Engineering and Technical
Teaching Equipment

① Unit: AEL-MEPD-01. Modular Marine Electrical Power Distribution 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

LabVIEW

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⤷PRODUCTS
⤷4.- ELECTRICITY

For more information about Key Features, click here

INTRODUCTION

A ship can be considered as a mobile power plant. Most of the machinery is driven electrically, which thus makes for a huge electrical power demand. This makes a shipboard electrical power distribution system very important.

Electricity has to be distributed with minimal losses after generation. Unlike a shore based transmission system, where the lengths of the conductors run throughout a country, a shipboard electrical distribution system is short and simple. Through this application, the general layout of the main electrical distribution system, along with the main switchboard and emergency switchboard arrangements, will be studied.

GENERAL DESCRIPTION

The Modular Marine Electrical Power Distribution Application, "AEL-MEPD-01" has been designed by Edibon for the training at both the theoretical and practical levels in the field of power generation and power distribution systems in ships. This system provides several levels of training to give the user full knowledge and experiences about the operation of Marine Electrical Power Distribution Systems. For this purpose, this application includes a specific manual, which explains at theoretical level the subjects relating to power generation and power distribution systems in ships. The thematic of the manual covers topics such as construction, cabling and configuration of the main switch distribution board, overcurrent protections, setting of frequency and voltage controllers, setting of the variable frequency drives, charging battery system, essential and non-essential circuits, etc. This power system consists of several elements and modules which represent the parties of a Marine Electrical Power Distribution System. These parties are the Main Busbar modules, the Power Distribution modules and the Emergency Switch-Board modules. Besides, two synchronous generator-turbine groups are provided to form a complete and real Marine Electrical Power System. On this way, the users can broaden their knowledge learning topics related to management of power generators used in ships such as parallel operation, load sharing, power generators control systems, etc.

The AEL-MEPD-01 includes a SCADA Control and Data Acquisition System. It represents faithfully a power generation substation with a turbine-generator control center with network analyzers, circuit breakers, distribution line and resistive and inductive loads. The SCADA is designed to control in real time of whole power system, for instance, the generator speed and voltage can be remotely controlled while the user observes the behavior of the operating system. On the other hand, it is possible to put in parallel operation the two generators. Thus, the user can understand what effects of the frequency and current excitation are in synchronism. Droop voltages, overspeed, underspeed, overcurrents, overloads and reverse power are some of many phenomena that the user can study from the SCADA. Besides, circuit breakers can be monitored and controlled from SCADA to study different switching operations and the effects produced in the power system. Other important point to be studied with this application is the black-out. When the two power generators fail, the interrupted power supply included in this application allows to study the energy recovery procedure in the ship power system.

The "AEL-MEPD-01" application includes the following elements:

Industrial Main Power Supply.

Power Generation Substation module with generator circuit breaker control.

Automatic speed and voltage controller and protection relay module for turbine-generator groups control.

Three Pole Circuit Breakers with Remote Control for distribution power system (ring topology).

Network Analyzer Modules with Data Acquisition.

Variable frequency drive for the propulsion control.

Three-phase squirrel cage induction motors for propulsion simulation.

Braking system to simulate the propulsion load.

1 kVA three-phase synchronous generators with independent excitation.

Lamps modules to simulate general services and auxiliary services lighting.

Three-phase resistive loads to simulate active power consumption.

Three-phase induction loads to simulate inductive power consumption.

Three-phase isolation transformer to simulate medium voltage and low voltage busbars.
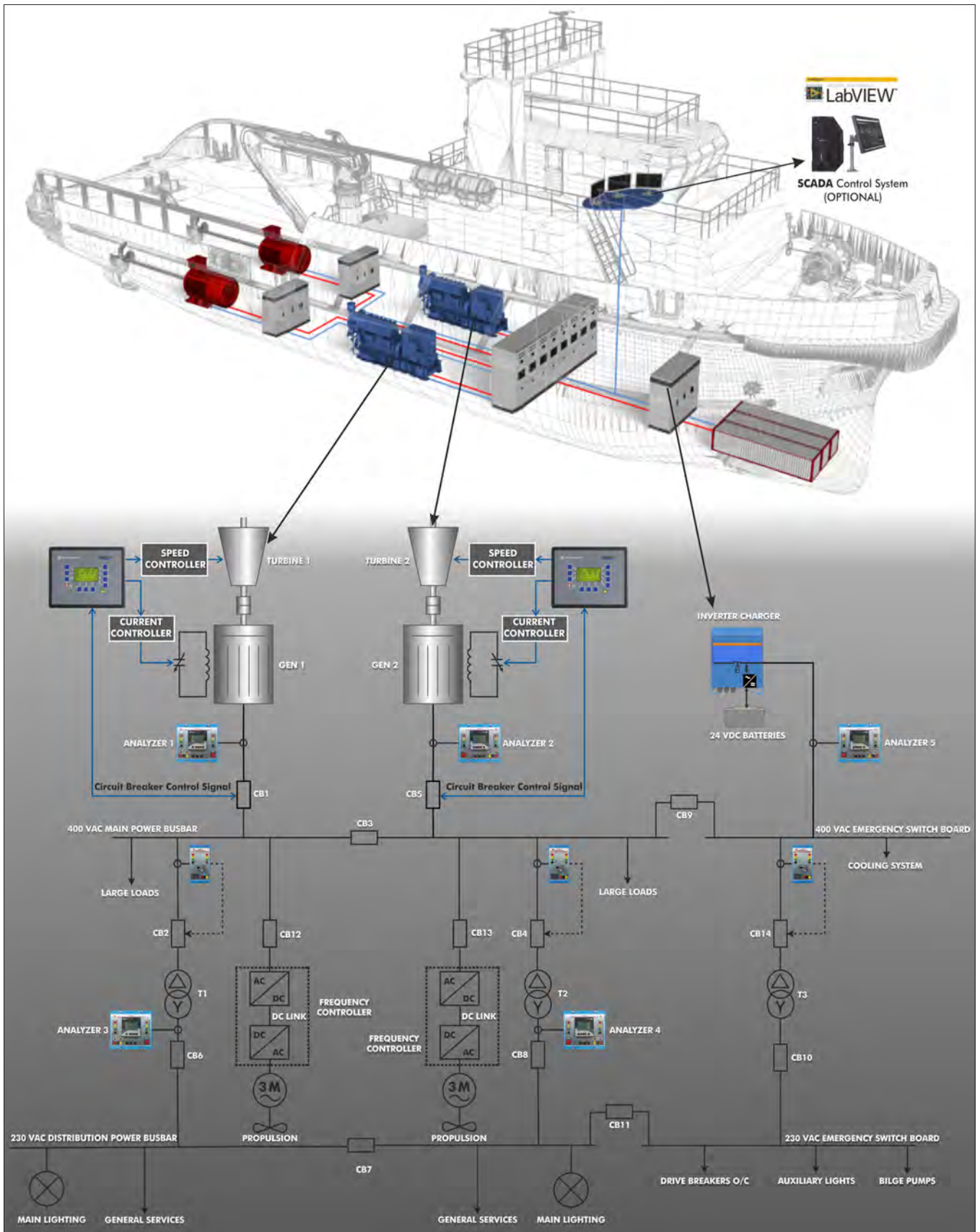
Three-phase hybrid inverter with battery for back-up energy system.

Electronic overcurrent relay.

