LVSIM-EMS Help

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Overview of LVSIM-EMS

The Electromechanical equipment in the Virtual Laboratory faithfully simulates electromechanical training systems. The exercises in the following manuals from the 0.2 kW Computer-Assisted Electromechanical Training System (EMS), Model 8006, can be performed using the virtual laboratory equipment:

- Power Circuits and Transformers (30328)
- AC/DC Motors and Generators (30329)

The exercises in the following manuals from the Electromechanical Training System, Model 8010-9 can be performed using the virtual laboratory equipment:

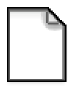
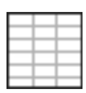
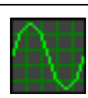
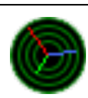
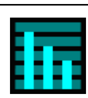
- Power Factor Correction (20116)
- AC Transmission Lines (20521)
- DC Power Circuits (86350)
- Permanent Magnet DC Motor (86357)
- Single-Phase AC Power Circuits (86358)
- Three-Phase AC Power Circuits (86360)
- Three-Phase Rotating Machines (86364)
- Single-Phase Power Transformers (86377)
- Three-Phase Transformer Banks (86379)
- Conventional DC Machines and Universal Motor (88943)
- Single-Phase Induction Motors (88944)

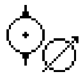
The Computer-Assisted EMS System is a set of modules (a power supply, resistive, inductive, and capacitive loads, transformers, motors, etc.) that can be installed in a laboratory workstation. These modules can be interconnected with wires to implement various electromechanical circuits. The operation and behavior of these circuits can be observed by measuring voltages, currents, powers, speeds, torques, etc., using the Data Acquisition Interface (DAI) or Data Acquisition and Control Interface (DACI) and computer-assisted instruments.

The Electromechanical equipment in the Virtual Laboratory provides replicas of the laboratory workstation and modules included in the actual Computer-Assisted EMS system. These replicas can be installed in the Virtual Laboratory and operate exactly as the actual equipment. The modules can be interconnected to set up a great variety of electromechanical circuits. These circuits can be analyzed using the same DAI or DACI and instruments as in the actual EMS system.

LVSIM-EMS Toolbar

The buttons on the toolbar can be clicked to perform different functions. The function of each button is briefly described below. You can click one of the following buttons to obtain additional information about the function related to the corresponding button.

Icon	Description
	Creates a new virtual laboratory
	Opens a virtual laboratory
	Saves the current setup of the virtual laboratory to a file
	Prints the current view of the virtual laboratory
	Undoes the last action
	Reverts the effects of the last Undo command
	Starts the Data Table application
	Starts the Oscilloscope application
	Starts the Metering application
	Starts the Phasor Analyzer application
	Starts the Harmonic Analyzer application
	Starts the Synchroscope application
	Shows/Hides the yellow multimeter

Icon	Description
	Shows/Hides the red multimeter
	Starts the Four-Quadrant Dynamometer/Power Supply application
	Zooms out
	Zooms in or zooms out
	Zooms in
	Changes the default wire color

LVSIM-EMS Menus

File Menu Commands

Virtual Laboratory File (filename.lvsimweb)

File containing a complete setup of the virtual laboratory. A Virtual Laboratory file preserves the position of the various training systems in the virtual laboratory, the setup and settings made on each training system, as well as the settings of other LVSIM-EMS options.

New

Creates a new Virtual Laboratory file (filename.lvsimweb). If the current setup of the virtual laboratory has been modified, a dialog box appears asking if you wish to create a new setup. If you choose to do so, any currently unsaved change in the setup will be lost.

Open...

Opens a Virtual Laboratory file (filename.lvsimweb). Opening a Virtual Laboratory file allows you to recover a setup of the virtual laboratory that has been saved previously. You can either open a file stored on your computer or a sample file stored on the web server. If the current setup of the virtual laboratory has been modified, a dialog box appears asking if you wish to save the changes to a Virtual Laboratory file before opening the selected Virtual Laboratory file.

Save...

Saves the current setup of the virtual laboratory to a Virtual Laboratory file. A dialog box appears asking you to name the Virtual Laboratory file.

Import ".DAI"...

Imports a configuration file from the Data Acquisition and Control for Electromechanical Systems (LVDAC-EMS). The extension for this type of file is .DAI. You can either open a file stored on your computer or a sample file stored on the web server. Importing a configuration file allows you to recover a specific instrument configuration previously saved to a file.

Print...

Sends the current view of the virtual laboratory to the printer. Note that the LVSIM-EMS menu bar, toolbars, status bar, equipment bars, and equipment list bar are not sent to the printer.

The Print dialog box appears before the current view of the virtual laboratory is sent to the printer. This box allows the print options to be modified before printing. The current view of the virtual laboratory is sent to the printer only after the OK button in the Print dialog box is clicked.

Edit Menu Commands

Undo

Undoes the last editing action. The number of successive actions that can be undone is virtually unlimited. The following actions can be undone:

- Installing equipment
- Moving equipment
- Removing equipment
- Making a connection
- Modifying a connection
- Removing a connection
- Installing a timing belt
- Modifying the installation of a timing belt
- Removing a timing belt

Redo

Reverts the effects of the last Undo command. The Redo command can no longer be used once a command other than Undo and Redo has been performed.

Remove All Banana Plug Wires

Removes all banana plug wire connections from the equipment.

View Menu Commands

Equipment List

Displays or hides the Equipment List panel. This panel provides a list of all equipment currently available in the virtual laboratory. See Equipment List for additional information on this topic.

Zoom in

Allows you to zoom in.

Zoom out

Allows you to zoom out.

Instruments Menu Commands

Each command in the Instruments menu launches a measuring instrument web application. Each of these can be used to measure one or several parameters in the training system installed in the virtual laboratory. The following instruments are available in LVSIM-EMS.

- Oscilloscope
- Metering
- Phasor Analyzer
- Harmonic Analyzer
- Synchroscope
- Four-Quadrant Dynamometer/Power Supply
- Yellow and Red Multimeters

Tools Menu Commands

Language

Selects the language used in the application.

Options...

Opens the LVSIM-EMS Options dialog box. In this dialog box, you can change the settings of the ac power network. Several combinations of language and ac power network voltage and frequency can be used in the virtual laboratory. This LVSIM-EMS Options dialog box also allows selection of the system of units. LVSIM-EMS can be set to display either International (SI) units or Imperial units. You can also choose the units of power you wish to display (hp or W). The system of units is selected by choosing the desired unit in the Units list box.

Settings for Model 9063

Opens the Settings for Model 9063 dialog box. This dialog box allows you to configure the settings for the Data Acquisition and Control Interface. See Settings for Model 9063 for additional information.

Data Table

Opens the Data Table application.

Help Menu Commands

Contents and Index...

Opens the Help file related to the software product you are currently using.

Manuals and Exercises...

Opens a page providing information about the student manuals that can be used with the LVSIM-EMS software.

What's New...

Opens a page providing information about the software version history.

About LVSIM-EMS...

Opens a window providing general information about the LVSIM-EMS software.

Context-Sensitive Menu Commands

A context-sensitive menu is available for each object in LVSIM-EMS. To open the context-sensitive menu for a particular object, move the cursor on the object, then right-click on the mouse. The context-sensitive menu will display the available commands for the object. Most commands available in the context-sensitive menu are listed below.

Delete Module

Deletes the module from the workstation.

Lower Front Panel

Lowers the front panel of the module. The front panel of several EMS modules can be lowered, providing access to the interior of the module. This is necessary in order to install a timing belt or reset a circuit breaker, for example.

Raise Front Panel

Raises the front panel of the module. It is recommended to raise the front panel of a module before using it.

Delete

Deletes the object. This command is common for wires, cables, and timings belts.

Remove Belt

Removes the timing belt.

Change Color

Changes the color of the object. This command is common for wires.

Bring on Top

Brings the object on top. This command is common for wires and enables them to be easily moved or deleted.

Highlight Nodes

Highlights all wires in the currently selected nodes (i.e., all connected wires). This command only takes into account banana plug wires and not miniature banana plug wires. It allows the user to easily view the different paths through which current flows in a circuit. Refer to Verifying Electrical Connections to know how to verify electrical connections using the Highlight Nodes tool.

Settings…

Shows the settings window of the module. This command is available mainly to configure the different settings of the Data Acquisition and Control Interface, Model 9063.

LVSIM-EMS Actions

Installing a Module in the Workstation

To install a module in the Workstation, drag and drop the module from the Equipment List on the left of the screen to the desired location in the Workstation.

Moving a Module in the Workstation

To move a module in the Workstation, drag and drop the module from its original location to its desired location. When moving a module this way, make sure to click on a part of the module not containing any interacting component (terminal, switch, knob, wire, etc.) as doing so would select the component.

Note that, when moving a module, all wires connected to the module remain connected. Also, a module cannot be moved as long as it is coupled to another module using a timing belt.

Lowering the Front Panel of a Module

The front panel of several EMS modules can be lowered, providing access to the interior of the module in order to install a timing belt or reset a circuit breaker, for example. It is recommended to raise the front panel of a module before using it.

To lower the front panel of a module, place the cursor on the desired module (not on an interacting component such as a terminal, switch, knob, or wire), right-click on the mouse to display the context-sensitive menu, then select the Lower Front Panel command.

Raising the Front Panel of a Module

The front panel of several EMS modules can be lowered, providing access to the interior of the module in order to install a timing belt or reset a circuit breaker, for example. It is recommended to raise the front panel of a module before using it.

To raise the front panel of a module, place the cursor on the desired module (not on an interacting component such as a terminal, switch, knob, or wire), right-click on the mouse to display the context-sensitive menu, then select the Raise Front Panel command.

Deleting a Module from the Workstation

To delete a module from the Workstation, place the cursor on the desired module (not on an interacting component such as a terminal, switch, knob, or wire), right-click on the mouse to display the context-sensitive menu, then select the Delete Module command.

Note that, when deleting a module, all wires connected to the module, as well as any timing belt coupled to it, are also deleted.

Installing a Timing Belt

To install a timing belt, lower the front panel of each module to be coupled. Refer to the Lowering the Front Panel of a Module section for more information on this topic.

To install a timing belt between two modules, do the following:

1. Place the cursor on the pulley of the first module, then left-click on the mouse to install a timing belt on this pulley. A black line appears between the pulley and the cursor to indicate that a timing belt is being installed.
2. Place the cursor on the pulley of the second module, then left-click on the mouse to install the timing belt on this pulley. The black line disappears and a timing belt couples the two modules.

Note that a timing belt can only be used to couple modules that are installed side by side in the Workstation.

Deleting a Timing Belt

To delete a timing belt, place the cursor on the pulley of one of the two modules coupled with the timing belt, right-click on the mouse to display the context-sensitive menu, then select the Remove Belt command.

Making an Electrical Connection

To make an electrical connection, do the following:

1. Place the cursor on a module terminal and left-click on the mouse. This connects one end of the wire to the selected terminal.
2. The cursor now holds the other end of the wire. Drag and drop this end of the wire to the desired terminal.

To cancel an uncompleted connection, press the Escape (ESC) key on the keyboard.

Modifying the Shape of an Electrical Connection

To modify the shape of an electrical connection, place the cursor anywhere on the desired wire except its ends, left-click and hold on the mouse, then move the cursor in any direction. This modifies the shape and length of the selected wire.

Note that clicking on a wire automatically brings this wire on top.

Modifying an Electrical Connection

To modify an electrical connection, place the cursor on either end of the desired wire, left-click and hold on the mouse, then drag and drop this end of the wire to the desired terminal.

Note that clicking on a wire automatically brings this wire on top.

Removing an Electrical Connection

To remove an electrical connection, place the cursor anywhere on the desired wire, right-click on the mouse to display the context-sensitive menu, then select the Delete command.

To remove all banana plug wire connections from the electromechanical equipment, select the Remove all Banana Plug Wires command in the Tools menu of LVSIM-EMS.

Verifying an Electrical Connection

To verify an electrical connection, place the cursor on the desired wire, right-click on the mouse to display the context-sensitive menu, then select the Highlight Nodes command.

The Highlight Nodes command highlights all wires in the currently selected nodes (i.e., all connected wires) by displaying them in blue, while all other wires are displayed in black. It allows the user to easily view the different paths through which current flows in a circuit.

Note that the Highlight Nodes command only takes into account banana plug wires and not miniature banana plug wires.

Changing the Color of an Electrical Connection

To change the color of an electrical connection, place the cursor on the desired wire, right-click on the mouse to display the context-sensitive menu, place the cursor on the Change Color command, then select the desired wire color.

When making new electrical connections, wires have a predetermined default color. To change this default color, modify the Wires' Color option in the toolbar.

Modifying a Control Knob Setting

To modify a control knob setting, place the cursor on the pointer or selector of the desired control knob, left-click and hold on the mouse, then drag the pointer or selector to the desired position.

Remove All Banana Plug Wires

To remove from the equipment all connections made using banana plug wires, select the Remove All Banana Plug Wires command in the Tools menu of LVSIM-EMS. Note that this command does not remove the connections made using miniature banana plug wires.

Equipment List

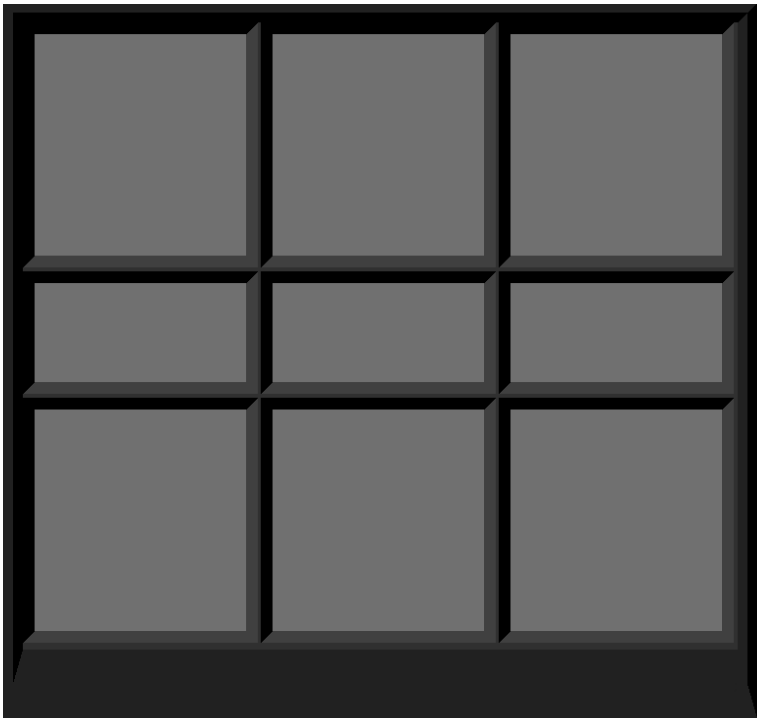
The Equipment List is a library of all the electromechanical modules available in LVSIM-EMS. Each available module is displayed in the Equipment List beside its corresponding name and part number. Each module in the Equipment List can be dragged to a free location in the Workstation. See Installing Modules in the Workstation for additional information on this topic.

Note that it is possible to obtain information about each terminal or toggle switch, as well as about certain knobs, on any module by letting the cursor hovers over the terminal.

Each available module in the Equipment List is described below.

Workstation

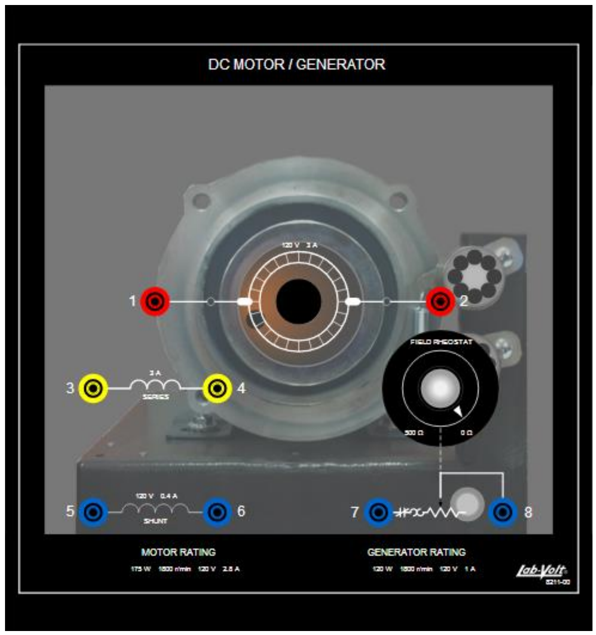
The Workstation provides the working space necessary to install modules in the LVSIM-EMS software. It has space to insert six full-size EMS module and three half-size EMS modules, or fifteen half-size EMS modules.



DC Motor/Generator

The DC Motor/Generator consists of a DC machine with series and shunt field windings, and a field rheostat. Access to the armature, series field winding, shunt field winding, and field rheostat is achieved through terminals on the module front panel. The field rheostat allows adjustment of the current in the shunt field winding when it is connected in series with this winding.

See Modifying a Control Knob Setting to obtain information on how to modify the setting of the field rheostat control knob.

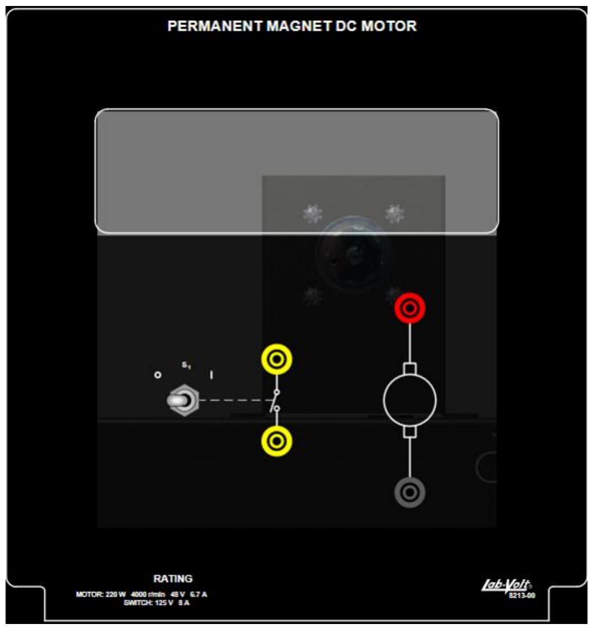


The field rheostat is protected against overcurrent by a circuit breaker. The current rating of this circuit breaker is the same as that of the shunt field winding. When the circuit breaker trips, its reset button, located inside the module (on the right-hand side of the panel on which the DC machine is fixed), extends and becomes red. The circuit breaker is reset by lowering the front panel of the module, clicking the reset button, and raising the front panel of the module.

Permanent Magnet DC motor

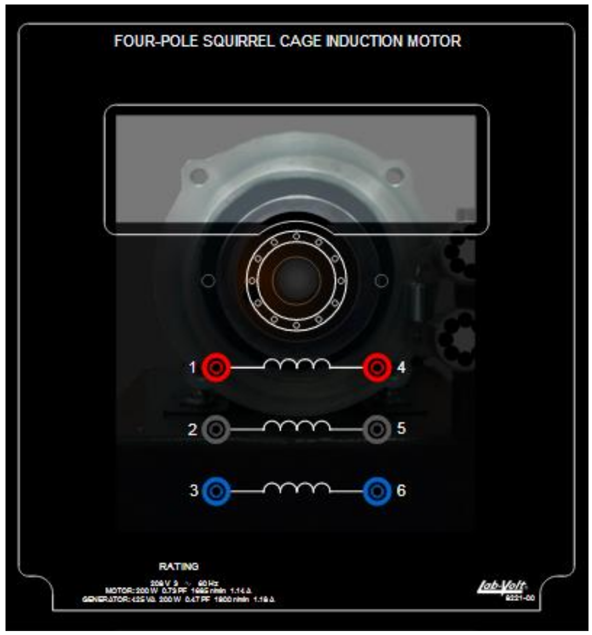
The Permanent Magnet DC Motor is a high-speed, brushed dc motor mounted in a full-size EMS module. Power must be fed to the motor by an external dc power source. A toggle switch mounted on the front panel can be used to switch dc power to the motor on and off when the motor is connected to a power supply. When driven by a prime mover, the Permanent Magnet DC Motor operates as a dc generator.

