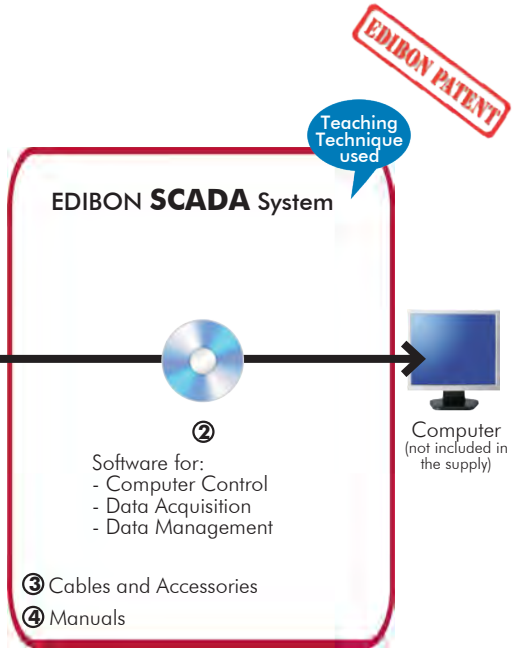
edibon

Engineering and Technical Teaching Equipment

Photovoltaic Power Plants Application, with SCADA

AEL-PHVGC



* Minimum supply always includes: 1 + 2 + 3 + 4 (Computer not included in the supply)

Configuration example of the AEL-PHVGC application

Key features:

- **Advanced Real-Time SCADA.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON Control Software based on LabVIEW.**
- **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**
- **Capable of doing applied research, real industrial simulation, training courses, etc.**
- **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**
- **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**
- **Designed and manufactured under several quality standards.**
- **Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.**
- **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

POWERED BY NATIONAL INSTRUMENTS LabVIEW

www.edibon.com
PRODUCTS
4.- ELECTRICITY

For more information about Key Features, click here

ISO 9001: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate (total safety)

Certificates ISO 14001 and ECO-Management and Audit Scheme (environmental management)

"Worlddidac Quality Charter" and Platinum Member of Worlddidac

INTRODUCTION

Energy saving and environmental pollution are crucial global issues. The use of renewable energies as alternative sources to fossil fuels can solve both problems, with great benefits particularly for countries where conventional energy sources are scarce. In the last two decades, photovoltaic energy has evolved from small-scale applications to become a dominant energy source.

GENERAL DESCRIPTION

The Photovoltaic Power Plants Application, with SCADA, "AEL-PHVGC", has been designed to study the operations carried out in photovoltaic power systems connected to the energy national grid. This application allows studying the procedure for voltage control in a local power grid, as well as the analysis of photovoltaic panels characteristic curves. For that end, the "AEL-PHVGC" application consists of different kits that allow studying the different aspects of photovoltaic power plants:

- PHVGC-K1. Photovoltaic Modules Analysis Kit.
- PHVGC-K2. Three-Phase Photovoltaic Power Plants Kit in Parallel with the Grid.
- PHVGC-K3. Voltage Regulation in Local Power Grids Kit. (complement to the PHVGC-K2).
- PHVGC-K4. Energy Storage Analysis Kit with Batteries (complement to the PHVGC-K2).

Each kit's didactic purpose is detailed below:

- **PHVGC-K1. Photovoltaic Modules Analysis Kit.**

  This kit consists of a photovoltaic module assembled on a wheeled structure that allows varying the solar module tilt angle. Thus, different roof tilts or typical structures can be simulated, above which these photovoltaic modules are installed. An halogen lamp assembled in an articulated arm is coupled to the mentioned structure for the sun's path simulation. The lamp has a current regulator which allows controlling the incident irradiance on the photovoltaic panel. In order to simulate the solar panel load, the kit includes a variable resistive load.

  With this kit, the user will be able to achieve the following learning: daily and yearly curves display, calculation of the photovoltaic modules optimal position, characteristic curves display and photovoltaic modules analysis in parallel, series and other configurations.

- **PHVGC-K2. Three-Phase Photovoltaic Power Plants Kit in Parallel with the Grid.**

  This kit consists of all the industrial elements needed to study a real photovoltaic power plant. Firstly, it includes a three-phase grid inverter supplied through a photovoltaic panel arrays simulator. At the exit of the inverter a network analyzer is connected, which will show the user every electrical parameter the inverter generates. In addition, it is also included a three-phase resistive load to simulate different consumption conditions. Lastly, the three-phase power supply allows simulating the mains conditions and the inverter connection to it.

  This kit consists of all the industrial elements needed to study a real photovoltaic power plant. Firstly, it includes a three-phase grid inverter supplied through a photovoltaic panel arrays simulator. At the exit of the inverter a network analyzer is connected, which will show the user every electrical parameter the inverter generates. In addition, it is also included a three-phase resistive load to simulate different consumption conditions. Lastly, the three-phase power supply allows simulating the mains conditions and the inverter connection to it.

  With this kit the user will be able to achieve the following learning: installation of photovoltaic plants and its connection to the grid, measurement of the photovoltaic plant electrical parameters, maximum power point tracking (MPPT), limit programming of the inverter power (derating), reactive energy generation, computation of the inverter efficiency, efficiency data record through a solar path simulator, analysis of the photovoltaic plant response to a black-out, photovoltaic plants protection against lightnings etc.