Power Generation Group 1

Power Generation Group 2

Power Distribution and Energy Consumption
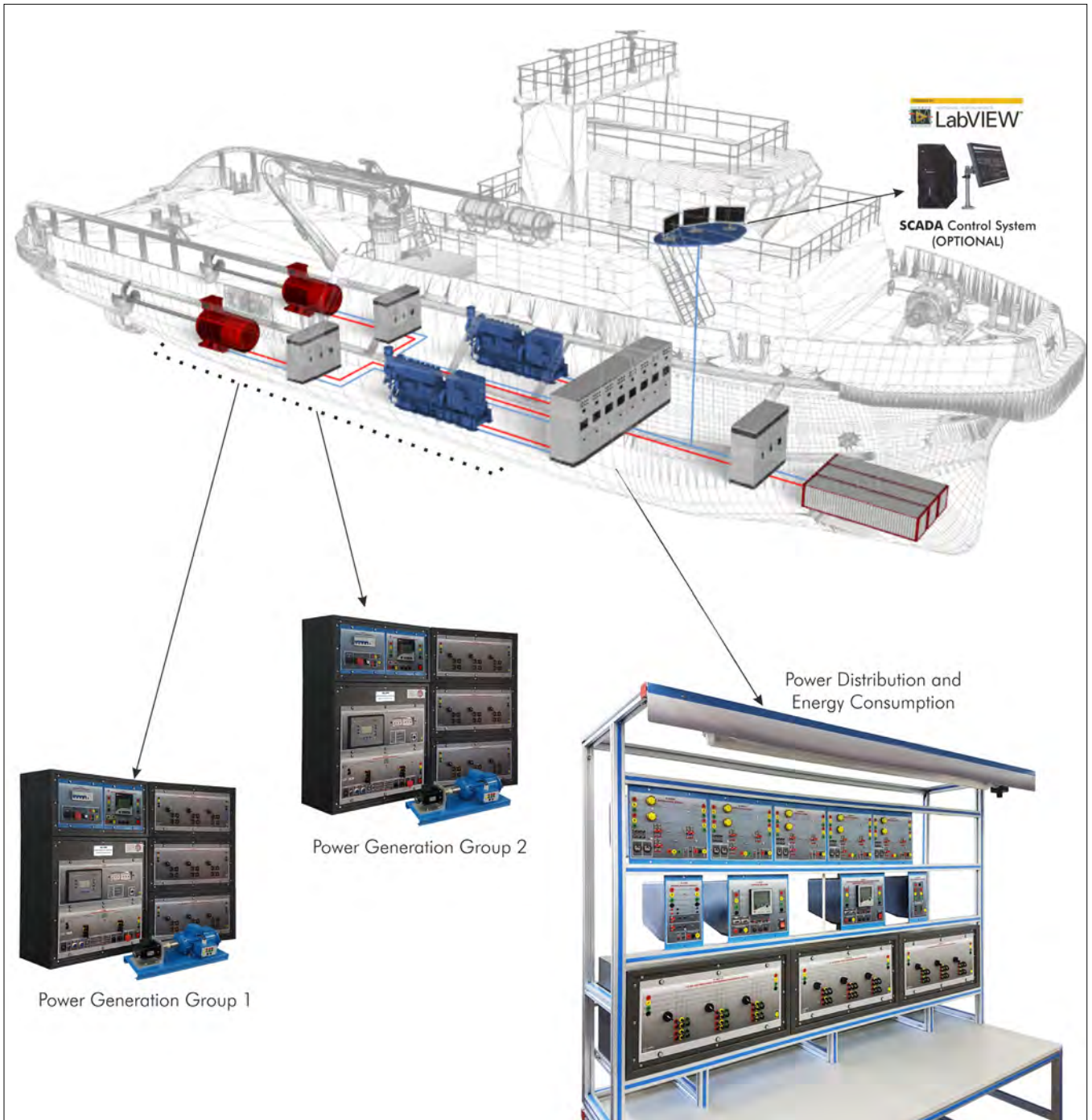
Power Generation and Distribution modules

Example of power system configuration with two main generators and inverter charger

This 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-MEPD-01. Unit.**
The application includes the following modules:
- **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 400V connecting plug.
  Differential magnetothermal, 4 poles, 25A, 300mA AC 6KA.

- **Power Generation Substation module with generator circuit breaker control.**
  Supply voltage: 400 VAC, 3PH+N+G
  ON/OFF switch.
  Power and signals connection:
    Auxiliary connection.
    Three-phase turbine supply hose with IP44 3PN+E 32A 400V connecting plug.
    Three-phase generator supply hose with IP44 3PN+E 32A 400V connecting plug.
  Three switches to choose between the different modes:
    Local and remote control mode.
    Manual and automatic speed control.
    Manual and automatic excitation control
  Three control switches to:
    Start and stop the turbine.
    Give permission to synchronize the generator with the grid.
    Give permission to close 52NET circuit breaker.
  Two potentiometers to regulate:
    Turbine speed.
    Generator excitation.
  Emergency stop button.
  Two circuit breakers for synchronization and stand-alone operations.
  Different terminals to measure.
  Ethernet connection: RJ45 communication port for SCADA remote control.

- **Automatic speed and voltage controller and protection relay module for turbine-generator groups control.**
  Automatic speed and voltage controller (easygen):
    Enables to connect up to 16 electric generators in parallel-island with distribution of active and reactive load and start/stop in function of the load demand.
    Enables to connect a generator in parallel with the grid.
    Enables different switches control modes, such as opening, closing and synchronization.
    Analogical outputs to control voltage and frequency regulators.
    Three-phase measurement of the grid and the generator voltage.
    Three-phase measurement of the generator intensity and power.
    Single-phase measurement of the grid intensity.
  Protection system.
  Generator:
    Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), voltage asymmetry, detection of dead busbars, overvoltage (32), load unbalance (46), negative sequence power/reduced power (32R/F), overcurrent by defined curve (50/51), inverse time overcurrent (IEC255), measured ground fault (50N/51N), phase rotation, switches faults.
  Network:
    Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), vector jump, phase rotation.
  Six alarms:
    Alarm 1: Reverse power.
    Alarm 2: Overcurrent.
    Alarm 3: Over/undervoltage.
    Alarm 4: Inverse Time Overcurrent.
    Alarm 5: Over/under frequency.
    Alarm 6: Shutdown Alarms.
  Four operation signals:
    Ready for operation.
    Start request.
    Synchronization conditions.
    Permission for synchronization.
  Back-up protections:
    Current relay.
    Reverse Power relay.
  Ethernet connection: RJ45 communication port.

- **Three Pole Circuit Breakers with Remote Control for distribution power system (ring topology).**
  Supply Voltage: 230 VAC.
  Simple busbar with ring topology, with two circuit breakers.
  Two interconnection terminals.
  One Power Input/Output to connect lines, generation, loads, etc.
  Two push-buttons by each disconnector / circuit breaker to open and close them.
  State indications lamps:
    Two lamps to indicate the state of busbars.
    Three pilot-lights to indicate the state of the circuit breaker and the disconnectors.
  Two Ethernet connections.

- **Network Analyzer Modules with Data Acquisition.**
  ON-OFF switch.
  Supply voltage: 400 VAC.
  Input terminals: Input connection with the measurement point.
  Output terminals: Output connection with the measurement point.
  Digital outputs: Three digital outputs are used for pulses or alarms, or for combining both.
  RS-485 Communication port.
  Fuses: 3x10 A.
  Network Analyzer Display. It shows:
    Active, reactive and apparent power.
    Active, reactive and apparent energies.
    Lines and phase currents.
    Line and phase voltages.
    Frequencies.
    Power Factor.

- **Variable frequency drive for the propulsion control.**
  Supply voltage: 230 VAC.
  Supply voltage: 230 VAC.
  Nominal power: 0,75 kW.
  PWM output voltage connections:
    Three-Phases: 230 VAC.
  Digital inputs control panel: 5 configurable digital inputs.
  Analog inputs control panel:
    0-10V analog input for speed control.
    4-20mA analog input for speed control.
  10K, potentiometer for the induction motor control speed.
  2 relay outputs for alarms configuration: 2 outputs NO/NC.
  50 mA, 2 transistors outputs for alarms configuration.
  Setting and visualization display of the machine parameters.

- **Three-phase squirrel cage induction motors for propulsion simulation.**
  Nominal power: 370 W.
  Nominal voltage: 3x 230/400 VAC Δ/Y.
  Frequency: 50/60 Hz.
  Number of poles: 2.
  Speed: 2730 rpm.
  Nominal current: 1,67/ 0,97 A.

- **Braking system to simulate the propulsion load.**
  Nominal Torque: 5 Nm.
  Maximum Power Dissipation: 100 W.
  Maximum output current adjustment.
  Operating modes "freewheel " and "blocking".
  Nominal voltage: 24 VAC/VDC.
  Maximum Output Current: 2 A.
  Output Load (Resistor): 4 to 20 Ohms.
  Maximum power consumed: 70 W.
  Remote voltage control: 0 to 10 VDC.
  Weight: 4 Kg.

- **1 kVA three-phase synchronous generators with independent excitation.**
  Nominal power: 250 W.
  Nominal voltage: 230 VAC.
  Nominal output voltage: 3 x 400 VAC.
  Frequency: 50/60 Hz.
  RPM: 3000 rpm.
  Nominal Current: 1 A.
  Nominal Excitation Current: 0.25 A.
  Shaft height: 71 mm.

- **Lamps modules to simulate general services and auxiliary services lighting.**

  Nominal voltage: 230 VAC (PH+N).

  Halogen lamp.

  Power: 60 W.

- **Three-phase resistive loads to simulate active power consumption.**

  Digital bank of commutable resistors module.

  Three sliding load switches.

  Three three-phase commutable banks of resistors of 150 ohm.

  Local/remote control switch.

  Communications connector SUB-D of 62 pins.

- **Three-phase induction loads to simulate inductive power consumption.**

  Digital banks of commutable inductances module.

  Three sliding load switches.

  Three three-phase commutable banks of inductances of 1.4 H.

  Local/remote control switch.

  Communications connector SUB-D of 62 pins.

- **Three-phase isolation transformer to simulate medium voltage and low voltage busbars.**

  Three-Phase Autotransformer.

  Supply Voltage: 400V AC (3PH).

  Nominal Output Voltage: 3 x 230V AC (3PH + N).

  Nominal power: 1 kVA.

  Transformer connection: YY0.

  Start / stop switch for instantaneous connection /disconnection of the network transformer.

  Fuses: 3 x 5 A.

  GND terminal.

- **Three-phase hybrid inverter with battery for back-up energy system.**

  Three-phase inverter.

  Three-phase energy injection into electrical grid.

  Terminals:

    One DC input voltage.

    One three-phase AC output voltage.

  Nominal power: 2000 W.

  Output voltage: 400 VAC.

  Frequency: 50 Hz.

  Long life battery.

  Battery capacity: 2000 Wh.

