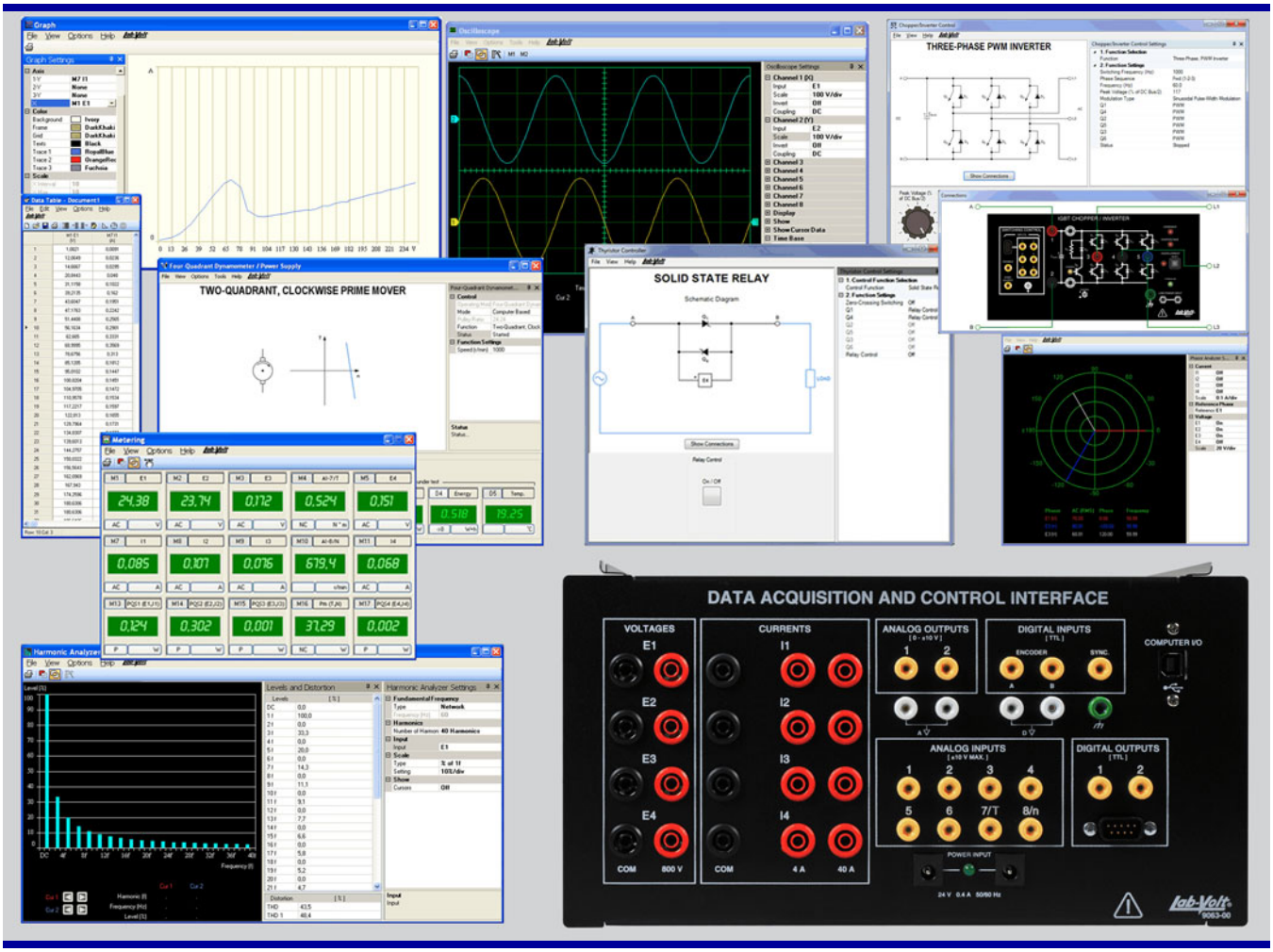
Electric Power / Controls

0.2 kW

EMS DATA ACQUISITION AND CONTROL INTERFACE (LVDAC-EMS) MODEL 9063



Model shown with optional functions.

GENERAL DESCRIPTION

The Lab-Volt Data Acquisition and Control Interface (DACI), Model 9063, is a versatile USB peripheral used for measuring, observing, analyzing, and controlling electrical and mechanical parameters in electric power systems and power electronics circuits. For these purposes, a set of computer-based instruments as well as a variety of control functions are available for the DACI. These instruments and control functions are accessed through the Lab-Volt Data Acquisition and Control for Electromechanical Systems (LVDAC-EMS) software. The LVDAC-EMS software, as well as all available upgrades, is free and can be downloaded anytime on the Lab-Volt website.Together, the DACI and the LVDAC-EMS software allow training in various areas such as electric power technology, ac/dc machines, renewable energy, transmission lines, and power electronics using modern and versatile measuring instruments and control functions. LVDAC-EMS also offers the possibility to use pre-built SCADA interfaces for several applications to ease the view and

understanding of the process taking place. The user guide provided allows students to quickly become familiar with the instruments and control functions available.

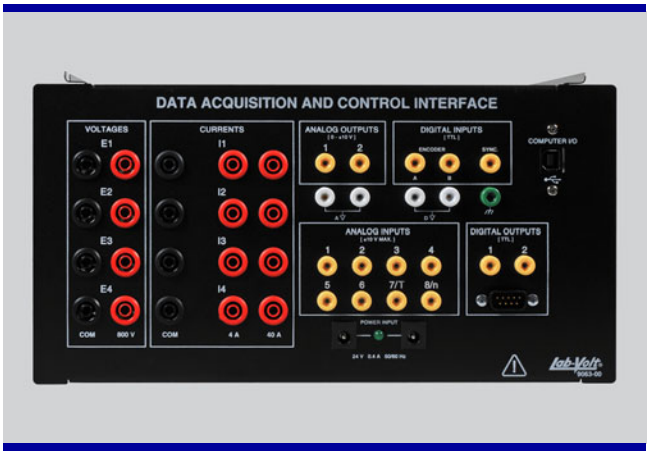
The DACI and the LVDAC-EMS software are standard features in the Electric Power Technology Training Systems, Series 8010, and in the Computer-Assisted 0.2-kW Electromechanical Training System, Model 8006.

The DACI and the LVDAC-EMS software can also be an excellent add-on to several Lab-Volt training systems, such as:

- 0.2-kW Electromechanical Training System, Model 8001
- 2-kW Electromechanical Training System, Model 8013
- 0.2-kW Power Electronics Training System, Model 8032
- 0.2-kW Electric Power Transmission Training System, Model 8055
- 2-kW Electric Power Transmission Training System, Model 8059

MODULE DESCRIPTION

Model 9063 – Data Acquisition and Control Interface[1]



The Data Acquisition and Control Interface (DACI) performs two main functions: data acquisition feeding raw signal data to the computer-based instruments, and data acquisition for implementing a control function. Each DACI can perform these two functions at the same time. However, when a complex control function is implemented, the DACI stops data acquisition for the computer-based instruments and performs only data acquisition for the control function.

The DACI has four isolated, high-level voltage inputs and four isolated, high-level current inputs. All these inputs are fitted with 4-mm banana safety jacks to make connections to electric power circuits implemented with Lab-Volt equipment quick, safe, and easy. The DACI also has eight low-level, analog inputs which allow measurement of other circuit parameters. Two of these inputs can be used to measure torque and speed using a Lab-Volt dynamometer (Model 8960-1 or 8960-2).

Finally, the DACI is provided with three digital inputs which can be monitored through the LVDAC-EMS software. Two of these digital inputs are used as an incremental encoder input (A-B) for speed measurement and the third input is used for synchronization. The eight low-level analog inputs and the three digital inputs are all fitted with miniature (2 mm) safety banana jacks to avoid accidental connection to high-level outputs.

The DACI has a parallel digital output which can be used to control Lab-Volt power electronics modules like the IGBT Chopper/Inverter, Model 8837, and the Power Thyristors, Model 8841. This output can also be used to control other types of modules. The parallel digital output provides TTL-level signals on a 9-pin, D-type connector. The DACI includes two additional digital outputs that also provide TTL-level signals. The DACI also includes two software-programmable analog outputs which can be used to control a dynamometer or a power electronics module. The two additional digital outputs and the two analog outputs are all fitted with miniature (2 mm) safety banana jacks. All inputs and outputs of the DACI are protected against improper connections and overvoltage/overcurrent conditions.