- **PHVGC-K3. Voltage Regulation in Local Power Grids Kit.**

  This kit is a complement to PHVGC-K2. It consists of a set of power elements intended for simulating photovoltaic power plants with voltage control at a certain point of the grid. Through the three-phase grid inverter, energy is provided to the grid by means of a transformer with galvanic insulation and a transformer with motor voltage regulator, both included with this kit. Due to changes in energy demand on account of the three-phase variable load, the appearing voltage variations will have to be compensated through the motorized transformer. This compensation can either be fulfilled manually or automatically, through a network analyzer programmed to detect over/undervoltage thresholds and thus control the transformer motorization.

  With this kit the user will be able to achieve the following learning: study of the local grid transformer, programming the limit of the inverter power (derating), manual and automatic control of the local grid voltage and parameters display in the software SCADA.

- **PHVGC-K4. Energy Storage Analysis Kit with Batteries.**

  This kit is a complement to the PHVGC-K2. It consists of an energy storage system based on a three-phase inverter with charge regulation (included) and a battery with great capacity (included).

  The ideal thing is to combine this kit with the PHVGC-K2 for the study of the optimal complement among the use of the grid electrical energy and the electrical energy coming from the battery. It is the perfect complement for future electrical facilities regarding the energy and economical saving achieved through this technology combination.

  With this kit the user will be able to achieve the following learning: installation procedure for energy storage in batteries combined with the inverter, start-up of the system, interaction between the photovoltaic system and the battery or efficiency improvement through self-consumption.

The “PHVGC-UB” is the base unit for the "AEL-PHVGC" application.

The “PHVGC-UB” unit includes the following elements:

- N-ALI01. Industrial Main Power Supply.

At least one of the following kits is required to work with the "PHVGC-UB" unit:

- PHVGC-K1. Photovoltaic Modules Analysis Kit.
  - PESS. Photovoltaic Module with Solar Path Simulation.
  - N-EAL-DC. DC Network Analyzer Unit.
  - N-REV01. Single-Phase Variable Resistor Module 0-1 kOhm.
- PHVGC-K2.Three-Phase Photovoltaic Power Plants Kit in Parallel with the Grid.
  - N-EALD/A. Advanced Network Analyzer Module.
  - APEM. Advanced Photovoltaic Emulator Module.
  - N-REVT/1K. 1kW Three-Phase Variable Resistors Module.
  - N-INV02. 3 kW Grid inverter.

  Recommended kits to work with the PHVGC-K2 kit:

  PHVGC-K3. Voltage Regulation in Local Power Grids Kit.
  - N-PST/1K. 1 kVA Phase Shifting Transformer.
  - N-TRANS3R/1K. Three-Phase Transformer with Motor Voltage Regulator.

  PHVGC-K4. Energy Storage Analysis Kit with Batteries.
  - N-INV/HY. Hybrid Inverter Module.
  - BAT3. Lithium-Iron-Phosphate Battery .

Recommended element to work with the SCADA System:

- AEL-PC. Touch Screen and Computer.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + Computer Control, Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

With this unit there are several options and possibilities:

- Main items: 1, 2, 3 and 4.
- Optional items: 5, 6 and 7.

Let us describe first the main items (1 to 4):

① AEL-PHVGCC Application.

N-ALI01

- N-ALI01. **Industrial Main Power Supply.**
  - Supply voltage: 400 VAC, 3PH+N+G.
  - ON-OFF removable key.
  - Output voltage connections:
    - Three-Phase + Neutral: 400 VAC.
    - Single-Phase: 230 VAC.
  - Three-Phase supply hose with IP44 3PN+E 32A 400 V connecting plug.
  - Differential magnetothermal, 4 poles, 25 A, 300 mA AC 6 KA.

PESS

- PESS. **Photovoltaic Module with Solar Path Simulation.**
  - Photovoltaic panel:
    - Maximum power : 15 W.
    - Open circuit voltage: 1,96 V.
    - DC current: 1 A.
    - Nominal current: 0,83 A.
    - Nominal voltage: 18 V.
  - Halogen lamp: 500 W.
  - Voltage supply: 230 VAC.

N-EAL-DC

- N-EAL-DC. **DC Network Analyzer Unit.**
  - DC analyzer module for measuring DC current and voltages.
  - Characteristics:
    - Phase voltage, phase current, active power, mean power, active energy, bidirectional measurement.
  - Communications: Modbus RS-485.

N-REV01

- N-REV01. **Single-Phase Variable Resistor Module 0-1 kOhm.**
  - 0-1 kOhm variable resistor.
  - Maximum Power: 500 W.
  - Potentiometer.
  - Terminals:
    - Three terminals for taking the maximum resistance or a variable value.

N-EALD/A

- N-EALD. **Network Analyzer Unit with Data Acquisition.**

  The network analyzer module allows fulfilling measurements, displaying and analyzing all the parameters of the AC electrical networks. It has an LCD screen and push-buttons for the navigation through the different menus. It includes specific software for monitoring current and voltage curves, harmonics display, tariffs programming, alarms programming and electrical parameters storage.