- **Electronic overcurrent relay.**

  Electronic thermal relay.

  Overload protection.

  Range 1.2 - 7 A.

  Reset and test function.

  1 NONC contact.

  Temporization.

- **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 knowwledge 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.

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② **AEL-MEPD-01/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-MEPD-01/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-MEPD-01 + AEL-MEPD-01/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

1.- Main switch board cabling and ring configuration.

2.- Overcurrent relay and circuit breakers setting.

3.- Study of the generation power flows, synchronization, active power-sharing and distribution power systems with different load conditions.

4.- Analysis of the measurements of the power flows of the synchronous generator and loads.

5.- Analysis of the active and reactive power of the synchronous generator against dynamic load variations (ship propulsion).

6.- Study of the synchronous generator in island operation mode.

7.- Study of excitation/voltage regulation of synchronous generator in island mode.

8.- Study of turbine regulation (frequency control) in island mode.

9.- Study of different situation in the distribution busbar with ring topology (maneuvers with circuit breakers).

10.- Logic operation with circuit breakers.

11.- Load sharing with different feeders: propellers, auxiliary services and emergency busbar.

12.- Busbar changeover without interruption.

13.- Study of a blackout in the power system of the ship. Step-by-step energy recovery.

14.- Study of the system response to opening circuit breakers due to failures conditions (simulated).

15.- Recovery of system energy through an uninterruptible power supply.

16.- Study of generator-shedding and energy saving in the UPS.

17.- Study of the auxiliary services of the ship.

18.- Study of emergency operations through the emergency switch boards.

19.- Emergency power requirements during a blackout or system failure until recovery.

20.- Essential and non-essential circuits.

21.- Study and measurement of charging battery system.

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.- The Computer Control System with SCADA allow a real industrial simulation.

24.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.

25.- This unit can be used for doing applied research.

26.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

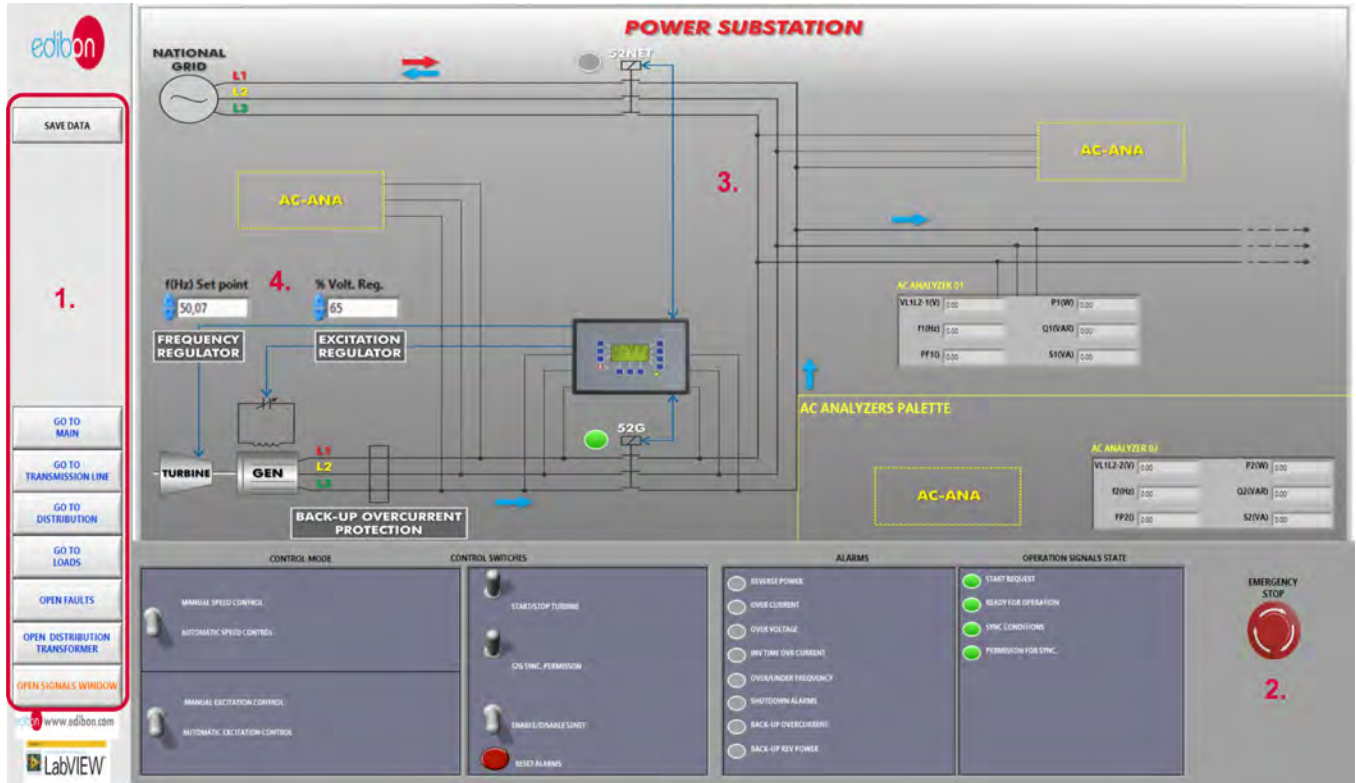- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: three-phase, 380V/50 Hz or 208V/60 Hz, 4 kW.
- Computer (PC).

DIMENSIONS AND WEIGHTS

AEL-MEPD-01:

-Dimensions: 1600 x 550 x 2000 mm approx.
               (62.99 x 21.65 x 78.74 inches approx.)
-Weight: 180 Kg approx.
               (397 pounds approx.)

SCADA
Main screen

① Navigation menu and save data button.

② **Power substation control panel**: - Manual / Automatic Speed Control switch. - Manual / Automatic Excitation Control switch. - Control switches group: Start/Stop turbine, 52G synchronization permission, Enable/Disable 52NET and reset alarms. - Alarms monitoring: Revers power, over current, over voltage, inverse time over current, over frequency, shutdown alarms, back-up over current and back-up reverse power. - Operation signals state: start request, ready for operation, sync conditions, permission for sync. - Emergency stop.

③ **Diagram of the power substation**. In the right of the screen has an "AC analyzers palette" with the measures of the network analyzers. These analyzers can be moved to different positions.

④ Manual speed and voltage control regulators.

Loads menu. This screen shows a three-phase diagram where the resistive, inductive and capacitive loads can be visualized.
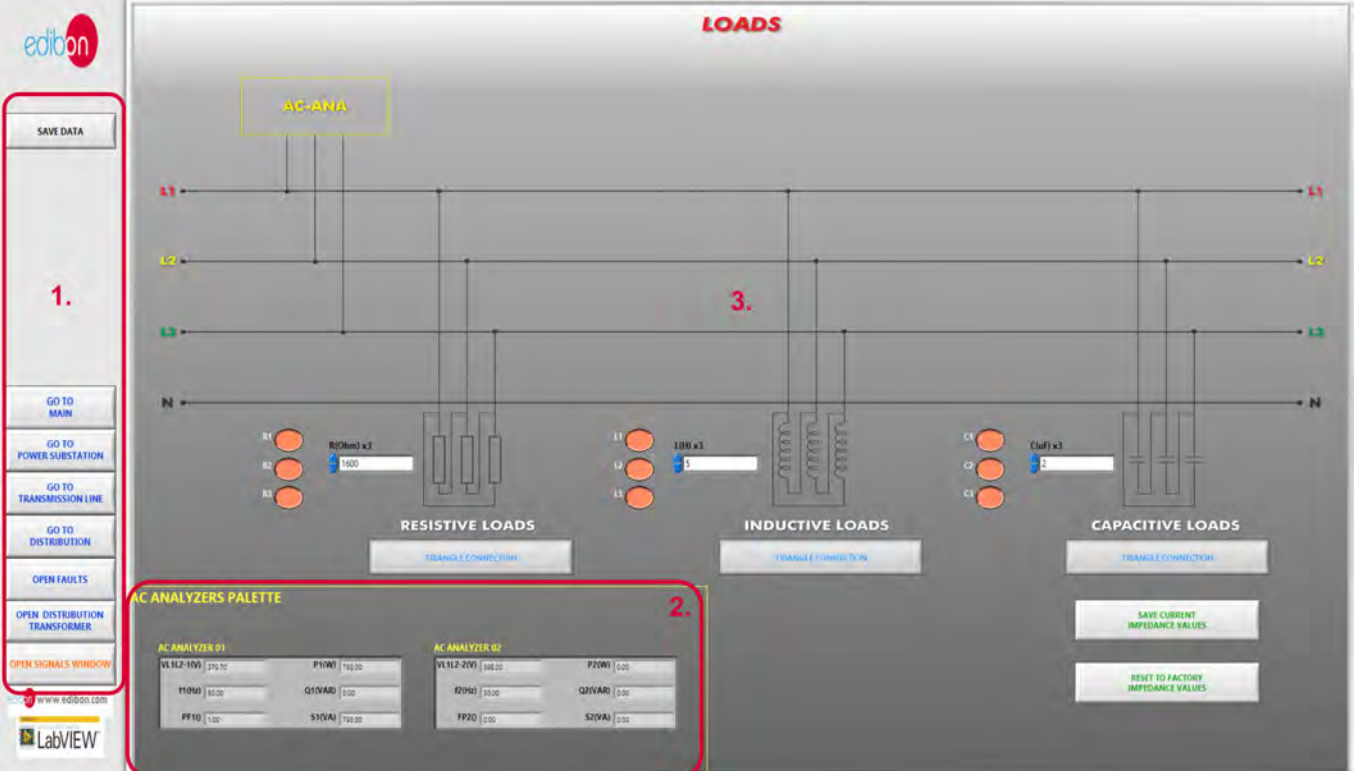

① Navigation menu and save data button.