The user guide included with the DACI provides detailed information about the module operation. Interconnection between the DACI and the personal computer running software LVDAC-EMS is through a standard USB cable included with the module.

To activate the data acquisition for any instrumentation function, a license for that specific instrumentation function must be ordered for each DACI that will be used with the instrumentation function. Similarly, to activate the data acquisition for any specific control function, a license for that specific function, must be ordered for each DACI that will be used to perform this control function.

[1] Each Data Acquisition and Control Interface (DACI), Model 9063-0X, must be ordered with at least one function license (e.g., the Computer-Based Instrumentation Function, Model 9069-1) unless the Model 9063-0x is an extension module to another Model 9063-xx which has a control function that needs an extension module (like Three-Phase PWM Rectifier/Inverter Control Function Model 9069-5 or High-Voltage DC Transmission System Control Function Model 9069-7).

The DACI is available in several model variants. Each variant has a unique combination of functions pre-activated at Lab-Volt. The available model variants are listed in the following table. Other model variants will be added to the table as they become available.

Description	Function	Model Variant							
		9063-B	9063-C	9063-D	9063-E	9063-F	9063-G	9063-H	9063-J
Computer-Based Instrumentation Function	9069-1	✓	✓	✓	✓	✓	✓	✓	✓
Chopper/Inverter Control Function Set	9069-2		✓	✓	✓	✓			
Thyristor Control Function Set	9069-3			✓				✓	✓
Home Energy Production Control Function Set	9069-4				✓	✓		✓	
Three-Phase PWM Rectifier/Inverter Control Function Set	9069-5					✓			
BLDC Motor/PMSM Control Function Set	9069-6								
High-Voltage DC (HVDC) Transmission System Control Function Set	9069-7							✓	✓
Static Var Compensator (SVC) Control Function Set	9069-8							✓	✓
9063 SDK (Software Development Kit)	9069-9								
Synchronous Generator Control Function Set	9069-A								
Static Synchronous Compensator (STATCOM) Control Function Set	9069-B							✓	✓
Synchroscope Function	9069-C						✓		

DACIs with a specific combination of pre-activated functions other than those listed above can also be ordered. To order a customized DACI, request DACI Model 9063-0 (DACI with no functions pre-activated) and state each function (Model 9069-X) you wish to be pre-activated.

It is important to know that LVDAC-EMS can accept more than one Data Acquisition and Control interface connected through USB on a single computer. When connected to the same computer, two DACIs will share their control functions. It means, for instance, that in the High-Voltage DC Transmission System application which requires two DACIs to control two separate Power Thyristors modules, Model 8841-2, you would only need one DACI that has the High-Voltage DC (HVDC) Transmission System Control Function Set, Model 9069-7, activated. Then, any other DACI connected to the same computer will be able to used the shared control function as well.

The firmware (program running in the microcontroller) of the Data Acquisition and Control Interface can be upgraded anytime using the device firmware upgrade (DFU) included with the latest version of the LVDAC-EMS software available on the Lab-Volt website (www.labvolt.com).

LVDAC-EMS Software

The LVDAC-EMS software is a freeware which can be downloaded anytime from the Lab-Volt website (www.labvolt.com). The LVDAC-EMS software is a user-friendly tool that facilitates the use of the various functions which can be implemented with the Lab-Volt USB peripherals like the Data Acquisition and Control Interface (DACI), Model 9063, and the Four-Quadrant Dynamometer / Power Supply, Model 8960-2.

LVDAC-EMS FUNCTIONS

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

Instrumentation Functions

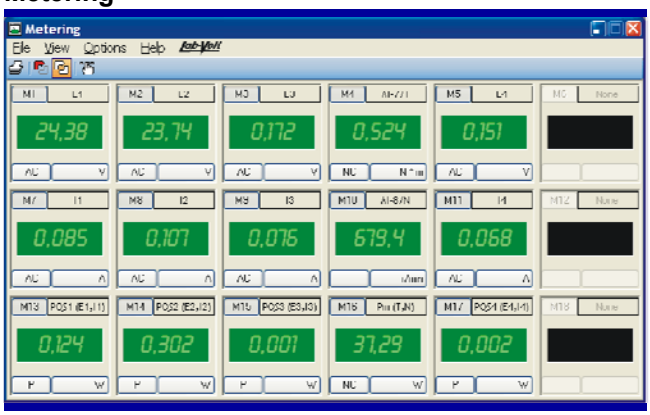
The instrumentation functions of LVDAC-EMS replace a multitude of actual data acquisition devices (e.g., voltmeters, ammeters, oscilloscopes, synchroscopes) with a series of computer-based instruments that display the data measured by the DACI. The instrumentation functions currently available in LVDAC-EMS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

Model 9069-1 – Computer-Based Instrumentation Function

The Computer-Based Instrumentation Function, Model 9069-1, includes the following computer-based instruments:

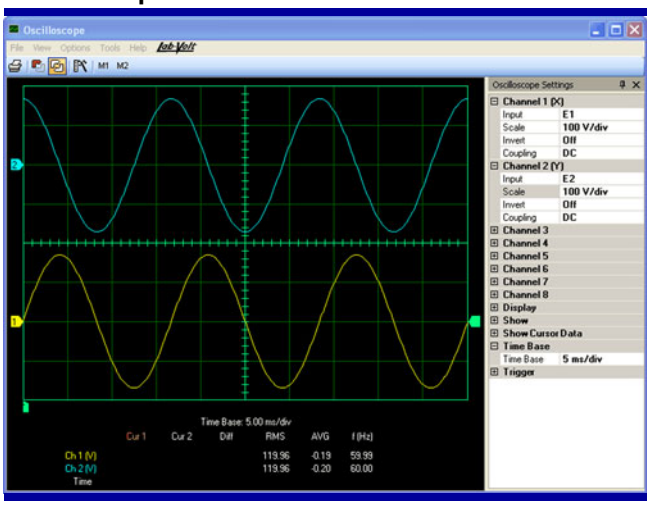
- Metering
- Data Table and Graph
- Oscilloscope
- Phasor Analyzer
- Harmonic Analyzer

Metering



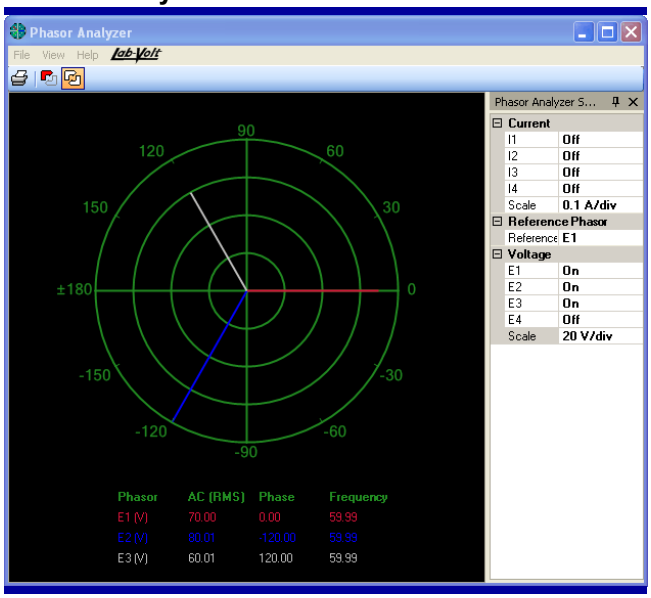
The Metering window displays up to eighteen meters that can be configured to measure a multitude of parameters (e.g., voltage, current, active power, reactive power, apparent power, efficiency, impedance, power factor, frequency, energy, torque, speed, mechanical power, phase angle, phase shift). The voltage and current meters have several modes of operation that allow measurement of the mean (DC) value, RMS value, crest factor, RMS value of a particular harmonic (up to the 15th), RMS value of the harmonics, and total harmonic distortion (THD). The layout of the meters in the Metering window can be customized by the user. The name of each meter can be edited to identify the measured circuit parameter.

Oscilloscope



The Oscilloscope can display up to eight waveforms simultaneously. Each waveform is of a different color for easy identification. Each channel has independent vertical controls similar to those found on conventional oscilloscopes. An automatic scale setting function allows the sensitivity of each channel to be set automatically according to the magnitude of the observed parameter. The time base and trigger controls are similar to those found on most oscilloscopes. The RMS value, average value, and frequency of each of the observed parameters can be displayed in a table in the Oscilloscope window. Two vertical cursors can be activated to perform precise measurements at particular points on the displayed waveforms. The Oscilloscope has two memory channels for saving the displayed waveforms.