  Features:
  - Multifunctional three-phase power meter:
    - Single and three-phase voltage. Up to 690 VAC L-L.
    - Phase and line current. Current range up to 200%. Measurement from 0-10 A.
    - Active, reactive and apparent power.
    - Suitable frequencies: 25 Hz, 50 Hz, 60 Hz y 400 Hz.
    - Display of the V-I vector diagram.
    - Supply voltage: 85-265 VAC.
  - Energy quality control:
    - Current and voltage individual harmonics measurement. Up to the 40th harmonic.
    - THD voltage and current, TDD and K-factor.
    - Maximums and minimums display.
    - Waveforms display, 128 samples/sec.
  - Events and data storage.
  - Harmonics analyzer:
    - THD voltage and current, TDD current and K-factor, up to the 40th harmonic.
    - Current and voltage harmonic spectrum and angles.
  - Tariff programming:
    - Class 0.5S IEC 62053-22, active and reactive power in four quadrants.
    - Measurement of the total and per phase three-phase active, reactive and apparent powers.
    - Usage time, 4 energy/demand records of total tariffs.
    - 8 tariffs, 4 seasons, 4 types of days.
    - Automatic daily report of energy consumption maximums and minimums.
  - Communications:
    - Modbus TCP communication protocol with Ethernet interface.

- APEM. **Advanced Photovoltaic Emulator Module.**
  Programmable power supply for solar cells simulation.
  It has a software included with the unit to set the solar module characteristics.
  Characteristics:
    Short circuit protection.
    Output voltage: 520 V.
    Power: 1600 W.
    Short-circuit current: 11 A.
    Voltage supply: 110 a 240 VAC/45-65 Hz.

APEM

- N-REVT/1K. **1kW Three-Phase Variable Resistors Module.**
  Three banks with three-phase variable resistances of 150-500 Ohms.
  Supply voltage: 230 VAC+N+GND
  Fuses: 3 x 2 A.

N-REVT/1K

- N-INV02. **3 kW Grid Inverter.**
  DC circuit switch.
  Ground voltage protection for bus terminals and photovoltaic.
  Output DC voltage range: 25-100 V.
  Output voltage: 3x 400 V/ 50 Hz.
  Output power: 3000 W.

N-INV02

- N-INV/HY. **Hybrid Inverter Module.**
  Three-phase inverter.
  Three-phase energy injection to the grid with battery charge control.
  Terminals:
    One DC input.
    One AC three-phase output.
  Nominal power: 2000 W.
  Output voltage: 400 VAC.
  Frequency: 50 Hz.

N-INV/HY

- BAT3. **Lithium - Iron Phosphate Battery.**
  Long lifespan battery.
  Battery capacity: 2000 Wh.

BAT3

- N-PST/1K. **1 kVA Phase Shifting Transformer.**
  Input voltages: 3 x 400V.
  Output voltage 1: 3 x 400V, 2 A.
  Output voltage 2: 3 x 30V, 1.25A.
  Power rating: 1 kVA.
  Vector group: Dyn5.

N-PST/1K

- N-TRANS3R/1K. **Three-phase Transformer with Motor Voltage Regulator.**
  Primary: 3x 400V AC.
  Secondary: 3x 0… 450 V.
  Nominal power: 1 Kva.
  Frequency: 50/60 HZ.
  25 V input/"Increase voltage" button.
  25 V input/"Decrease voltage" button.

N-TRANS3R/1K

- AEL-PC. **Touch Screen and Computer.**
  Touch Screen:
    Energy efficiency class: A.
    Screen diagonal: 68.6 cm (27 inch (s)).
    Power consumption (operating): 26 watts.
    Annual energy consumption: 38 kWh.
    Power consumption (standby / off) 0.49 watts.
    Screen resolution: 1920 x 1080 pixels.
  Computer:
    Processor Number: Intel Core i7-6600U Processor (4M Cache, up to 3,40 GHz).
    Cache: 4 MB Intel Smart Cache.
    Clock speed: 2.6 GHz.
    # Of Cores/# of Threads: 2/4.
    Max. TDP/Power: 15 W.
    Memory Types: DDR4-2133, LPDDDR3-1866, DDR3L-1600.
    Graphics: Intel HD Graphics 530.

AEL-PC

- **All necessary cables to realize the practical exercises are included.**

The complete unit includes as well:

Advanced Real-Time SCADA.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on LabVIEW.

Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.

Capable of doing applied research, real industrial simulation, training courses, etc.

Remote operation and control by the user and remote control for EDIBON technical support, are always included.

Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).

Designed and manufactured under several quality standards.

Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.

This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② **AEL-PHVGC/CCSOF. Computer Control + Data Acquisition + Data Management Software:**

The three softwares are part of the SCADA system.

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.**

Registration and visualization of all process variables in an automatic and simultaneous way.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

AEL-PHVGC/CCSOF

③ **Cables and Accessories**, for normal operation.

④ **Manuals:**

This unit **is supplied with 7 manuals:** Required Services, Assembly and Installation, Control Software, Starting-up, Safety, Maintenance & Practices Manuals.

References 1 to 4 are the main items: AEL-PHVGC + AEL-PHVGC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

Practical possibilities with the PHVGC-K1 kit:

1.- Daily and yearly curves display.
2.- Calculation of the photovoltaic modules optimal position.
3.- Display of the photovoltaic modules characteristic curves.