② **AC analyzers palette**. It shows the measures taken by the analyzers. The analyzers can be moved to the positions named as AC-ANA in the three-phase diagram.

③ **Diagram of the loads**. It has nine push-buttons for remote control of resistive, inductive and capacitive loads commutation.
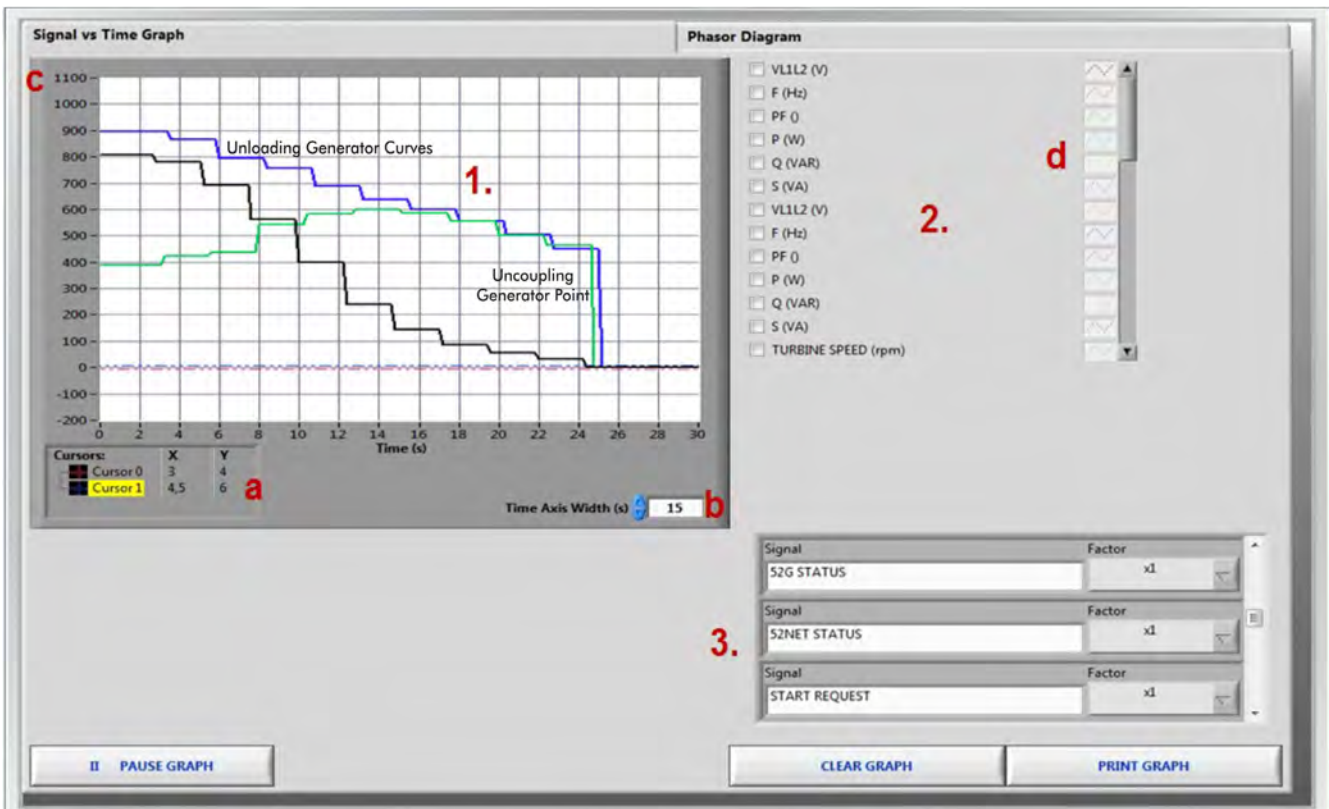
① **Real time graph.** It displays the variables selected and it is possible to take measures using two cursors (**a**) and modify the time (**b**) and the amplitude (**c**) scales. These three curves (apparent, active and reactive powers) represent uncoupling process of the generator and grid.

② **Variable selector.** In this section the variables showed in the real time graph are selected and configured.

③ **Multiplier of digital variables.**
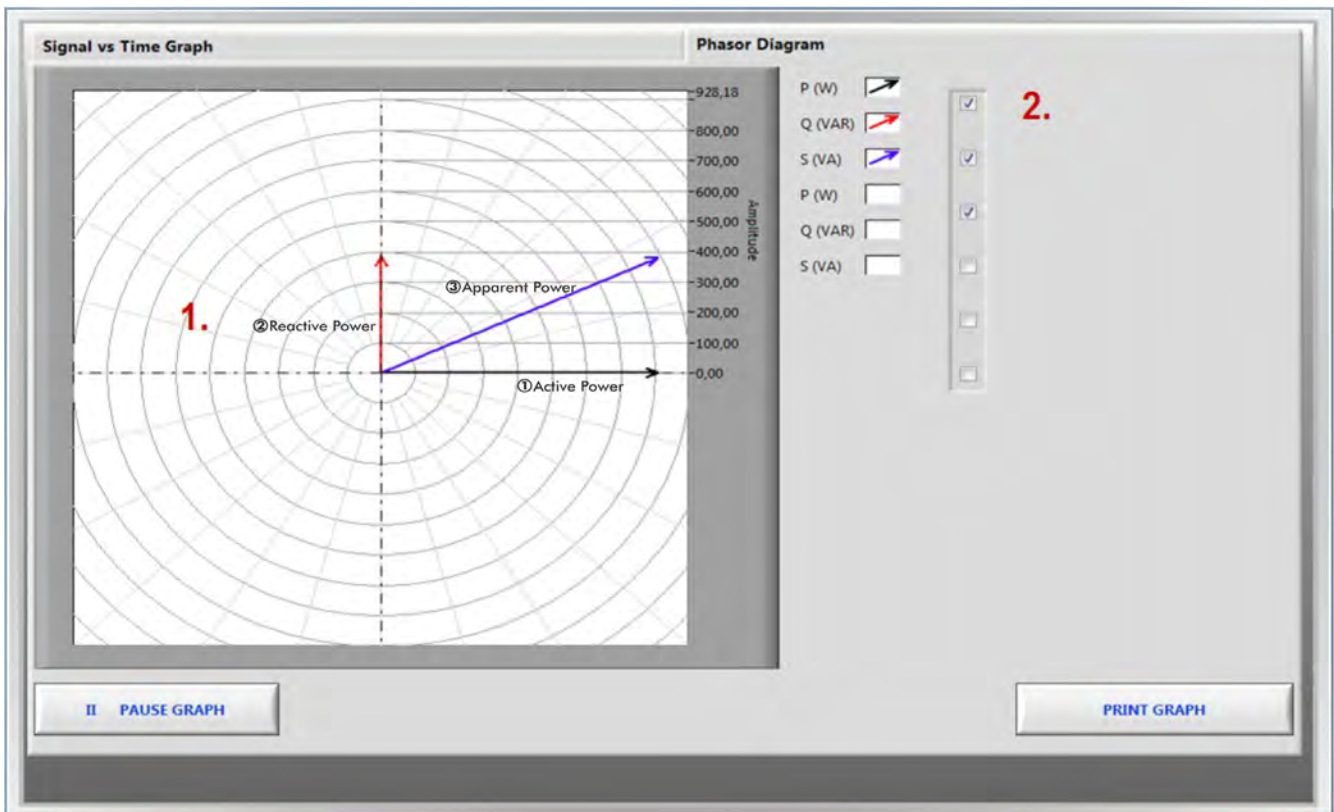
① **Real time graph.** It displays the variables selected. This picture shows the phasors diagram of the active, reactive and apparent powers of the network analyzers.