Phasor Analyzer

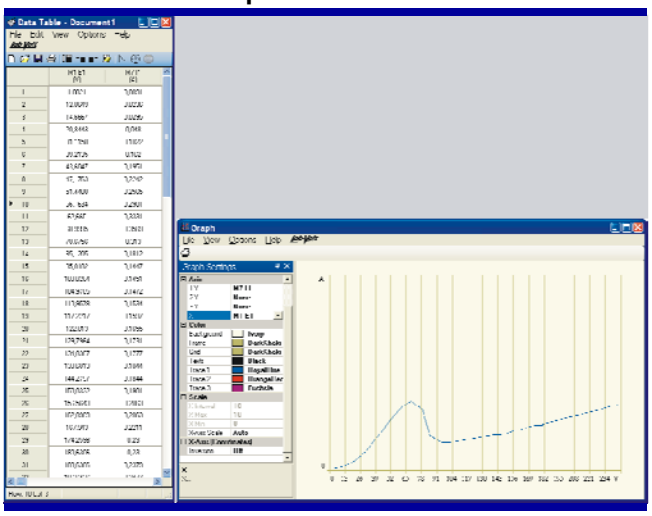


The innovative Phasor Analyzer displays the phasors related to measured voltages and currents instead of the values and waveforms related to these voltages and currents. The Phasor Analyzer allows circuit voltages and currents to be monitored easily for relative amplitudes and phase differences simply by looking at their respective phasors. This produces a unique and dynamic display of the voltages and currents in a circuit (especially in three-phase circuits) that cannot be obtained with conventional instruments. The RMS value, phase angle, and frequency of the voltage or current related to each phasor are displayed in a table in the Phasor Analyzer window.

Harmonic Analyzer

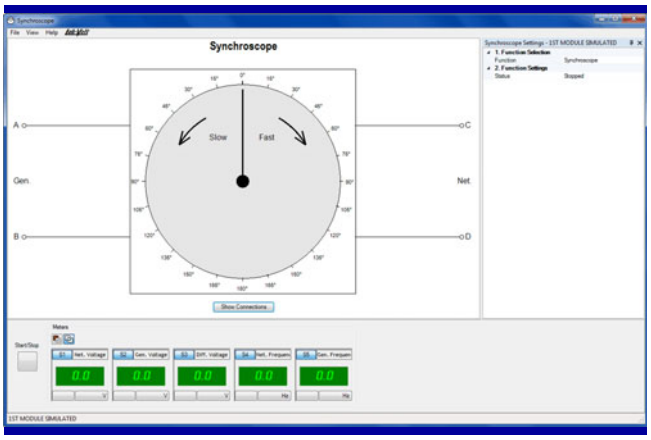
The Harmonic Analyzer allows observation and analysis of the harmonic components in the measured voltages and currents. The fundamental frequency can either be set to the ac power network frequency, manually by the user, or automatically to the frequency of the fundamental component of the selected voltage or current. The number of harmonic components displayed can be varied between 5 and 40. The harmonic components of the selected voltage or current can be displayed using a vertical scale graduated in either absolute or relative values. Various vertical scale settings are available. A group of data displays in the Harmonic Analyzer indicates the values of the dc component, fundamental component, and harmonic components of the selected voltage or current, as well as the total harmonic distortion (THD). Vertical and horizontal cursors can be activated to perform precise measurements at particular points on the display.

Data Table and Graph



The values indicated by the meters or indicators of all computer-based instruments and control functions (see later in this section for more detail about control functions) in LVDAC-EMS can be recorded in the Data Table window. A timer option is provided to help record data at specific time intervals. The values recorded in the Data Table can be saved to a file. The recorded data can also be used to plot graphs by selecting which parameter(s) to plot in the Graph window. This allows lab results to be plotted quickly and easily. More complex graphs can be created by exporting the contents of the Data Table window to any popular spread sheet program, such as Microsoft® Excel®.

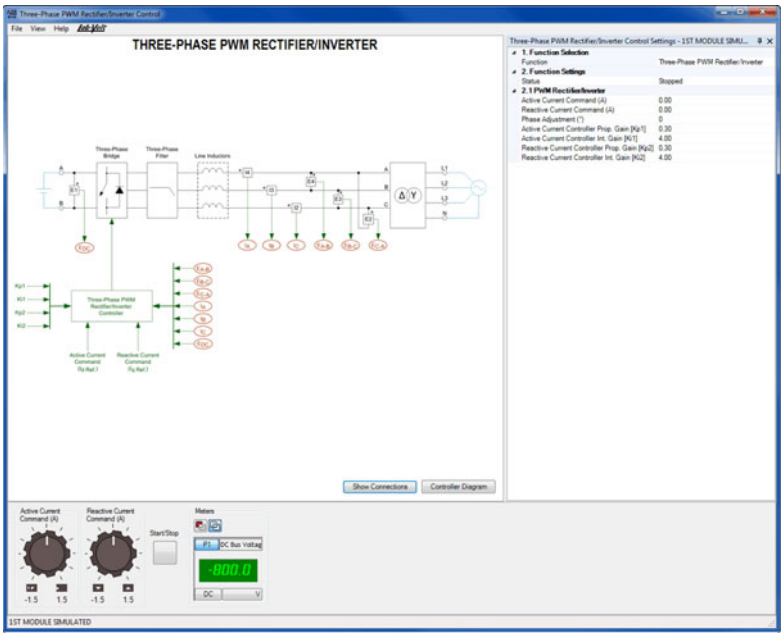
Model 9069-C – Synchroscope Function



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

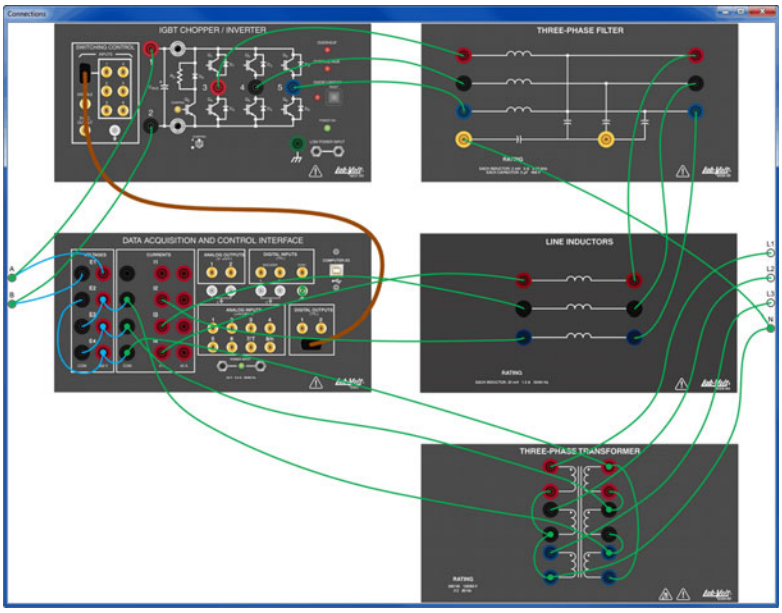
Control Function Sets

Several sets of computer-based functions (function sets) allowing control of power electronics modules can be activated in the DACI. Each control function in a set allows the implementation of a power electronics device or system. Control of any of the required power electronics modules is achieved by first connecting the DACI to both the host computer (via a USB connection) and to the required power electronics module, and accessing the desired control function via the LVDAC-EMS software running on the host computer. Each control function has a specific set of user-friendly controls for easy operation of the device implemented (see figure on the right for an example of a control function window).



Example of a control function window.

Each control function also gives access to one or more schematic and connection diagrams (see figure on the right for an example of a connection diagram) that show all connections required to implement the device. The switching and/or firing signals necessary to control the implemented device are produced by the DACI and routed to the power electronics module used. The control function sets currently available in LVDAC-EMS are described in the following pages.