Practical possibilities with the PHVGC-K2 kit:

4.- Installation of photovoltaic power plants.
5.- Grid-connection of photovoltaic plants.
6.- Measuring the electrical parameters of the photovoltaic plant.
7.- Maximum power point tracking (MPPT).
8.- Limiting the inversor power (derating).
9.- Reactive energy generation.
10.- Determining the inverter efficiency.
11.- Efficiency data record through the solar path simulation module.
12.- Analysis of the photovoltaic plant response to a black-out.
13.- Photovoltaic plants lightning protection.

Practical possibilities with the PHVGC-K2 and PHVGC-K4:

14.- Installation process for energy accumulation systems based on the combination of batteries with the charge controller inverter.
15.- Start-up of the photovoltaic system.
16.- Interaction among the photovoltaic system and the battery.
17.- Efficiency improvement through self-consumption.
18.- Study of the local grid transformer.
19.- Programming the limit of the inverter power (derating).
20.- Manual and automatic regulation of the local grid voltage.
21.- Parameters display from the SCADA software.

Other possibilities to be done with this Unit:

22.-Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
23.-Open Control, Multicontrol and Real Time Control.
This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.
24.-The Computer Control System with SCADA allows a real industrial simulation.
25.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
26.-This unit can be used for doing applied research.
27.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
28.-Control of the AEL-PHVGC unit process through the control interface box without the computer.
29.-Visualization of all the sensors values used in the AEL-PHVGC unit process.

- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: Three-phase, 380 VAC-415 VAC/ 50 Hz or 190 VAC-240/60 Hz, 3 kW.
- Computer (PC).

DIMENSIONS AND WEIGHTS

AEL-PHVGC:

- Dimensions: 1380 x 840 x 1010 mm approx.
  (54,33 x 33,07 x 39,76 inches approx).
- Weight: 80 kg approx.
  (176,37 pounds approx).

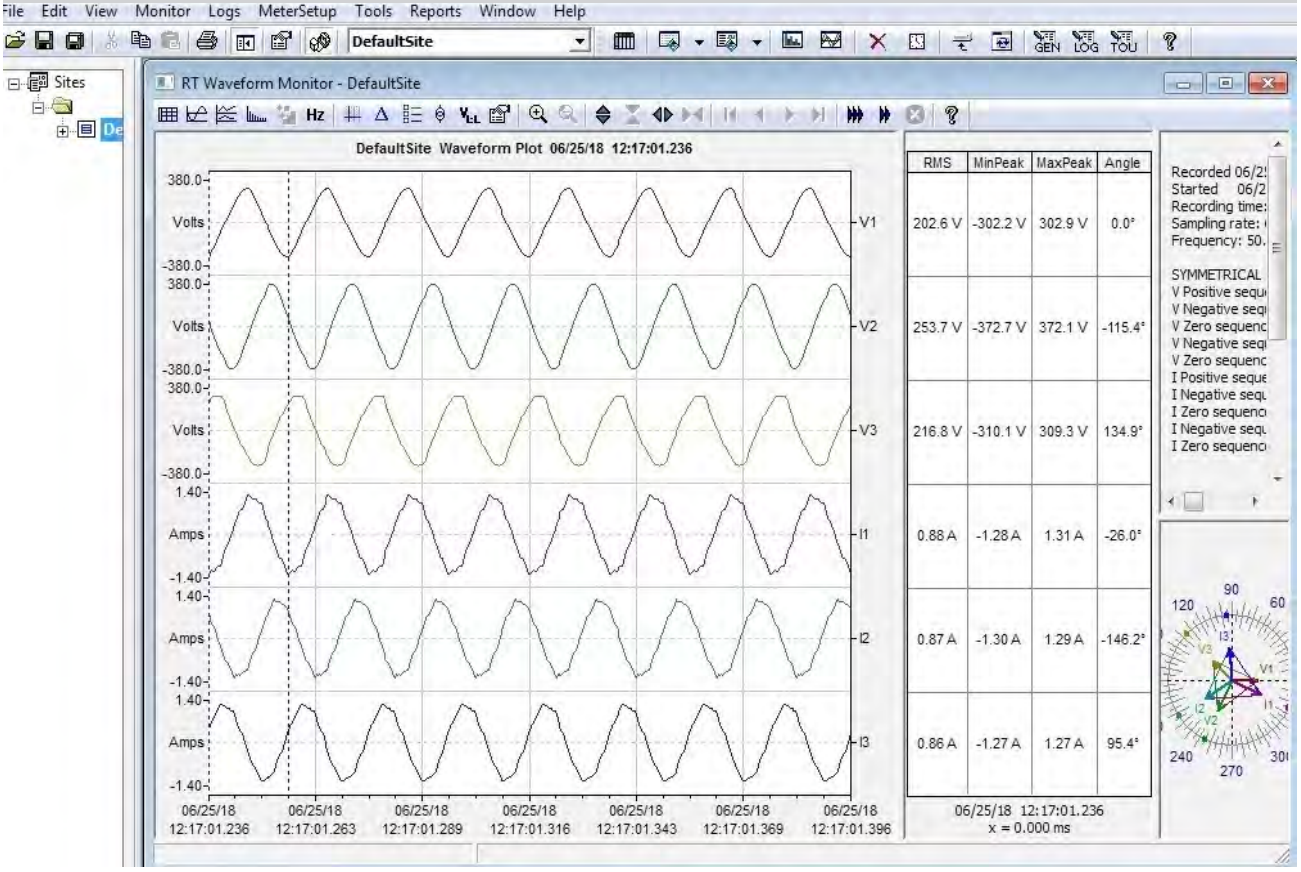
Photovoltaic Panel:

- Dimensions: 730 x 510 x 1150 mm approx.
  (28,74 x 20,07 x 45,27 pounds approx).
- Weight: 10 kg approx.
  (22,04 pounds).