The diameter of the Permanent Magnet DC Motor pulley is smaller (12 teeth) than that of the pulleys of the Four-Quadrant Dynamometer/Power Supply (24 teeth). This difference of pulley ratio (12 to 24) permits adapting the speed (0 4000 r/min) of the Permanent Magnet DC Motor to the speed of the Four-Quadrant Dynamometer/Power Supply (between 0 2000 r/min).



Four-Pole Squirrel-Cage Induction Motor

The Four-Pole Squirrel-Cage Induction Motor is a three-phase induction machine which can operate as either an asynchronous motor or an asynchronous generator. Access to each of the three stator windings is achieved through terminals on the module front panel. This allows operation in either star (wye) or delta configuration.

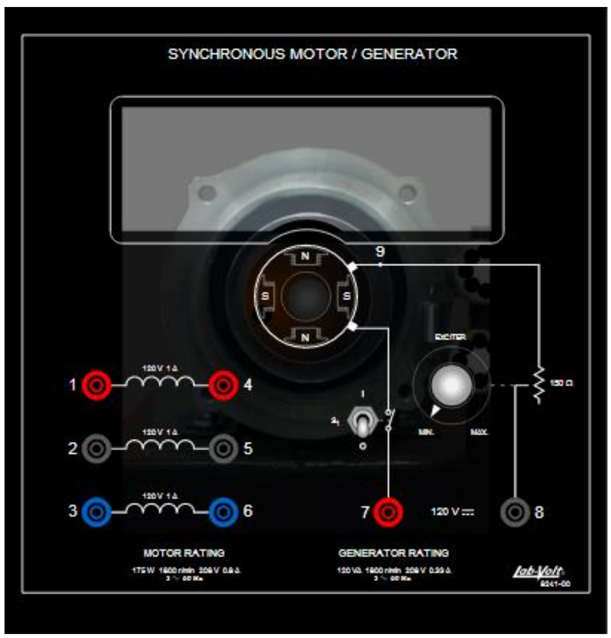


Synchronous Motor/Generator

The Synchronous Motor/Generator is a three-phase machine which can operate as a motor, a generator, or a synchronous condenser. Access to each of the three stator windings is achieved through terminals on the module front panel. This allows operation in either star (wye) or delta configuration. DC power is provided to the exciter circuitry through a pair of terminals on the module front panel. The exciter controls consist of an on/off switch and a rheostat. The rheostat allows adjustment of the exciting current.

To modify the exciter switch setting (open or closed), place the cursor on the exciter switch, then left-click on the mouse. This toggles the exciter switch from one position to the other. Note that the exciter circuit is closed when the exciter switch is in the I position, and it is open when the exciter switch is in the O position.

See Modifying a Control Knob Setting to obtain information on how to modify the setting of the exciter rheostat control knob.



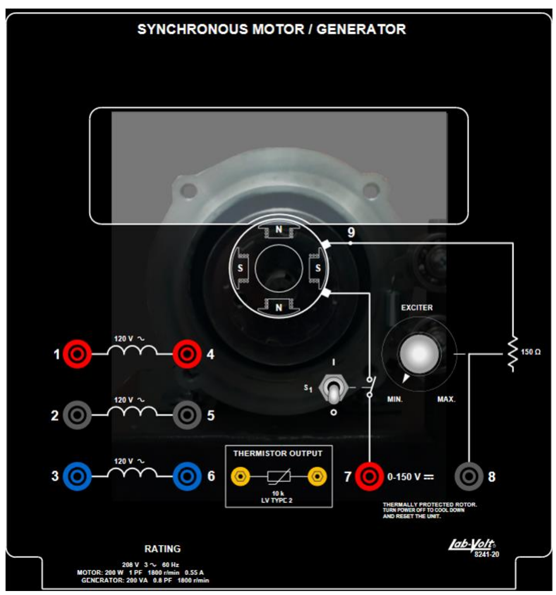
Synchronous Motor/Generator with Thermistor Output

The Synchronous Motor/Generator with Thermistor Output is a three-phase machine which can operate as a motor, a generator, or a synchronous condenser. Access to each of the three stator windings is achieved through terminals on the module front panel. This allows operation in either star (wye) or delta configuration. DC power is provided to the exciter circuitry through a pair of terminals on the module front panel. The exciter controls consist of an on/off switch and a rheostat. The rheostat allows adjustment of the exciting current.

To modify the exciter switch setting (open or closed), place the cursor on the exciter switch, then left-click on the mouse. This toggles the exciter switch from one position to the other. Note that the exciter circuit is closed when the exciter switch is in the I position, and it is open when the exciter switch is in the O position.

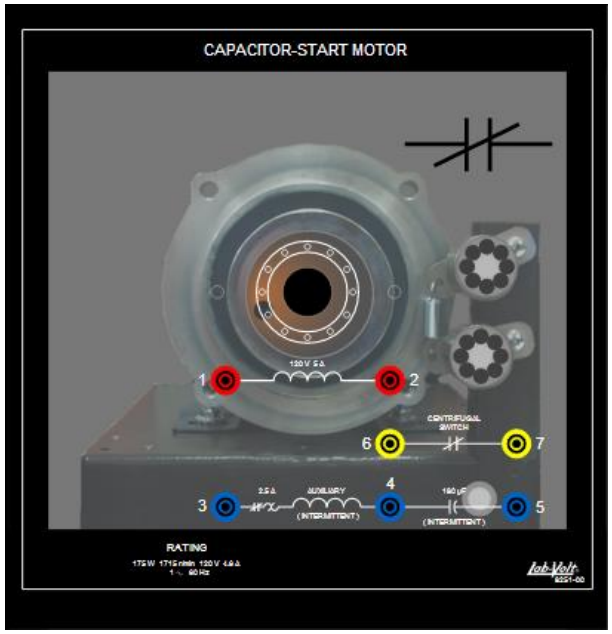
See Modifying a Control Knob Setting to obtain information on how to modify the setting of the exciter rheostat control knob.

Note that the thermistor output on the machine front panel is not implemented in the present version of LVSIM-EMS.



Capacitor-Start Motor

The Capacitor-Start Motor is a single-phase motor which can operate as either a split-phase or a capacitor-start induction motor. Access to the main winding, starting winding, centrifugal switch contacts, and starting capacitor is achieved through terminals on the module front panel.

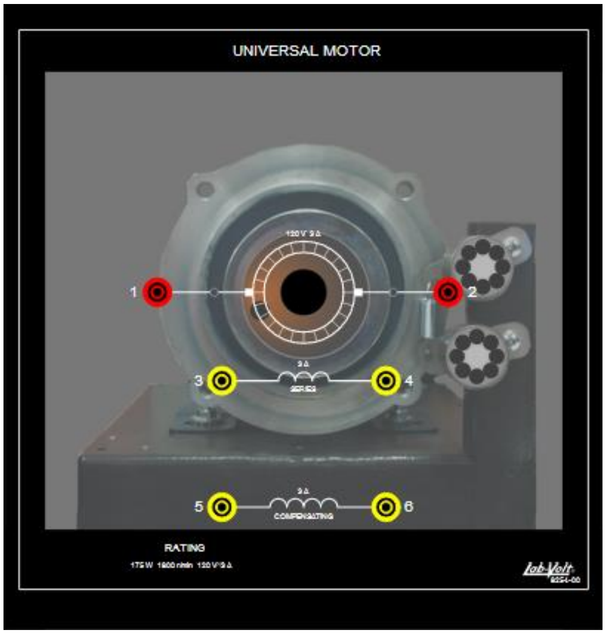


The centrifugal switch is provided with normally-closed contacts. This means that the switch contacts are closed when the motor is at standstill. They open when the motor speed reaches 1000 r/min. The status (open or closed) of the centrifugal switch contacts is indicated in the upper-right corner of the module front panel.

The starting winding, or auxiliary (AUX.) winding, is protected against overcurrent by a circuit breaker. The current rating of this circuit breaker is the same as that of the starting winding. When the circuit breaker trips, its reset button, located inside the module (on the right-hand side of the panel on which the motor is fixed), extends and becomes red. The circuit breaker is reset by lowering the front panel of the module, clicking the reset button, and raising the front panel of the module.

Universal Motor

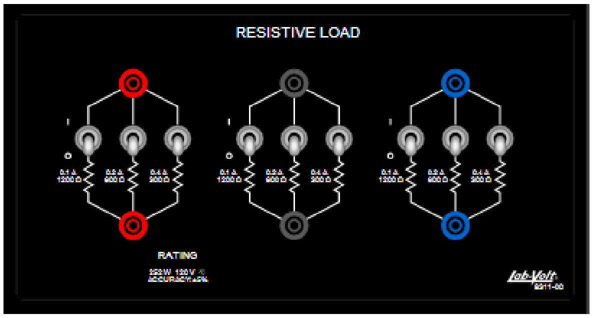
The Universal Motor is a single-phase motor which can operate with either AC or DC power. Access to the armature winding, series field winding, and compensating winding is achieved through terminals on the module front panel.



Resistive Load

The Resistive Load is divided in three identical sections, each consisting of three resistors which can be connected to a single pair of terminals located on the module front panel. These resistors are schematized on the module front panel.

A toggle switch, located over each resistor on the module front panel, controls the connection of the resistor to the terminals. The connection is made or broken by clicking the toggle switch. A resistor is connected to the terminals when the corresponding toggle switch is set to the I position.

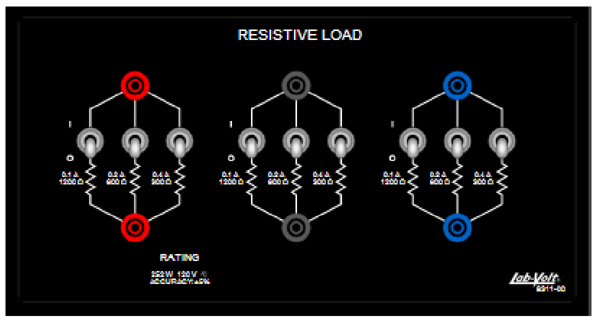


Low-Voltage Resistive Load

The Low-Voltage Resistive Load is divided in three identical sections, each consisting of three resistors which can be connected to a single pair of terminals located on the module front panel. These resistors are schematized on the module front panel.

A toggle switch, located over each resistor on the module front panel, controls the connection of the resistor to the terminals. The connection is made or broken by clicking the toggle switch. A resistor is connected to the terminals when the corresponding toggle switch is set to the I position.

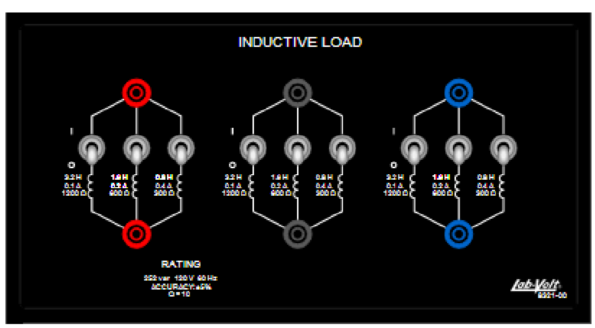
The Low-Voltage Resistive Load is used to provide low resistance values to users operating in a high-voltage ac power network. Because of this, the module is only available to users that selected either a 220 V or 240 V ac power network.



Inductive Load

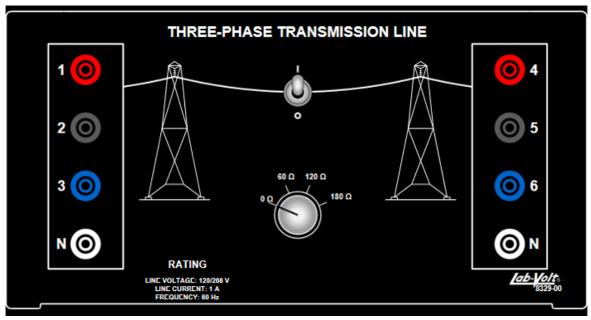
The Inductive Load module is divided in three identical sections, each consisting of three inductors which can be connected to a single pair of terminals located on the module front panel. These inductors are schematized on the module front panel.

A toggle switch, located over each inductor on the module front panel, controls the connection of the inductor to the terminals. The connection is made or broken by clicking the toggle switch. An inductor is connected to the terminals when the corresponding toggle switch is set to the I position.



Three-Phase Transmission Line

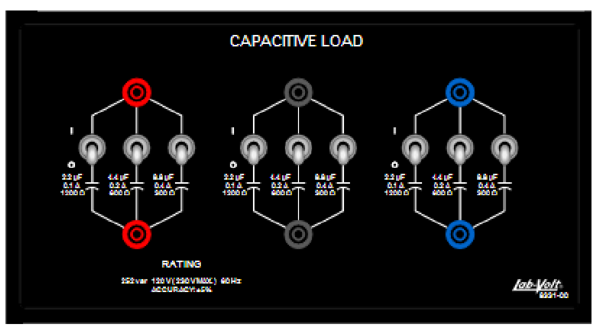
The Three-Phase Transmission Line consists of three iron-core inductors. The inductors are specifically designed to simulate a high-voltage ac transmission line. The line impedance can be adjusted to four different values using a selector switch mounted on the front panel. A three-pole switch is used to induce transients by momentarily interrupting the power flow.



Capacitive Load

The Capacitive Load module is divided in three identical sections, each consisting of three capacitors which can be connected to a single pair of terminals located on the module front panel. These capacitors are schematized on the module front panel.

A toggle switch, located over each capacitor on the module front panel, controls the connection of the capacitor to the terminals. The connection is made or broken by clicking the toggle switch. A capacitor is connected to the terminals when the corresponding toggle switch is set to the I position.

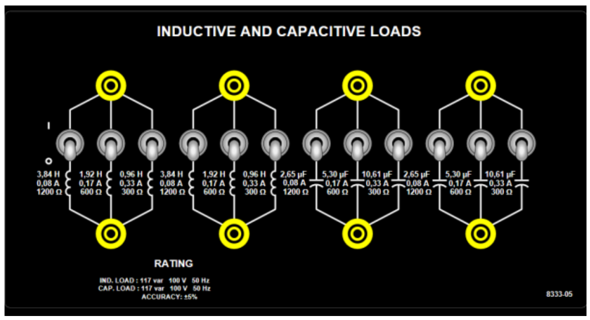


Inductive and Capacitive Loads

The Inductive and Capacitive Loads module consists of six iron-core power inductors and 6 oil-filled capacitors, with each type of load grouped into two identical banks. The different load inductors and capacitors in each bank can be connected in parallel through switches located on the front panel of the module.

A toggle switch, located over each capacitor and each inductor on the module front panel, controls the connection of the capacitor to the terminals. The connection is made or broken by clicking the toggle switch. A capacitor or an inductor is connected to the terminals when the corresponding toggle switch is set to the I position.

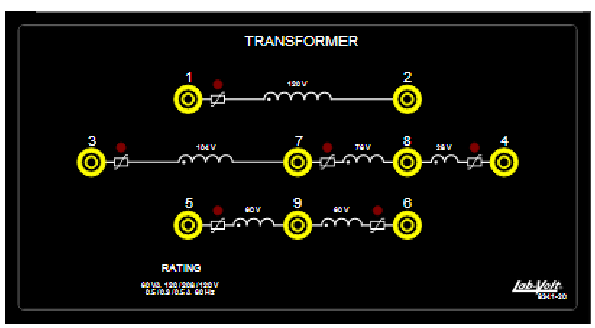
The module is only available to users that selected either a 220 V or 240 V ac power network.



Single-Phase Transformer (Model 8341)

The Single-Phase Transformer consists of three discrete windings. Each winding can be used as either a primary or a secondary. Two of the windings have multiple taps. These features allow transformers having different voltage ratios to be implemented. Access to the windings is achieved through terminals on the module front panel.

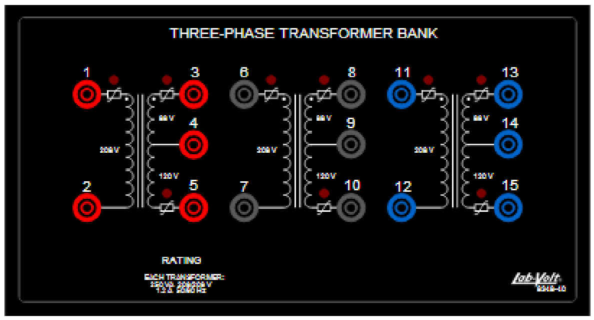
Note that the overcurrent LEDs on the front panel of the module are not implemented in the present version of LVSIM-EMS.



Three-Phase Transformer

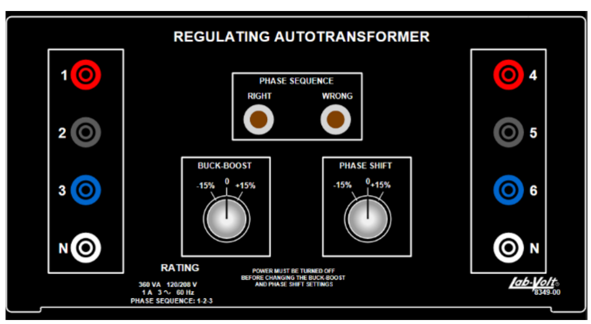
The Three-Phase Transformer consists of three identical single-phase transformers. Each winding can be used as either a primary or a secondary. One of the windings of each transformer has an intermediate tap. These features allow delta-star (wye), star-delta, star-star, and delta-delta connections. Access to the windings is achieved through terminals on the module front panel.

Note that the overcurrent LEDs on the front panel of the module are not implemented in the present version of LVSIM-EMS.



Regulating Autotransformer

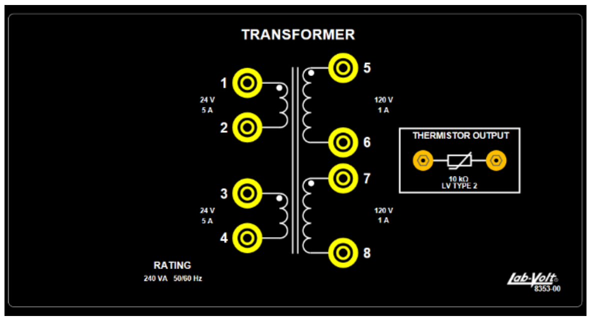
The Three-Phase Regulating Autotransformer consists of a three-phase autotransformer. A buck-boost selector switch can be used to increase or decrease the autotransformer output voltage by 15%. A phase-shift selector switch can be used to set the phase shift produced by the autotransformer output voltage to ±15°. A phase sequence indicator on the module front panel indicates the phase sequence of the voltages across the autotransformer.



Single-Phase Transformer (Model 8353)

The Transformer consists of a power transformer. Both the primary and secondary sides of the Transformer are made of two identical separate windings. The Transformer has a turns ratio of 1:5, when considering the totality of its primary and secondary windings. The Transformer windings are polarized and the polarity of each winding is indicated by a small dot on the module front panel. A typical application of the Transformer is to convert the energy stored in batteries to a suitable voltage level (for example, to the level of the ac power network voltage).

Note that the thermistor output on the module front panel is not implemented in the present version of LVSIM-EMS.

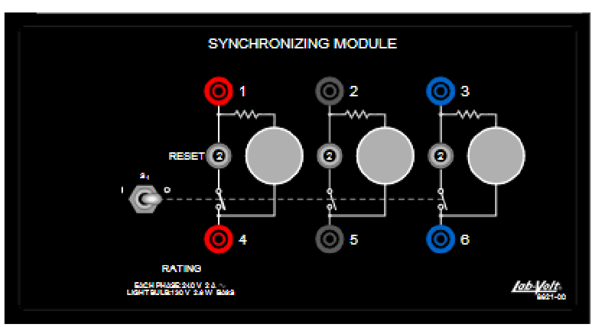


Synchronizing Module

The Synchronizing Module consists of a triple-pole, single-throw switch and three indicator lamps. Each lamp is connected in parallel with a contact pair of the triple-pole switch. Access to the lamps and switch contacts is achieved through three pairs of terminals on the module front panel. The main function of the Synchronizing Module is to indicate synchronism between two AC generators and to electrically interconnect the generators by closing the triple-pole switch.