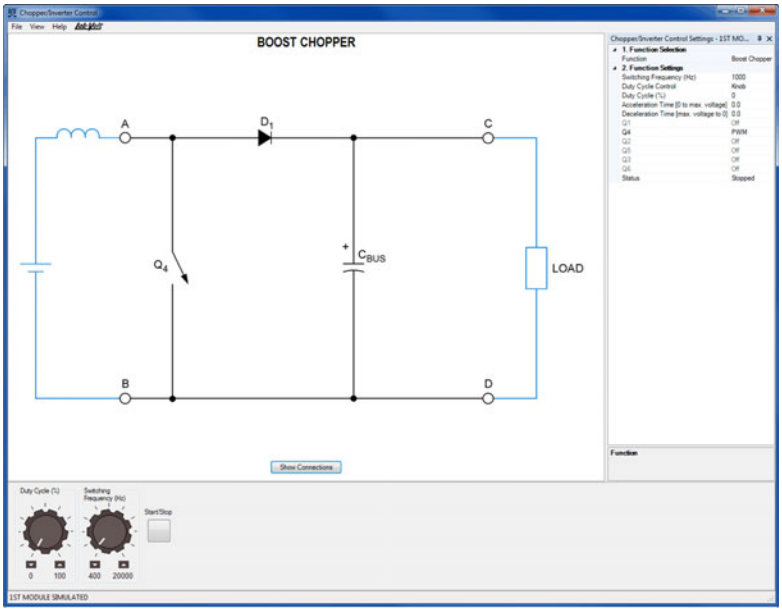


Example of a connection diagram accessed from a control function window.

Model 9069-2 – Chopper/Inverter Control Function Set

The Chopper/Inverter Control Function Set enables the following choppers and inverters to be implemented using the DACI and the IGBT Chopper/Inverter, Model 8837-B:

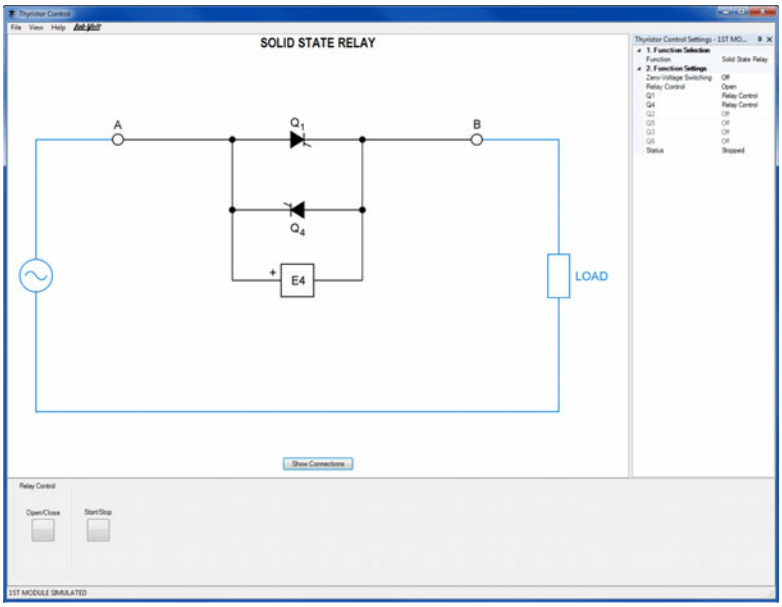
- Buck Chopper (high-side switching)
- Buck Chopper (low-side switching)
- Buck/Boost Chopper
- Boost Chopper
- Four-Quadrant Chopper
- Buck Chopper with Feedback
- Boost Chopper with feedback
- Single-Phase, 180° Modulation Inverter
- Single-Phase PWM Inverter
- Three-Phase, 180° Modulation Inverter
- Three-Phase PWM Inverter
- Three-Phase Inverter (constant V/f ratio)



Model 9069-3 – Thyristor Control Function Set

The Thyristor Control Function Set enables the following thyristor-based devices to be implemented using the DACI and the Power Thyristors, Model 8841:

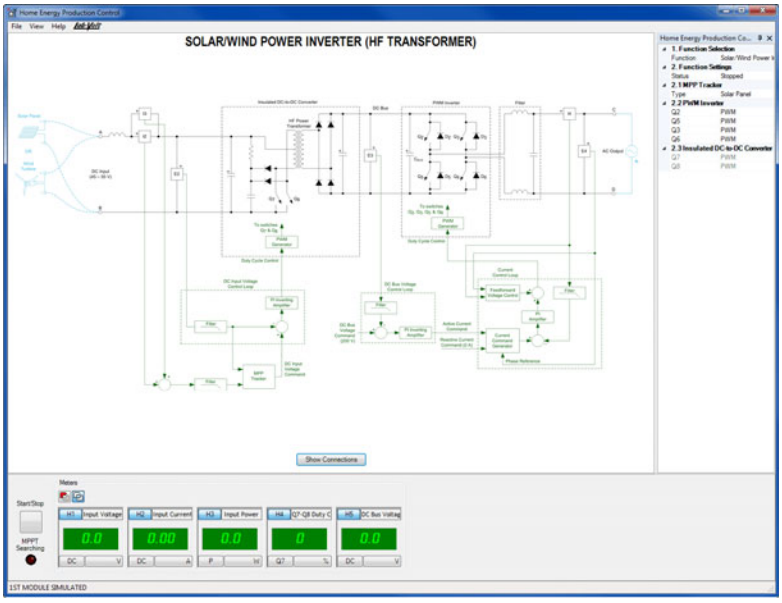
- Thyristor, Single-Phase, Half-Wave Rectifier
- Thyristor Single-Phase Bridge
- Thyristor Three-Phase Bridge
- Solid-State Relay
- Thyristor, Single-Phase, AC Power Control
- Thyristor, Three-Phase, AC Power Control



Model 9069-4 – Home Energy Production Control Function Set

The Home Energy Production Control Function Set enables the following devices required for home energy production to be implemented using the DACI, the IGBT Chopper/Inverter, Model 8837-B, and the Insulated DC-to-DC Converter, Model 8835:

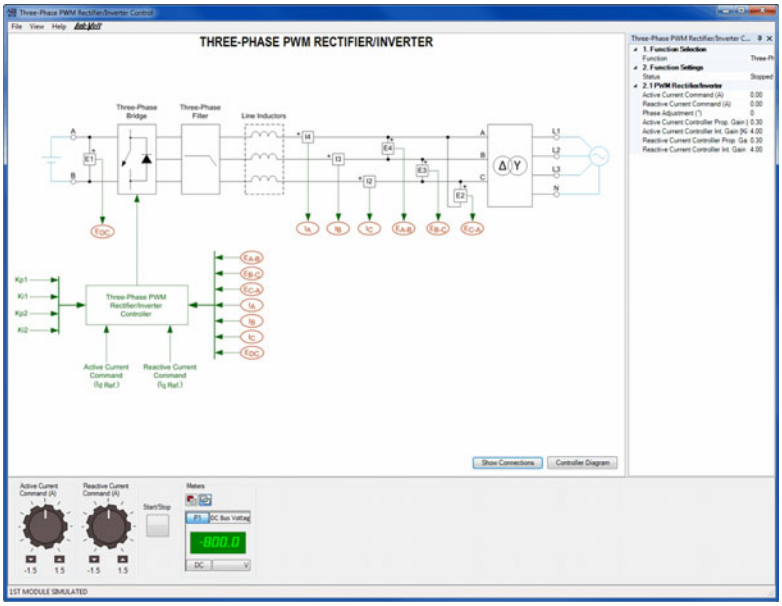
- Insulated DC-to-DC Converter
- Single-Phase Stand-Alone Inverter
- Single-Phase Grid-Tied Inverter
- Solar Power Inverter (LF Transformer)
- Solar/Wind Power Inverter (HF Transformer)



Model 9069-5 – Three-Phase PWM Rectifier/Inverter Control Function Set

The Three-Phase PWM Rectifier/Inverter Control Function Set enables the following three-phase PWM rectifiers/inverters to be implemented using the DACI and the IGBT Chopper/Inverter, Model 8837-B:

