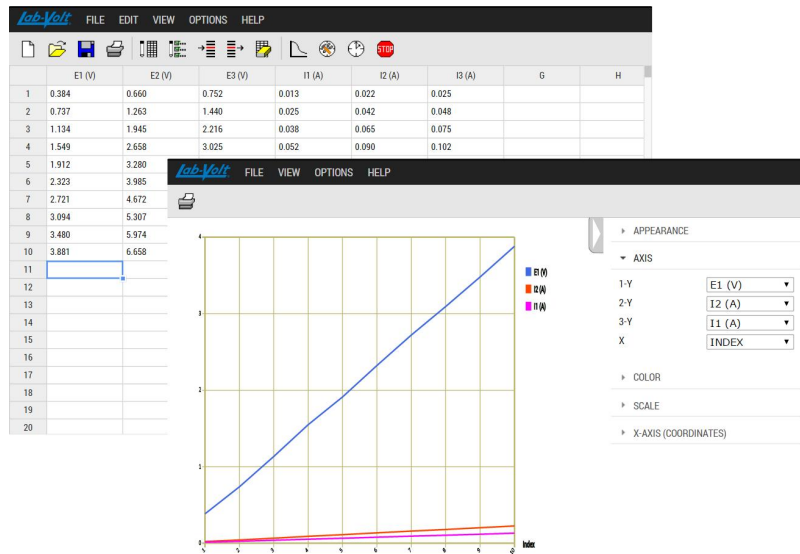


The Harmonic Analyzer allows observation and analysis of the harmonic components in the measured voltages and currents. The fundamental frequency can be manually set to the ac power network frequency or automatically set to the frequency of the fundamental component of the selected voltage or current. The harmonic components of the selected voltage or current can be displayed using a vertical scale graduated in either absolute or relative values. A group of data displays in the Harmonic Analyzer indicates the values of the dc component of the selected voltage or current, as well as the total harmonic distortion (THD). Vertical and horizontal cursors can be displayed to perform precise measurements at particular points on the display. Since the equipment simulated by LVSIM-EMS produces only dc and sinusoidal ac signals (without harmonics), the Harmonic Analyzer, which is intended for use with devices that produce harmonics, is not often used with LVSIM-EMS.

The Phasor Analyzer displays the phasors related to the measured voltages and currents. The amplitude and phase angle of each voltage and current is clearly represented by the orientation and length of their corresponding phasors, allowing easy comparison between the displayed parameters. This produces a unique and dynamic display of the voltages and currents in a circuit (especially in three-phase circuits) that cannot be obtained with conventional

The Harmonic Analyzer allows observation and analysis of the harmonic components in the measured voltages and currents. The fundamental frequency can be manually set to the ac power network frequency or automatically set to the frequency of the fundamental component of the selected voltage or current. The harmonic components of the selected voltage or current can be displayed using a vertical scale

Data Table and Graph Windows



The values indicated by the various meters in the Metering window, as well as values measured by the other instruments, can be recorded in the Data Table window with a click of the mouse. The values recorded in the Data Table can be saved to a file (ASCII-formatted file). The recorded data can also be used to plot graphs by selecting which parameter(s) to plot in the Graph window. This allows lab results to be plotted quickly and easily. More sophisticated graphs can be created by exporting the contents of the Data Table window to any spreadsheet program, such as

Microsoft Excel[®], directly through the Windows Clipboard.

Software Protection and Licensing

The local and network version provides a perpetual licence and the online access version provides a annual licence (additional years can be purchased when ordering).

The local and network version of LVSIM-EMS are copy-protected by means of a hardlock security device. When LVSIM-EMS detects the security device, students have complete access to all measuring functions of the virtual instruments and other protected features of LVSIM-EMS, as well as to the student manuals included with the simulation software. Note that students are allowed to copy the software onto their personal computer to allow them to prepare laboratories in advance.