The color of the lamps on the Synchronizing Module gradually passes from white to orange when the lamp brightness increases.

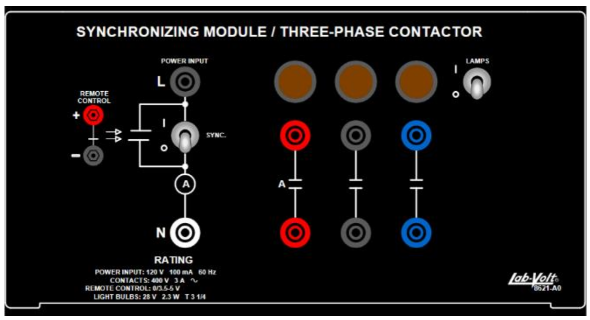
To modify the triple-pole, single-throw switch setting (open or closed), place the cursor on the switch, then left-click on the mouse. This toggles the switch from one position to the other. Note that the circuit is closed when the switch is in the I position, and it is closed when the switch is in the O position.



Each pole of the triple-pole switch is protected against overcurrent by a circuit breaker. The current rating of each circuit breaker is the same as that of the switch. When one of the circuit breakers trips, its reset button, located on the module front panel becomes red. The circuit breaker is reset by clicking the reset button.

Synchronizing Module / Three-Phase Contactor

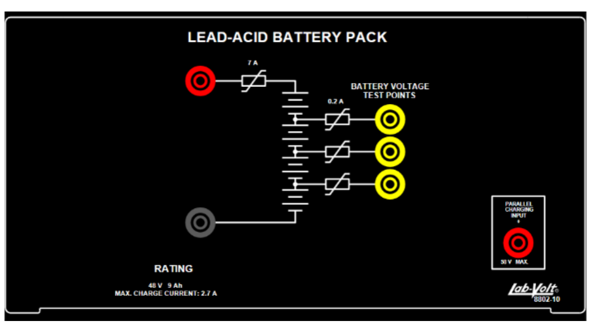
The Synchronizing Module/Three-Phase Contactor is used to control various electric devices, or synchronize two ac power sources like a synchronous generator with an ac power network. It consists of a three-phase contactor whose coil can be energized either manually with a toggle switch, or automatically with a thyristor fired by applying to the Remote Control input of the module, a low-level (TTL) signal from the Data Acquisition and Control Interface, Model 9063. Three indicator lamps indicate the relative level of the voltage across their corresponding contact terminals.



Lead-Acid Battery Pack

The Lead-Acid Battery Pack houses four 12 V lead-acid batteries connected in series. It thus provides a fixed dc voltage of 48 V. Three battery voltage test points allow measurement of the voltage provided by each of the four 12 V batteries. The Lead-Acid Battery Pack can be used as a 48 V dc power source.

Note that the parallel charging input on the module front panel is not implemented in the present version of LVSIM-EMS.

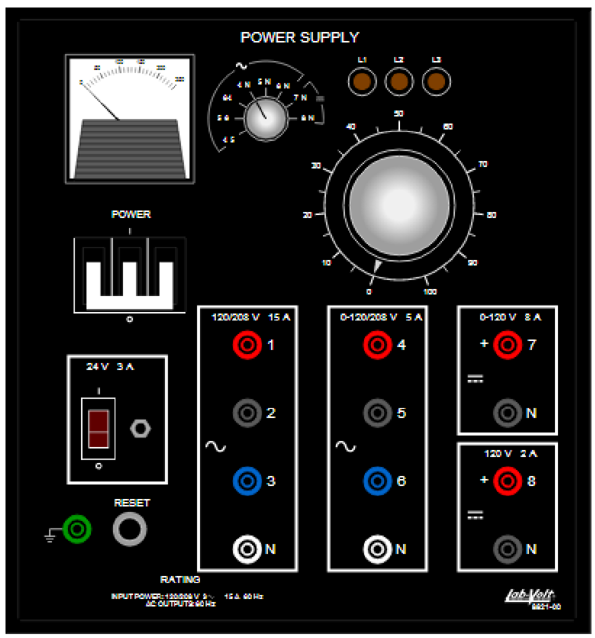


Power Supply (Model 8821)

The Power Supply is one of the power sources available in the EMS System. It mainly consists of the following five power sources:

- a fixed-voltage, three-phase, four-wire power source;
- a variable-voltage, three-phase, four-wire power source;
- a fixed-voltage DC power source;
- a variable-voltage DC power source;
- a 24 V AC power source.

The Power Supply is automatically connected to a three-phase AC power network when it is installed in the workstation.



Main Power Sources

The three-phase power sources and the DC power sources supply power to the various circuits which can be implemented with the EMS System. Access to these power sources is achieved through terminals on the module front panel. These power sources are turned on by setting the POWER switch to the I position. The setting of the POWER switch (I or O) is changed whenever it is clicked with the left mouse button. The three pilot lights located in the upper right corner of the module front panel light up to indicate that the power sources are turned on.

The voltages of the variable-voltage, three-phase power source and variable-voltage DC power source are adjusted using the control knob located in the upper right corner of the module front panel. These voltages are increased when the control knob is turned clockwise and decreased when it is turned counterclockwise. See Modifying a Control Knob Setting to obtain information on how to modify the setting of the voltage control knob.

Built-In Voltmeter

The voltages of the variable-voltage, three-phase power source, variable-voltage DC power source, and fixed-voltage DC power source can be measured using the module's built-in voltmeter. The display of this voltmeter is located in the upper left corner of the module front panel. The source voltage measured with this voltmeter is indicated in volts (V).

The button located on the right of the voltmeter display allows selection of the source voltage. This button is referred to as the voltage selector. See Modifying a Control Knob Setting to obtain information on how to modify the setting of the voltage selector control knob.

The following voltages are available for the variable-voltage, three-phase ac power source:

- Line-to-line voltages 4-5, 5-6, and 6-4
- Line-to-neutral voltages 4-N, 5-N, and 6-N

The following voltages are available for the dc power source:

- Variable-voltage 7-N
- Fixed-voltage 8-N

Low Power AC Source

The 24 V AC power source is used to supply power to the Prime Mover / Dynamometer and Data Acquisition Interface modules. Access to this power source is achieved through a jack on the module front panel. The 24 V AC power source is turned on by setting the 24 V AC power switch to the I position. The setting of the 24 V AC power switch (I or O) is changed whenever it is clicked with the left mouse button.

Overcurrent Protection

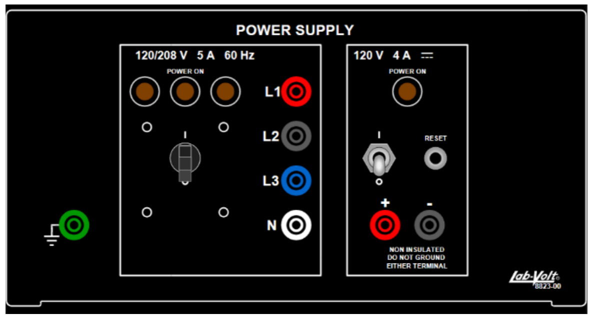
The variable-voltage power sources and the fixed-voltage DC power source are protected against overcurrent by thermomagnetic circuit breakers. When the current rating of any of these sources is exceeded, one or several circuit breaker(s) may trip. When so, the RESET button, located in the lower left corner of the module front panel, becomes red. The tripped circuit breaker(s) can be reset by clicking the RESET button with the left mouse button.

Line Input Overcurrent Protection

The POWER switch is also a three-phase circuit breaker which prevents the Power Supply from drawing too much current from the three-phase AC power network as the loads applied to the various power sources increase. When the maximum input current per phase is exceeded, the three-phase circuit breaker may trip. When so, the button of the POWER switch returns to the O position. The three-phase circuit breaker can be reset by placing the POWER switch to the I position. This is done by clicking the POWER switch with the left mouse button. The current rating of the three-phase circuit breaker is the same as that of the fixed-voltage, three-phase power source.

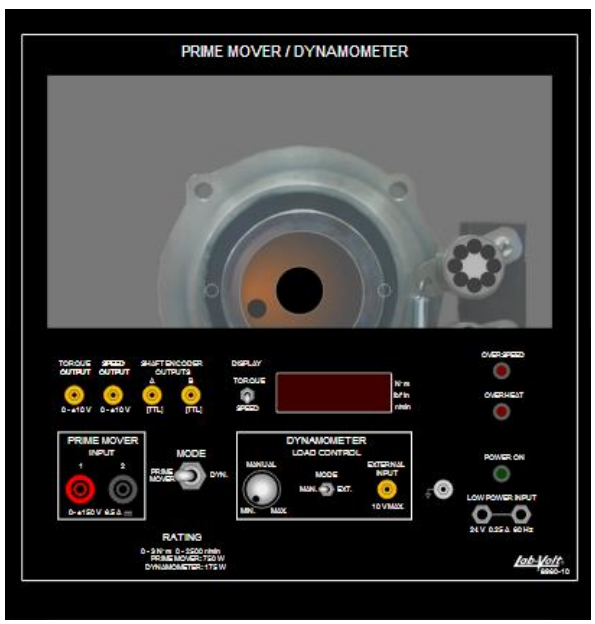
Power Supply (Model 8823)

The Power Supply consists of a fixed-voltage three-phase ac power source and a fixed-voltage dc power source. It can be used to power most of the EMS modules. Independent circuit breakers, with a reset button on the front panel of the module, protect the inputs and outputs from overcurrent conditions. Indicator lamps allow monitoring the presence of input voltage on each phase.



Prime Mover / Dynamometer

The Prime Mover / Dynamometer consists of a permanent-magnet DC motor, a variable load circuit, and a digital display indicating the motor speed or torque. The module can be used as a prime mover or as a dynamometer depending on whether the MODE switch is set to the prime mover (PRIME MOVER) or dynamometer (DYN.) position. To modify the MODE switch setting (PRIME MOVER. or DYN.), place the cursor on the switch, then left-click on the mouse. This toggles the switch from one position to the other.



Prime Mover

When the module is used as a prime mover, the permanent-magnet DC motor drives another machine. DC power is supplied to the armature of the permanent-magnet DC motor through input terminals 1 and 2. The motor speed is proportional to the DC voltage applied to the armature.

Dynamometer

When the module is used as a dynamometer, the permanent-magnet DC motor is driven by another machine and acts as a generator. The armature of the permanent-magnet DC motor is connected to the variable load circuit. The mechanical load to the driving machine is proportional to the electrical load applied to the generator. The load can be controlled manually or externally depending on whether the LOAD CONTROL MODE switch is set to the manual (MAN.) or external (EXT.) position. To modify the LOAD CONTROL MODE switch setting (MAN. or EXT.), place the cursor on the switch, then left-click on the mouse. This toggles the switch from one position to the other.

In the manual load control mode, the load is varied using the MANUAL knob. The load is increased as the knob is turned clockwise and it is decreased when the knob is turned counterclockwise. See Modifying a Control Knob Setting to obtain information on how to modify the setting of MANUAL knob.

In the external load control mode, the load is controlled by the voltage applied to the external input (EXTERNAL INPUT) terminal. The load increases as the voltage increases. The voltage range is from 0 V to 10 V.

Digital Display

In both operating modes, the digital display on the module front panel indicates either the motor speed or the motor torque. The switch located to the left of the display is used to select between the speed (SPEED) and torque (TORQUE). The selected parameter changes whenever the selection switch is clicked with the left mouse button. An LED located to the right of the display lights up to indicate the selected parameter. The speed is expressed in r/min and the torque is expressed in N·m or lbf·in depending on the selected system of units. See General Options for additional information on the system of units.

Outputs

In both operating modes, the torque (TORQUE) terminal provides a voltage proportional to the torque developed by the machine coupled to the Prime Mover / Dynamometer. Similarly, the speed (SPEED) terminal provides a voltage proportional to the machine speed. Note that the polarity of the voltages at the TORQUE and SPEED terminals is positive when the torque and the direction of rotation are clockwise and vice versa. The TORQUE, SPEED, and common terminals can be connected to the corresponding terminals on the Data Acquisition Interface, Model 9062, or the Data Acquisition and Control Interface, Model 9063, to allow torque and speed measurements using the Metering window.

Low Power Input

The Prime Mover / Dynamometer requires low-voltage AC power (24 V) to operate. Two input jacks located in the lower right corner of the front panel allow the module to be connected to the 24 V AC power source on the Power Supply, Model 8821, or on the 24 V external power supply located near the bottom right side of the EMS workstation. An LED located over the 24 V power input of the Prime Mover / Dynamometer lights up when power is supplied to the module.

Overspeed Indicator

The overspeed indicator is an LED located beside the digital display on the module front panel.

When the module is used as a prime mover and the AC power network voltage is 220 V or 240 V, the overspeed indicator lights up and a protection circuit disconnect the armature of the permanent-magnet DC motor from input terminals 1 and 2, when either one of the following two situations occurs:

- When the speed exceeds 2500 r/min.
- When low-voltage AC power is supplied to the module while a DC voltage is already applied to input terminals 1 and 2.

In both cases, the voltage at input terminals 1 and 2 must be reduced to zero for the overspeed indicator to go out and the protection circuit to reconnect the armature of the permanent-magnet DC motor to the input terminals.

When the module is used as a dynamometer, the overspeed indicator lights up when the speed exceeds 3200 r/min. If the speed exceeds 3600 r/min, the mechanical load is automatically increased to maximum so that the speed decreases. The mechanical load is set back to its original value once the speed has decreased below 3600 r/min.

Four-Quadrant Dynamometer / Power Supply

The Four-Quadrant Dynamometer/Power Supply mainly consists of a permanent magnet (PM) DC motor, four-quadrant power supply, and onboard microcontroller enclosed in a full-height EMS module. A toggle switch on the front panel allows selection of the operating mode. The module can be used as a four-quadrant dynamometer or a four-quadrant power supply depending on whether the OPERATING MODE switch is set to the DYNAMOMETER or POWER SUPPLY position. To modify the OPERATING MODE switch setting (DYNAMOMETER or POWER SUPPLY), place the cursor on the switch, then left-click on the mouse. This toggles the switch from one position to the other.

In each operating mode, key parameters related to the selected function are displayed. Speed, torque, mechanical power, and energy are displayed in the Dynamometer mode while voltage, current, electrical power, and energy are displayed in the Power Supply mode.

Dynamometer

In the Dynamometer mode, the unit becomes a four-quadrant dynamometer that can act as either a fully-configurable brake (i.e., a mechanical load) or a fully-configurable prime mover (i.e., a motor drive). A wide variety of user-selectable functions is available specifically in this operating mode. To select a function, place the cursor on Function button, then left-click on the mouse to cycle through the available functions. The name of the currently activated function appears in the status screen on the right of the module. The following functions are currently available for the Four-Quadrant Dynamometer/Power Supply in dynamometer mode:

- Clockwise (CW) Prime Mover/Brake
- Counterclockwise (CCW) Prime Mover/Brake
- Two-Quadrant (2Q) Constant-Torque (CT) Brake
- Clockwise (CW) Constant-Speed (CS) Prime Mover/Brake

- Counterclockwise (CCW) Constant-Speed (CS) Prime Mover/Brake
- Positive Constant-Torque (CT) Prime Move/Brake
- Negative Constant-Torque (CT) Prime Move/Brake
- Speed Sweep (available in the Four-Quadrant Dynamometer/Power Supply instruments window)

Power Supply

In the Power Supply mode, the unit becomes a four-quadrant power supply that can act as a DC voltage source, DC current source, AC power source, and many other types of power supplies. A wide variety of user-selectable functions is available specifically in this operating mode. To select a function, place the cursor on Function button, then left-click on the mouse to cycle through the available functions. The name of the currently activated function appears in the status screen on the right of the module. The following functions are currently available for the Four-Quadrant Dynamometer/Power Supply in power supply mode:

- Voltage Source (+)
- Voltage Source (-)
- 50 Hz Power Source
- 60 Hz Power Source
- AC Power Source (available in the Four-Quadrant Dynamometer/Power Supply instruments window)
- DC Voltage Source (available in the Four-Quadrant Dynamometer/Power Supply instruments window)

Digital Display

In both operating modes, the digital display on the module front panel indicates key parameters. For example, in the dynamometer operating mode, parameters such as speed, torque, mechanical power, and energy are displayed on the status screen. On the other hand, in the power supply operating mode, parameters such as voltage, current, electrical power, and energy are displayed on the status screen.

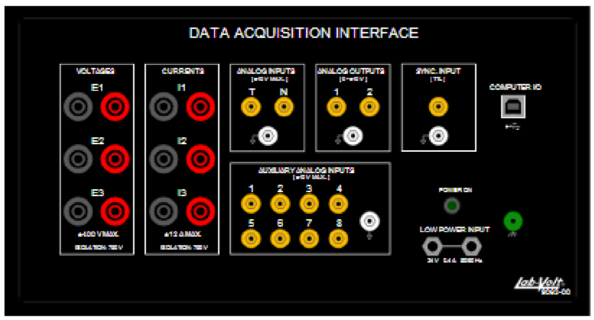
Power Input

The Four-Quadrant Dynamometer/Power Supply is powered via its main power input. It requires power from a standard ac power outlet. The LVSIM-EMS software assumes that the module is connected to such an ac power outlet. Therefore, to turn the power supply on, place the cursor on the Power Input switch, then left-click on the mouse. This toggles the Power Input switch from one position to the other. When the Power Input switch is in the I position, the module is on. When the Power Input switch is in the O position, the module is off.

Data Acquisition Interface 9062 (DAI)

The Data Acquisition Interface (DAI) module is required to perform voltage, current, speed, and torque measurements using the computer-based instruments for electromechanical systems. It consists of three voltage inputs (E1, E2, and E3), three current inputs (I1, I2, and I3), a torque input (T), a speed input (N), two control outputs (ANALOG OUTPUTS 1 and 2), a synchronization input (SYNC. INPUT), and eight auxiliary analog inputs. Access to the various inputs and the ANALOG OUTPUTS is achieved through terminals on the module front panel. The USB port of the DAI module is automatically connected to the computer that implements the computer-based instruments when the module is installed in the Workstation.

Note that ANALOG OUTPUTS 1 and 2, the SYNC. INPUT and the ANALOG INPUTS 1 to 8 are not functional in the current version of the application.

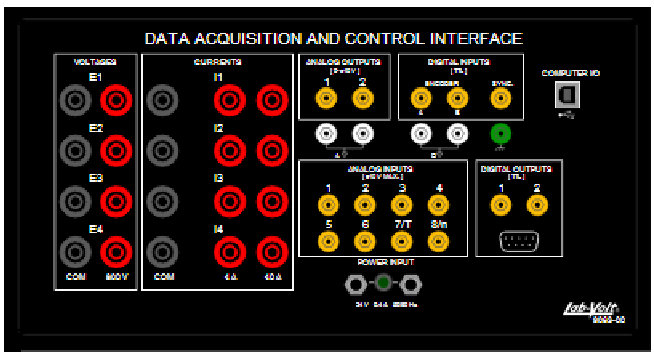


The DAI requires low-voltage AC power (24 V) to operate. Two input jacks located in the lower right corner of the front panel allow the module to be connected to the 24 V AC power source on the Power Supply, Model 8821, or on the 24 V external power supply located near the bottom right side of the EMS workstation. An LED located over the low power inputs of the DAI lights up when power is supplied to the module.

Data Acquisition and Control Interface 9063 (DACI)

The Data Acquisition and Control Interface (DACI) is required to perform voltage, current, speed, and torque measurements using the computer-based instruments for electromechanical systems. It has four isolated, high-level voltage inputs (E1, E2, E3, E4) and four isolated, high-level current inputs (I1, I2, I3, I4). All these inputs are fitted with 4-mm banana safety jacks to make connections to electric power circuits quick, safe, and easy. The DACI also has eight low-level, analog inputs which allow measurement of other circuit signals (AI-1 to AI-8/n). Two of these inputs can be used to measure torque (AI 7/T) and speed (AI 8/n). Finally, the DACI is provided with three digital inputs. Two of these digital inputs are used as an incremental encoder input (A-B) and the third input (SYNC) is used for synchronization. The USB port of the DACI module is automatically connected to the computer that implements the computer-based instruments when the module is installed in the Workstation.

Note that inputs E4 and I4, the DIGITAL INPUTS, ANALOG INPUTS 1 to 6, and the DIGITAL OUTPUTS are not functional in the current version of the application.



The DACI module requires low-voltage AC power (24 V) to operate. Two input jacks located on the front panel allow the module to be connected to the 24 V AC power source on the Power Supply, Model 8821, or on the 24 V external power supply located near the bottom right side of the EMS workstation. An LED located between the 24 V power inputs of the DACI lights up when power is supplied to the module.

Half- and Full-Height Blank Modules

In the actual EMS system, blank modules should be installed in the workstation to fill it up, after the equipment setup is done. This prevents the students from accessing components inside the modules (resistors, motors, generators etc.), and thereby, eliminates risks of electrical shocks and minor injuries.

Although there are no risks of electrical shocks and injuries when using the virtual electromechanical equipment, blank modules can be installed in the virtual Mobile Workstation to encourage good safety habits. The blank modules are standard modules with no components inside and no markings on the front panel. Half- and full-height blank modules are available.

Instruments

Metering

The Metering window provides a complete set of meters that allow measurements of electrical and mechanical quantities in electromechanical systems as well as in power electronics circuits. It contains 18 meters that can each be configured to measure one of the following parameters: voltage, current, power (active, reactive, and apparent), efficiency, impedance, power factor, frequency, energy, torque, speed, and phase shift. All meter settings, that is, the meter range, the meter status (on or off), etc., can be changed according to your needs. Values measured with the various meters can be recorded in a data table to plot graphs.

Menus

File Menu Commands

Print...

Sends the Metering data to the printer. The Print dialog box appears before the Metering data is sent to the printer. This box allows the print setup and options to be modified before printing. The Metering data is effectively sent to the printer after the OK button in the Print dialog box is clicked.

Close

Closes the Metering window. Note that the current configuration (meter settings) of the Metering window is kept in memory as long as the application from which the Metering window was opened is running.

View Menu Commands

Layout...

Opens the Layout dialog box. This box allows you to select and modify a meter layout. A meter layout is the arrangement of the meters in the Metering window. Four meter layouts are available. See Meter Layout to obtain additional information.

Meter Settings...

Opens the Meter Settings dialog box. This box allows the various settings of each meter in the Metering window to be changed. See Meter Settings to know how to change the meter settings.

Single Refresh

Refreshes the value indicated by each of the meters in the Metering window. Note that when this command is performed while the values indicated by the meters are refreshed at regular time intervals (Continuous Refresh mode), the current refreshing cycle is completed and the continuous refresh of the meters is stopped.

Continuous Refresh

Automatically refreshes the values indicated by the meters in the Metering window at regular time intervals. A circle appears around the Continuous Refresh command in the View menu when the continuous refresh mode is selected. To stop the continuous display refresh, click either the Refresh or the Continuous Refresh button or choose either the Refresh or Continuous Refresh command in the View menu.

Options Menu Commands

Acquisition Settings...

Opens the Acquisition Settings dialog box. This box allows you to select the length of the sampling window, that is, the time interval during which parameters are sampled to obtain the data used to calculate the values indicated by the various meters in the Metering window. See Acquisition Settings to obtain additional information.

Help Menu Commands

Contents and Index...

Opens the Help file related to the software product you are currently using.

Toolbar

The buttons in the toolbar can be clicked to perform various functions. The function related to each button is briefly described below.

Icon	Description
	Print
	Single Refresh
	Continuous Refresh
	Meter Settings

Status Bar

The Metering status bar is located at the bottom of the Metering window. It contains two information fields.

The first field in the status bar indicates which one of the available sampling windows is selected in order to acquire the data required to calculate the values displayed by the various meters in the Metering window. See Acquisition Settings in Options Menu Commands (Metering) for additional information.

The second field in the status bar indicates the fundamental frequency of the parameters to be measured. See Acquisition Settings to obtain additional information.

Meter Settings

The settings of the various meters in the Metering window can be changed through the Meter Settings dialog box. Shortcuts in the Metering window are also available for changing the meter settings. See Shortcuts to Meter Settings for additional information. The various items in the Meter Settings dialog box are described in this topic.

Meter

In the Meter Settings dialog box, meter settings can be changed one meter at a time. The Meter list allows selection of the meter whose settings are changed.

Type and Input / Function

The Type list allows selection of the parameter type (voltage, power, impedance, frequency, energy, etc.) that is measured by the programmable meter.

Once the type of parameter has been selected, the Input / Function list indicates the functions which are available for measuring this type of parameter. The desired function is selected by clicking an option in the Input / Function list. See Technical Information about the Programmable Meter Functions to obtain information on the various meter functions.

Label

In the Metering window, there is a label above the display of each meter. The Label box allows edition of the label of the meter selected in the Meter list. Note that the label of each meter can also be edited directly in the Metering window.

Mode

The Mode list allows selection of the operating mode of the meter selected in the Meter list. The available modes mainly depend on the type of parameter (voltage, current, power, impedance, power factor, torque, etc.) that is measured with the meter. See Meter Operating Modes to obtain additional information about the operating modes available for each of the various types of meter.

Display

Each meter in the Metering window can have a digital-type or analog-type display. The display type of the meter selected in the Meter list is determined by clicking one of the two Display option buttons.

Scale

When the Analog Display option button is selected, the Scale list allows selecting the scale of the meter selected in the Meter list.

Meter Status (On or Off)

The status (on or off) of the meter selected in the Meter list can be changed by clicking the ON check box. A check mark appears in the ON check box to confirm that the meter is turned on. Note that a programmable meter cannot be turned on as long as the meter definition (nature of the measured parameter, input(s), function) has not been determined by selecting an option in the Type and Input / Function lists.

Analog Meter Zero Location

In the Metering window, the zero on analog-type display meters may be located in the middle or on the left-hand side of the scale. When the Analog Display option button is selected, the zero location (middle or left) of the meter selected in the Meter list can be changed by clicking the 0 Center check box. A check mark appears in the 0 Center check box to confirm that the zero is located in the middle of the scale.

Command Buttons

Clicking the Apply button applies the settings made in the Meter Settings dialog box to the meters in the Metering window.

Clicking the Cancel button returns to the Metering window without changing the settings of the meters in this window.

Clicking the OK button applies the settings made in the Meter Settings dialog box to the meters in the Metering window and returns to this window.

Meter Operating Modes

Various operating modes are available for several of the meters in the Metering window. The modes which are available for a particular meter mainly depend on the type of parameter (voltage, current, power, impedance, torque, etc.) that is measured. The operating modes available for each of the various types of meters are listed below.

Voltage and Current Meters (Voltmeters and Ammeters)

Three operating modes are available: DC, AC, and CF. In the DC mode, the average value of the parameter is measured. In the AC mode, the root-mean-square (RMS) value of the parameter is measured. In the CF mode, the crest factor of the parameter is measured.

Additional operating modes are available when the 2-cycle or 8-cycle sampling window is selected (you can refer to Acquisition Settings to obtain additional information on the sampling window). The following operating modes become available: AC1 to AC15, THD, THD1, and ACh. In the AC1 mode, the RMS value of the parameter's fundamental-frequency component is measured. In the AC2 to AC15 modes, the RMS value of the corresponding harmonic of the parameter is measured. For instance, the AC4 mode measures the RMS value of the fourth harmonic. The THD mode measures the total harmonic distortion with respect to the RMS value of the parameter's ac component. The THD1 mode measures the total harmonic distortion with respect to the RMS value of the parameter's fundamental-frequency component. In the ACh mode, the RMS value of the harmonics (second harmonic to fifteenth harmonic) is measured.

See Technical Information about the Voltmeters and Ammeters for additional information.

Symmetrical Component Meters

Three operating modes are available: P, N, and Z. In the P mode, the positive sequence voltage (or current) related to a three-phase power system is indicated. In the N mode, the negative sequence voltage (or current) is indicated. In the Z mode, the zero sequence voltage (or current) is indicated. See Voltage and Current in Technical Information about the Programmable Meter Functions for additional information.

Electrical Power Meters

Three operating modes are available: S, P, and Q. The S mode measures the apparent power. The P mode measures the active power. The Q mode measures the reactive power. See Technical Information about the Electrical Power Meters for additional information.

Impedance Meters

Three operating modes are available: R, X, and Z. In the R mode, resistance is measured. In the X mode, reactance is measured. In the Z mode, impedance is measured. See Impedance in Technical Information about the Programmable Meter Functions for additional information.

Torque and Mechanical Power Meters

Two operating modes are available: NC and C. In the NC (non-corrected) mode, the torque measured by the torque measurement mechanism, or the mechanical power calculated using this torque, is indicated. In the C (corrected) mode, the measured torque is corrected to compensate for errors due to friction in the torque measurement mechanism. The corrected torque, or the mechanical power calculated using the corrected torque, is indicated. See Technical Information about the Torque and Speed Meters for additional information.

Power Factor Meters

Three operating modes are available for the single-phase power factor meters when the 2-cycle or 8-cycle sampling window is selected: True, Disp, and Dist. In the True mode, the true power factor is measured. In the Disp mode, the displacement power factor is measured. In the Dist mode, the distortion power factor is measured. See Technical Information about the Programmable Meter Power Factor Functions for additional information.

Note that no operating mode is available for the following types of meters:

- Frequency Meters
- Energy Meters
- Speed Meters (Tachometers)
- Phase Meters

Shortcuts to Meter Settings

The settings of the various meters in the Metering window can be changed using the Meter Settings dialog box. However, most of the meter settings can also be changed directly from the Metering window using shortcuts. These shortcuts consist of zones (usually boxes) on each meter in the Metering window. Each of these zones can be clicked to modify a particular meter setting. Available shortcuts are briefly described in the following figure and paragraphs.

Meter Identification Tag

Clicking the Meter Identification Tag changes the on/off status of the meter. Note that a meter with no function selected remains off when its identification tag is clicked.

Meter Label

Clicking on the small rectangle above the digital display allows the edition of the Meter Label.

Input/Function Display

The upper right corner box display the input or combination of inputs used for the measurement.

Digital Display

Clicking in the digital display of a meter changes the meter display type (analog or digital).

Analog Display

On meters with an analog-type display, clicking anywhere in the analog display changes the zero location (middle or left).

Lower Left Corner Zone

Clicking the lower left corner box using the left mouse button toggles between the operating modes available for the selected meter function. Clicking the lower left corner box using the right mouse button displays a menu that allows selection of the alternate mode of operation.

See Meter Operating Modes to obtain additional information about the operating modes available for each of the various types of meter.

Meter Range

On meters with an analog-type display, clicking the range indicated in the lower right corner changes the meter range.

See Meter Operating Modes to obtain additional information about the operating modes available for each of the various types of meter.

Meter Layout

The Layout dialog box allows you to select the layout of the meters in the Metering window. It also allows a meter layout to be edited by changing the number of meters. The Layout dialog box is opened by choosing the Layout... command in the View menu.

In the Layout dialog box, the Layout list allows selection of one of the four meter layouts available.

The number of meters in the selected meter layout can be adjusted by changing the number of columns and rows. The number of columns is modified using the Number of Columns parameter. Similarly, the number of rows is modified using the Number of Rows parameter.

Clicking the Default button changes the currently-selected meter layout to the default all meters arrangement.

Clicking the OK button applies the currently-selected meter layout to the Metering window, saves all changes made to the meter layouts, and returns to the Metering window.

Clicking the Cancel button returns to the Metering window without taking into account any of the selections and changes made in the Layout dialog box.

Acquisition Settings

The Acquisition Settings dialog box allows you to select the length of the sampling window, that is, the time interval during which parameters are sampled to obtain the data used to calculate the values indicated by the various meters in the Metering window.

The length of the sampling window is determined by selecting one of the following options in the Sampling Window drop-down list: Extended, 2 cycles, and 8 cycles. When the Extended option is selected in the drop-down list, the sampling window is set to 250 ms. When the 2 cycles option is selected in the drop-down list, the sampling window spreads over a time interval equal to 2 cycles of parameters having a specific frequency. Similarly, when the 8 cycles option is selected, the sampling window spreads over a time interval equal to 8 cycles of parameters having a specific frequency.

When either the 2 cycles or 8 cycles option is selected in the Sampling Window drop-down list, the Fundamental Frequency data field becomes active. This data field allows you to specify the frequency of the parameters to be measured. This data is used by the system to calculate the duration of the time intervals corresponding to 2 cycles and 8 cycles of these parameters.

See Technical Information about Signal Sampling for additional information on the sampling window.

Technical Information

Signals Sampling

The values indicated by the various meters in the Metering window are calculated from samples of the signals at the DAI or DACI module inputs. These signals are sampled whenever a refresh command is performed in the Metering window.

The time interval during which the signals at the DAI or DACI inputs are sampled to obtain the data required to calculate the values indicated by the various meters in the Metering window is referred to as the sampling window. Three sampling windows of different lengths are available in the Metering window: Extended, 8 Cycles, and 2 Cycles. These sampling windows are described below. See Acquisition Settings to know how to select the sampling window.

2-Cycle Sampling Window

When the 2-Cycle sampling window is selected, the parameters are sampled during an interval equal to 2 cycles of the parameters to be measured. The sampling frequency is adjusted so that 64 samples are taken per cycle of each parameter. This provides 128 samples per parameter. These samples are used to calculate the mean (DC) and root-mean-square (RMS) values of the parameter. A fast Fourier transform (FFT) is also performed using the sampled data when a meter indicates a value related to the harmonic contents of the parameter it measures. The meters are refreshed every 0.5 s when the continuous refresh mode is selected.

The 2-Cycle sampling window should be used whenever the frequency of the parameters to be measured is known and fixed. When the 2-Cycle sampling window is used, each meter can display the mean (DC) or root-mean-square (RMS) value of the parameter, or a value related to the harmonic contents of the parameter, such as the RMS value of the fundamental or an harmonic component, the total harmonic distortion, etc.

8-Cycle Sampling Window

The 8-Cycle sampling window is very similar to the 2-Cycle sampling window. When the 8-Cycle sampling window is selected, the parameters are sampled during an interval equal to 8 cycles of the parameters to be measured. The sampling frequency is adjusted so that 64 samples are taken per cycle of each parameter. This provides 512 samples per parameter. These samples are used to calculate the value indicated by each meter, in the same way as when the 2-Cycle sampling window is used.

The 8-Cycle sampling window should be used whenever the frequency of the parameters to be measured is known and fixed. It allows measurement of the DC value, RMS value, or any harmonic-related value of a parameter.

Modes of Measurement

DC Mode

In the DC mode, the meter provides the mean value of the measured parameter. This value is obtained by calculating the mean value of the samples of the measured parameter.

AC Mode

In the AC mode, the meter provides the root-mean-square (RMS) value of the measured parameter. The RMS value is obtained by squaring the samples of the measured parameter, calculating the mean value of the squared samples, and then calculating the square root of the mean value of the squared samples.

Crest Factor (CF) Mode

In the CF mode, the meter indicates the crest factor of the measured parameter. The crest factor is calculated by dividing the peak value of the measured parameter (maximum value reached by the parameter) by the RMS value of the parameter.

The RMS value of the measured parameter is calculated as in a meter operating in the AC mode.

AC1 to AC15 Modes

In the AC1 mode, the meter provides the RMS value of the parameter's fundamental-frequency component. In the AC2 to AC15 modes, the meter provides the RMS value of the corresponding harmonic in the parameter. For instance, the RMS value of the fourth harmonic is measured when the AC4 mode is selected. In any of these modes, a fast Fourier transform (FFT) is performed using the samples of the measured parameter. The FFT provides the RMS values of the first fifteen harmonics in the measured parameter.

Note that the AC1 to AC15 modes are only available when the 2-Cycle or 8-Cycle sampling window is selected. See Technical Information about Signal Sampling for additional information about the sampling window.

ACh Mode

In the ACh mode, the meter provides the RMS value of the harmonics (second harmonic and higher harmonics) in the measured parameter. This value is obtained by subtracting the squared RMS value of the fundamental-frequency component of the measured parameter from the squared RMS value of this parameter, and calculating the square root of the result of the subtraction. The RMS value of the measured parameter is calculated as in a meter operating in the AC mode. The RMS value of the fundamental-frequency component of the measured parameter is obtained by performing a fast Fourier transform (FFT) using the samples of the measured parameter.

Note that the ACh mode is only available when the 2-Cycle or 8-Cycle sampling window is selected. See Technical Information about Signal Sampling for additional information about the sampling window.

Total Harmonic Distortion (THD) Modes

In the THD mode, the meter indicates the total harmonic distortion with respect to the RMS value of the measured parameter's ac component. The total harmonic distortion is calculated by dividing the RMS value of the harmonics (second harmonic and higher harmonics) in the measured parameter by the RMS value of this parameter, and multiplying the result by 100%.

In the THD1 mode, the meter provides the total harmonic distortion, with respect to the RMS value of the measured parameter's fundamental-frequency component. The total harmonic distortion is calculated by dividing the RMS value of the harmonics (second harmonic and higher harmonics) in the measured parameter by the RMS value of the measured parameter's fundamental-frequency component, and multiplying the result by 100%.

The RMS value of the measured parameter is calculated as in a meter operating in the AC mode. The RMS value of the fundamental-frequency component is obtained by performing a fast Fourier transform (FFT) using the samples of the measured parameter. The RMS value of the harmonics (second harmonic and higher harmonics) in the measured parameter is calculated as in a meter operating in the ACh mode.

Note that the THD and THD1 modes are only available when the 2-Cycle or 8-Cycle sampling window is selected. See Technical Information about Signal Sampling for additional information about the sampling window.

Power Calculations with the Extended Sampling Window

The apparent power is obtained by multiplying the RMS values of the voltage and current. The RMS values are calculated as in the AC mode of the voltmeters and ammeters. See Technical Information about the Programmable Meter Voltage and Current Functions for additional information about the AC mode.

The active power is obtained by multiplying the voltage and current values for each sample and then calculating the mean value of the voltage-current products.

The reactive power is obtained by shifting the phase of the current by 90 degrees, multiplying the voltage and phase-shifted current values for each sample, and then calculating the mean value of the voltage-current products. Note that the phase shift of 90 degrees is determined by analyzing the AC component of each parameter to find the instants at which the parameter passes through zero, and determine the period of each parameter. The longer of these two periods is used to determine the time interval that corresponds to a phase shift of 90 degrees. Also note that reactive power measurement is accurate as long as the waveforms of the voltage and current are sinusoidal.

Power Calculations with the 2-Cycle and 8-Cycle Sampling Windows

The apparent power is obtained by multiplying the RMS values of the fundamental-frequency components of the voltage and current.

The active power is obtained by multiplying the RMS values of the fundamental-frequency components of the voltage and current, and then multiplying the result by the cosine of the phase shift ø (cos ø) between the fundamental-frequency components of the voltage and current.

The reactive power is obtained by multiplying the RMS values of the fundamental-frequency components of the voltage and current, and then multiplying the result by the sine of the phase shift ø (sin ø) between the fundamental-frequency components of the voltage and current.

Note that for all these power calculations, the RMS values of the fundamental-frequency components of the voltage and current are calculated as in the AC1 mode of the voltmeters and ammeters. The phase shift ø between the fundamental-frequency components of the voltage and current is obtained by calculating the difference between the phase angles of these components. These phase angles are provided by the fast Fourier transforms (FFT's) performed to obtain the RMS value of the fundamental-frequency components of the voltage and current. See Technical Information about the Programmable Meter Voltage and Current Functions for additional information about the AC1 mode.

Programmable Meter Functions

All meters can be used as voltmeters, ammeters, torque meters, speed meters, power meters, efficiency meters, impedance meters, power factor meters, etc. This depends on the type of physical quantity and function selected for each meter, using the Meter Settings dialog box.

Voltage and Current Functions

There are a number of different voltage and current functions available for voltmeters and ammeters. The following list gives an example for each different type of Voltage and Current functions:

- E1 I1
- E1+E2 I1+I2
- Avg (E1,E2,E3) Avg (I1,I2,I3)
- PNZ (E1,E2,E3) PNZ (I1,I2,I3)

The simple voltage functions (E1, E2, etc.) measure the value of the voltage at a single input (E1, E2, etc.) of the Data Acquisition and Control Interface (DACI) module. The nature of the measured value depends on the mode of operation selected on the meter (DC, AC, AC1, CF, THD, etc.).

The simple current functions (I1, I2, etc.) measure the value of the current at a single input (I1, I2, etc.) of the Data Acquisition and Control Interface (DACI) module. The nature of the measured value depends on the mode of operation selected on the meter (DC, AC, AC1, CF, THD, etc.).

The voltage summing functions (E1+E2, E1+E2+E3, etc.) sum the voltages indicated in parentheses for each sample and then calculate the value of the voltage sums. The nature of the calculated value depends on the mode of operation selected on the meter (DC, AC, AC1, CF, THD, etc.). For example, the root-mean-square (RMS) value of the voltage sums is indicated when the meter operates in the AC mode. The current summing functions (I1+I3, I2+I3, etc.) sum the currents indicated in parentheses in the same manner as the voltage summing functions.

The voltage averaging function Avg (E1, E2, E3) calculates the average value of voltages E1, E2, and E3. The nature of the values used to calculate the average value depends on the mode of operation selected on the meter (DC, AC, AC1, CF, THD, etc.). For example, the average value of the RMS values of the fundamental-frequency component of voltages E1, E2, and E3 is calculated when the meter operates in the AC1 mode. The current averaging function Avg (I1,I2,I3) calculates the average value of currents I1, I2, and I3 in the same manner as the voltage averaging function.

The symmetrical component function PNZ (E1, E2, E3) measures the positive, negative or zero sequence voltage related to a three-phase power system using voltages E1, E2, and E3. Similarly, the symmetrical component function PNZ (I1,I2,I3) measures the positive, negative or zero sequence current using currents I1, I2, and I3. The symmetrical component that is measured depends on the operating mode selected for the meter. The positive sequence voltage is obtained by advancing the phase of voltages E2 and E3 by 120 and 240 degrees, respectively, summing voltage E1 and phase shifted voltages E2 and E3 for each sample, dividing the result of each voltage sum by three, and then calculating the RMS value of the weighted voltage sums. The negative sequence voltage is obtained by delaying the phase of voltage E2 and E3 by 120 and 240 degrees, respectively, summing voltage E1 and phase shifted voltages E2 and E3 for each sample, dividing the result of each voltage sum by three, and then calculating the RMS value of the weighted voltage sums. The zero sequence component is obtained by summing voltages E1, E2, and E3 for each sample, dividing the result of each voltage sum by three, and then calculating the RMS value of the weighted voltage sums. The positive, negative, and zero sequence currents are calculated using the same methods.

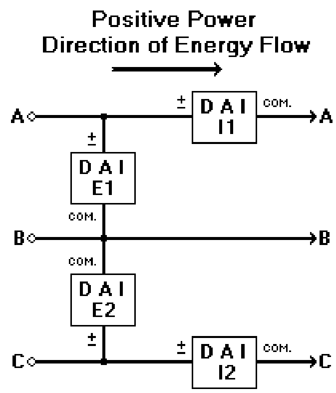
Electrical and Mechanical Power Functions

There are a number of different electrical and mechanical power functions available for power meters. The following list gives an example for each different type of electrical and mechanical power functions:

- PQS1 (E1,I1)
- PQS1+PQS2
- PQS1 (E1,I1) 3~
- Pm (T,N)

The simple electrical power functions (PQS1 (E1,I1), PQS2 (E2,I2), etc.) measure the value of the power from a single voltage input and a single current input (E1, I1, for example) of the Data Acquisition and Control Interface (DACI) module. Electrical power functions measure active power (P), reactive power (Q) or apparent power (S), depending on the operating mode selected on the meter.

The electrical power summing functions (PQS1+PQS2, PQS1+PQS2+PQS3, etc.) sum active (P), reactive (Q) or apparent (S) power of two or more power meters, depending on the operating mode selected on the meter. Active power sums are obtained by calculating the algebraic sum of the active powers. Similarly, reactive power sums are obtained by calculating the algebraic sum of the reactive powers. Apparent power sums are obtained by calculating the vectorial sum of the active and reactive power sums. Note that the PQS1+PQS2 power summing function can be used to measure three-phase power using the two-wattmeter method, when inputs E1, E2, I1,and I2 of the Data Acquisition and Control Interface (DACI) module are connected as shown in the following figure.



The three-phase electrical power functions (PQS1 (E1,I1) 3~, PQS2 (E2,I2) 3~, etc.) measure three-phase power using the line-to-line voltage and line current indicated in parentheses. Active power (P), reactive power (Q) or apparent power (S) is measured depending on the operating mode selected on the meter. Three-phase power is calculated in three steps. The line-to-line voltage is phase shifted by 30 degrees and divided by the root square of 3 to determine the corresponding line-to-neutral voltage. Single-phase power is then calculated using the line-to-neutral voltage and the line current. Finally, three-phase power is obtained by multiplying the single-phase power by 3. Note that accurate three-phase power measurements are obtained as long as the system is balanced.

Efficiency Functions

The following functions are available for measuring efficiency:

- Pm/P1
- Pm/(P1+P2)
- Pm/(P1+P2+P3)
- P2/P1
- P1/Pm
- (P1+P2)/Pm
- (P1+P2+P3)/Pm

Active powers P1, P2, and P3 used to calculate the efficiency in the above functions are obtained using voltage E1 and current I1, voltage E2 and current I2, and voltage E3 and current I3, respectively. The method used to calculate active powers P1, P2, and P3 is the same as that used to calculate active power in the electrical power meters. See Technical Information about the Programmable Meter Electrical and Mechanical Power Functions for additional information.

For more information on how power functions calculate mechanical power, see Technical Information about the Programmable Meter Electrical and Mechanical Power Functions for additional information.

Impedance Functions

The following functions are available for measuring impedance:

- RXZ (E1,I1)
- RXZ (E2,I2)
- RXZ (E3,I3)
- RXZ (E4,I4)
- RXZ// (E1,I1)
- RXZ// (E2,I2)
- RXZ// (E3,I3)
- RXZ// (E4,I4)
- RDC (E1,I1)
- RDC (E2,I2)
- RDC (E3,I3)
- RDC (E4,I4)

The impedance functions RXZ (E1,I1), RXZ (E2,I2), RXZ (E3,I3), and RXZ (E4,I4) measure resistance (R), reactance (X) or impedance (Z) in AC series circuits, depending on the operating mode selected on the meter. The voltage and current indicated in the parentheses are used to calculate the resistance, the reactance or the impedance.

The impedance functions RXZ// (E1,I1), RXZ// (E2,I2), RXZ// (E3,I3), and RXZ// (E4,I4) measure resistance (R), reactance (X) or impedance (Z) in AC parallel circuits, depending on the operating mode selected on the meter. The voltage and current indicated in the parentheses are used to calculate the resistance, the reactance or the impedance.

The impedance functions RDC (E1,I1), RDC (E2,I2), RDC (E3,I3), and RDC (E4,I4) measure resistance (R) in the same way as a multimeter, that is, using the mean (DC) values of the voltage and current. The resistance is calculated using the voltage and current indicated in the parentheses.

The calculations of resistance, reactance, and impedance in the RXZ (Ex,Ix) and RXZ// (Ex,Ix) impedance functions not only depend on the nature of the circuit (series or parallel), but also on whether the Extended, 2-Cycle or 8-Cycle sampling window is used. The various calculations used with each type of sampling window are described below. See Technical Information about Signal Sampling for additional information about the sampling window.

Resistance, Reactance, and Impedance Calculations with the Extended Sampling Window

The following equations are used to calculate resistance (R), reactance (X), and impedance (Z) in the RXZ (Ex,Ix) impedance functions (for series circuits):

- $R = P / I^2$
- $X = Q / I^2$
- $Z = E / I$

The following equations are used to calculate resistance (R), reactance (X), and impedance (Z) in the RXZ// (Ex,Ix) impedance functions (for parallel circuits).

- $R = E^2 / P$
- $X = E^2 / Q$
- $Z = E / I$

In all of the above equations:

- E is the RMS value of the voltage across the circuit;
- I is the RMS value of the current flowing through the circuit;
- P is the active power in the circuit;
- Q is the reactive power in the circuit.

Note that the RMS values of the voltage (E) and current (I) are calculated as in the AC mode of the voltmeters and ammeters. See Technical Information about the Programmable Voltage and Current Functions for additional information about the AC mode.

Also note that the methods used to calculate the active (P) and reactive (Q) powers are the same as those used in electrical power meters when the Extended sampling window is selected. See Technical Information about the Programmable Meter Electrical and Mechanical Power Functions for additional information.

Resistance, Reactance, and Impedance Calculations with the 2-cycle and 8-Cycle Sampling Windows

The following equations are used to calculate resistance (R), reactance (X), and impedance (Z) in the RXZ (Ex,Ix) impedance functions (for series circuits):

- $R = (E / I) \times \cos \phi$
- $X = (E / I) \times \sin \phi$
- $Z = E / I$

The following equations are used to calculate resistance (R), reactance (X), and impedance (Z) in the RXZ// (Ex,Ix) impedance functions (for parallel circuits).

- R = E / (I cos ø)
- X = E / (I sin ø)
- Z = E / I

In all of the above equations:

- E is the RMS value of the fundamental-frequency component of the voltage across the circuit;
- I is the RMS value of the fundamental-frequency component of the current flowing through the circuit;
- ø is the phase shift between the fundamental-frequency components of the voltage and current;

Note that the methods used to calculate the RMS values of the fundamental-frequency components of the voltage and current as well as the phase shift between these components are the same as those used in electrical power meters when the 2-Cycle or 8-Cycle sampling window is selected. See Technical Information about the Programmable Meter Electrical and Mechanical Power Functions for additional information

Power Factor Functions

There are a number of different power factor functions available. The following list gives an example for each different type of power factor functions:

- PF (E1,I1)
- PF (EI1,EI2)
- PF (E1,I1) 3~

Single-Phase Power Factor Functions

The single-phase power factor functions (PF (E1,I1), PF (E2,I2), etc.) calculate the power factor in single-phase circuits using the voltage and current indicated in the parentheses. The power factor is obtained by first calculating the active and apparent powers, and then dividing the active power by the apparent power. The methods used to calculate the active and apparent powers are the same as those used to calculate active and apparent powers in electrical power meters. See Technical Information about the Programmable Meter Electrical and Mechanical Power Functions for additional information

Note that in addition to the power factor, simple single-phase power functions can also calculate the distortion power factor or the displacement power factor when the 2-cycle or 8-cycle sampling window is selected (you can refer to Technical Information about Signal Sampling for additional information about the sampling window). In this situation, the type of power factor that is calculated is selected by choosing an operating mode on the meter.

The distortion power factor is obtained by dividing the apparent power at the fundamental frequency by the apparent power. The apparent power at the fundamental frequency is determined by multiplying the RMS values of the fundamental-frequency components of the voltage and current. In fact, this same method is used to calculate apparent power in electrical power meters when the 2-cycle or 8-cycle sampling window is selected. The apparent power is calculated using the same method as in electrical power meters when the Extended sampling window is selected. See Technical Information about the Programmable Meter Electrical and Mechanical Power Functions for additional information.

The displacement power factor is obtained by calculating the cosine of the phase shift ø (cos ø) between the fundamental-frequency components of the voltage and current. The phase shift ø is obtained by calculating the difference between the phase angles of the fundamental-frequency components of the voltage and current. These phase angles are obtained by performing two fast Fourier transform (FFT): one with the samples of the measured voltage and one with the samples of the measured current. Each FFT provides the RMS value and phase angle of the various harmonic components in the corresponding signal.

Three-Phase Power Factor Functions

The three-phase power factor functions PF (EI1,EI2) and PF (EI1,EI2,EI3) calculate the power factor in three-phase circuits using the voltage and current inputs indicated in the parentheses. The function PF (EI1,EI2) calculates the power factor using line-to-line voltages measured at inputs E1 and E2, and line currents measured at inputs I1 and I2. The function PF (EI1,EI2,EI3) calculates the power factor using phase voltages measured at inputs E1, E2, and E3, and line currents measured at inputs I1, I2, and I3.

The three-phase power factor functions PF (E1,I1) 3~, PF (E2,I2) 3~, PF (E3,I3) 3~, and PF (E4,I4) 3~ calculate the power factor in three-phase circuits using the voltage and current inputs indicated in the parentheses. Each function calculates the power factor using the corresponding measured line-to-line voltage and line-to-line current.

In three-phase power factor functions, the power factor is obtained by first calculating the three-phase active and apparent powers, and then dividing the three-phase active power by the three-phase apparent power. The methods used to calculate the three-phase active and apparent powers are the same as those used to calculate active and apparent powers in electrical power summing functions (PQS1+PQS2, for example). See Technical Information about the Programmable Meter Electrical and Mechanical Power Functions for additional information about the electrical power summing functions.

Frequency Functions

The following functions are available for measuring frequency:

- f(E1)
- f(E2)
- f(E3)
- f(E4)
- f(I1)
- f(I2)
- f(I3)
- f(I4)

The above frequency functions determine frequency from the number of times the signal indicated in parentheses goes through its mean value, either on a negative or positive slope, during a fixed time interval.

The range over which frequency can be measured mainly depends on whether the Extended, 2-Cycle, or 8-Cycle sampling window is selected (you can refer to Technical Information about Signal Sampling for additional information about the sampling window). When the Extended sampling window is selected, the frequency range also depends on whether a 50-Hz or 60-Hz version Data Acquisition and Control Interface (DACI) module is used. When either the 2-Cycle or 8-Cycle sampling window is selected, the frequency range also depends on the specified fundamental frequency (you can refer to Acquisition Settings to know how to specify the fundamental frequency). The frequency ranges associated with the various sampling windows are indicated below.

Frequency Range (Extended Sampling Window -- 50-Hz DACI Module)

- f min. = 6 Hz
- f max. = 800 Hz

Frequency Range (Extended Sampling Window -- 60-Hz DACI Module)

- f min. = 6 Hz
- f max. = 960 Hz

Frequency Range (2-Cycle Sampling Window)

- f min. = 0.75 x specified fundamental frequency
- f max. = 16 x specified fundamental frequency

Frequency Range (8-Cycle Sampling Window)

- f min. = 0.1875 x specified fundamental frequency
- f max. = 16 x specified fundamental frequency

The above frequency ranges are valid for voltage and current waveforms having a 50% duty cycle. The maximum frequency which can be measured may be reduced when the duty cycle is not 50%.

Energy Functions

The following functions are available for measuring amounts of energy:

- W (E1, I1)
- W1+W2
- W (E1, I1) 3~

Simple energy functions (W (E1, I1), W (E2, I2), etc.) measure the amount of energy using the active power calculated from the voltage and current inputs indicated in parentheses.

Energy summation function W1+W2 measures the amount of energy using the algebraic sum of the active power calculated from the voltage and current inputs E1 and I1, and the active power calculated from voltage and current inputs E2 and I2. Similarly, energy summation function W1+W2+W3 measures the amount of energy using the algebraic sum of the active powers calculated from the voltage and current inputs E1 and I1, the active power calculated from voltage and current inputs E2 and I2, and the active power calculated from voltage and current inputs E3 and I3.

Three-phase energy functions (W (E1, I1) 3~, W (E2, I2) 3~, etc.) measure the amount of energy using the three-phase active power calculated from the voltage and current inputs indicated in parentheses.

Energy measurement starts as soon as the continuous refresh mode is selected, and stops when the manual refresh mode is selected. Energy is obtained by multiplying the active power by time. This is performed continually at short time intervals. The result obtained at each time interval is added to the sum of the results of the previous time intervals until the meter is reset to zero (by clicking the button in the lower left corner of the meter).

The method used to calculate active power is the same as that used to calculate active power in the electrical power meters. See Technical Information about the Programmable Meter Electrical and Mechanical Power Functions for additional information.

Reactive Power Integral Function

The following functions are available for measuring the reactive power integral:

- ΣQ (E1, I1)
- ΣQ1 + ΣQ2
- ΣQ (E1, I1) 3~

This type of meter is a very unique one. We always refer the energy to the integral of the active power over a given time. By developing the static VAR compensator system using the Data Acquisition and Control Interface, we wanted the user to be able to measure the amount of reactive power that could be compensated over time in this kind of system. Since there is no name such as ''energy'' to express the reactive power used by a system over time, we created a Reactive Power Integral meter type. Put it simply, it sums the reactive power used over time according to the inputs specified in parentheses. To simplify the text, we will call the value obtained the ''reactive energy''.

Simple reactive power integral functions (ΣQ (E1, I1), ΣQ (E2, I2), etc.) measure the amount of reactive energy using the reactive power calculated from the voltage and current inputs indicated in parentheses.

Reactive energy summation function ΣQ1+ ΣQ2 measures the amount of reactive energy using the algebraic sum of the reactive power calculated from the voltage and current inputs E1 and I1, and the reactive power calculated from voltage and current inputs E2 and I2. Similarly, reactive energy summation function ΣQ1+ ΣQ2+ ΣQ3 measures the amount of reactive energy using the algebraic sum of the reactive powers calculated from the voltage and current inputs E1 and I1, the reactive power calculated from voltage and current inputs E2 and I2, and the reactive power calculated from voltage and current inputs E3 and I3.

Three-phase energy functions (ΣQ (E1, I1) 3~, ΣQ (E2, I2) 3~, etc.) measure the amount of reactive energy using the three-phase reactive power calculated from the voltage and current inputs indicated in parentheses.

The reactive power integral measurement starts as soon as the continuous refresh mode is selected, and stops when the manual refresh mode is selected. The reactive energy is obtained by multiplying the reactive power by time. This is performed continually at short time intervals. The result obtained at each time interval is added to the sum of the results of the previous time intervals until the meter is reset to zero (by clicking the button in the lower left corner of the meter).

The method used to calculate reactive power is the same as that used to calculate reactive power in the electrical power meters. See Technical Information about the Programmable Meter Electrical and Mechanical Power Functions for additional information.

Torque and Speed Functions

The following functions are available for measuring torque and speed:

- T
- Encoder A B
- N

The torque function T measures the torque at input T of the Data Acquisition and Control Interface (DACI) module.

The speed function Encoder A B measures the speed at digital encoder inputs A and B of the DACI module.

The speed function N measures the speed at input n of the DACI module.

Phase Shift Functions

There are a number of different phase shift functions available. Each follows the model of this example:

- PS (E1, I1)

The method used to measure phase shifts in the meters depends on whether the Extended, 2-Cycle or 8-Cycle sampling window is used. The phase-shift measurement method used with each type of sampling window is described below. See Technical Information about Signal Sampling for additional information about the sampling window.

Phase-Shift Measurement Method with the Extended Sampling Window

To measure phase shift, each function analyzes the samples of the physical quantities indicated in the parentheses to find the instants at which each signal passes through its mean value. This information is used to determine the period of each signal. This information is also used to determine the time interval between the instant when the first signal passes through its mean value and the instant when the second signal passes through its mean value, either on a positive or negative slope. This time interval is divided by the period of the signal (the longer period is used when the periods of the two signals differ) and the result is multiplied by 360 to obtain a phase shift expressed in degrees.

Phase-Shift Measurement Method with the 2-Cycle and 8-Cycle Sampling Windows

To measure phase shift, the difference between the phase angles of the fundamental-frequency components of the two signals indicated in the parentheses is calculated. These phase angles are obtained by performing two fast Fourier transforms (FFT's): one with the samples of first signal and one with the samples of the second signal. Each FFT provides the RMS value and phase angle of the various harmonic components in the corresponding signal.

Overrange Indication

Overrange occurs when the magnitude of the signal being measured exceeds the capability of the selected meter range. For example, trying to measure a 50 V DC voltage using the 20 V range on a DC voltmeter results in an overrange indication.