② **Variable selector.** In this section the variables showed in the real time graph are selected.
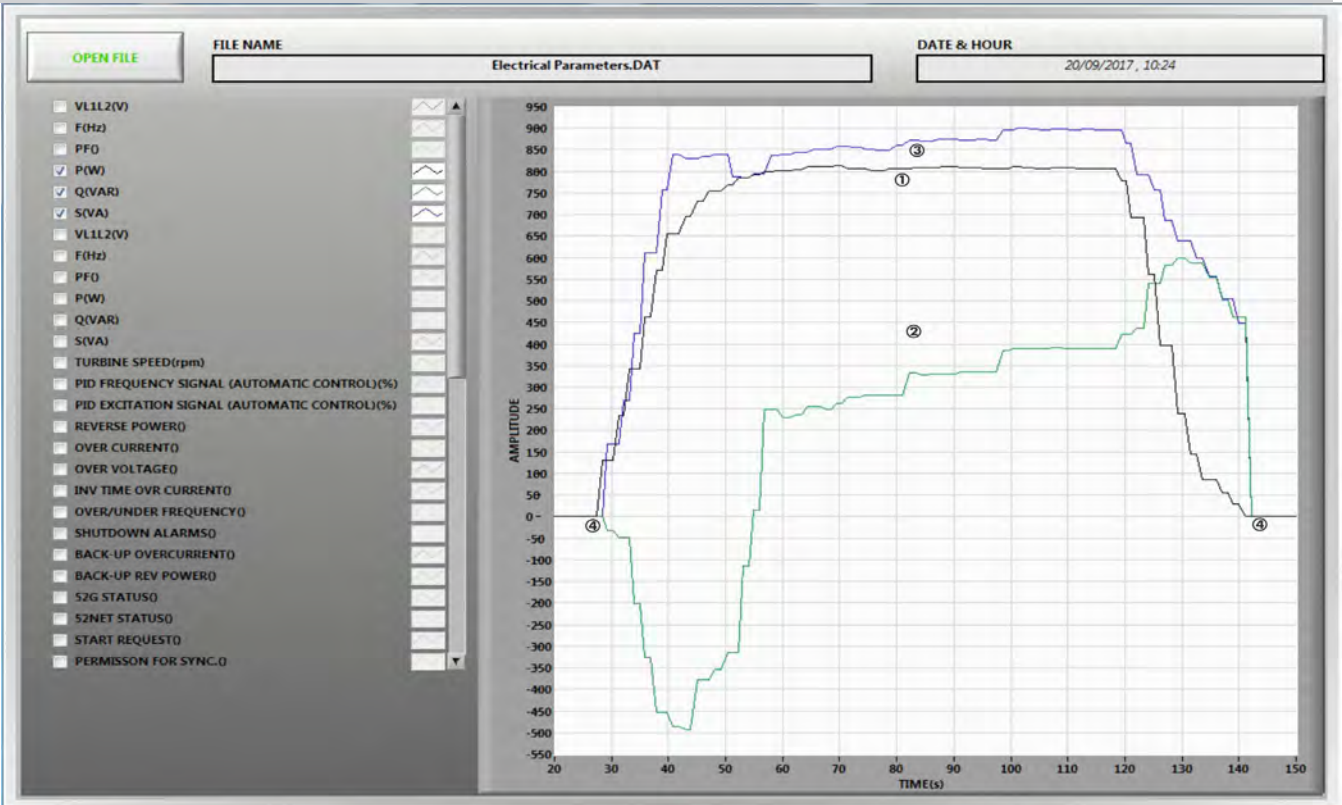
Some **real** results obtained from this Application

This picture shows a PID frequency signal report since the generator is synchronized with the grid till the generator is uncoupled of it.
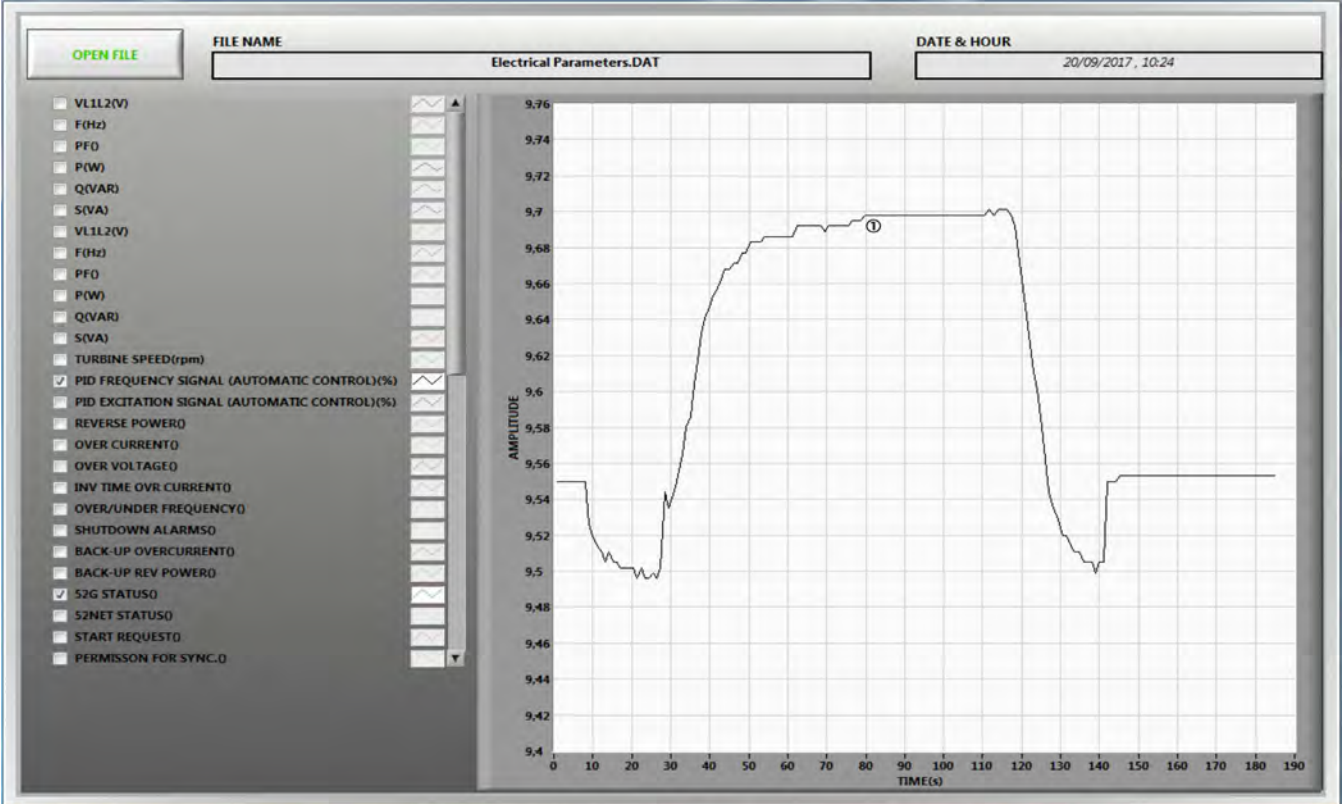

① PID Frequency Signal Reported.

This picture shows the processes of synchronization, active and reactive power generation and uncoupling generator.

① Generator Active Power Wave.
② Generator Reactive Power Wave.
③ Generator Apparent Power Wave.
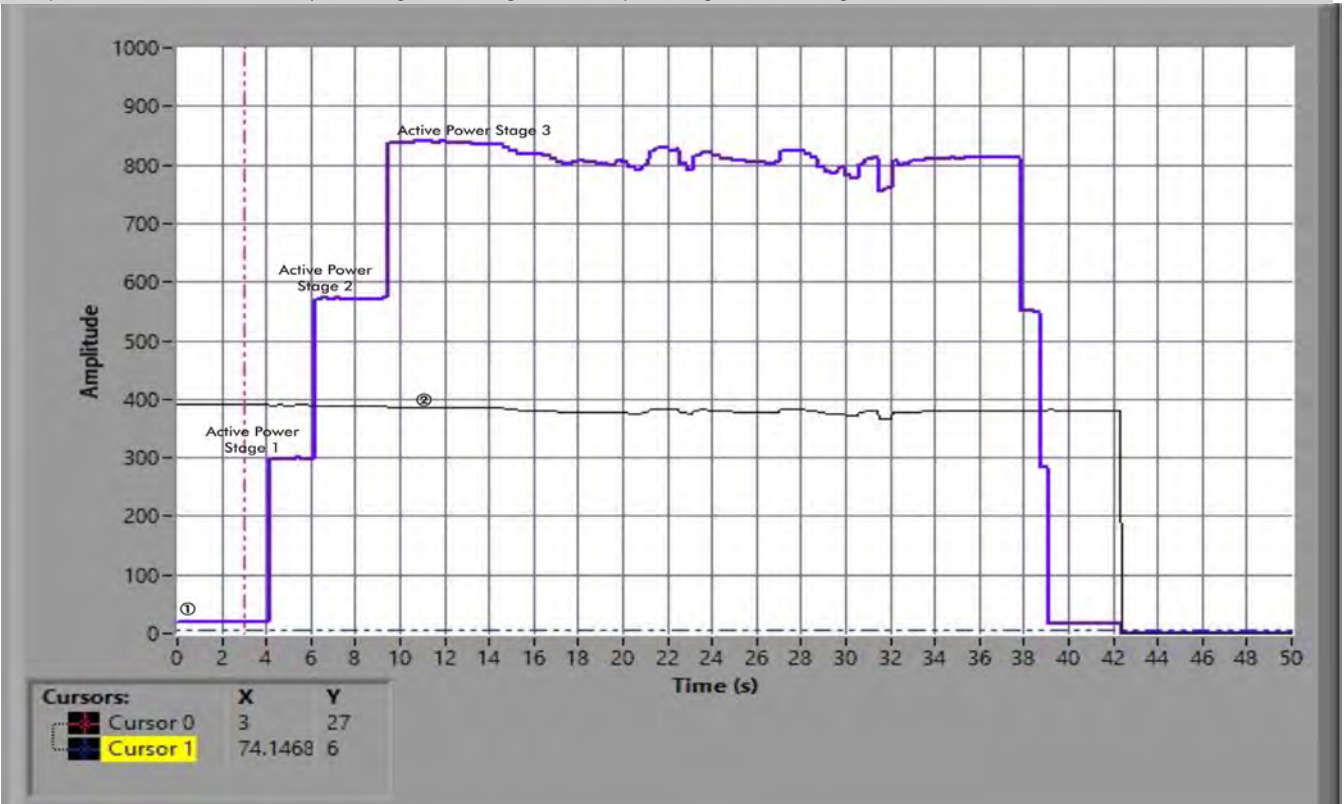④ Synchronization.
⑤ Uncoupling generator.