Two different security devices are available for LVSIM-EMS: a single-user hardlock key, which can be inserted in the USB port of the user's computer, and a multiple-user hardlock key, which can be inserted in the USB port of the network server or any computer in the same network. Once the hardlock key is active on the network, the other computer will see the available licences. Alternately, the multiple-user hardlock key can be inserted in a USB port inside the server using a circuit board with edge-type connector (provided with the key) that can be installed in a PCI expansion slot of the server.

The multiple-user hardlock key can be installed in servers running under one of the following Microsoft[®] operating systems: Windows 7, Windows 8, Windows 10, Windows 2008 Server, and Windows 2013 Server. As its name indicates, the multiple-user hardlock key allows several users of a network to run LVSIM-EMS simultaneously. Different versions of LVSIM-EMS are available, each allowing a particular number of users.

Online Edition

The online version of LVSIM-EMS is accessible directly via the internet, and requires no software installation nor any update since the latest version of the software is always available. The online version of LVSIM-EMS also includes a demo mode that allows students to prepare laboratories in advance by familiarizing with the equipment and connections. The demo mode does not require any login.

Computer Requirements

Local and Network Versions:

- One (1) USB 2.0 port for the security dongle, Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8), basic dual core CPU, Google Chrome web browser installed (for better experience)

Online Version:

- Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8 but not fully compatible with mobile devices), basic dual core CPU, internet access (bandwidth usage of 50 KB/s maximum), Google Chrome web browser installed (for better experience)

List of Manuals

Description	Manual number
Electromechanical Systems Simulation Software (User Guide) _____	583879 (20858-E0)
Computer-Based Instruments for EMS (User Guide) _____	584396 (36221-E0)

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- 3 Familiarization with the Phasor Analyzer
- 4 Familiarization with the Harmonic Analyzer
- 5 Measuring Three-Phase Power Using the Metering Window

Topic Coverage

- Fundamentals for Electric Power Technology
- Alternating Current
- Capacitors in AC Circuits
- Inductors in AC Circuits
- Power, Phasors, and Impedance in AC Circuits
- Three-Phase Circuits
- Special Transformer Connections
- Single- and three-Phase Transformers
- Fundamentals for Rotating Machines
- DC Motors and Generators
- Special Characteristics of DC Motors
- AC Induction and Synchronous Motors
- Three-Phase Synchronous Generators

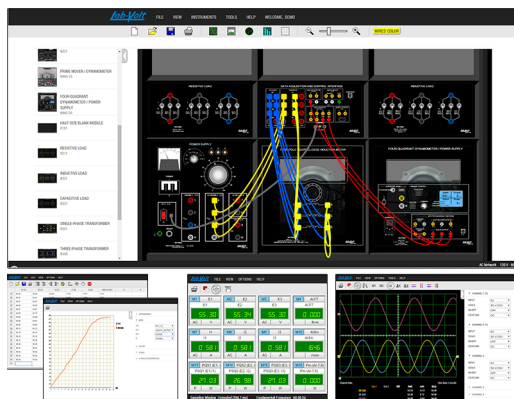
Features & Benefits

- Replicates the Electromechanical Training System, enabling students to perform actual experiments using virtual equipment
 - Install, move, and remove EMS modules in and from the workstation
 - Modify module connections at any time and change the color of wires
 - Install a timing belt between two EMS machines
 - Verify module connections using a tool that highlights all wires connected to a same circuit point
 - Perform measurements of voltage, current, power, speed, torque, impedance, resistance, reactance, and frequency and display the values on digital or analog meters
 - Record measurements in a data table and plot graphs using the recorded data
 - Display waveforms on a multi-channel oscilloscope and ac voltages and currents as phasors
- Students prepare for laboratories in advance using virtual equipment, thereby decreasing the time they require to perform the exercises using actual equipment
- Decreases the quantity of actual equipment required per student
- Allows students to practice with EMS equipment operation and connection at home on a personal computer

Specifications

Parameter	Value
Computer Requirements	
Local and Network versions	One (1) USB 2.0 port for the security dongle, Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8), basic dual core CPU, Google Chrome web browser installed (for better experience)
Online version	Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8 but not fully compatible with mobile devices), basic dual core CPU, internet access (bandwidth usage of 50 KB/s maximum), Google Chrome web browser installed (for better experience)