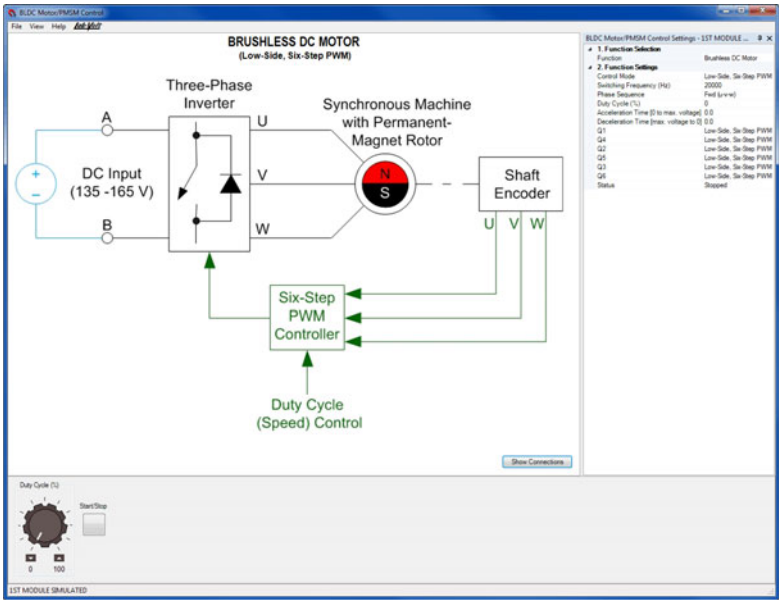
- Three-Phase PWM Rectifier/Inverter
- PWM Rectifier/Inverter with Buck/Boost Chopper



Model 9069-6 – BLDC Motor/PMSM Control Function Set

The BLDC Motor/PMSM Control Function Set enables the following control types for brushless dc (BLDC) motors and permanent-magnet synchronous machines (PMSM) to be implemented using a DACI and a IGBT Chopper/Inverter, Model 8837-B, or using two DACIs and two IGBT Chopper/Inverter, Model 8837-B:

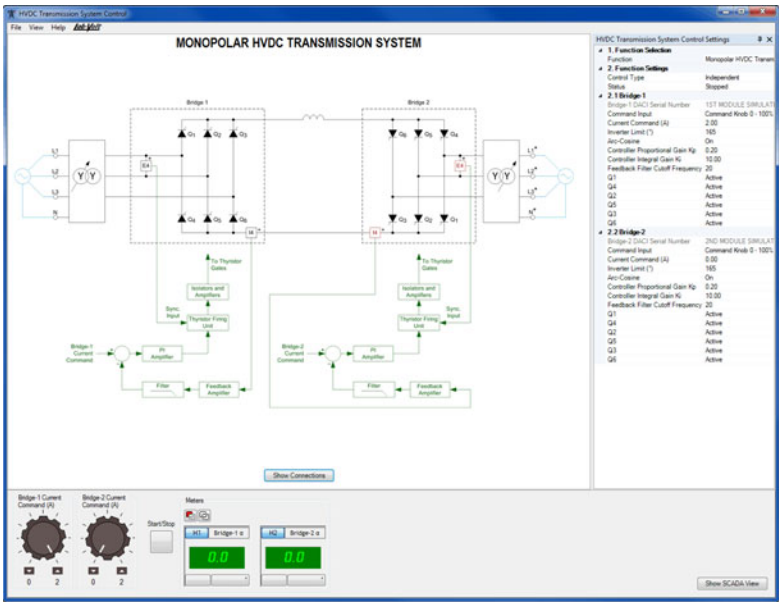
- Three-Phase, Six-Step 120° Modulation Inverter
- Brushless DC Motor (Six-Step 120° Modulation)
- Brushless DC Motor (Low-Side, Six-Step PWM)
- Permanent-Magnet Synchronous Motor (Field-Oriented Control)
- Wind Turbine with Permanent-Magnet Synchronous Generator



Model 9069-7 – High-Voltage DC (HVDC) Transmission System Control Function Set

The High-Voltage DC (HVDC) Transmission System Control Function Set enables the following devices required for the study of HVDCs to be implemented using two DACIs and two Power Thyristors, Model 8841:

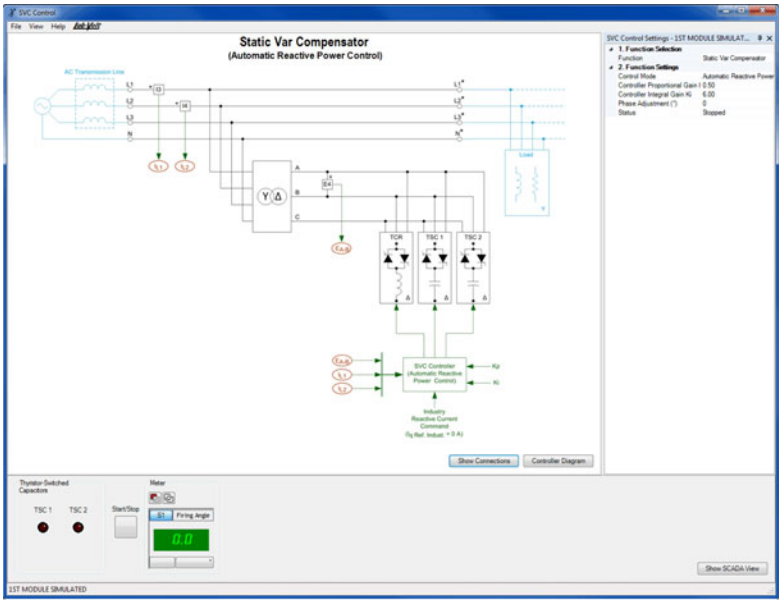
- Dual Thyristor Bridge
- Monopolar HVDC Transmission System
- 12-Pulse Converter



Model 9069-8 – Static Var Compensator (SVC) Control Function Set

The Static Var Compensator (SVC) Control Function Set enables the following devices required for the study of SVCs to be implemented using the DACI and the Power Thyristors, Model 8841:

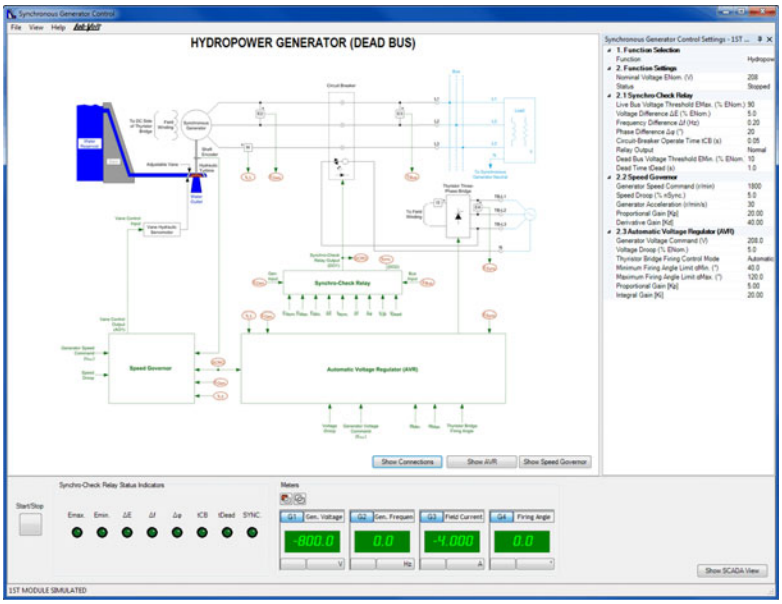
- Static Var Compensator (Manual Control)
- Static Var Compensator (Automatic Voltage Control)
- Static Var Compensator (Automatic Reactive Power Control)



Model 9069-A – Synchronous Generator Control Function Set

The Synchronous Generator Control Function Set enables the control of synchronous generators using different prime movers (emulated using the Four-Quadrant Dynamometer/Power Supply, Model 8960-2) and different control types for each prime mover. The function set allows the following prime movers and control types to be implemented using the DACI and the Power Thyristors, Model 8841:

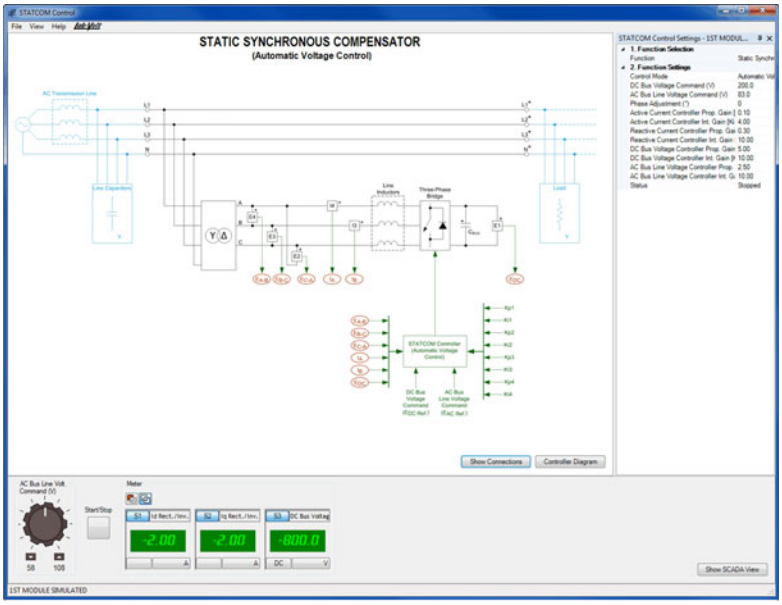
- Hydropower Generator (Dead Bus - Balanced Load)
- Hydropower Generator (Infinite Bus)
- Hydropower Generator (Balanced Infinite Bus)
- Hydropower Generator (Generator Paralleling - Balanced Bus)



Model 9069-B – Static Synchronous Compensator (STATCOM) Control Function Set

The Static Synchronous Compensator (STATCOM) Control Function Set enables the following devices required for the study of STATCOMs to be implemented using the DACI and the IGBT Chopper/Inverter, Model 8837-B:

- Static Synchronous Compensator (Automatic Voltage Control)
- Static Synchronous Compensator (Automatic Reactive Power Control)



Software Development Functions

Model 9069-9 – 9063 SDK (Software Development Kit)

The 9063 SDK (Software Development Kit) offers the possibility to control various inputs and outputs of the Data Acquisition and Control Interface, Model 9063 using third-party rapid prototyping software like Mathworks® MATLAB, National Instruments® LabVIEW, and other programming tools that support Microsoft® .NET Framework 3.5. The SDK gives users the possibility to build their own advanced functions using Model 9063. The SDK includes the following:

- DLL files for communication with the DACI
- Documentation related to the functions
- MATLAB (2010 or later) and LabVIEW (2009 or later) example programs.

The following functions are available using the SDK:

- Acquisition through the voltage and current inputs
- Acquisition through the encoder inputs
- Acquisition through the analog inputs
- Control of the digital outputs
- Control of the analog outputs

Important Notice: One Model 9069-9 must be ordered for each Data Acquisition and Control Interface, Model 9063, to unlock the SDK features.

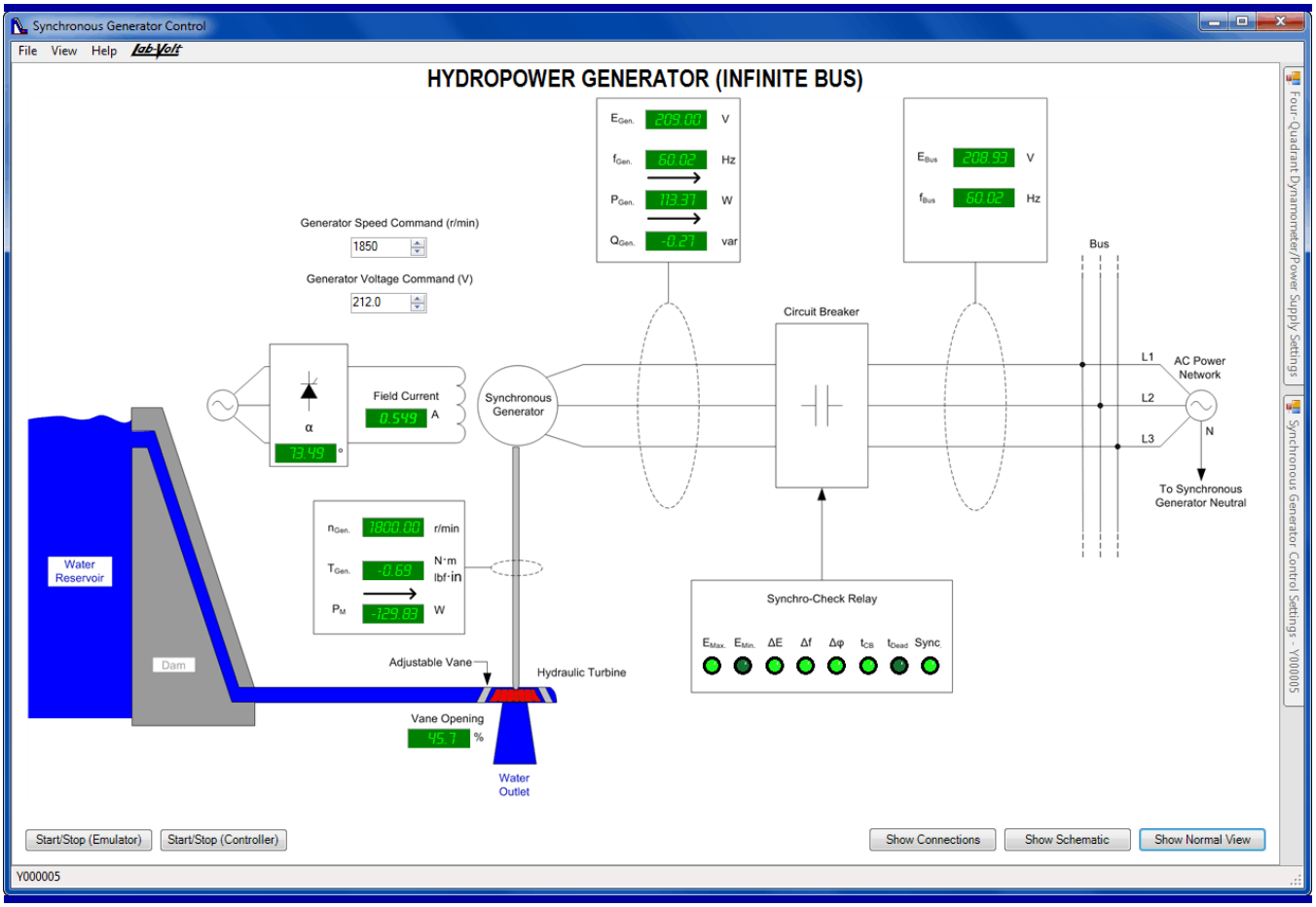
SCADA – SUPERVISORY CONTROL AND DATA ACQUISITION

The LVDAC-EMS software and the Data Acquisition and Control Interface, Model 9063, allow complex power system applications such as hydropower generators, large-scale wind turbines (PMSG and DFIG), high-voltage direct-current (HVDC) transmission systems, static var compensators (SVCs), and static synchronous compensators (STATCOMs) to be implemented. SCADA windows are available in the LVDAC-EMS software for these complex applications to ease system control and monitoring as well as to allow the student to quickly understand what is going on in these applications. Each SCADA view consists of a simplified diagram of the application integrating the main system controls as well as meters showing the values of the meaningful system parameters. All other system controls remain available through a parameter setting window which is easily accessed from the SCADA window.SCADA windows are currently available for the following applications:

- Static Var Compensator (SVC) - Automatic Voltage Control
- Static Var Compensator (SVC) - Automatic Reactive Power Control
- Wind Turbine with Permanent-Magnet Synchronous Generator (PMSG)
- High-Voltage DC (HVDC) Transmission - Monopolar HVDC Transmission System
- Hydropower Generator - Dead Bus
- Hydropower Generator - Infinite Bus
- Hydropower Generator - Generator Paralleling
- Static Synchronous Compensator (STATCOM) - Automatic Voltage Control
- Static Synchronous Compensator (STATCOM) - Automatic Reactive Power Control
- Three-Phase PWM Inverter (for doubly-fed induction generator application)
- Doubly-Fed Induction Generator (DFIG)

Normal windows of the Hydropower Generator application.

EMS DATA ACQUISITION AND CONTROL INTERFACE (LVDAC-EMS)
MODEL 9063



SCADA window of the Hydropower Generator application.

SPECIFICATIONS

Model 9063 – Data Acquisition Interface		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Insulated Voltage Inputs[2] (4)	Range (Low / High Scales)	-80 to +80 V / -800 to +800 V (user selectable through software)		
	Impedance (Low / High Scales)	326.6 kΩ / 3.25 MΩ		
	Bandwidth	DC to 65 kHz (-3dB)		
	Accuracy	1% (DC to 10 kHz)		
	Insulation	800 V		
Insulated Current Inputs[2] (4)	Range (Low / High Scales)	-4 to +4 A / -40 to +40 A (25 A RMS)		
	Impedance (Low / High Scales)	50 mΩ / 5 mΩ		
	Bandwidth	DC to 65 kHz (-3 dB)		
	Accuracy	1% (dc to 10 kHz)		
	Insulation	800 V		
Analog Inputs (8)	Voltage Range	-10 to +10 V		
	Impedance	> 10 MΩ		
	Bandwidth	DC to 125 kHz		
	Measured Parameters	User selectable through software		
	Parameter-to-Voltage Ratio	User determined through software		

[2] Designed for utilization within MEASUREMENT CATEGORY I. Network voltage ≤ 240 V~.