In the Metering window, the value indicated by a meter becomes red to indicate overrange.

Clipping Indication

Clipping occurs when the magnitude of the measured parameter momentarily exceeds the measurement capability of a meter even though the parameter value does not exceed the range selected on that meter. In other words, clipping occurs when the parameter magnitude becomes such that the meter crest-factor rating is exceeded. For example, measuring a 150 V DC voltage with peaks of 500 V using the 200 V range on a DC voltmeter with a measurement capability of 800 V results in a clipping indication.

In the Metering window, the value indicated by a meter becomes yellow to indicate clipping.

Oscilloscope

The Oscilloscope allows time domain observation and analysis of electrical and mechanical parameters in electromechanical systems. Up to eight parameters can be observed at a time since the Oscilloscope has eight channels. The waveforms of the parameters are displayed on the Oscilloscope screen using different colors to facilitate observation.

Menus

File Menu Commands

Print...

Sends the Oscilloscope window to the printer. The Print dialog box appears before the Oscilloscope window is sent to the printer. This box allows the print setup and options to be modified before printing. The Oscilloscope window is effectively sent to the printer after the OK button in the Print dialog box is clicked.

Export Data...

Opens the Export Data dialog box. This command is used to save the signals displayed on the Oscilloscope screen to a text file (filename.txt). The resulting file contains the time and value (signal magnitude) associated with the samples used to display the waveform of each signal on the Oscilloscope screen.

Close

Closes the Oscilloscope window. Note that the current configuration (instrument settings) of the Oscilloscope is kept in memory as long as the application from which the Oscilloscope window was opened is running.

View Menu Commands

Show Settings

Shows or hides the Oscilloscope Settings table. The menu item is highlighted to indicate that the table is visible. See Oscilloscope Settings for more information.

Color Settings

Shows or hides the Color Settings table. The Color Settings dialog box allows the color associated with each channel of the Oscilloscope to be changed. It also allows selection of the colors of the screen background, the display grid and axes, the cursors, the channels stored in memory, and the traces in the X-Y mode. To change the color associated with a particular item in the Oscilloscope window, select this item in the Item list, then select the desired color by clicking the corresponding color in one of the color tabs. When a new color is selected for a particular item, the color of the corresponding item is instantly changed on screen.

Single Refresh

Refreshes the waveforms of the signals displayed on the Oscilloscope screen and the contents of the Waveform Data table. Note that when this command is performed while the Continuous Refresh option of the waveforms and Waveform Data table contents is selected, the current refreshing cycle is completed and the continuous refresh of the Oscilloscope is stopped.

Continuous Refresh

Automatically refreshes the signals displayed on the Oscilloscope screen and the contents of the Waveform Data table at regular time intervals. A circle appears around the Continuous Refresh button in the toolbar when the continuous refresh mode is selected. To stop the continuous display refresh, click either the Refresh or the Continuous Refresh button or choose either the Refresh or Continuous Refresh command in the View menu.

Options Menu Commands

Auto Scale

Automatically selects the best scale settings of the various channels of the Oscilloscope according to the magnitude of the sampled signals.

Tools Menu Commands

Horizontal Cursors

Displays/hides the horizontal cursors on the Oscilloscope screen. Any cursor can be moved by dragging the horizontal line to the desired location. The Channel Data table at the bottom of the Oscilloscope shows the data relative to the horizontal cursors (columns Cur 1 and Cur 2).

Vertical Cursors

Displays/hides the vertical cursors on the Oscilloscope screen. Any cursor can be moved by dragging the vertical line to the desired location. The Channel Data table at the bottom of the Oscilloscope shows the data relative to the vertical cursors (columns Cur 1 and Cur 2).

Both Cursors (Horizontal Active)

Displays/hides both the horizontal and vertical cursors on the Oscilloscope screen. Only the horizontal cursors can be moved by dragging the horizontal lines to the desired location. Also, the Channel Data table at the bottom of the Oscilloscope only shows the data relative to the horizontal cursors (columns Cur 1 and Cur 2).

Both Cursors (Vertical Active)

Displays/hides both the horizontal and vertical cursors on the Oscilloscope screen. Only the vertical cursors can be moved by dragging the vertical lines to the desired location. Also, the Channel Data table at the bottom of the Oscilloscope only shows the data relative to the vertical cursors (columns Cur 1 and Cur 2).

View Last Acquisition

Displays on the Oscilloscope screen the last acquisition made by the Oscilloscope.

View Memory 1

Displays on the Oscilloscope screen the waveforms stored in the first memory.

View Memory 2

Displays on the Oscilloscope screen the waveforms stored in the second memory.

Store in Memory 1

Stores the waveforms that are currently shown on screen in the first memory.

Store in Memory 2

Stores the waveforms that are currently shown on screen in the second memory.

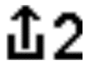
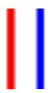
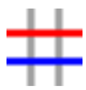
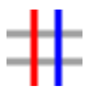
Help Menu Commands

Contents and Index...

Opens the Help file related to the software product you are currently using.

Toolbar

Icon	Description
	Print
	Single Refresh
	Continuous Refresh
	Auto Scale
M1	Store to Memory 1
M2	Store to Memory 2
LA	View Last Acquisition

Icon	Description
	View Memory 1
	View Memory 2
	Horizontal Cursors
	Vertical Cursors
	Both Cursors (Horizontal Active)
	Both Cursors (Vertical Active)

Oscilloscope Settings

Channel Control

Each of the eight channels of the Oscilloscope (numbered 1 to 8) has independent controls. The controls of each channel are used to set the scale (sensitivity) and select the observed physical quantity and the input coupling.

Input

The physical quantity to be observed is determined by selecting the desired input in the Input list. Selecting the Off option in the Input list disables the channel.

Scale

The scale can be set by selecting the desired scale in the Scale list

The scale setting can be optimized according to the magnitude of the measured physical quantity by choosing the Auto Scale command in the Options menu or by clicking the Auto Scale button in the toolbar.

Invert

The invert option allows the selected waveform to be inverted along the X axis.

Coupling

The type of input coupling can be selected from the Input Coupling list. The two possible coupling types are DC coupling and AC coupling. Choosing the AC coupling will remove any DC component of a signal while DC coupling will give you all components of that same signal. Note that this function is made by calculation and not by analog signal coupling like a standard scope.

Vertical Position of the Traces (Not shown in Oscilloscope Settings)

A box located at the left side of the oscilloscope screen will appear for each channel that is sampling a signal. You can adjust the vertical position of the trace related to each channel by dragging up or down the corresponding box (associated by color with the channel) using your mouse. Note that when two or more traces are at the same vertical position, only one of the boxes related to these traces is shown. By moving them around and adjusting the scale manually, it is possible to display a large number of different traces without one being on top of another.

Time Base

The Oscilloscope time base can be set by selecting the desired time base in the Time Base list.

Trigger

The trigger controls are used to select the triggering signal, determine whether triggering occurs on the positive or negative slope of the triggering signal, and set the level at which triggering should occur.

Source

The parameter used to trigger the Oscilloscope is determined by selecting a trigger source in the Source list. For the trigger to work perfectly, you need to select a channel that is already active. The EXT option allows triggering from an input signal that is not necessarily located in a channel.

Ext. Source

If the EXT option is selected in the Source setting, the Ext. Source list allows the external source triggering signal to be selected. The signals that can be measured through the various inputs of the Data Acquisition and Control Interface or Data Acquisition and Control Interface (DACI) are available in this list.

Selecting the None option in the Source Ext. list located beside the Source list turns the trigger section off and the Oscilloscope operates in free-run mode.

Level

The trigger level can be adjusted by editing the contents of the Level text box. When one of the eight channels is selected as the trigger source, the trigger level can also be adjusted using a box located on the right-hand side of the Oscilloscope screen. This box can be dragged up or down using the mouse to adjust the trigger level.

Note that the trigger-level indicator boxes becomes red and is located at either the top or bottom end of the Oscilloscope screen, when the trigger level entered in the Level text box is outside the range of the trigger level corresponding to the full-height of the Oscilloscope screen. This indicates that the vertical position of the trigger-level indicator does not correspond to the trigger level entered in the Level text box.

Note that when the EXT option is selected as the trigger source, the trigger level cannot be adjusted using the trigger-level indicator (the box is not shown in this case).

Pre-trig / post-trig (Not shown in Oscilloscope Settings)

At the bottom-left side of the oscilloscope screen, you can see a trigger cursor. This cursor can be used to adjust the pre-trig / post-trig position of all signals on the screen. Simply use your mouse to drag the cursor left and right.

Slope

The trigger slope can either be on the rising or falling part on a wave. By selecting Rising, the triggering will happen at the beginning of the rising period of the source selected and on the falling period if Falling is selected.

Show

Memories

The Show Memories parameter determines which memory (Memory 1 or Memory 2) is shown (if any) on the Oscilloscope screen. It is also possible to show both memories at the same time by selecting Both.

Last Acquisition

The Show Last Acquisition parameter determines if the last acquisition made by the Oscilloscope is shown on the Oscilloscope screen.

Cursors

The Show Cursors parameter determines which cursors (horizontal or vertical) are shown (if any) on the Oscilloscope screen. It is also possible to show both cursors at the same time. In that case, only one set of parameter is active at the same time, either the horizontal cursors for Both (Hor. Active) or the vertical (Vert. Active).

Current Data

The Show Current Data parameter determines the source of the data displayed in the Channel Data table at the bottom of the Oscilloscope screen. The Channel Data table can display the data related to the last acquisition made by the Oscilloscope or the data related to the waveforms stored in either memories of the Oscilloscope (Memory 1 or Memory 2).

Display

X-Y

The X-Y mode of operation can be selected using the Display menu in the Oscilloscope Settings. Note that the X-Y mode of operation is not available when no inputs (Off option in the Input list) are selected on either channel 1 (X) or channel 2 (Y).

In the X-Y mode of operation, the signals observed through channels 1 (X) and 2 (Y) are used to obtain a two-dimensional (2D) plot on the Oscilloscope screen. The 2D plot displayed on the Oscilloscope screen is automatically updated when the scale or input coupling of channel 1 or channel 2 is changed. The arrow symbols at the bottom and left-hand side of the Oscilloscope screen allow the position of the two-dimensional plot to be modified. The Oscilloscope automatically returns to the normal mode of operation when selecting the Off option in the Input list of either channel 1 or channel 2.

X-Y Average

The X-Y Average option sums the value of each point of a X-Y drawing and divide this number by the number of points of the drawing, and so, the final result is a mean value expressed by a dot on the screen.

Display mode

The Display mode can be changed to Normal (standard line), Dots or Squared in the Display list under Display Mode.

Persistence

The Persistence option superimposes multiple waveforms of the same input signal. This can be useful for spotting glitches, small fault or rare fault hidden in a series of normal events. The persistence can be adjusted to 2, 4, 8 or 16 traces.

Show Channel Data

Channel 1 to Channel 8

The Show Channel 1 to Show Channel 8 parameters toggle on or off the waveform related to the corresponding channel, as determined in the Channel Control settings.

Vertical Cursor Position

The Vertical Cursor Position parameter determines the nature of the value indicated by the vertical cursors displayed on the Oscilloscope screen. The possible choices are Time, Phase Angle, and Frequency. The corresponding data is shown in the Channel Data table at the bottom of the Oscilloscope screen.

Channel Data Table

The Channel Data table provides data on the signals observed using the eight channels of the Oscilloscope. Data associated with all eight channels can be displayed simultaneously. The displayed data can be selected by enabling the channel options (Ch1 to Ch8) in the Show Channel Data menu.

If cursors have been enabled, the Channel Data table also shows the position of the cursors in relation to each opened channel, as well as the position of the cursors in relation one to another. The cursors can be enabled by selecting one of the various cursors options in the Cursors list of the Show menu.

When no cursor is displayed on screen, the Channel Data table indicates the root-mean-square (RMS) value, average value (AVG), and frequency (f) of each of the signals. Note that when the sampled signal is electrical power, torque, speed, or mechanical power, no data is indicated in the RMS column. Similarly, when the signal is a torque, speed, or mechanical power, no data is indicated in the frequency column. Also note that a question mark is displayed in the frequency column of the table when the frequency of a signal cannot be evaluated. This may occur when less than one cycle of the waveform of that signal is displayed on the Oscilloscope screen. Selecting a bigger time base per division in the Time Base list can correct this problem.

The Cur 1 and Cur 2 columns of the Channel Data table indicate the instantaneous values of the cursors following their position on the Oscilloscope screen. The Diff. column indicates the difference between the values in the Cur 1 and Cur 2 columns (Cur 2 column value minus Cur 1 column value) for each of the signals. Those values can be expressed in seconds, degrees or Hertz when using the Horizontal cursors. To change the unit, go in the Show Channel Data list and select the desired Time Units.

Technical Information

Signal Sampling

The Oscilloscope allows time domain observation and analysis of electrical and mechanical quantities. Up to eight signals can be observed simultaneously.

- For the Data Acquisition Interface, all signals can be observed, except for the ANALOG OUTPUTS, the SYNC. INPUT, and ANALOG INPUTS 1 to 8.
- For the Data Acquisition and Control Interface, all signals can be observed, except for the SYNC. DIGITAL INPUTS, ANALOG INPUTS 1 to 6, and the DIGITAL OUTPUTS.

Note that electrical power and mechanical power are derived from two input signals. Power is obtained by multiplying the values measured from a voltage input and the values measured from a current input. Mechanical power is obtained from the values measured from a torque input and the values measured from a speed input and scaling to obtain the values in Watts.

The signals to be displayed on the Oscilloscope screen are sampled at the same time. To do so, the Oscilloscope takes a sample of each of the input signals required to display the signals selected in the eight channels. It repeats this cycle until a sufficient number of samples of each signal is taken. This is similar to the chopped vertical mode on conventional oscilloscopes.

The waveform of each signal on the Oscilloscope screen consists of 512 samples. The frequency at which the signals are sampled (sampling frequency) is increased as the time base setting is decreased.

Trigger Operation

In the Oscilloscope, signal sampling is started immediately after a display refresh command. The signals are sampled during a period equal to twice the interval covered by the complete Oscilloscope screen when in Software trigger mode. For instance, when the time base is set to 10 ms/DIV, the complete screen corresponds to a 100-ms interval, and thereby, the signals are sampled during 200 ms in Software trigger mode.

In Software trigger mode, once sampling is finished, the triggering signal is examined to find the instant at which it went through the trigger point. This instant is used to determine which portion (interval) of the sampled signal is displayed on the Oscilloscope screen. When the triggering signal does not go through the trigger point during the sampling period, the signals sampled during the first half of the sampling period are displayed.

Channel Data Calculation

The rms and average values indicated in the Channel Data table are calculated using the same methods as those used in the voltage, current, power, torque, and speed functions of the Metering application. See Technical Information about the Programmable Meter Voltage and Current Functions for additional information about the calculation of the rms and average values.

The frequency is determined from the number of times the measured signal goes through its mean value, either on a negative or positive slope, during a fixed time interval. If the measured signal never passes through its mean value, or passes through the mean value only one time during the measuring interval, a question mark is displayed in the Channel Data table to indicate that frequency cannot be determined. In most cases, selecting AC coupling to remove the DC component from the signal, or increasing the time base setting, allows the frequency to be measured. Note that the threshold for detecting the number of times the signal passes through its mean value is set to half the amplitude of the AC component of that signal. This provides a certain immunity to noise that may be present in the waveform of the signal.

Phasor Analyzer

The Phasor Analyzer allows observation and analysis of phase relationships between voltages and currents in three-phase power systems. Up to six phasors can be observed simultaneously on the Phasor Analyzer display. This display, referred to as a phasor display, is a circle graduated in phase angle. The phasors corresponding to the observed signals are displayed in this circle using different colors to facilitate observation.

Menus

File Menu Commands

Print...

Sends the Phasor Analyzer window to the printer. The Print dialog box appears before the Phasor Analyzer window is sent to the printer. This box allows the print setup and options to be modified before printing. The Phasor Analyzer window is effectively sent to the printer after the OK button in the Print dialog box is clicked.

Close

Closes the Phasor Analyzer window. Note that the current configuration, before closing, of the Phasor Analyzer is kept in memory as long as the application from which the Phasor Analyzer window was opened is running.

View Menu Commands

Show Settings

Shows or hides the Phasor Analyzer Settings table. The menu item becomes highlighted to indicate that the table is visible. See Phasor Analyzer Settings for more information.

Color Settings...

Shows or hides the Color Settings table. The Color Settings dialog box allows the color associated with each phasor in the Phasor Analyzer window to be changed. It also allows selection of the colors of the Phasor Analyzer display background, axes, and divisions. To change the color associated with a particular item in the Phasor Analyzer, select this item in the Item list, then select the desired color by clicking the corresponding color in one of the color tabs. When a new color is selected for a particular item, the color of the corresponding item changes instantly on screen.

Single Refresh

Refreshes the phasors displayed on the Phasor Analyzer screen and the contents of the Phasor Data table. Note that when this command is performed while the Continuous Refresh command of the phasors and Phasor Data table contents is selected, the current refreshing cycle is completed and the continuous refresh of the Phasor Analyzer is stopped.

Continuous Refresh

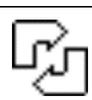
Automatically refreshes the waveforms of the signals displayed on the Phase Analyzer screen and the contents of the Phasor Data table at regular time intervals. A circle appears around the Continuous Refresh button in the toolbar when the continuous refresh mode is selected. To stop the continuous display refresh, click either the Refresh or the Continuous Refresh button or choose either the Refresh or Continuous Refresh command in the View menu.

Help Menu Commands

Contents and Index...

Opens the Help file related to the software product you are currently using.

Toolbar

Icon	Description
	Print
	Single Refresh
	Continuous Refresh

Phasor Analyzer Settings

Current and Voltage Settings

The phasors displayed in the Phasor Analyzer window depend on the selected voltage (E1, E2, E3, E4) and current (I1, I2, I3, I4) phasors. When a voltage or a current phasor is set to On in the Phasor Analyzer Settings menu, it is instantly shown on the main screen of the Phasor Analyzer (or as soon as the data shown on screen is next refreshed, if not in continuous refresh mode).

Scales

The voltage and current scales used to display the phasors corresponding to the selected voltages and currents can be changed using the Phasor Analyzer Settings menu. One Scale drop-down list is available for the three Voltage phasor and one for the three current phasors. The scale selected will then be applied to the three voltage phasors or current phasors at the same time.

Reference Phasor

A reference phasor is selected by choosing one of the phasors in the Reference Phasor list. The phasor corresponding to the selected signal is displayed at a phase angle of 0 degrees, and is used as the reference to display the phasors corresponding to other signals. Note that the phasor corresponding to voltage E1 is selected as the default reference phasor.

Phasor Data Table

The Phasor Data table provides data on the observed phasors. The AC (RMS) column indicates the root-mean-square (rms) value of the AC component of the signal associated with each of the observed phasors. The Phase column indicates the phase angle with respect to the reference phasor for each of the observed phasors. The Frequency column indicates the frequency of the signal associated with each of the observed phasors. Note that a question mark is displayed in the Frequency column when the frequency of a signal cannot be measured.

See Technical Information about the Phasor Analyzer for additional information on the measurement of the AC-component rms value, phase angle, and frequency of the signal associated with each phasor.

Technical Information

Scale Settings

The various scale settings in the Phasor Analyzer are graduated in rms voltage and current values per circular division.

Phasor Angular Position

To determine the angular position on the Phasor Analyzer display of the phasor related to a signal, the phase angle between this signal and the reference signal (signal whose phasor is selected as the reference phasor) must be determined. To do so, the frequency of the reference signal is measured and used to determine the fundamental frequency of the system (usually the AC network frequency). Then, the signals are sampled at the proper frequency to obtain 512 samples over a time interval equal to 2 cycles of the reference signal. For each signal, these samples are used to perform a fast Fourier transform (FFT) that provides the phase angle of the frequency component at the reference signal frequency (fundamental frequency of the system). This phase angle is compared to the phase angle of the fundamental component of the reference signal to determine the angular position of the corresponding phasor on the Phasor Analyzer display.

