Electric Power / Controls

Data Acquisition and Control System
LVDAC-EMS

User Guide
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Lab-Volt®
Foreword

Computer-based teaching technologies are becoming more and more widespread in the field of education, and the Lab-Volt Data Acquisition and Control for Electromechanical Systems (LVDAC-EMS) is witness to this new approach.

The LVDAC-EMS system, is a complete set of instruments that runs on an IBM®-compatible computer under the Microsoft® Windows® operating environment. Computer-based instruments provide instructors and students the opportunity to demonstrate concepts related to electric power technology clearly that, until now, could only be presented using traditional textbook methods and static drawings.

The LVDAC-EMS system is centered around the Data Acquisition and Control Interface (DACI) module that interconnects modules of the Lab-Volt Electromechanical and Power Electronics training systems to a personal computer. The system software feeds data coming from the DACI module to computer-based instruments that provide all the standard measurements associated with voltage, current, power, and other electrical and mechanical parameters. However, the system does much more, built-in capabilities for waveform, phasor, and harmonic observation and analysis, data storage and graphical representation, as well as programmable meter functions, allow unimaginable possibilities for presenting courseware material.
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We Value Your Opinion!
Introduction

This user guide is designed to provide all the information required to install the Lab-Volt Data Acquisition and Control for Electromechanical Systems (LVDAC-EMS). It is mainly intended for instructors and technicians.

The guide is divided into three sections, each dealing with a different aspect of the LVDAC-EMS system. The first section is an overview of the LVDAC-EMS system. Section 2 explains what a data acquisition and control system is. This section also describes the hardware used in the LVDAC-EMS system. Section 3 explains how to install and run the LVDAC-EMS software.
Overview of the LVDAC-EMS System

The Lab-Volt Data Acquisition and Control for Electromechanical Systems (LVDAC-EMS) is a computer-based system for measuring, observing, and analyzing electrical and mechanical parameters in electromechanical systems and power electronics circuits. The LVDAC-EMS system consists of a data acquisition and control interface (DACI) module and the LVDAC-EMS software.

The DACI module consists of an insulation unit and a data acquisition and control unit. These units convert the high-level voltages and currents found in electric power systems and power electronics circuits into digital numbers that are used by the personal computer which runs the LVDAC-EMS software.

The LVDAC-EMS software is a complete set of instruments that runs on an IBM®-compatible personal computer under the Microsoft® Windows® operating environment. Available instruments are voltmeters, ammeters, power meters, an eight-channel oscilloscope, a phasor analyzer, a harmonic analyzer, and a spectrum analyzer. Furthermore, built-in capabilities for data storage and graphical representation, as well as programmable meter functions, allow unimaginable possibilities for studying and analyzing electromechanical systems and power electronics circuits.

Once running, the LVDAC-EMS system uses the data transmitted by the DACI module to calculate the values indicated by the meters and update the waveforms, phasors, harmonic components, and frequency spectra displayed by the Oscilloscope, Phasor Analyzer, Harmonic Analyzer, and Spectrum Analyzer, respectively.
Introduction

This section is divided into three subsections. The subsection, Description of a Data Acquisition and Control System, explains the advantages of using a data acquisition and control system for the study and analysis of electromechanical systems and power electronics circuits. It also explains the operation of data acquisition and control systems.

The subsection, Data Acquisition and Control System of the LVDAC-EMS System, describes the function of the Data Acquisition and Control Interface module in the LVDAC-EMS system.

The remaining subsection, Data Acquisition and Control Interface module, Model 9063, explains the operation of the DACI module.

Description of a Data Acquisition and Control System

Studying electrical power circuits, especially three-phase power circuits, involves measuring different parameters as well as observing voltage and current waveforms. Voltage, current, power (active, reactive, apparent), impedance, motor speed, and torque are some of the many parameters usually measured, and phasor analysis can be essential for detailed three-phase study.

Because most conventional instruments only present one type of information, measuring all the different parameters requires a variety of instruments. The instruments are often limited with fixed scales and input ranges, most oscilloscopes only have two channels, and torque/speed measuring devices are not commonplace items. The amount of information that must be collected becomes enormous, and most data analysis, calculation, and plotting of graphs must be done by hand. Therefore, in-depth study of many circuits is not always easy to do with conventional equipment.

A data acquisition and control system is a computer-based system that can gather and analyze information from several external sources, and perform different calculations on the acquired data. A single computer can thus replace a variety of meters and instruments, display several waveforms simultaneously, analyze waveforms and data to extract important information, record data, and plot graphs.

Generally, data acquisition and control systems gather information represented by electrical signals. Some information, such as the input or output voltage of an electrical device is already in electrical form. Other information can be converted to electrical form by a transducer. For example, the speed of a motor can be converted into an electrical signal by a speed sensor.
The electrical signal from a speed sensor is called an analog signal because it is analogous to the speed; if the speed increases, the voltage increases, and vice versa. The voltage of an analog signal can vary continuously and take on any value within a certain range.

Computers are digital devices that use discrete numbers to store and process data. A data acquisition and control system therefore requires a circuit that converts continuous analog signals to discrete digital values. The type of circuit used for this purpose is called an analog-to-digital converter, or A/D converter. The sampling and conversion process is illustrated in Figure 2-1.

![Figure 2-1. Sampling and analog-to-digital (A/D) conversion of an analog signal.](image)

The analog signal is first sampled at regular intervals by a sample-and-hold circuit, which holds each sampled level until the analog-to-digital (A/D) converter has converted it to a digital number. The rate at which the signal is sampled is called the sampling rate. The higher the sampling rate, the more faithfully the digital numbers produced will follow the original signal. High sampling rates, however, generate lots of numbers and these may fill the computer memory very quickly, so the sampling rate should not be too high. In theory, the lowest sampling rate that can be used is equal to twice the frequency of the highest frequency component in the analog signal. In practice, most systems use a higher sampling rate than that.

When a data acquisition and control system must acquire data from several different sources, a single A/D converter can be used along with a multiplexer, as shown in Figure 2-2. The multiplexer is a switch that selects each analog input, or channel, in turn. Each time the multiplexer selects a new analog input, the signal present at the input is sampled and converted to a digital number.

The number of channels sampled by the multiplexer affects the sampling rate per channel. If the A/D converter can convert 100 000 samples per second, a single channel could be sampled at that rate. However, if two channels were used, each channel would be sampled at 50 000 samples per second, and four channels would be sampled at 25 000 samples per second.
Data Acquisition and Control Interface

Figure 2-2. Input configuration of a typical multi-channel A/D converter.

Depending on the application, a data acquisition and control system may sample signals continuously, or it may take a certain number of samples and then stop sampling until commanded to take another batch of samples. In either case, the digital numbers representing the samples can be processed and analyzed by the computer to extract useful information. Usually, this information can be presented on the computer screen in different ways, which are selected by the user of the system.

Data Acquisition and Control System of the LVDAC-EMS System

In the LVDAC-EMS system, data is acquired through an insulation unit and a data acquisition and control unit. Both units are enclosed in the Data Acquisition and Control Interface (DACI) module.

The insulation unit insulates and converts the high-level voltages and currents applied to the voltage and current inputs of the DACI module into low-voltage signals. Each low-voltage signal is proportional to, and electrically insulated from, the high-level electrical signal present at the corresponding input. The low-voltage signals, and other signals coming from low-voltage inputs of the DACI module, are internally routed to the data acquisition and control unit.

The data acquisition and control unit contains the circuitry needed for analog signal sampling and A/D conversion. It converts the low-voltage signals into corresponding digital data. The digital data is then read and analyzed by the LVDAC-EMS software running in the personal computer. The results are displayed on the computer screen according to the representation selected by the user. The display can be a panel of meters showing the values of the measured parameters, an oscilloscope showing the waveforms of the measured parameters, etc.

A high-speed USB port cable is used to connect the DACI module to the personal computer. Figure 2-3 gives an overview of the data acquisition and control process.
The DACI module, Model 9063, is enclosed in a half-height standard EMS module that can be easily installed in an EMS Workstation. It requires 24-V AC power available in the training system.

Data Acquisition and Control Interface module, Model 9063

The front panel of the Data Acquisition and Control Interface (DACI) module, Model 9063, is shown in Figure 2-4. It consists of four high-voltage inputs (E1 to E4), four high-current inputs (I1 to I4), two ANALOG OUTPUTS, eight ANALOG INPUTS, three DIGITAL INPUTS, and nine DIGITAL OUTPUTS. Access to inputs E1 to E4 and I1 to I4 is made through 4-mm safety banana jacks mounted on the front panel. Access to the ANALOG OUTPUTS, ANALOG INPUTS, DIGITAL INPUTS, and DIGITAL OUTPUTS is made through miniature banana jacks also mounted on the front panel, except for seven of the nine DIGITAL OUTPUTS which are accessible through a D-type connector.
Inputs E1 to E4 and I1 to I4 of the model 9063 are fully protected against over-voltage and short-circuit conditions. Furthermore, these inputs are electrically insulated from the circuitry in the DACI module through voltage and current isolators. This allows direct connection to electrical power circuits. Each of these isolators has two measuring ranges (high and low) and the following table shows the rating of the low and high ranges of the voltage and current isolators of the DACI module.