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Some **real** results obtained from this Application

This picture shows the generator starting, as well as the voltage and requency regulation of the same one.
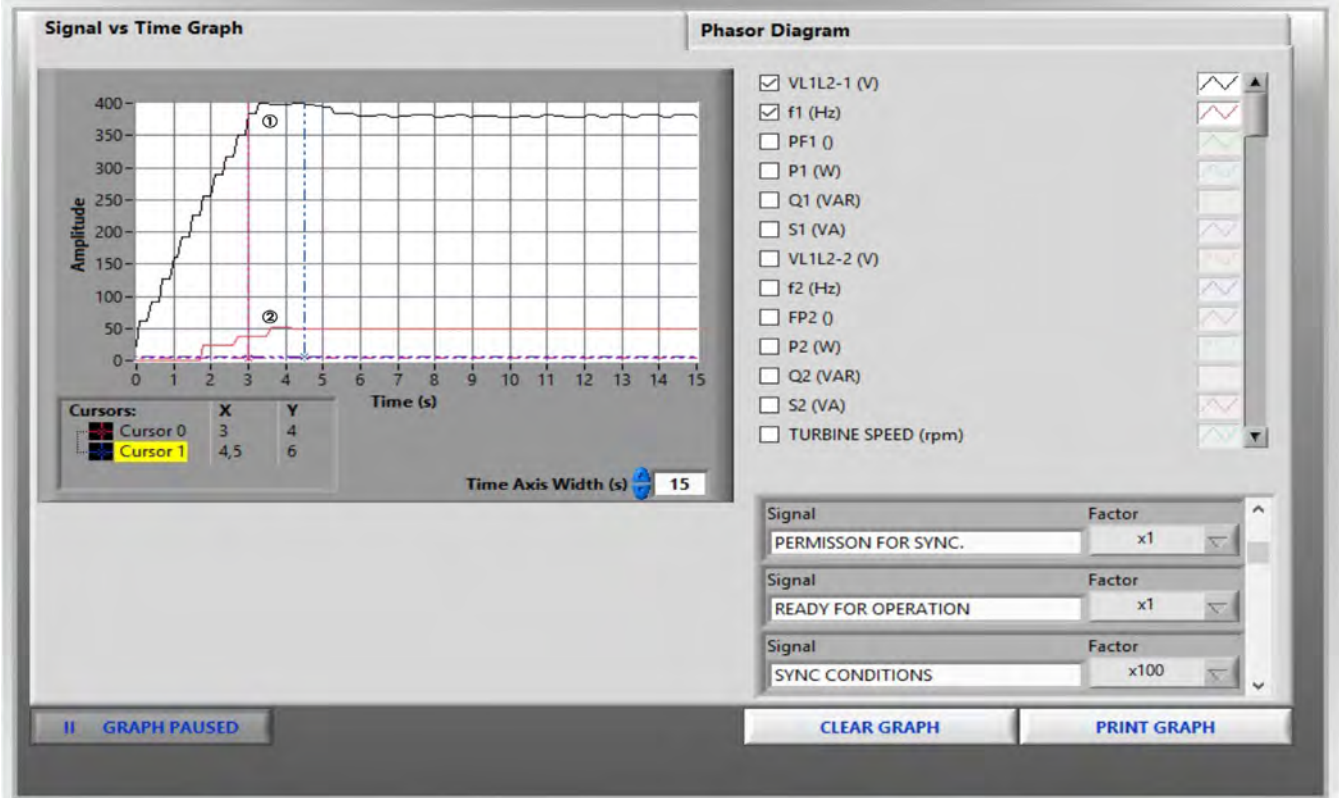

① Generator Voltage Wave.
② Generator Frequency Wave.

This picture shows different active power stages and the generator responses against these stages.

① Active power generator wave with three load stages.
② Generator voltage wave.

This picture shows the synchronization process between the generator and the grid. In the first stage, the turbine is unstable (0 - 6 sec.) and there are fluctuations in P and Q powers up to 6 seconds. After this point, the active power generator ramp is linear up to 18 seconds. Finaly, the generator works in permanent regime.
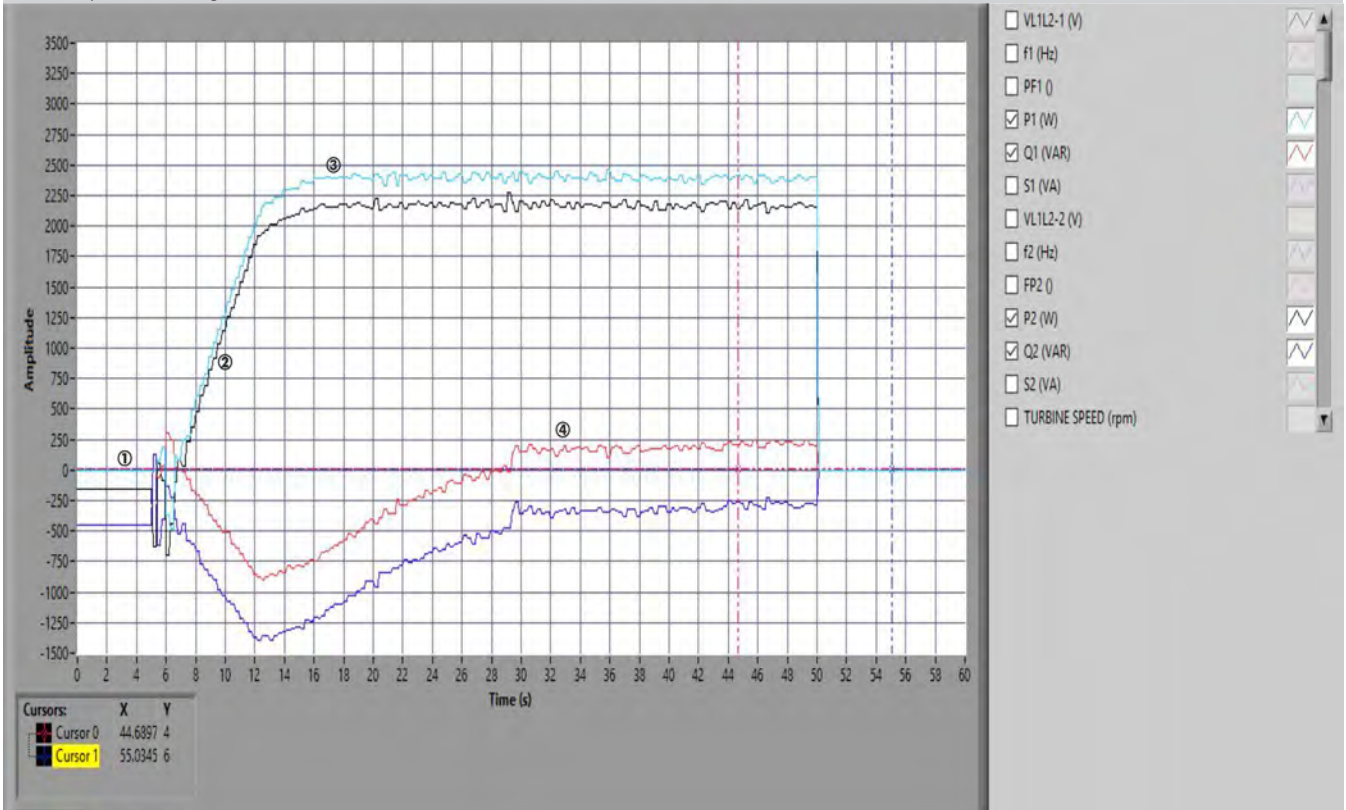
① Generation of active power in permanent regimen in parallel with the grid.

② Generator loading ramp.

③ Reactive power wave during synchronization and loading of generator.

④ Coupling of the generator with the grid.

This picture shows the generation/demand of active power while the injection of a fault and the stopping of the machine after this fault.
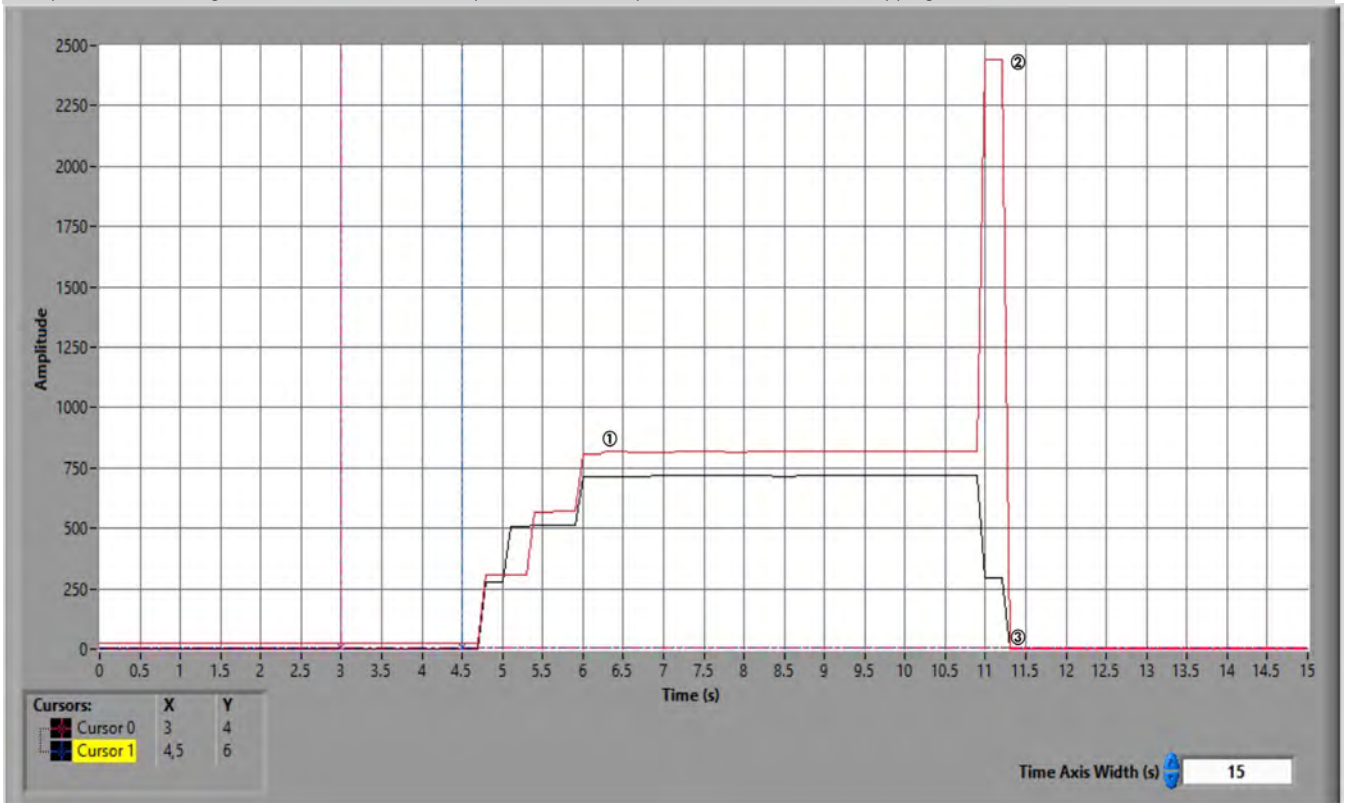
① Active power consumption.

② Fault overcurrent.

③ Turning off the generator.

COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

Additionally to the main items (1, 2, 3 and 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. (ICAI)

  b) Multipost Expansions options. (Mini ESN and ESN)

a) Technical and Vocational Education configuration

⑤ **AEL-MEPD-01/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).
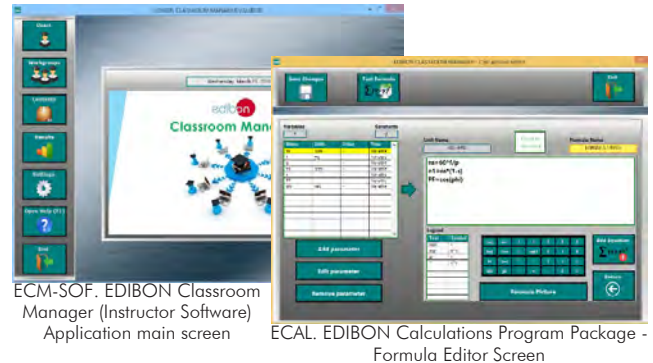
-**ECM-SOF. EDIBON Classroom Manager (Instructor Software).**

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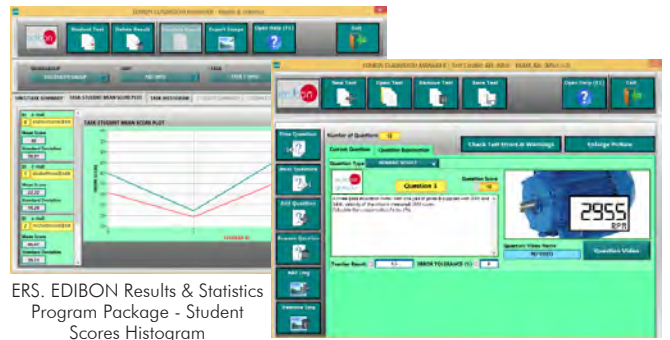
ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram

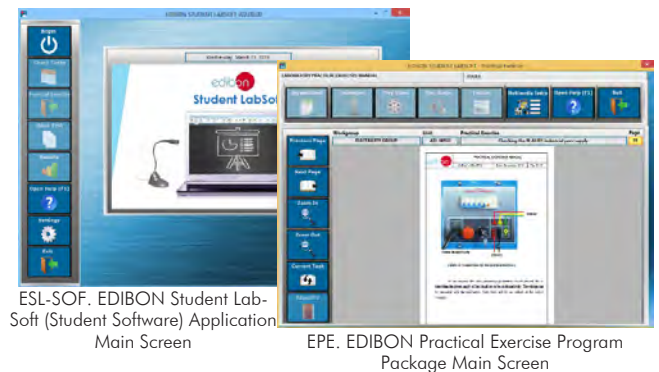ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

Student Software

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

EPE. EDIBON Practical Exercise Program Package Main Screen

ERS. EDIBON Results & Staticstics Program Package-Question Explanation

ECAL. EDIBON Calculations ProgramPackage Main Screen

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/products/catalogues/en/Mini-ESN.pdf

Mini ESN.
EDIBON Mini Scada-Net System

1 UNIT= up to 30 STUDENTS can work simultaneously

Modular Marine Electrical Power Distribution Application, with SCADA (AEL-MEPD-01)

Software for:
- Computer Control
- Data Acquisition
- Data Management

Instructors Central Computer

Mini Scada-Net Software

LOCAL NET FOR 30 STUDENTS

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL
+
MULTI STUDENT POST

Note: The Mini ESN system can be used with any EDIBON computer controlled unit

⑦ **ESN. EDIBON Scada-Net System.**

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
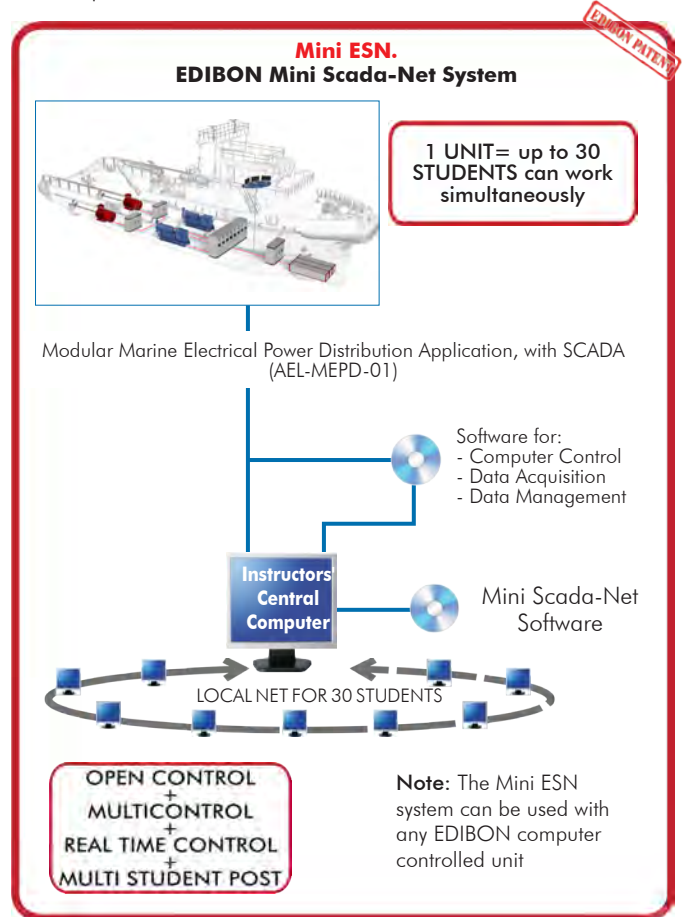
Main items (always included in the supply)

Minimum supply always includes:

① Unit: AEL-MEPD-01. Modular Marine Electrical Power Distribution Application, with SCADA.

② AEL-MEPD-01/CCSOF. Computer Control + Data Acquisition + Data Management Software.

③ Cables and Accessories, for normal operation.

④ Manuals.

*IMPORTANT: Under AEL-MEPD-01 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 configuration

⑤ AEL-MEPD-01/ICAI. Interactive Computer Aided Instruction Software System.

b) Multipost Expansions options

⑥ Mini ESN. EDIBON Mini Scada-Net System.

⑦ ESN. EDIBON Scada-Net System.

① AEL-MEPD-01. Unit.

The application includes the following modules:

- 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 400V connecting plug.

  Differential magnetothermal, 4 poles, 25A, 300mA AC 6KA.

- Power Generation Substation module with generator circuit breaker control.

  Supply voltage: 400 VAC, 3PH+N+G

  ON/OFF switch.

  Power and signals connection:

  Auxiliary connection.

  Three-phase turbine supply hose with IP44 3PN+E 32A 400V connecting plug.

  Three-phase generator supply hose with IP44 3PN+E 32A 400V connecting plug.

  Three switches to choose between the different modes:

  Local and remote control mode.

  Manual and automatic speed control.

  Manual and automatic excitation control

  Three control switches to:

  Start and stop the turbine.

  Give permission to synchronize the generator with the grid.

  Give permission to close 52NET circuit breaker.

  Two potentiometers to regulate:

  Turbine speed.

  Generator excitation.

  Emergency stop button.

  Two circuit breakers for synchronization and stand-alone operations.

  Different terminals to measure.

  Ethernet connection: RJ45 communication port for SCADA remote control.

- Automatic speed and voltage controller and protection relay module for turbine-generator groups control.

  Automatic speed and voltage controller (easygen):

  Enables to connect up to 16 electric generators in parallel-island with distribution of active and reactive load and start/stop in function of the load demand.

  Enables to connect a generator in parallel with the grid.

  Enables different switches control modes, such as opening, closing and synchronization.

  Analogical outputs to control voltage and frequency regulators.

  Three-phase measurement of the grid and the generator voltage.

  Three-phase measurement of the generator intensity and power.

  Single-phase measurement of the grid intensity.

  Protection system.

  Generator:

  Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), voltage asymmetry, detection of dead busbars, overvoltage (32), load unbalance (46), negative sequence power/reduced power (32R/F), overcurrent by defined curve (50/51), inverse time overcurrent (IEC255), measured ground fault (50N/51N), phase rotation, switches faults.

  Network:

  Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), vector jump, phase rotation.

  Six alarms:

  Alarm 1: Reverse power.

  Alarm 2: Overcurrent.

  Alarm 3: Over/undervoltage.

  Alarm 4: Inverse Time Overcurrent.

  Alarm 5: Over/under frequency.

  Alarm 6: Shutdown Alarms.

  Four operation signals:

  Ready for operation.

  Start request.

  Synchronization conditions.

  Permission for synchronization.

  Back-up protections:

  Current relay.

  Reverse Power relay.

  Ethernet connection: RJ45 communication port.

- Three Pole Circuit Breakers with Remote Control for distribution power system (ring topology).
    Supply Voltage: 230 VAC.
    Simple busbar with ring topology, with two circuit breaker.
    Two interconnection terminals.
    One Power Input/Output to connect lines, generation, loads, etc.
    Two push-buttons by each disconnector / circuit breaker to open and close them.
    State indications lamps:
        Two lamps to indicate the state of busbars.
        Three pilot-lights to indicate the state of the circuit breaker and the disconnectors.
    Two Ethernet connections.
- Network Analyzer Modules with Data Acquisition.
    ON-OFF switch.
    Supply voltage: 400 VAC.
    Input terminals: Input connection with the measurement point.
    Output terminals: Output connection with the measurement point.
    Digital outputs: Three digital outputs are used for pulses or alarms, or for combining both.
    RS-485 Communication port.
    Fuses: 3x10 A.
    Network Analyzer Display. It shows:
        Active, reactive and apparent power.
        Active, reactive and apparent energies.
        Lines and phase currents.
        Line and phase voltages.
        Frequencies.
        Power Factor.
- Variable frequency drive for the propulsion control.
    Supply voltage: 230 VAC.
    Supply voltage: 230 VAC.
    Nominal power: 0,75 kW.
    PWM output voltage connections:
        Three-Phases: 230 VAC.
    Digital inputs control panel: 5 configurable digital inputs.
    Analog inputs control panel:
        0-10V analog input for speed control.
        4-20mA analog input for speed control.
    10K, potentiometer for the induction motor control speed.
    2 relay outputs for alarms configuration: 2 outputs NO/NC.
    50 mA, 2 transistor outputs for alarms configuration.
    Setting and visualization display of the machine parameters.
- Three-phase squirrel cage induction motors for propulsion simulation.
    Nominal power: 370 W.
    Nominal voltage: 3x 230/400 VAC Δ/Y.
    Frequency: 50/60 Hz.
    Number of poles: 2.
    Speed: 2730 r.p.m.
    Nominal current: 1,67/ 0,97 A.
- Braking system to simulate the propulsion load.
    Nominal Torque: 5 Nm.
    Maximum Power Dissipation: 100 W.
    Maximum output current adjustment.
    Operating modes "freewheel " and "blocking".
    Nominal voltage: 24 VAC/VDC.
    Maximum Output Current: 2 A.
    Output Load (Resistor): 4 to 20 Ohms.
    Maximum power consumed: 70 W.
    Remote voltage control: 0 to 10 VDC.
    Weight: 4 Kg.
- 1 kVA three-phase synchronous generators with independent excitation.
    Nominal power: 250 W.
    Nominal voltage: 230 VAC.
    Nominal output voltage: 3 x 400 VAC.
    Frequency: 50/60 Hz.
    RPM: 3000 rpm.
    Nominal Current: 1 A.
    Nominal Excitation Current: 0.25 A.
    Shaft height: 71 mm.

- Lamps modules to simulate general services and auxiliary services lighting.

  Nominal voltage: 230 VAC (PH+N).

  Halogen lamp.

  Power: 60 W.

- Three-phase resistive loads to simulate active power consumption.

  Digital bank of commutable resistors module.

  Three sliding load switches.

  Three three-phase commutable banks of resistors of 150 ohm.

  Local/remote control switch.

  Communications connector SUB-D of 62 pins.

- Three-phase induction loads to simulate inductive power consumption.

  Digital banks of commutable inductances module.

  Three sliding load switches.

  Three three-phase commutable banks of inductances of 1.4 H.

  Local/remote control switch.

  Communications connector SUB-D of 62 pins.

- Three-phase isolation transformer to simulate medium voltage and low voltage busbars.

  Three-Phase Autotransformer.

  Supply Voltage: 400V AC (3PH).

  Nominal Output Voltage: 3 x 230V AC (3PH + N).

  Nominal power: 1 kVA.

  Transformer connection: YY0.

  Start / stop switch for instantaneous connection /disconnection of the network transformer.

  Fuses: 3 x 5 A.

  GND terminal.

- Three-phase hybrid inverter with battery for back-up energy system.

  Three-phase inverter.

  Three-phase energy injection into electrical grid.

  Terminals:

    One DC input voltage.

    One three-phase AC output voltage.

  Nominal power: 2000 W.

  Output voltage: 400 VAC.

  Frequency: 50 Hz.

  Long life battery.

  Battery capacity: 2000 Wh.

- Electronic overcurrent relay.

  Electronic thermal relay.

  Overload protection.

  Range 1.2 - 7 A.

  Reset and test function.

  1 NONC contact.

  Temporization.

- 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 knowwledge 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-MEPD-01/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.

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.

Exercises and Practical Possibilities to be done with the Main Items

1.- Main switch board cabling and ring configuration.

2.- Overcurrent relay and circuit breakers setting.

3.- Study of the generation power flows, synchronization, active power sharing and distribution power systems with different load conditions.

4.- Analysis of the measurements of the power flows of the synchronous generator and loads.

5.- Analysis of the active and reactive power of the synchronous generator against dynamic load variations (ship propulsion).

6.- Study of the synchronous generator in island operation mode.

7.- Study of excitation/voltage regulation of synchronous generator in island mode.

8.- Study of turbine regulation (frequency control) in island mode.

9.- Study of different situation in the distribution busbar with ring topology (maneuvers with circuit breakers).

10.- Logic operation with circuit breakers.

11.- Load sharing with different feeders: propellers, auxiliary services and emergency busbar.

12.- Busbar changeover without interruption.

13.- Study of a blackout in the power system of the ship. Step-by-step energy recovery.

14.- Study of the system response to opening circuit breakers due to failures conditions (simulated).

15.- Recovery of system energy through an uninterruptible power supply.

16.- Study of generator-shedding and energy saving in the UPS.

17.- Study of the auxiliary services of the ship.

18.- Study of emergency operations through the emergency switch boards.

19.- Emergency power requirements during a blackout or system failure until recovery.

20.- Essential and non-essential circuits.

21.- Study and measurement of charging battery system.

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.- The Computer Control System with SCADA allow a real industrial simulation.

24.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.

25.- This unit can be used for doing applied research.

26.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

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

<u>a) Technical and Vocational Education configuration</u>

⑤ **AEL-MEPD-01/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.

<u>b) Multipost Expansions options</u>

⑥ **Mini ESN. EDIBON Mini Scada-Net System.**

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 and PID Control 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 and PID Control, 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.

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