The frequency of the reference signal is determined from the number of times this signal goes through its mean value, either on a negative or positive slope, during a fixed time interval. The frequency can be measured over a range of 10 Hz to 7.5 kHz. The above frequency range is valid for a voltage or current waveform having a 50% duty cycle and that is free of noise. The maximum frequency which can be measured may be reduced when the duty cycle is not 50%.

Phasor Magnitude

The rms value of the AC component of each signal is used to determine the length (magnitude) on the Phasor Analyzer display of the corresponding phasor. The rms value of the AC component is obtained by squaring each sample of the signal, summing the squared values, and dividing the result by the number of samples. The signal average value is squared, and then subtracted from the result of the first calculation. Finally, the square root of the subtraction is carried out to obtain the rms value of the AC component. Note that the signal average value is obtained with the same method as that used in the voltage and current functions of the Metering application. See Technical Information about the Programmable Meter Voltage and Current Functions for additional information about the calculation of the average value.

Harmonic Analyzer

The Harmonic Analyzer allows observation and analysis of the harmonic components in voltages and currents signals. One of the following signals can be selected for observation and analysis: the voltages at inputs E1, E2, E3, and E4 and the currents at inputs I1, I2, I3, and I4. The harmonic components of the selected input signal can be displayed on the Harmonic Analyzer display using various scale and range settings.

Menus

File Menu Commands

Print…

Sends the Harmonic Analyzer window to the printer. Note that the menu bar, toolbar, and status bar in the Harmonic Analyzer window are not sent to the printer.

The Print dialog box appears before the Harmonic Analyzer window is sent to the printer. This box allows the print setup and options to be modified before printing. The Harmonic Analyzer window is effectively sent to the printer after the OK button in the Print dialog box is clicked.

Close

Closes the Harmonic Analyzer window. Note that, before closing, the current configuration of the Harmonic Analyzer is kept in memory as long as the application from which the Harmonic Analyzer window was opened is running.

View Menu Commands

Show Settings

Shows or hides the Harmonic Analyzer Settings table. The menu item becomes highlighted to indicate that the table is visible. See Harmonic Analyzer Settings for more information.

Show Levels and Distortion

Shows or hides the Levels and Distortion table. The menu item becomes highlighted to indicate that the table is visible.

The Levels and Distortion table is divided in two for easier reading.

Levels

From top to bottom, the first table, called Levels, provides the level of the DC Component as well as all the levels for the harmonics selected for the chosen input signal. The component levels indicated in the Levels section are expressed as either absolute values or relative values. The number of harmonics shown and their type of value can be changed in the Harmonic Analyzer Settings. See Scale for additional information.

Distortion

Just under the Levels table, the Distortion table of the Harmonic Analyzer indicates the total harmonic distortion of the selected input signal. Two values of total harmonic distortion are indicated in the Distortion table: THD and THD 1. The THD value is the total harmonic distortion, expressed as a percentage, calculated with respect to the RMS value of the input signal's ac component. The THD 1 value is the total harmonic distortion, expressed as a percentage, calculated with respect to the RMS value of the input signal's fundamental-frequency component.

See Technical Information about the Harmonic Analyzer to obtain additional information.

Single Refresh

Refreshes the harmonic components shown in the Harmonic Analyzer display and other data in the Harmonic Analyzer window. Note that when this command is performed while the Continuous Refresh command of the Harmonic Analyzer is selected, the current refreshing cycle is completed and the continuous refresh of the Harmonic Analyzer is stopped.

Continuous Refresh

Automatically refreshes the display and data in the Harmonic Analyzer window at regular time intervals. A circle appears around the Continuous Refresh button in the toolbar when the continuous refresh mode is selected. To stop the continuous display refresh, click either the Refresh or the Continuous Refresh button or choose either the Refresh or Continuous Refresh command in the View menu.

Options Menu Commands

Auto Scale

Optimizes the vertical scale setting of the Harmonic Analyzer according to the magnitude of the selected input signal. Note that this function is not available when the Harmonic Analyzer display needs to be refreshed (when the input signal is changed for example). Also note that the Auto Scale function is not available when a relative scale (percentage scale) is selected for measuring the level of the harmonic components. See Vertical Scale Settings for additional information.

Help Menu Commands

Contents and Index...

Opens the Help file related to the software product you are currently using.

Toolbar

Icon	Description
	Print
	Single Refresh
	Continuous Refresh
	Auto Scale

Harmonic Analyzer Settings

Setting the Harmonic Analyzer to observe the harmonic components of a signal consists in choosing the input signal, adjusting the vertical scale of the display, deciding whether the cursors are shown or not, and determining the fundamental frequency and number of harmonic components.

Fundamental Frequency

The fundamental frequency of the Harmonic Analyzer can be set using three types: Network, User, or Automatic. Using Network, the fundamental frequency will be set to the AC power network frequency selected when the application was started. With User type, the fundamental frequency can be set manually by the user using the Frequency (Hz) box. Finally, the Automatic option automatically set the fundamental frequency to the frequency of the fundamental component (harmonic component at the fundamental frequency) of the selected input signal.

Harmonics

The number of harmonic components in the Harmonic Analyzer display is set by selecting the desired number of harmonics in the Number of Harmonics list. A maximum of forty harmonic components of the selected input signal can be displayed.

Input

The input signal to be analyzed is determined by selecting the desired parameter in the Input list. Note that selecting the NONE option in the Input list turns the Harmonic Analyzer off.

Scale

The vertical scale of the Harmonic Analyzer display can be graduated with absolute values or relative values. The type of vertical scale is determined by selecting the desired option in the Type list. When absolute values are selected (V or A option in the Type list), the vertical scale is graduated with root-mean-square (RMS) values of voltage or current depending on the nature of the selected input signal. When relative values are selected (% of DC and % of 1f options in the Type list), the vertical scale is graduated with either percentages of the level of the DC component in the selected input signal or percentages of the level of the fundamental component (harmonic component at the fundamental frequency) in the selected input signal.

The vertical scale setting of the Harmonic Analyzer display is set by selecting the desired option in the Setting list of the Scale menu.

Show

Vertical or horizontal cursors can be displayed on the Harmonic Analyzer display by selecting either the Vertical or Horizontal cursors option in the Cursors list. When the Off option is selected, no cursor is displayed. See Cursors for more information.

Harmonic Analyzer Cursors

Vertical Cursors

The vertical cursors are two vertical lines on the Harmonic Analyzer display which can be moved to any of the harmonic component positions in the display. The cursors are labeled Cur 1 and Cur 2. Each cursor is independent and can be moved from one harmonic component position to another by dragging it with the mouse. Each cursor can also be moved one harmonic component position at a time using the corresponding left and right seek buttons in the bottom left corner of the screen.

The Harmonic (f), Frequency (Hz), and Level data fields in the Cursors section indicate the number, frequency, and level of the harmonic component on which each vertical cursor is positioned. Note that the levels indicated in the Level data fields are expressed as either absolute values or relative values. This depends on the type of vertical scale which is selected. See Scale for additional information.

Horizontal Cursors

The horizontal cursors are two horizontal lines on the Harmonic Analyzer display which can be set to different levels. The cursors are labeled Cur 1 and Cur 2. Each cursor is independent and can be set to any level by dragging it with the mouse. The level of each cursor can also be set to the level of any of the harmonic components in the display using the corresponding left and right seek buttons in the bottom left corner of the screen. In this case, the cursor level is increased or decreased to the level of the harmonic component that is closest to the current level of the cursor, depending on whether the left or right seek button is used.

The Level data fields in the Cursors section indicate the level of each horizontal cursor. Note that these levels are expressed as either absolute values or relative values. This depends on the type of vertical scale which is selected. See Scale for additional information.

Technical Information

Data Sampling and Fast Fourier Transform (FFT)

In the Harmonic Analyzer, the selected input signal is sampled during a certain time interval, referred to as the sampling window, each time a refresh command is performed. A fast Fourier transform (FFT) is then performed using the sampled data to obtain the harmonic components of the selected input signal.

The Harmonic Analyzer optimizes the sampling of the selected input signal so that the output components of the FFT is at frequencies that are as close as possible to multiples of the Fundamental Frequency setting, which is normally adjusted to the frequency of the selected input signal. To do so, the sampling frequency and the number of samples of the selected input signal, which can be any power of 2 between 512 and 8192, are adjusted so that the duration of the sampling window is as close as possible to an integer number N of cycles of the selected input signal, where N is comprised between 2 and 15 inclusively. Note that the sampling frequency (fs) can be adjusted over the following range:

120 x fundamental frequency < fs < 180 kHz

The amplitude of the FFT output components are used directly to display the harmonic components of the selected input signal.

When the Automatic option is selected in the Fundamental Frequency setting, the Harmonic Analyzer automatically sets the fundamental frequency to the frequency of the selected input signal. To do so, the selected input signal is sampled a first time at a frequency of 8.192 kHz during an interval of 1 s. A fast Fourier transform (FFT) is performed using the sampled data to find the fundamental frequency of the selected input signal. Then, the input signal is sampled a second time using the optimization process described above and a second FFT is performed to obtain the harmonic components of the selected input signal.

Frequency Range

The frequency range of the Harmonic Analyzer is 0 Hz (DC component) to 8 kHz.

Fundamental-Frequency Range

The fundamental-frequency range is 1 Hz to 200 Hz.

RMS Value Calculation

The RMS values of the fundamental-frequency component and harmonic components are obtained by dividing the amplitude of the corresponding FFT output component by 1.4142 (square root of 2).

Calculation of Total Harmonic Distortions

Two values of total harmonic distortion are indicated in the Distortion table: THD and THD 1. The THD value is the total harmonic distortion, expressed as a percentage, calculated with respect to the root-mean-square (RMS) value of the selected input signal's ac component. The THD 1 value is the total harmonic distortion, expressed as a percentage, calculated with respect to the RMS value of the selected input signal's fundamental-frequency component.

The THD value is obtained by dividing the RMS value of the harmonic components (second to fortieth harmonic) by the RMS value of the selected input signal's ac component. The THD1 value is obtained by dividing the RMS value of the harmonic components (second to fortieth harmonic) by the RMS value of the selected input signal's fundamental-frequency component.

The rms value of the harmonic components is obtained by squaring the value of each harmonic component, from the second harmonic to the fortieth harmonic inclusively, summing the squared values, and calculating the square root of the sum.

The rms value of the ac component of the selected input parameter is obtained by squaring the value of each of the first forty harmonic components, summing the squared values, and calculating the square root of the sum.

Synchroscope

The Synchroscope window 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 (E3) and the network voltage (E4). In addition, the Synchroscope window includes meters displaying various parameters important to generator synchronization (e.g., network voltage and frequency, generator voltage and frequency, voltage difference).

Menus

File Menu Commands

Close

Closes the Synchroscope window.

View Menu Commands

Single Refresh

Refreshes the position of the Synchroscope needle, as well as the values indicated by the meters in the Synchroscope window. Note that when this command is performed while the Continuous Refresh command of the Synchroscope is selected, the current refreshing cycle is completed and the continuous refresh of the Synchroscope is stopped.

Continuous Refresh

Automatically refreshes at regular time intervals the position of the Synchroscope needle, as well as the values indicated by the meters in the Synchroscope window. A circle appears around the Continuous Refresh button in the toolbar when the continuous refresh mode is selected. To stop the continuous display refresh, click either the Refresh or the Continuous Refresh button or choose either the Refresh or Continuous Refresh command in the View menu.

Help Menu Commands

Contents and Index…

Opens the Help file related to the software product you are currently using.

Technical Information

Synchroscope

The value indicated by the needle of the synchroscope is the phase difference between the generator voltage and the network voltage. When the needle is located in the left half of the synchroscope display, the generator voltage lags behind the network voltage. Conversely, when the needle is located in the right half of the synchroscope display, the generator voltage leads the network voltage.

The movement of the synchroscope needle also indicates whether the generator frequency is lower or higher than the network frequency. When the synchroscope needle rotates in the direction of the Slow arrow, the generator frequency is lower (“slower”) than the network frequency. Conversely, when the synchroscope needle rotates in the direction of the Fast arrow, the generator frequency is higher (“faster”) than the network frequency. The rotation speed of the synchroscope needle is proportional to the frequency difference between the generator and the network (i.e., the faster the needle rotation speed, the greater the frequency difference).

Network Voltage

The value indicated by the Network Voltage meter corresponds to the voltage measured at input E4.

Generator Voltage

The value indicated by the Generator Voltage meter corresponds to the voltage measured at input E3.

Difference in Voltage

The value indicated by the Difference in Voltage meter corresponds to the difference between the generator voltage (E3) and the network voltage (E4). A positive value indicates that the generator voltage is higher than the network voltage, while a negative value indicates that the generator voltage is lower than the network voltage.

Network Frequency

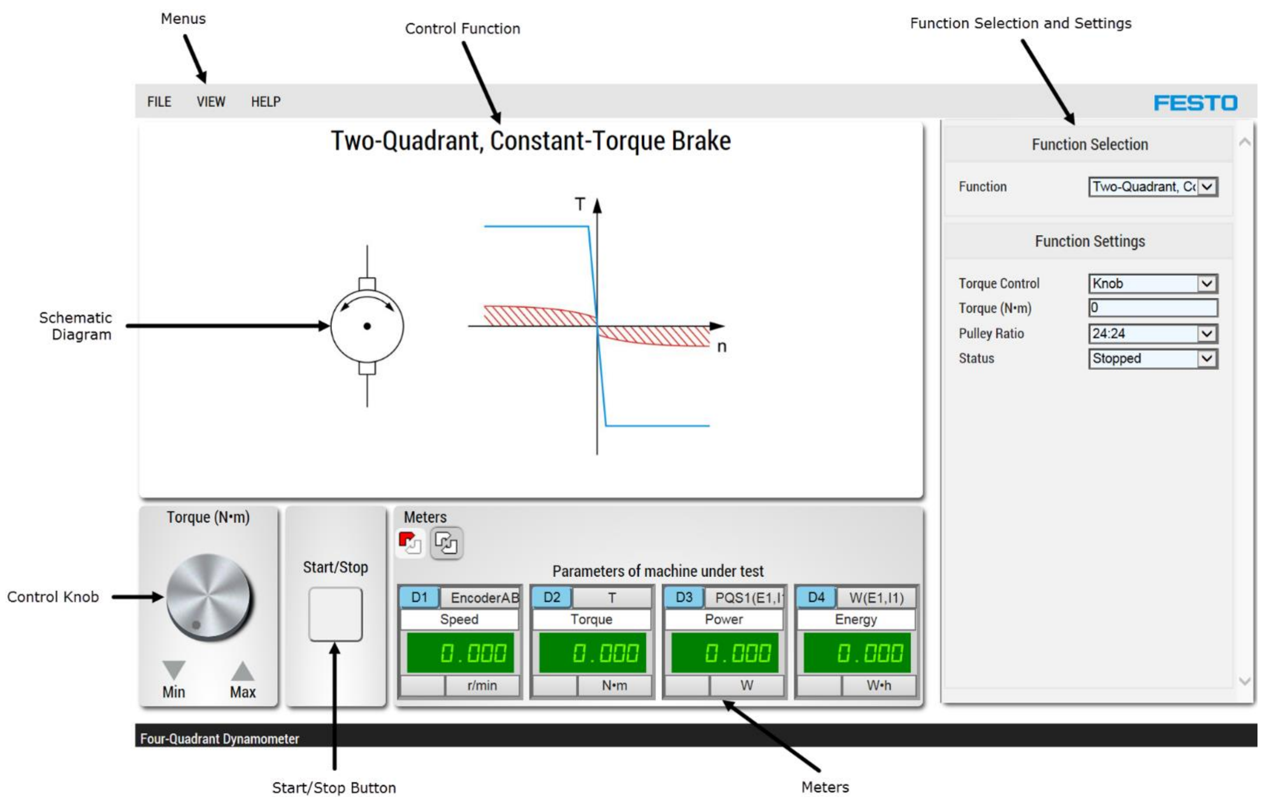
The value indicated by the Network Frequency meter corresponds to the frequency measured at input E4.

Generator Frequency

The value indicated by the Generator Frequency meter corresponds to the frequency measured at input E3.

Four-Quadrant Dynamometer/Power Supply

The Four-Quadrant Dynamometer / Power Supply window provides an easy and useful way of controlling the behaviour of the Four-Quadrant Dynamometer / Power Supply. You will find all the functions accessible using the front panel of the Four-Quadrant Dynamometer / Power Supply in this window. Here is a picture of the Four-Quadrant Dynamometer / Power Supply window:



From the picture, select one of the following topics for more information:

- Menus
- Function Selection and Settings
- Schematic Diagram
- Control Knob and Start/Stop Button
- Meters
- Control Function

Menus

File Menu Commands

Close

Closes the Four-Quadrant Dynamometer/Power Supply window. Note that the current configuration (instrument settings) of the Four-Quadrant Dynamometer/Power Supply is kept in memory as long as LVSIM-EMS runs.

View Menu Commands

Show Settings

Shows or hides the Four-Quadrant Dynamometer/Power Supply Settings table. The menu item becomes highlighted to indicate that the table is visible. See Four-Quadrant Dynamometer/Power Supply Settings for more information.

Single Refresh

Refreshes the data shown in the Four-Quadrant Dynamometer/Power Supply window. Note that when this command is performed while the Continuous Refresh command of the Four-Quadrant Dynamometer/Power Supply window is selected, the current refreshing cycle is completed and the continuous refresh of the window is stopped.

Continuous Refresh

Automatically refreshes at regular time intervals the data shown in the Four-Quadrant Dynamometer/Power Supply window. A circle appears around the Continuous Refresh button in the toolbar when the continuous refresh mode is selected. To stop the continuous display refresh, click either the Refresh or the Continuous Refresh button or choose either the Refresh or Continuous Refresh command in the View menu.

Help Menu Commands

Contents and Index...

Opens the Help file related to the software product you are currently using.

Function Selection and Settings

The Function Selection and Settings menu displays the currently selected control function and settings parameters for the Four-Quadrant Dynamometer/Power Supply. Each parameter can be modified by clicking on the corresponding drop-down list item (double-clicking on the item will modify the parameter to the next available option).

The Four-Quadrant Dynamometer / Power Supply Settings section can be divided into three groups: Operating Mode, Function Selection and Function Settings.

Operating Mode

To access all the functions available with the Four-Quadrant Dynamometer / Power Supply, the user must be able to change the Operating Mode from Four-Quadrant Dynamometer to Power Supply. The Operating Mode parameter cannot be changed using the Settings section of the Four-Quadrant Dynamometer/Power Supply window. It can only be changed using the Operating Mode switch located on the front panel of the Four-Quadrant Dynamometer/Power Supply.

Function Selection

The Function Selection parameter indicates which control function of the Four-Quadrant Dynamometer/Power Supply is currently selected. Changing the currently selected control function automatically sets the Status parameter of the Four-Quadrant Dynamometer/Power Supply to Stopped. The selection of available control functions in the drop-down list varies depending on the currently selected Operating mode. See the Four-Quadrant Dynamometer/Power Supply Control Function section for more information on the different control functions.

Function Settings

This section allows the different parameter settings of the currently selected Four-Quadrant Dynamometer/Power Supply control function to be selected. The number and nature of the available parameters is dependent on the currently selected function. An Informative box at the bottom of the Function Settings section informs you of the various characteristics of each parameter as soon as they are selected. See the Four-Quadrant Dynamometer/Power Supply Control Function section for more information on the different control functions.

Schematic Diagram

The Four-Quadrant Dynamometer/Power Supply window shows a schematic diagram of the currently selected Four-Quadrant Dynamometer/Power Supply control function. When applicable, a graphical representation of the control function is also shown accompanying the schematic diagram. The schematic diagram and graphical representation are designed to give a quick visual reference of the control function.