Electromechanical Systems Simulation Software (LVSIM[®]-EMS) - 40 Users Online, 1 year (Optional) 586995 (8972-H0)



The Electromechanical Systems Simulation Software (LVSIM[®]-EMS) is a simulation software that covers the same courseware as the following systems:

Computer-Assisted 0.2 kW Electromechanical Training System, Model 8006-1

DC and AC Power Circuits Training System, Model 8010-1

Electromechanical Training System, Model 8010-9

AC Power Transmission Training System, Model 8010-B

All workbooks parts of the systems above are available in the navigation menu of LVSIM-EMS for online consultation. To obtain the printing rights, Campus Licenses for each are

available and must be ordered separately.

With LVSIM-EMS, all the standard EMS laboratory equipment is replaced by images of the actual EMS modules that students can manipulate on the computer screen. Students can identify and set up equipment for a given exercise, make the necessary connections between the virtual EMS modules, and verify the connections made without the need for actual EMS equipment.

Sophisticated mathematical models fully simulate the electrical and mechanical characteristics of all the actual EMS modules: power supplies, motors, generators, transformers, electrical and mechanical loads, etc. All

modules simulated in the LVSIM-EMS software feature the same front panel information as the actual EMS modules. Short-circuit connections in the virtual equipment setup cause the virtual circuit-breaker protection to trip. This trip condition is clearly indicated on the virtual EMS modules.

Used either as a complement to the actual EMS laboratory equipment, or as a stand-alone product, LVSIM-EMS is a cost-effective tool that enables students to perform the same exercises as in the courseware of the above-mentioned training systems. When used as a stand-alone package, the LVSIM-EMS software allows students to perform hands-on activities related to electrical power and machines, including active, reactive, and apparent power, phasors, ac/dc motors and generators, three-phase circuits, and transformers.

LVSIM-EMS is a web-browser based application **available in three different configurations**. The simulation software can either be installed locally on a Windows® personal computer (local version), on a Windows server (network version), or accessed directly online through the labvolt.com website at lvsim.labvolt.com (online version). Both network and local versions are delivered with perpetual license for the current version. The online version is delivered as a annual license with possibility to expand for more years.

Please visit <https://lvsim.labvolt.com> and try the online version!

Virtual Instrumentation

LVSIM-EMS comprises a set of conventional and specialized instruments that can be used for measuring, observing, and analyzing electrical and mechanical parameters in electric power systems and power electronic circuits. Each instrument appears as a window on the computer screen. The conventional instruments include ac/dc voltmeters and ammeters, power meters, and an eight-channel oscilloscope. The specialized instruments include a six-channel phasor analyzer, a harmonic analyzer, torque, speed, and mechanical power meters, and user-programmable meters. The software is also provided with data-recording and graph-plotting capabilities. The various instruments are briefly described in the next section of this datasheet.

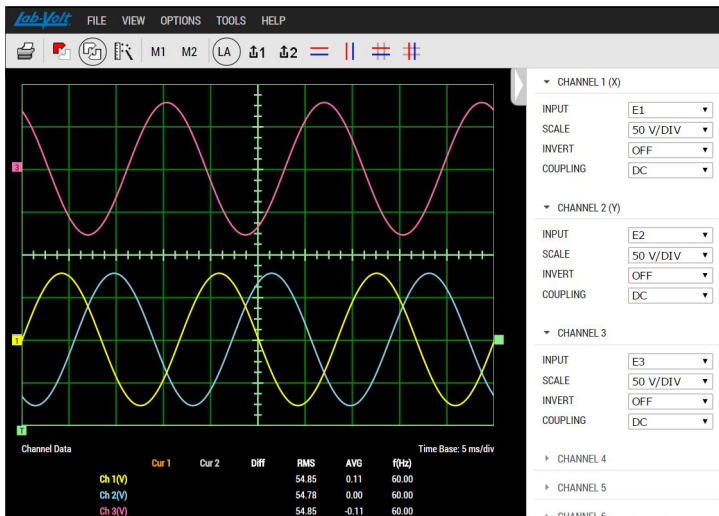
Metering Window



The Metering window displays up to eighteen meters, which can be configured individually for measuring ac/dc voltage and current, electrical power (active, reactive, and apparent), torque, speed, mechanical power, etc. The voltage and current meters have several modes of operation that allow measurement of the mean (dc) value, RMS value, crest factor, RMS value of a particular harmonic (up to the 15th