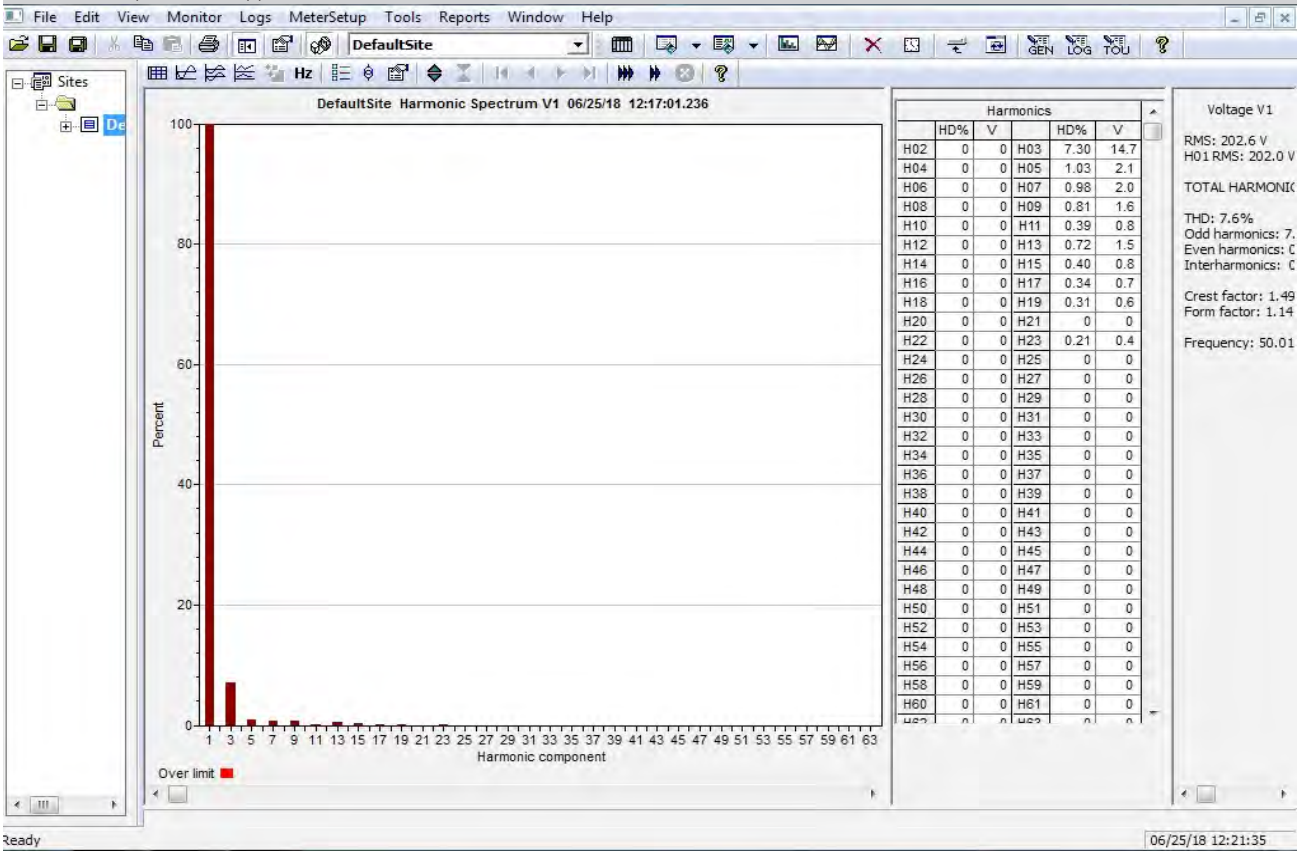
ADDITIONAL APPLICATIONS (Not Included)

- AEL-TI-01. Analysis of Three-phase Power Lines Application.
- AEL-TI-02. Distribution Transformer with Motor Regulation Application.
- AEL-TI-03. Arc suppression Coil Application.
- AEL-TI-04. Underground Transmission lines Application.
- AEL-TI-05. Parallel and Series Transmission Lines Application.
- AEL-TI-06. Analysis of flow power on Transmission Lines Application.
- AEL-TI-07. Transmission Application with Synchronous Generator.
- AEL-SST-01. Switching and Distribution Power Substations Aplication.
- AEL-SST-02. Switching Substation Protection Application.

Waveform plot of the real time currents and voltages measured by the analyzer, showing the angular, maximum, minimum and RMS values, and the phasors corresponding to such electrical parameters.



Representation of the torque-speed curve for the Three-Phase Asynchronous Squirrel Cage Motor. Notice that the motor nominal speed and the maximum torque can be appreciated.



Additionally to the main items (1 to 4) described, we can offer, as optional, other items from 5 to 7.
All these items try to give more possibilities for:

a) Technical and Vocational Education configuration. (ICA)
b) Multipost Expansions options. (MINI ESN and ESN)

a) Technical and Vocational Education configuration

⑤ AEL-PHVGC/ICAI. Interactive Computer Aided Instruction Software System.
This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.
This software is optional and can be used additionally to items (1 to 4).