Model 9063 – Data Acquisition Interface (cont'd)		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
A/D Converter for Insulated and Analog Inputs (16)	Type	Successive approximation		
	Resolution	12 bits		
	Integral Non-Linearity	≤±1.5 LSB		
	Differential Non-Linearity	≤±1 LSB		
	Maximum Sampling Rate	600 ksamples/s (one channel)		
	FIFO Buffer Size	16 ksamples		
Analog Outputs (2)	Voltage Range	-10 to +10 V		
	Operational Load Impedance	> 600 Ω		
D/A Converter for Analog Outputs (2)	Type	Resistor string		
	Resolution	12 bits		
	Integral Non-Linearity	≤±8 LSB		
	Differential Non-Linearity	-0.5 to +0.7 LSB		
Digital Inputs (3)	Types	Encoder (2), Synchronization (1)		
	Signal Level	0-5 V (TTL compatible)		
	Maximum Input Frequency	50 kHz		
	Impedance	5 kΩ		
Digital Outputs (9)	Type	Control (six on a DB9 connector and two on 2-mm banana jacks) Synchronization (one on a DB9 connector)		
	Signal Level	0-5 V (TTL compatible)		
	Maximum Output Frequency	20 kHz (software limited)		
	Impedance	200 Ω		
Computer I/O Interface		USB 2.0 full speed via type-B receptacle		
Power Requirement		24 V - 0.4 A - 50/60 Hz		
Accessories		2-m USB interconnection cable (1)		
		24-V power cable (1)		
		2-mm banana plug test leads (3)		
		DB9-connector control cable (1)		
Physical Characteristics	Dimensions (H x W x D)	154 x 287 x 410 mm (6.1 x 11.3 x 16.1 in)		
	Net Weight	3.9 kg (8.6 lb)		
Model 9069-1 – Computer-Based Instrumentation Function		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Metering	Number of Meters	18		
	Sampling Window	250 ms or user adjusted through software (11.4 to 819 ms)		
	Sampling Frequency (each meter)	7.68 kHz or user adjusted through software (1.25 kHz to 22.4 kHz)	6.4 kHz or user adjusted through software (1.25 kHz to 22.4 kHz)	
	Display Type	digital or analog, user selectable through software		
Oscilloscope	Number of Channels	8		
	Vertical Sensitivity	2 V/div. to 200 V/div.		
	Time Base	0.1 ms/div. to 10 s/div.		
	Sampling Window	20 x selected time base		
	Sampling Frequency	512 samples per measured parameter per horizontal sweep, up to a maximum of 512 kHz		
Phasor Analyzer	Sensitivity	2 V/div. to 200 V/div., 0.05 A/div. to 5 A/div.	2 V/div. to 200 V/div., 0.05 A/div. to 5 A/div.	
	Sampling Window	software adjusted (2 ms to 614 ms)		
	Sampling Frequency (each phasor)	software adjusted (10 kHz to 512 kHz)		
Harmonic Analyzer	Fundamental-Frequency Range	1 Hz to 1400 Hz		
	Number of Harmonic Components	5 to 40, user selectable through software		
	Vertical Scale (relative scale)	0.1%/div. to 10%/div.		

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Model 9069-1 – Computer-Based Instrumentation Function (cont'd)		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
	Vertical Scale (absolute scale)	0.5 V/div. to 50 V/div., 0.01 A/div. to 1 A/div.		
	Sampling Window	software adjusted (10 ms to 15 s)		
	Sampling Frequency	software adjusted (120 Hz to 180 kHz)		
Model 9069-2 – Chopper/Inverter Control Function Set		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Control Functions		chopper, chopper with feedback, 180° modulation inverter, PWM inverter, V/f inverter		
Chopper Control Functions	Switching Frequency	2000 Hz to 20 kHz		
	Duty Cycle	0 to 100%		
	Acceleration Time [0 to max. voltage]	0 to 100 s		
	Deceleration Time [max. voltage to 0]	0 to 100 s		
Chopper with Feedback Control Functions	Switching Frequency	400 Hz to 20 kHz		
	Duty Cycle Command	0 to 100%		
	Controller Proportional Gain Kp	0.1 to 100		
	Controller Integral Gain Ki	0 to 20 000		
	Feedback Filter Cutoff Frequency	100 Hz to 9.8 kHz		
	Type of Feedback	voltage, current, speed, power, low power analog signal		
	Feedback Range (voltage)	0 to 800 V		
	Feedback Range (current)	0 to 40 A		
	Feedback Range (speed)	0 to 2500 r/min		
	Feedback Range (power)	0 to 32 kW		
	Feedback Range (analog signal)	0 to 10 V		
	Acceleration Time [0 to max. voltage]	0 to 100 s		
	Deceleration Time [max. voltage to 0]	0 to 100 s		
180° Modulation Inverter Control Functions	Inverter Output Frequency	0 to 120 Hz		
	Direction of Rotation (three-phase inverter)	forward and reverse		
PWM Inverter Control Functions	Switching Frequency	400 Hz to 20 kHz		
	Inverter Output Frequency	0 to 120 Hz		
	Inverter Peak Output Voltage	0 to 100% of dc bus voltage		
	Direction of Rotation (three-phase inverter)	forward and reverse		
V/f Inverter Control Function	Switching Frequency	400 Hz to 20 kHz		
	Inverter Output Frequency	0 to 120 Hz		
	Knee Voltage (peak value)	0 to 100 % of dc bus voltage		
	Knee Frequency	1 Hz to 120 Hz		
	Direction of Rotation (three-phase inverter)	forward and reverse		
	Acceleration Time [0 to knee]	0 to 100 s		
	Deceleration Time [knee to 0]	0 to 100 s		
Model 9069-3 – Thyristor Control Function Set		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Control Functions		half-wave rectifier, bridge, solid-state relay, ac power control		
Rectifier and Bridge Control Functions	Firing Angle	0 to 180°		
	Acceleration Time [0 to max. voltage]	0 to 100 s		
	Deceleration Time [max. voltage to 0]	0 to 100 s		
Solid-State Relay Control Function	Zero-Crossing Switching	On or Off		
AC Power Control Function	Control Mode	Phase Control, Burst Fire Control		
	Firing Angle (phase control)	15 to 180°		
	Acceleration Time (phase control)	0 to 100 s		
	Deceleration Time (phase control)	0 to 100 s		
	Period (burst fire control)	4 to 1000 cycles		