Control Knob and Start/Stop Button

The Control Knob and the Start/Stop button of the Four-Quadrant Dynamometer/Power Supply are located in the bottom left corner of the Four-Quadrant Dynamometer/Power Supply window. The Control Knob and the Start/Stop button can be used instead of the corresponding parameter and control settings in the Function Settings menu and allow rapid access to certain important commands of the Four-Quadrant Dynamometer/Power Supply module. A description of the Control Knob and the Start/Stop button.

Control Knob

The Control Knob located in the bottom left of the Four-Quadrant Dynamometer/Power Supply window allows the manual control of a parameter related to the currently selected Four-Quadrant Dynamometer/Power Supply control function. Control functions have either one or zero knob, when not applicable. The Control Knob can also be replaced by a Slider in some functions (e.g., Wind Turbine Emulator). The Control Knob related to a function (if any) generally commands the main parameter of that function (e.g., the voltage parameter for the DC Voltage Source control function).

Manual control and digital control of a parameter can be achieved jointly using, respectively, the Control Knob and the corresponding parameter option in the Four-Quadrant Dynamometer/ Power Supply Settings menu. When the Control Knob of a parameter is manually rotated, the numerical value of the corresponding parameter in the Function Settings menu is modified accordingly.

The Control Knob also has two arrow buttons allowing the knob to be rotated in either direction (depending on which arrow button is pressed) in order to modify the value of the parameter by a fixed increment. The numerical value of the increment depends on the parameter that is being controlled.

Start/Stop Button

The Start/Stop button starts or stops the currently selected control function. Command of the control function is also possible using the Status parameter in the Four-Quadrant Dynamometer/Power Supply Settings menu. The Status parameter indicates whether the function is currently Started or Stopped.

Meters

The Four-Quadrant Dynamometer/Power Supply window includes four meters located at the bottom of the screen. Each meter is associated with a measured parameter related to the currently selected Four-Quadrant Dynamometer/Power Supply operating mode. In some functions, meters can be added to the default one. In the Dynamometer operating mode, the following default meters are shown on screen:

- Speed
- Torque
- Power
- Energy

In the Power Supply operating mode, the following default meters are shown on screen:

- Voltmeter
- Ammeter
- Power
- Energy

The meters shown in the Four-Quadrant Dynamometer / Power Supply window can be configured manually in the same way as the meters of the Metering application. See Shortcuts to Meter Settings for additional information on how to manually configure meters.

Single Refresh and Continuous Refresh buttons

The Single Refresh and Continuous Refresh buttons located above the Meters section in the Four-Quadrant Dynamometer/Power Supply window allow the user to change the display refresh mode, exactly as the corresponding command buttons in the View menu. See the View Menu section for additional information on the different refresh modes.

Control Function

The Four-Quadrant Dynamometer/Power Supply has a large number of related control functions that can be chosen in order to make the module act as a particular device. The available control functions are listed below.

Dynamometer operating mode

Two-Quadrant, Constant Torque Brake

This function makes the PM-DC motor operate as a generator to produce a constant opposition to the rotation of the machine coupled to the Four-Quadrant Dynamometer/Power Supply (i.e., the machine under test). Closed-loop control is used to maintain the opposition torque constant when the rotation speed changes. A torque command entered by the user determines the value (magnitude) of the torque opposing rotation of the machine under test.

Clockwise (CW) Prime Mover / Brake

This function uses the PM-DC motor to make the machine coupled to the Four-Quadrant Dynamometer / Power Supply (i.e., the machine under test) rotates clockwise at a certain speed. A speed command entered by the user determines the no-load rotation speed of the machine under test. This function is well suited for the study of AC generator synchronization.

Counter-Clockwise (CCW) Prime Mover / Brake

This function operates as the CW Prime Mover / Brake function except for the direction of rotation.

Clockwise (CW) Constant-Speed Prime Mover / Brake

This function uses the PM-DC motor to make the machine coupled to the Four-Quadrant Dynamometer / Power Supply (i.e., the machine under test) rotates clockwise at a fixed speed. A closed-loop control is used to maintain the rotation speed constant under varying load conditions. A speed command entered by the user determines the rotation speed of the machine under test.

Counter clockwise (CCW) Constant-Speed Prime Mover / Brake

This function operates as the CW Constant-Speed Prime / Brake Mover except for the direction of rotation.

Positive Constant-Torque Prime Mover / Brake

This function uses the PM-DC motor to apply a constant positive torque to a machine coupled to the Four-Quadrant Dynamometer / Power Supply (i.e., the machine under test). A closed-loop control is used to maintain the torque at a constant value under varying speed conditions. A torque command entered by the user determines the torque value. Be aware that a closed-loop torque control will speed up the PM-DC motor to its max speed if the opposing torque of the machine under test is lower than the value applied by the user.

Negative Constant-Torque Prime Mover / Brake

This function operates as the Positive Constant-Torque Prime Mover / Brake function except that the torque is negative. As for the other function, be aware that a closed-loop torque control will speed up the PM-DC motor to its max speed if the opposing torque of the machine under test is lower than the value applied by the user.

Speed Sweep

This function uses the PM-DC motor to make the machine coupled to the Four-Quadrant Dynamometer/Power Supply (i.e., the machine under test) rotate at various speeds within a specific range, in a certain number of steps and in a certain time interval. A closed-loop control is used to ensure accurate speed sweep. The speed sweep performed is defined entirely by the user with only four parameters (start speed, end speed, number of steps, and step duration). The Speed Sweep function is useful to measure how parameters related to the machine under test vary as a function of the rotation speed.

Power Supply Operating Mode

Positive Voltage Source

This function uses the four-quadrant power supply to implement a DC voltage source having a positive polarity. The source can either source or sink current (two-quadrant operation). A voltage command entered by the user determines the value of the source voltage.

Negative Voltage Source

This function operates as the Positive Voltage Source function except for the polarity.

50 Hz Power Source

This function uses the four-quadrant power supply to implement a variable-voltage 50 Hz power source. A voltage command entered by the user determines the rms value of the source voltage. The source can either source or sink current no matter if the source voltage polarity (instantaneous) is positive or negative (four-quadrant operation). No meters are available except the temperature meter for this function.

60 Hz Power Source

This function operates as the 50 Hz Power Source function except for the frequency.

AC Power Source

This function uses the four-quadrant power supply to implement a variable-voltage, variable-frequency AC power source. The source can either source or sink current no matter if the source voltage polarity (instantaneous) is positive or negative (four-quadrant operation). Voltage and frequency commands entered by the user determine the rms value and frequency of the source voltage. No meters are available except the temperature meter for this function.

DC Voltage Source

This function uses the four-quadrant power supply to implement a DC voltage source having either positive or negative polarity. The source can either source or sink current no matter if the source voltage polarity is positive or negative (four-quadrant operation). A voltage command entered by the user determines the polarity and value of the source voltage.

Yellow and Red Multimeters

The yellow and red multimeters are used to perform voltage, current, and resistance measurements. Both multimeters can be used at the same time. To open a multimeter, in the main application toolbar, click the button corresponding to the desired multimeter. The yellow and red multimeters are connected and operate just like actual multimeters.

Tools

Language

This option allows you to set language used in LVSIM-EMS. English, French, and Spanish are available.

Options...

This dialog box allows you to set general options in LVSIM-EMS such as AC Power Network and the type of units (SI or Imperial) used. Make the settings you want and click on OK.

Settings for Model 9063...

This dialog box allows you to modify different settings for the DACI, Model 9063.

Analog Inputs

The setting of analog input 7/T (torque) determines how the torque is corrected in the Metering window.

- If the Corrected Torque option is used, the torque measured by the DACI is automatically corrected. Therefore, any meter set to measure torque will display the corrected torque value. Because of this, torque correction (mode C or NC) will not be available for this meter.
- If the Non-Corrected Torque option is used, the torque measured by the DACI is not corrected. Because of this, torque correction (mode C or NC) will be available for any meter set to measure torque.

See Technical Information about the Torque and Mechanical Power Meters for additional information about the torque function.

Digital Inputs

The A/B Encoder (PPR) setting allows the user to set the number of pulse per rotation (PPR) of the A/B Encoder.

Range

The range of the main voltage and current inputs (E1 to E4 and I1 to I4) on the Data Acquisition Interface or Data Acquisition and Control Interface can be set to high, low, or Auto. Setting the input range to high maximizes the measurement range but decreases the resolution. Conversely, setting the input range to low maximizes the resolution but decreases the measurement range. Finally, setting the input range to auto scale makes the DACI automatically adjust the range according to the measured voltage and current values.

Clicking the OK button applies the settings currently defined in the Settings for Model 9063 dialog box and closes the dialog box.

Clicking the Cancel button closes the Settings for Model 9063 dialog box without changing the settings. Note that the settings currently defined in the Settings for Model 9063 dialog box, if not applied, are lost when clicking the Cancel button.

Data Table

The Data Table is used to record and organize measured values during a work session. Once values are in the Data Table, different graphs can be generated using the associated Graph function.

Display and General Commands

The Data Table consists of columns and numbered rows. The user assigns a column to each of the parameters measured during a work session. The different values measured for each parameter during the work session can then be recorded manually or automatically.

At the top of each column is a grey cell used to enter the column title (parameter's name and unit of measurement). This can be done manually by using the Properties command of the contextual menu when the desired column to be modified is selected. Here is series of operation that can be accomplished directly on the display:

Selecting a Column or a Row

A column in the Data Table can be selected by clicking the header of the desired column with the mouse. Similarly, a row in the Data Table can be selected by clicking the row numbering cell of the desired row with the mouse.

Editing Data

The contents of a cell can be edited by double clicking the cell that contains the data to be edited. Once data is edited, the selected cell can be released by clicking any empty cell in the Data Table or by selecting another cell.

Selecting Values

The values of one or more parameters recorded in the Data Table can be selected to plot one or more curves in the Graph window. A single parameter is selected by clicking the header of the column corresponding to the desired parameter. Several parameters are selected by pressing and holding the Control (Ctrl) key and clicking the headers of the columns corresponding to the desired parameters.

Context-Sensitive Menu Commands

A context sensitive menu is available in the Data Table window. This menu is displayed by clicking the right button of the mouse when the cursor is located over the Data Table. The commands available in the context-sensitive menu depend on whether the cursor is located over a column header, a row numbering cell, or a data cell. The various commands that may be available in the context sensitive menu are listed below:

- Cut
- Copy
- Paste
- Insert Row
- Delete Row
- Insert Column
- Delete Column
- Set Column Width
- Properties

Menus

File Menu Commands

New

Creates a new Data Table file (filename.sdt). When creating a Data Table file, the Data Table returns automatically to its default settings.

You will be asked to save the current document as a .sdt file if you made any modification to it.

Open...

Opens a Data Table file (filename.sdt) to the same state it was when saved.

You will be asked to save the current document as a .sdt file if you made any modification to it before opening the saved file.

Save...

Saves the current Data Table to a Data Table file. A dialog box opens allowing you to name the Data Table file and choose the directory where you wish it to be saved.

Export...

Opens the Export... dialog box to save the Data Table values to a .txt file. This file contains the rows, columns and values of your currently opened Data table file.

Print...

Sends the Data Table window to the printer. Note that the menu bar, toolbar, and status bar in the Data Table window are not sent to the printer.

The Print dialog box appears before the Data Table window is sent to the printer. This box allows the print setup and options to be modified before printing. The Data Table is effectively sent to the printer after the OK button in the Print dialog box is clicked.

Close

Closes the Data Table window.

Edit Menu Commands

Record Data

Records in the Data Table the current reading(s) of the instrument(s) selected in the Record Settings dialog box, accessible by selecting Record Settings from the Options menu. All the instruments and control functions of LVSIM-EMS that read or display a certain value can be recorded in the Data Table.

Cut

Moves the data selected in a cell of the Data Table to the clipboard.

Copy

Copies the data selected in a cell of the Data Table to the clipboard.

Paste

Inserts the contents of the clipboard at the insertion point, and replaces any selected contents.

Insert

- Column: inserts a column at the left of the selected column.
- Row: inserts a row over the selected row.

Delete

- Column: deletes the selected column.
- Row: deletes the selected row.

Set Column Width…

Opens the Column Width dialog box. This box allows the width of the currently selected column to be changed by editing the number in the Column Width field. Increasing the number in this field increases the column width.

Clicking the OK button closes the dialog box and modifies the width of the currently selected column.

Clicking the Cancel button closes the dialog box without changing the column width.

Clear Data Table

Deletes the contents of the Data Table without moving it to the clipboard.

Properties…

Opens the Properties dialog box. This box allows the title (parameter's name and unit of measurement) of the currently selected column to be edited.

Clicking the OK button inserts the title in the blank cell at the top of the selected column, and closes the Properties dialog box.

Clicking the Cancel button closes the Properties dialog box without modifying the currently selected column.

View Menu Commands

Graph

Opens the Graph window.

Options Menu Commands

Record Settings…

Allows the user to choose the various parameters he wishes to record. See Record Settings for more information.

Timer Settings…

Opens the Timer Settings dialog box. This option allows the user to start an automatic recording of the Data Table at periodic time as specified in the dialog box. Two parameters are available within this dialog box;

Interval between records: Specify the number of seconds, minutes or hour that will space each automatic record. The number must be an integer.

Number of records: Specify the number of automatic record that will be taken before the timer stops.

Start Timer

Starts the automatic recording system.

Stop Timer

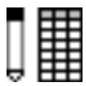
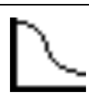
Stops the automatic recording system.

Help Menu Commands

Contents and Index…

Opens the Help file related to the software product you are currently using.

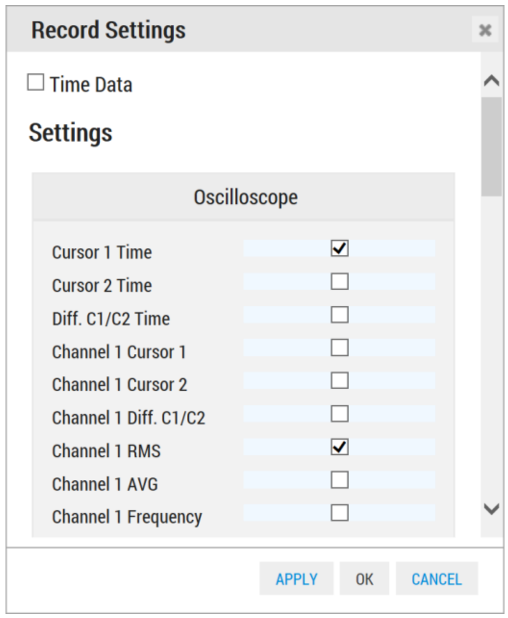
Toolbar

Icon	Description
	New
	Open
	Save
	Print
	Record Data
	Record Settings
	Insert Row
	Delete Row
	Clear Data Table
	Graph
	Timer Settings
	Start Timer
	Stop timer

Record Settings

Opens the Record Settings dialog box if at least one instrument of LVSIM-EMS is open. The instruments currently opened in LVSIM-EMS appear in the Settings drop-down list of the Record Settings dialog box.

To create a column associated with an instrument in the Data Table, first select the instrument in the Settings list. All the recordable parameters of the selected instrument will then appear in the large white box with a check-box at their left side. Here is an example of the Record Settings dialog box with the Oscilloscope instrument.



For each parameter selected, the Data Table will create a column with the name and units of this parameter, if specified, as title. In this example, the Cursor 1 Time and Channel 1 RMS will create a column in the Data Table. Proceed the same way for every instruments for which some values are needed. Once all the selections have been made, click on the OK button. Please note that you can also record a Time Data by adding to your selection the Time Data parameter, located at the top of the Record Settings dialog box.

From now, clicking the Record button of the Toolbar will cause the software to automatically record the values chosen for each instrument in the proper columns of the Data Table.

Graph

The Graph is used to plot the relationship between two or more parameters recorded in the Data Table. Up to three curves (traces) can be plotted on the graph. Note that the Graph Editor is designed to be used to verify the value taken during a work session using curves to ensure that every value is realistic before leaving the workplace. It is not meant to be a powerful tool to draw graphs. It is suggested to export the data of the Data Table to a more powerful graph editor for more possibilities when completing a session report. The Graph window consists of the three following sections:

1. The upper section contains the menus and Print button.
2. The display section contains the graph with the plotted curve(s).
3. The right section contains the Graph Settings and allows you to set the scale and the type of the graph, select the parameters plotted in the graph, choose the colors used, and invert the display of the X-axis coordinates.

Menus

File Menu Commands

Print…

Opens the Print dialog box. By clicking on the OK button, the Graph will be printed without the settings section on the right of the graph. The Print button under the menus acts exactly the same as the Print… command.

Close

Closes the Graph window.

View Menu Commands

Show Settings

Shows/hides the Graph Settings section on the right.

Options Menu Commands

Graph…

Brings up the Graph Options dialog box, allowing you to enter titles for your graph and for the X and Y axes. Once the desired titles have been entered, click OK to close the dialog box. The graph title appears at the top of the graph, while the axis titles appear along the X- and Y-axes.

Help Menu Commands

Contents and Index…

Opens the Help file related to the software product you are currently using.

Graph Settings

Information on the settings of the Graph is provided below.

Appearance

Display	Selects the desired type of curve. Dots, Curves and Curve with dots are available.
Scale	Selects the graph scale. This scale is default set for the display of all traces.
Type	Selects the type of scale (linear or logarithmic) used for the X and Y axes of the graph.

Axis

This section is used to select the parameters plotted on the graph. Each field consists of a drop-down list permitting selection of a parameter (column of data) recorded in the Data Table. The parameter selected for the X axis is the parameter used for the abscissa. The parameters selected for the 1-Y, 2-Y, and 3-Y axes are plotted in relation to the parameter selected for the X axis. Three traces can therefore be simultaneously plotted on the graph.

1-Y	Selects the parameter to plot in relation to the parameter selected for the X axis. The resulting trace is Trace 1.
2-Y	Selects the parameter to plot in relation to that selected for the X axis. The resulting trace is Trace 2.
3-Y	Selects the parameter to plot in relation to that selected for the X axis. The resulting trace is Trace 3.
X	Selects the parameter used for the X axis (abscissa) of the graph.

Color

Background	Selects the color of the graph background.
Frame	Selects the color of the graph contour.
Grid	Selects the color of the graph grid.
Texts	Selects the color of the X- and Y-axis coordinate values.
Trace 1	Selects the color used to plot Trace 1.
Trace 2	Selects the color used to plot Trace 2.
Trace 3	Selects the color used to plot Trace 3.

Scale

X Interval	Changes the interval between the X-axis lines. This field is enabled only when the X-Axis Scale field is set to Manual.
X Max.	Changes the maximum value of the X-axis. This field is enabled only when the X-Axis Scale field is set to Manual.
X Min.	Changes the minimum value of the X-axis. This field is enabled only when the X-Axis Scale field is set to Manual.
X-Axis Scale	Selects between Manual or Automatic scaling of the X-Axis. This field is default set to Automatic: in this case, the X-axis coordinates are determined by the values recorded for the corresponding parameter in the Data Table. When this field is set to Manual, the minimum and maximum values of the X axis can be changed manually, as well as the spacing between this axis coordinates.
Y Interval	Changes the interval between the Y-axis lines. This field is enabled only when the Y-Axis Scale field is set to Manual.
Y Max.	Changes the maximum value of the Y-axis. This field is enabled only when the Y-Axis Scale field is set to Manual.
Y Min.	Changes the minimum value of the Y-axis. This field is enabled only when the Y-Axis Scale field is set to Manual.
Y-Axis Scale	Selects between Manual or Automatic scaling of the Y-Axis. This field is default set to Automatic: in this case, the Y-axis coordinates are determined by the values recorded for the corresponding parameter in the Data Table. When this field is set to Manual, the minimum and maximum values of the Y-axis can be changed manually, as well as the spacing between this axis coordinates.

X-Axis (Coordinates)

Inversion	Displays the coordinates of the X-axis in the reverse order.

Help

Contents and Index...

Opens the Help file related to the software product you are currently using.

Manuals and Exercises...

Opens a page providing information about the student manuals that can be used with the LVSIM-EMS software.

What's New...

Opens a page providing information about the software version history.

About LVSIM-EMS...

Opens a window providing general information about the LVSIM-EMS software.