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc... so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- **User Data Base Management.**
- **Administration and assignment of Workgroup, Task and Training sessions.**
- **Creation and Integration of Practical Exercises and Multimedia Resources.**
- **Custom Design of Evaluation Methods.**
- **Creation and assignment of Formulas & Equations.**
- **Equation System Solver Engine.**
- **Updatable Contents.**
- **Report generation, User Progression Monitoring and Statistics.**

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

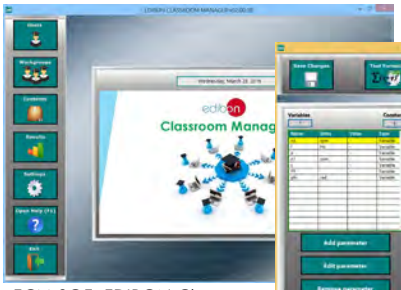
Innovative features:

- **Student Log-In & Self-Registration.**
- **Existing Tasks checking & Monitoring.**
- **Default contents & scheduled tasks available to be used from the first session.**
- **Practical Exercises accomplishment by following the Manual provided by EDIBON.**
- **Evaluation Methods to prove your knowledge and progression.**
- **Test self-correction.**
- **Calculations computing and plotting.**
- **Equation System Solver Engine.**
- **User Monitoring Learning & Printable Reports.**
- **Multimedia-Supported auxiliary resources.**

For more information see **ICAI** catalogue. Click on the following link:

www.edibon.com/en/files/expansion/ICAI/catalog

Instructor Software



ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen

ECAL. EDIBON Calculations Program Package - Formula Editor Screen

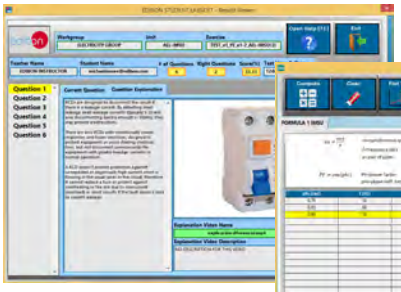
ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram

ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

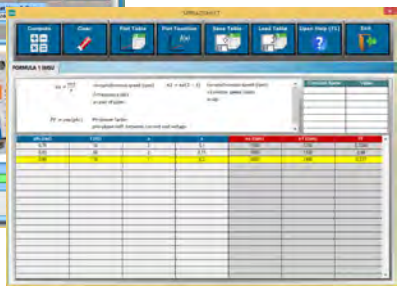
Student Software

ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen

EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

b) Multipost Expansions options

⑥ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously. It is useful for both, Higher Education and/or Technical and Vocational Education.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.

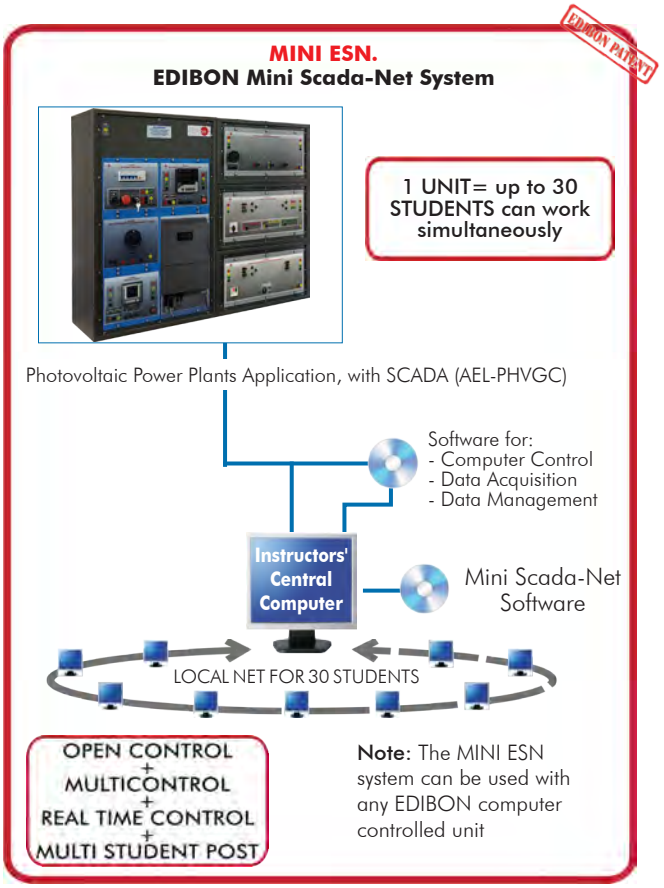
This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

Main characteristics:

- **It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.**
- **Open Control + Multicontrol + Real Time Control + Multi Student Post.**
- **Instructor controls and explains to all students at the same time.**
- **Any user/student can work doing "real time" control/multicontrol and visualisation.**
- **Instructor can see in the computer what any user/student is doing in the unit.**
- **Continuous communication between the instructor and all the users/students connected.**

Main advantages:

- **It allows an easier and quicker understanding.**
- **This system allows you can save time and cost.**
- **Future expansions with more EDIBON Units.**



For more information see **MINI ESN** catalogue. Click on the following link:

www.edibon.com/en/files/expansion/MINI-ESN/catalog

⑦ ESN. EDIBON Scada-Net Systems.