Model 9069-3 – Thyristor Control Function Set (cont'd)		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
	Duty Cycle (burst fire control	0 to 100%		
Model 9069-4 – Home Energy Production Control Function Set		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Control Functions		Insulated DC-to-DC Converter, Single-Phase Stand-Alone Inverter, Single-Phase Grid-Tied Inverter, Single-Phase Grid-Tied Inverter with LF Power Transformer, Single-Phase Grid-Tied Inverter with Insulated DC-to-DC Converter		
Insulated DC-to-DC Converter Function	Duty Cycle	10 to 45% (per transistor)		
Stand-Alone Inverter Function	Battery Min. Voltage	35 to 50 V		
	Peak Output Voltage	50 to 95% of DC Bus Voltage		
	Output Power Limit	50 to 250 W		
	Output Frequency	50 or 60 Hz		
	DC Bus Voltage Command	100 to 400 V		
	Transistor Switching	Manual or Automatic		
Grid-Tied Inverter	Active Current Command	-2 to 2 A		
	Reactive Current Command	-2 to 2 A		
	DC Bus Voltage Command	100 to 400 V		
	Transistor Switching	Manual or Automatic		
Grid-Tied Inverter with LF Transformer	Output Power Limit	50 to 250 W		
	Transistor Switching	Manual or Automatic		
	MPP Tracker Type	Off, Solar Panel or Wind Turbine		
Grid-Tied Inverter with Insulated DC-to-DC Converter	Output Power Limit	50 to 250 W		
	Transistor Switching	Manual or Automatic		
	MPP Tracker Type	Off, Solar Panel or Wind Turbine		
Model 9069-5 – Three-Phase PWM Rectifier/Inverter Control Function Set		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Active Current Command		-1.5 to 1.5 A		
Reactive Current Command		-1.5 to 1.5 A		
Phase Adjusment		-90 to 90°		
Model 9069-6 – BLDC Motor/PMSM Control Function Set		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Control Modes		120° Modulation Six Steps, PWM Six Steps, Field-Oriented Control (FOC)		
120° Modulation Six Steps	Phase Sequence	Forward (1-2-3) or Reverse (1-3-2)		
	Transistor Switching	Manual or Automatic		
	Compatible Motors	Models 8245 (0.2 kW) and 8541 (2 kW)		
PWM Six Steps	Switching Frequency	400 Hz to 20 kHz		
	Phase Sequence	Forward (1-2-3) or Reverse (1-3-2)		
	Duty Cycle	0 to 100 %		
	Acceleration Time (0 to max. voltage)	0 to 100 seconds		
	Deceleration Time (max. voltage to 0)	0 to 100 seconds		
	Transistor Switching	Manual or Automatic		
	Compatible Motors	Models 8245 (0.2 kW) and 8541 (2 kW)		
Field-Oriented Control (FOC)	Switching Frequency	400 Hz to 20 kHz		
	Phase Sequence	Forward (1-2-3) or Reverse (1-3-2)		
	Speed Command	0 to 6000 rpm		
	Quadrature Current [Iq] Limit	0 to 3 A		
	Direct Current [Id] Limit	0 to 5 A		
	Transistor Switching	Manual or Automatic		
	Compatible Motor	Model 8245 (0.2 kW) only		

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Model 9069-7 – High-Voltage DC (HVDC) Transmission System Control Function Set		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Control Functions		Dual Thyristor Bridge, Monopolar HVDC Transmission System, 12-Pulse Converter		
Dual Thyristor Bridge	Control Types	Independent, Common (α,α), Common (α,β)		
	Acceleration Time (0 to max. voltage)	0 to 100 seconds		
	Deceleration Time (max. voltage to 0)	0 to 100 seconds		
	Firing Angle Control (for each bridge)	Manual or through an Analog Input		
	Firing Angle	0 to 180°		
	Transistor Switching	Manual or Automatic		
Monopolar HVDC Transmission System	Control Types	Independent, Linked (Rectifier = Bridge 1), Linked (Rectifier = Bridge 2)		
	Firing Angle Control (for each bridge)	Manual, Analog Input or Automatic (Linked Mode)		
	Adjustable Variables (for each bridge)	Arc-Cosine Calculation (On-Off), Firing Angle Limit (120 to 180°), Controller Proportional and Integral Gains, Feedback Filter Cutoff Frequency		
	Current Command Limit	2 A		
	Current Command Margin Limit	0.5 A		
	Transistor Switching	Manual or Automatic		
12-Pulse Converter	Firing Angle	0 to 180°		
	Acceleration Time (0 to max. voltage)	0 to 100 seconds		
	Deceleration Time (max. voltage to 0)	0 to 100 seconds		
	Transistor Switching	Manual or Automatic		
Model 9069-8 – Static Var Compensator (SVC) Control Function Set		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Control Modes		Manual Control, Automatic Voltage Control, Automatic Reactive Power Control		
Manual	TCR Firing Angle	0 to 180°		
	TSC 1 and TSC 2	Switched In or Switched Out		
Automatic Voltage Control	Line Voltage Command	160 to 440 V		
	Proportional and Integral Gains	Varies with the gain types		
Automatic Reactive Power Control	Phase Adjustment	-90 to 90°		
	Proportional and Integral Gains	Varies with the gain types		
Model 9069-A – Synchronous Generator Control Function Set		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Controller Features		Speed Governor, Automatic Voltage Regulator (AVR), Synchro-Check Relay		
Speed Governor	Speed Command	1450 to 1850 rpm		
	Speed Droop	0 to 10%		
Automatic Voltage Regulator (AVR)	Bus Voltage Command	180 to 430 V		
	Voltage Droop	0 to 10%		
Synchro-Check Relay	Voltage Difference	5 to 50 V		
	Frequency Difference	0.02 to 0.5 Hz		
	Phase Difference	5 to 50°		
	Synchronized on Dead Bus	Yes or No		
	Nominal Frequency	45 to 65 Hz		
	Nominal Voltage	200 to 430 V		
Model 9069-B – Static Synchronous Compensator (STATCOM) Control Function Set		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Control Modes		Automatic Voltage Control, Automatic Reactive Power Control		
Automatic Voltage Control	DC Bus Voltage Command	150 to 250 V		
	AC Bus Line Voltage Command	58 to 108 V		

Model 9069-B – Static Synchronous Compensator (STATCOM) Control Function Set (cont'd)		120/208 V – 60 Hz	220/380 V – 50 Hz	240/415 V – 50 Hz
	Phase Adjustment	-90 to 90°		
	Proportional and Integral Gains	Varies with the gain types		
Automatic Reactive Power Control	DC Bus Voltage Command	150 to 250 V		
	Phase Adjustment	-90 to 90°		
	Proportional and Integral Gains	Varies with the gain types		
Model 9069-C – Synchroscope Function		**120/208 V – 60 Hz**	**220/380 V – 50 Hz**	**240/415 V – 50 Hz**
Monitored Values (in addition to phase difference dial)		Network voltage, generator voltage, voltage difference, network frequency, generator frequency		

PERSONAL COMPUTER REQUIREMENTS

A Pentium-type personal computer with a USB port, running under one of the following Microsoft® operating systems, Windows® XP, Windows® Vista, or Windows®7, is required.

ORDERING NUMBERS

120/208 V – 60 Hz			220/380 V – 50 Hz			240/415 V – 50 Hz
ENGLISH	**FRENCH**	**SPANISH**	**ENGLISH**	**FRENCH**	**SPANISH**	**ENGLISH**
9063-00[3]	9063-01[3]	9063-02[3]	9063-00[3]	9063-01[3]	9063-02[3]	9063-00[3]
9063-B0	9063-B1	9063-B2	9063-B0	9063-B1	9063-B2	9063-B0
9063-C0	9063-C1	9063-C2	9063-C0	9063-C1	9063-C2	9063-C0
9063-D0	9063-D1	9063-D2	9063-D0	9063-D1	9063-D2	9063-D0
9063-E0	9063-E1	9063-E2	9063-E0	9063-E1	9063-E2	9063-E0
9063-F0	9063-F1	9063-F2	9063-F0	9063-F1	9063-F2	9063-F0
9063-G0	9063-G1	9063-G2	9063-G0	9063-G1	9063-G2	9063-G0
9063-H0	9063-H1	9063-H2	9063-H0	9063-H1	9063-H2	9063-H0
9063-J0	9063-J1	9063-J2	9063-J0	9063-J1	9063-J2	9063-J0
9069-10	9069-10	9069-10	9069-10	9069-10	9069-20	9069-10
9069-20	9069-20	9069-20	9069-20	9069-20	9069-20	9069-20
9069-30	9069-30	9069-30	9069-30	9069-30	9069-30	9069-30
9069-40	9069-40	9069-40	9069-40	9069-40	9069-40	9069-40
9069-50	9069-50	9069-50	9069-50	9069-50	9069-50	9069-50
9069-60	9069-60	9069-60	9069-60	9069-60	9069-60	9069-60
9069-70	9069-70	9069-70	9069-70	9069-70	9069-70	9069-70
9069-80	9069-80	9069-80	9069-80	9069-80	9069-80	9069-80
9069-90	9069-90	9069-90	9069-90	9069-90	9069-90	9069-90
9069-A0	9069-A0	9069-A0	9069-A0	9069-A0	9069-A0	9069-A0
9069-B0	9069-B0	9069-B0	9069-B0	9069-B0	9069-B0	9069-B0
9069-C0	9069-C0	9069-C0	9069-C0	9069-C0	9069-C0	9069-C0

Table 1. Equipment Ordering Numbers

[3] Each Data Acquisition and Control Interface (DACI), Model 9063-0X, must be ordered with at least one function license (e.g., the Computer-Based Instrumentation Function, Model 9069-1) unless the Model 9063-0x is an extension module to another Model 9063-xx which have a control functions that needs an extension module (like Three-Phase PWM Rectifier/Inverter Control Function Model 9069-5 or High-Voltage DC Transmission System Control Function Model 9069-7).

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