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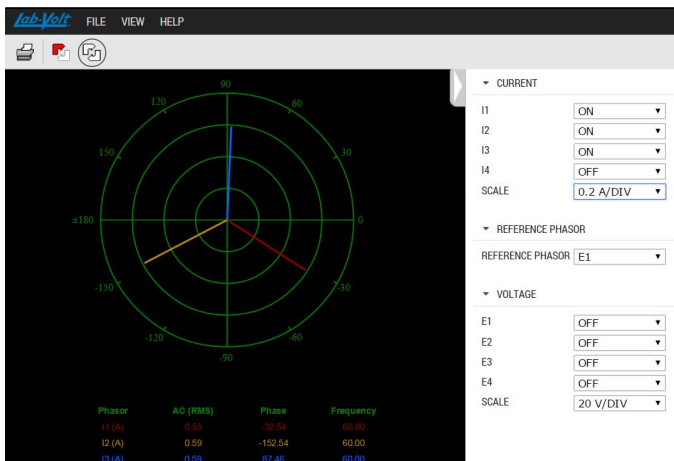
Oscilloscope



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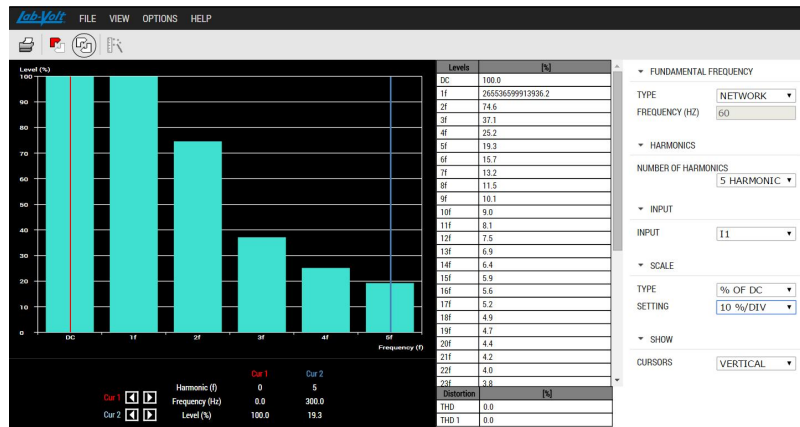
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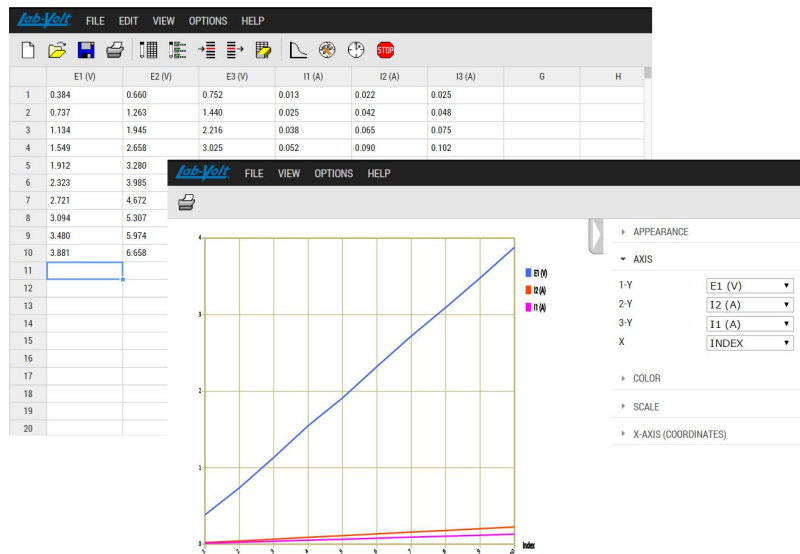
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Online Version:

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Topic Coverage

- Fundamentals for Electric Power Technology
- Alternating Current
- Capacitors in AC Circuits
- Inductors in AC Circuits
- Power, Phasors, and Impedance in AC Circuits
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- Single- and three-Phase Transformers
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Features & Benefits

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Specifications

Parameter	Value
Computer Requirements	

Parameter	Value
Local and Network versions	One (1) USB 2.0 port for the security dongle, Microsoft Windows 10 operating system recommended (compatible with Windows 7 and 8), basic dual core CPU, Google Chrome web browser installed (for better experience)
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SCADA for LVDAC-EMS (Optional) 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.

LVDAC-EMS

The LVDAC-EMS software is a freeware which can be downloaded anytime from the Festo Didactic website (www.labvolt.com). The LVDAC-EMS software is a user-friendly tool that facilitates the use of the various functions which can be implemented with USB peripherals such as the Data Acquisition and Control Interface (DACI), LabVolt Series 9063, and the Four-Quadrant Dynamometer / Power Supply, LabVolt Series 8960.

The LVDAC-EMS software also includes a firmware update for the DACI. When a DACI is connected to a newer version of LVDAC-EMS, the user can easily update the module using a simple update wizard.

LVDAC-EMS Functions

The functions that are currently available for the DACI, Model 9063, are described below. All functions can be activated in any DACI by purchasing a license for that specific function and then performing the upgrade procedure on the DACI. New functions will be added to this datasheet as they become available.

Instrumentation Functions

The instrumentation functions of LVDAC-EMS replace a multitude of actual data acquisition devices (e.g., voltmeters, ammeters, oscilloscopes, synchroscopes) with a series of computer-based instruments that display the data measured by the DACI.

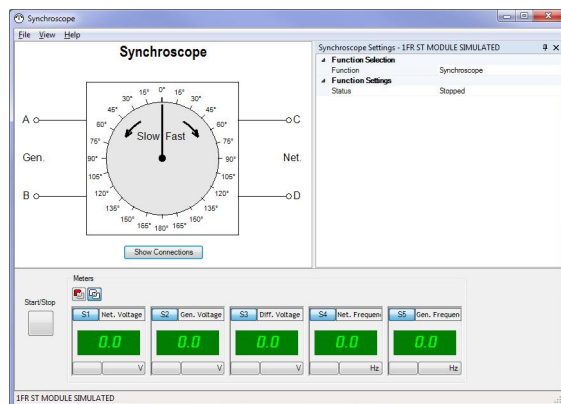
Features & Benefits

- 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

Complete Function Set (Optional) 581451 (9069-00)

This Model activates all currently available control function sets for the Data Acquisition and Control Interface, Model 9063. See individual control functions sets, Models 9069-X, for more information on the included functions.

Synchroscope Function (Optional) 579789 (9069-C0)



The Synchroscope Function is used for the synchronization of synchronous generators. This function emulates the operation of an actual synchroscope by showing on-screen the dial indicating the phase angle difference between the generator voltage and the network voltage. In addition, the Synchroscope Function includes meters displaying various parameters important to generator synchronization (e.g., network voltage and frequency, generator voltage and frequency, voltage difference).

Specifications

Parameter	Value
Monitored Values (in Addition to Phase Difference Dial)	
Monitored Values (in Addition to Phase Difference Dial)	Network voltage
	Network frequency
	Generator voltage
	Generator frequency
	Voltage difference

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 reserves the right to make product improvements at any time and without notice and is not responsible for typographical errors. Festo Didactic recognizes all product names used herein as trademarks or registered trademarks of their respective holders. © Festo Didactic Inc. 2024. All rights reserved.

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