This unit can be integrated, in the future, into a Complete Laboratory with many Units and many Students.

For more information see **ESN** catalogue. Click on the following link:

www.edibon.com/en/files/expansion/ESN/catalog

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: AEL-PHVGC. Photovoltaic Power Plants Application, with SCADA.**

② **AEL-PHVGC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**

③ **Cables and Accessories,** for normal operation.

④ **Manuals.**

*IMPORTANT: Under AEL-PHVGC we always supply all the elements for immediate running as 1, 2, 3 and 4.

Optional items (supplied under specific order)

a) Technical and Vocational Education configuration

⑤ AEL-PHVGC/ICAI. Interactive Computer Aided Instruction Software System.

b) Multipost Expansions options

⑥ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

⑦ ESN. EDIBON Scada-Net Systems.

①AEL-PHVGCC Application.

- N-ALI01. Industrial Main Power Supply.
  - Supply voltage: 400 VAC, 3PH+N+G.
  - ON-OFF removable key.
  - Output voltage connections:
    - Three-Phase + Neutral: 400 VAC.
    - Single-Phase: 230 VAC.
  - Three-Phase supply hose with IP44 3PN+E 32A 400 V connecting plug.
  - Differential magnetothermal, 4 poles, 25 A, 300 mA AC 6 KA.
- PESS. Photovoltaic Module with Solar Path Simulation.
  - Photovoltaic panel:
    - Maximum power : 15 W.
    - Open circuit voltage: 1,96 V.
    - DC current: 1 A.
    - Nominal current: 0,83 A.
    - Nominal voltage: 18 V.
  - Halogen lamp: 500 W.
  - Voltage supply: 230 VAC.
- N-EAL-DC. DC Network Analyzer Unit.
  - DC analyzer module for measuring DC current and voltages.
  - Characteristics:
    - Phase voltage, phase current, active power, mean power, active energy, bidirectional measurement.
  - Communications: Modbus RS-485.
- N-REV01. Single-Phase Variable Resistor Module 0-1 kOhm.
  - 0-1 kOhm variable resistor.
  - Maximum Power: 500 W.
  - Potentiometer.
  - Terminals:
    - Three terminals for taking the maximum resistance or a variable value.
- N-EALD. Network Analyzer Unit with Data Acquisition.

  The network analyzer module allows fulfilling measurements, displaying and analyzing all the parameters of the AC electrical networks. It has an LCD screen and push-buttons for the navigation through the different menus. It includes specific software for monitoring current and voltage curves, harmonics display, tariffs programming, alarms programming and electrical parameters storage.
  - Features:
    - Multifunctional three-phase power meter:
      - Single and three-phase voltage. Up to 690 VAC L-L.
      - Phase and line current. Current range up to 200%. Measurement from 0-10 A.
      - Active, reactive and apparent power.
      - Suitable frequencies: 25 Hz, 50 Hz, 60 Hz y 400 Hz.
      - Display of the V-I vector diagram.
      - Supply voltage: 85-265 VAC.
    - Energy quality control:
      - Current and voltage individual harmonics measurement. Up to the 40th harmonic.
      - THD voltage and current, TDD and K-factor.
      - Maximums and minimums display.
      - Waveforms display, 128 samples/sec.
    - Events and data storage.
    - Harmonics analyzer:
      - THD voltage and current, TDD current and K-factor, up to the 40th harmonic.
      - Current and voltage harmonic spectrum and angles.
    - Tariff programming:
      - Class 0.5S IEC 62053-22, active and reactive power in four quadrants.
      - Measurement of the total and per phase three-phase active, reactive and apparent powers.
      - Usage time, 4 energy/demand records of total tariffs.
      - 8 tariffs, 4 seasons, 4 types of days.
      - Automatic daily report of energy consumption maximums and minimums.
    - Communications:
      - Modbus TCP communication protocol with Ethernet interface.
- APEM. Advanced Photovoltaic Emulator Module.
  - Programmable power supply for solar cells simulation.
  - It has a software included with the unit to set the solar module characteristics.
  - Characteristics:
    - Short circuit protection.
    - Output voltage: 520 V.
    - Power: 1600 W.
    - Short-circuit current: 11 A.
    - Voltage supply: 110 a 240 VAC/45-65 Hz.
- N-REVT/1K. 1kW Three-Phase Variable Resistors Module.
  - Three banks with three-phase variable resistances of 150-500 Ohms.
  - Supply voltage: 230 VAC+N+GND
  - Fuses: 3 x 2 A.