<table>
<thead>
<tr>
<th>INPUTS E1 TO E4</th>
<th>INPUTS I1 TO I4</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW RANGE</td>
<td>HIGH RANGE</td>
</tr>
<tr>
<td>±80 V</td>
<td>±800 V</td>
</tr>
<tr>
<td>LOW RANGE</td>
<td>HIGH RANGE</td>
</tr>
<tr>
<td>±4.0 A</td>
<td>±40 A</td>
</tr>
</tbody>
</table>

Table 2-1. Rating of the low and high ranges of the voltage and current isolators of the DACI module, Model 9063.

The ANALOG OUTPUTS provide a voltage whose amplitude can be set between +10 V and -10 V using the LVDAC-EMS software. Each voltage can be used to control a device in an electrical power circuit through the LVDAC-EMS software.

ANALOG INPUTS 1 to 8 are low voltage inputs (±10 V max.). These inputs can be connected to the outputs of voltage isolators, current isolators, torque sensors, speed sensors, etc. to measure various type of parameters. Each of these inputs is programmable through the LVDAC-EMS software.

The DIGITAL INPUTS are TTL compatible. Two of them are used as an incremental encoder input (A-B) and the third one is used for synchronization.
The DIGITAL OUTPUTS provide TTL level signals (accessible through a D-type connector) that can be used to control Lab-Volt power electronics modules like the IGBT Chopper/Inverter, Model 8837, and the Power Thyristors, Model 8841.

All data exchanges between the DACI module and the computer running software LVDAC-EMS are made through a USB port connection. The USB port connector is located in the upper right corner of the module’s front panel. Note that the data exchanged between the DACI module and the computer not only includes the digitized input and output signals but also control signals for range selection on the isolators and status verification.

The DACI module, Model 9063, requires low-voltage AC power (24 V). This voltage must be applied to one of the POWER INPUT jacks on the front panel of the DACI module. A led confirms the presence of input power.
LVDAC-EMS Software Installation Procedure

Introduction

This section provides the necessary information to install and run the LVDAC-EMS software. The subsection LVDAC-EMS Software Installation deals with the installation of the LVDAC-EMS software on the hard disk of your computer. The subsection Running LVDAC-EMS explains how to run LVDAC-EMS.

LVDAC-EMS Software Installation

- Insert the LVDAC-EMS CD-ROM into your CD-ROM drive.
- Choose the Run command in the Start menu of Windows®.
- Type X:\Setup in the command line, then click the OK button (or press the ENTER key on the keyboard).

  Note: Replace the X by the letter associated with your CD-ROM drive.

- Follow the instructions on the computer screen to complete the LVDAC-EMS installation.

  Note: If problems occur when installing LVDAC-EMS, disable all terminate-and-stay resident programs (anti-virus, screen-saver, etc.) and redo the installation.

- The installation is now complete.

Running LVDAC-EMS

Introduction

LVDAC-EMS can run in either one of the following two modes: acquisition and stand-alone. In the acquisition mode, the parameters measured by LVDAC-EMS come from samples of the signals applied to the various inputs of the Data Acquisition and Control Interface (DACI) module. In the stand-alone mode, the parameters measured by LVDAC-EMS come from computer-simulated input signals, and thereby, the DACI module is not required. The following procedure describes how to run LVDAC-EMS.
LVDAC-EMS Software Installation Procedure

Procedure

☐ 1. Make sure the DACI module is connected to the USB port of the computer and that the led on the module’s front panel is illuminated, thereby indicating that the module is correctly powered.

☐ 2. In the LAB-VOLT Programs group, click the LVDAC-EMS option to start LVDAC-EMS. The LVDAC-EMS entry window should appear for a few seconds then LVDAC-EMS should try to connect to the DACI module.

☐ 3. If LVDAC-EMS is able to establish the connection, the icon in the lower right corner of the LVDAC-EMS window should indicate that the connection is established. Go to step 5 of this procedure.

☐ 4. On the other hand, if LVDAC-EMS is unable to establish the connection with the DACI module, the message “NO MODULE FOUND” should appear in the MODULE SELECTOR window. Then, two options are offered to you:

   - Retry the connection by clicking the REFRESH button
   - Work in stand-alone mode by clicking the OK button

When you select the first option and click the REFRESH button, LVDAC-EMS tries to connect to the DACI module once again. If it is still unable to establish the connection, the aforementioned message should still appear in the MODULE SELECTOR window. You should make sure that the DACI module is correctly powered and check the USB port connection.

When you select the second option and click the OK button, the LVDAC-EMS system is then set in stand-alone mode and is ready to be used without the DACI module. Go to the following step.

☐ 5. To start an instrument, choose the corresponding command in the LVDAC-EMS Instruments menu or click the corresponding button on the toolbar. The selected instrument should appear on the computer screen. To get familiar with the various instruments in the LVDAC-EMS system, refer to the Lab-Volt user guide dealing with the Computer-Based Instruments for EMS.
We Value Your Opinion!

Your comments will allow us to produce better manuals and develop new systems in order to better meet the needs of our users. Please contact us by Email at:

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