- N-INV02. 3 kW Grid Inverter.
  - DC circuit switch.
  - Ground voltage protection for bus terminals and photovoltaic.
  - Output DC voltage range: 25-100 V.
  - Output voltage: 3x 400 V/ 50 Hz.
  - Output power: 3000 W.
- N-INV/HY. Hybrid Inverter Module.
  - Three-phase inverter.
  - Three-phase energy injection to the grid with battery charge control.
  - Terminals:
    - One DC input.
    - One AC three-phase output.
  - Nominal power: 2000 W.
  - Output voltage: 400 VAC.
  - Frequency: 50 Hz.
- BAT3. Lithium - Iron Phosphate Battery.
  - Long lifespan battery.
  - Battery capacity: 2000 Wh.
- N-PST/1K. 1 kVA Phase Shifting Transformer.
  - Input voltages: 3 x 400V.
  - Output voltage 1: 3 x 400V, 2 A.
  - Output voltage 2: 3 x 30V, 1.25A.
  - Power rating: 1 kVA.
  - Vector group: Dyn5.
- N-TRANS3R/1K. Three-phase Transformer with Motor Voltage Regulator.
  - Primary: 3x 400V AC.
  - Secondary: 3x 0 … 450 V.
  - Nominal power: 1 Kva.
  - Frequency: 50/60 HZ.
  - 25 V input/"Increase voltage" button.
  - 25 V input/"Decrease voltage" button.
- AEL-PC. Touch Screen and Computer.
  - Touch Screen:
    - Energy efficiency class: A.
    - Screen diagonal: 68.6 cm (27 inch (s)).
    - Power consumption (operating): 26 watts.
    - Annual energy consumption: 38 kWh.
    - Power consumption (standby / off) 0.49 watts.
    - Screen resolution: 1920 x 1080 pixels.
  - Computer:
    - Processor Number: Intel Core i7-6600U Processor (4M Cache, up to 3,40 GHz).
    - Cache: 4 MB Intel Smart Cache.
    - Clock speed: 2.6 GHz.
    - # Of Cores/# of Threads: 2/4.
    - Max. TDP/Power: 15 W.
    - Memory Types: DDR4-2133, LPDDDR3-1866, DDR3L-1600.
    - Graphics: Intel HD Graphics 530.
- All necessary cables to realize the practical exercises are included.

The complete unit includes as well:

- Advanced Real-Time SCADA.
- Open Control + Multicontrol + Real-Time Control.
- Specialized EDIBON Control Software based on LabVIEW.
- Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
- Capable of doing applied research, real industrial simulation, training courses, etc.
- Remote operation and control by the user and remote control for EDIBON technical support, are always included.
- Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
- Designed and manufactured under several quality standards.
- Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
- This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

②AEL-PHVGC/CCSOF. Computer Control +Data Acquisition+Data Management Software:

The three softwares are part of the SCADA system.

Compatible with the industry standards.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data.

It allows the registration of the alarms state and the graphic representation in real time.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

③Cables and Accessories, for normal operation.

④Manuals:

This unit is supplied with 7 manuals: Required Services, Assembly and Installation, Control Software, Starting-up, Safety, Maintenance & Practices Manuals.

Exercises and Practical Possibilities to be done with the Main Items

Practical possibilities with the PHVGC-K1 kit:

1.- Daily and yearly curves display.
2.- Calculation of the photovoltaic modules optimal position.
3.- Display of the photovoltaic modules characteristic curves.

Practical possibilities with the PHVGC-K2 kit:

4.- Installation of photovoltaic power plants.
5.- Grid-connection of photovoltaic plants.
6.- Measuring the electrical parameters of the photovoltaic plant.
7.- Maximum power point tracking (MPPT).
8.- Limiting the inversor power (derating).
9.- Reactive energy generation.
10.- Determining the inverter efficiency.
11.- Efficiency data record through the solar path simulation module.
12.- Analysis of the photovoltaic plant response to a black-out.
13.- Photovoltaic plants lightning protection.

Practical possibilities with the PHVGC-K2 and PHVGC-K4:

14.- Installation process for energy accumulation systems based on the combination of batteries with the charge controller inverter.
15.- Start-up of the photovoltaic system.
16.- Interaction among the photovoltaic system and the battery.
17.- Efficiency improvement through self-consumption.
18.- Study of the local grid transformer.
19.- Programming the limit of the inverter power (derating).
20.- Manual and automatic regulation of the local grid voltage.
21.- Parameters display from the SCADA software.

Other possibilities to be done with this Unit:

22.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
23.- Open Control, Multicontrol and Real Time Control.
This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.
24.- The Computer Control System with SCADA allows a real industrial simulation.
25.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
26.- This unit can be used for doing applied research.
27.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
28.- Control of the AEL-PHVGC unit process through the control interface box without the computer.
29.- Visualization of all the sensors values used in the AEL-PHVGC unit process.
- Several other exercises can be done and designed by the user.

a) Technical and Vocational Education configuration

⑤ AEL-PHVGC/ICAI. Interactive Computer Aided Instruction Software System.

This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc...so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.
- Updatable Contents.
- Report generation, User Progression Monitoring and Statistics.

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

- Student Log-In & Self-Registration.
- Existing Tasks checking & Monitoring.
- Default contents & scheduled tasks available to be used from the first session.
- Practical Exercises accomplishment by following the Manual provided by EDIBON.
- Evaluation Methods to prove your knowledge and progression.
- Test self-correction.
- Calculations computing and plotting.
- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

b) Multipost Expansions options

⑥ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit.

Main characteristics:

- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing "real time" control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:

- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

The system basically will consist of:

This system is used with a Computer Controlled Unit.

- Instructor's computer.
- Students' computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- MINI ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

✱ Specifications subject to change without previous notice, due to the convenience of improvement of the product.

edibon INTERNATIONAL

C/ Julio Cervera, 10-12-14. Móstoles Tecnológico.
28935 MÓSTOLES. (Madrid). ESPAÑA - SPAIN.
Tel.: 34-91-6199363 Fax: 34-91-6198647
E-mail: edibon@edibon.com Web: **www.edibon.com**

Edition: ED01/18
Date: October/2018

REPRESENTATIVE: