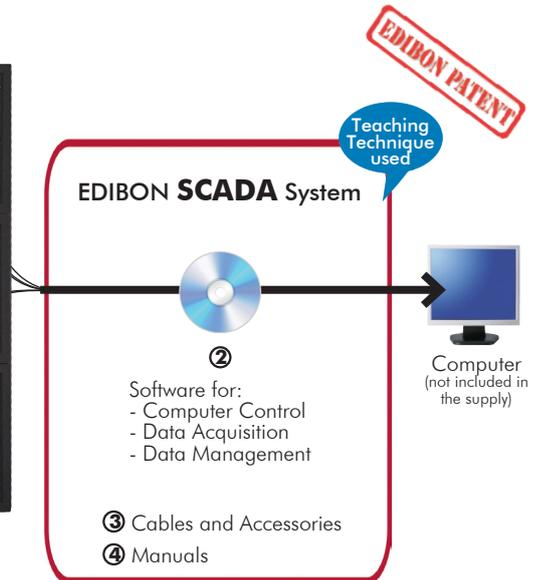




① Application: AEL-BSGC. Computer Controlled Power Smart Grids Application.



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

Key features:

- **Real and complete control of a Smart-Grid.**
- **Power Generator, Transmission and Load consumption studies.**
- **Analysis of energy requirements in a Smart-Grid.**
- **Study of energy balance: energy production VS load consumption.**
- **Manual and automatic speed and excitation control of the generator-motor group.**
- **Synchronous generator Stand-Alone operation studies.**
- **Synchronous generator parallel operation studies.**
- **Transmission lines energy effects according to length line.**
- **Power factor compensation effects.**
- **Visualization of power generation waves through SCADA Control System.**
- **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.**
- **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**
- **Remote operation and control by the user and remote control for EDIBON technical support are always included.**
- **Designed and manufactured under several quality standards.**
- **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**



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)



Certificate and Worlddidac Member

INTRODUCTION

A Smart Grid is an electrical grid that includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy sources, and energy efficiency resources. Control production and distribution of electricity are important aspects of Smart Grids that are studied with the "AEL-BSGC", Computer Controlled Power Smart Grids Application.

GENERAL DESCRIPTION

The Computer Controlled Power Smart Grids Application, "AEL-BSGC", has been designed to study the Smart Grids in the generation, transmission, distribution and load consumption fields.

Students and teachers of universities and research laboratories schools can easily study and investigate how a real Smart Grid works since electrical energy is produced till it is consumed, analyzing problems and solutions in each part of the process or as the whole. The AEL-BSGC includes a 1 kVA Three-Phase Synchronous Generator-Motor group which is used to study the production of electricity. The synchronous generator is coupled to a three-phase induction motor of squirrel cage controlled through a variable frequency drive. With the frequency controller the user can control (manual and automatic) the induction motor speed and reproduce any power generation condition. In addition, the generator excitation is controlled by an AVR (automatic voltage regulator) that allows user to control (manual and automatic) the current excitation of the synchronous generator. This device is an advanced speed and voltage controller and allows to study the operation of a real speed and voltage controller, synchronization and stand-alone operations. The user can monitor speed and voltage PIDs in order to study the stability of the synchronous generator-motor group. In power generation systems it is very important to maintain speed and voltage constants to avoid possible damages due to frequency or voltage oscillations. With this application students will learn how actual speed/voltage controller works. Additionally, Edibon recommends a second power generation substation to study parallel operations with two generators, recovery system after black-outs, etc.

In addition, a transmission line module is included. With this module it is possible to study how electrical energy is transported and distributed along hundreds of kilometers. The transmission line module is designed according to the concentrated parameters theory with variable inductances, capacitances and resistances. This module allows change the lines length, the capacitive effect with the ground and the capacitive effect between the lines. Thus the students will understand how the line parameters affect in the transported energy.

On the other hand two network analyzers for bidirectional smart metering (Smart Meter Simulators) are included. Through these analyzers the user can study energy losses in the transmission lines, measuring upstream and downstream voltages, active powers, reactive powers, power factor, line currents and many other electrical parameters.

Finally, know that any power system requires consumption devices and energy balance is an issue to be analyzed. For this purpose, the AEL-BSGC includes resistive, inductive and capacitive loads in order to provoke unstable conditions in power generation to study how this smart grid reach the stability automatically.

The AEL-BSGC 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, transmission line and resistive, capacitive and inductive loads. The SCADA is designed to control in real time of whole power substation, for instance, 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 synchronize the generator with the national grid and take the control of the turbine and generator. Thus the user can understand what effects of the frequency and current excitation are in synchronism with the grid. Droop voltages, overspeed, underspeed, overcurrents, overloads and reverse power are some of many phenomena that the user can study from the SCADA.

In addition, SCADA Control System acquires in real time many electrical parameters from the network analyzers. Power generation, power transmission and energy consumption can be monitored and are displayed to analyze power, current, voltages and many other waves. After electrical data acquisition it is possible carry out data logging for future analysis.

The AEL-BSGC includes the following modules:

- N-ALI01. Industrial Main Power Supply.
- N-MPS. Motor Protection (1.6 A-2.5 A).
- N-PPIM1. Instrumentation Module 1.
- N-PPCM1. Control and Protection of Turbine-Generator Group Module 1.
- N-PSUB1. Power Generation Substation Module 1.
- N-EALD. Network Analyzer Unit with Data Acquisition (2 units).
- N-AE1. Transmission Lines Simulation Module.
- N-REFT/3C. 3 x 300 W Three-Phase Configurable Resistors Module.
- N-INDT/3C. 3 x 300 VAr Three-Phase Configurable Inductances Module.
- N-CAR19T/3C. 3 x 300 VAr Three-Phase Configurable Capacitors Module.
- EMT6/1K. 1kW/1P Three-Phase Synchronous Generator.
- EMT7/1K. 1kW/1P Asynchronous Three-Phase Motor of Squirrel Cage.

General Description

Additional and recommended modules and machines:

National Grids consist of several energy sources working in parallel. The following modules are recommended in order to study parallel operations with two or more generators and transmission lines:

- N-PPIM1. Instrumentation Module 1.
- N-PPCM1. Generator Group Module 1.
- N-PSUB1. Power Generation Substation Module 1.
- N-EALD. Network Analyzer Unit with Data Acquisition.
- EMT6/1K. 1kW/1P Three-Phase Synchronous Generator.
- EMT7/1K. 1kW/1P Asynchronous Three-Phase Motor of Squirrel Cage.

Transmission line module and loads:

- N-AE1. Transmission Lines Simulation Module.
- N-REFT/3C. 3 x 300 W Three-Phase Configurable Resistors Module.
- N-INDT/3C. 3 x 300 VAR Three-Phase Configurable Inductances Module.
- N-CAR19T/3C. 3 x 300 VAR Three-Phase Configurable Capacitors Module.

Similar applications available:

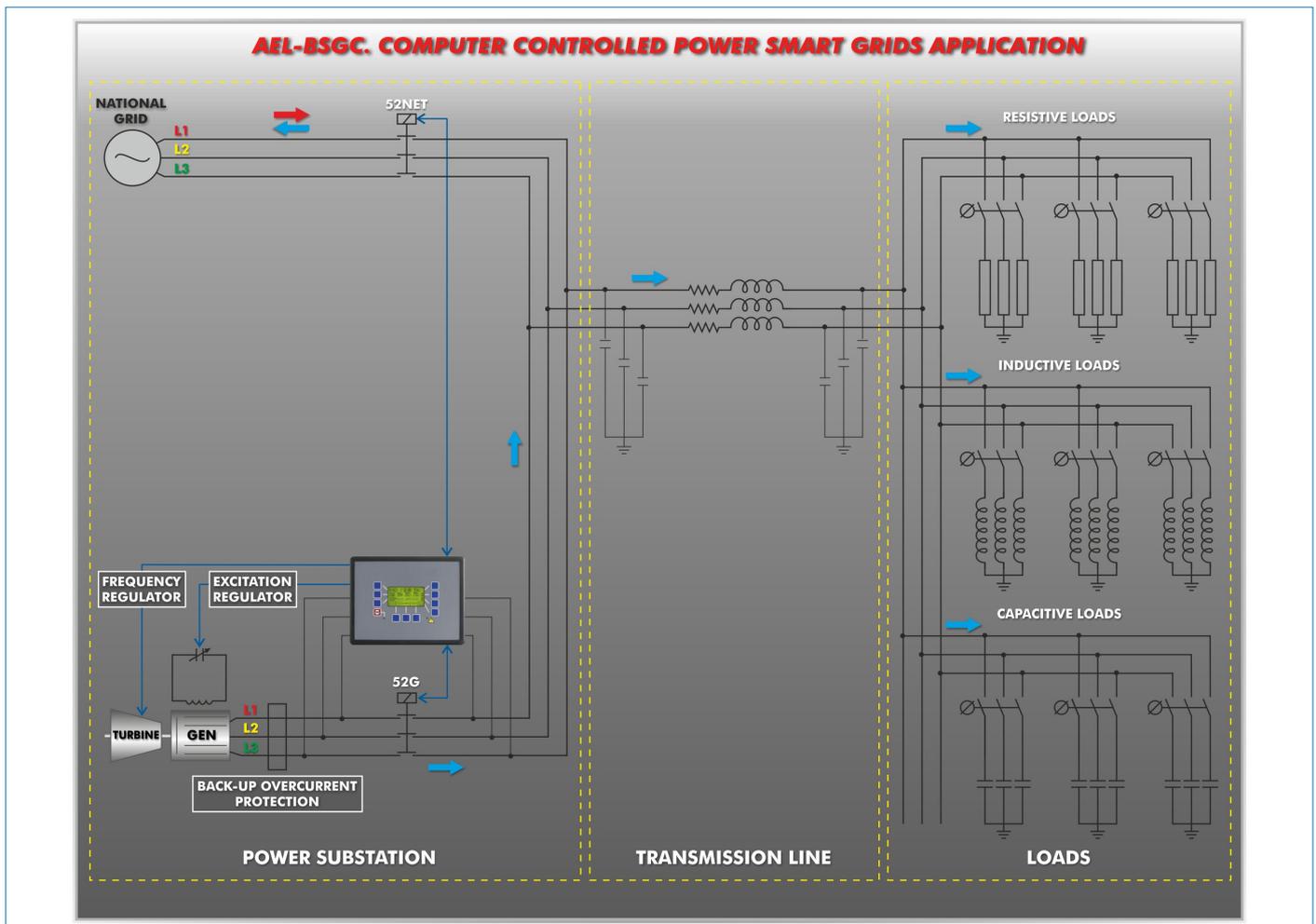
- AEL-MPSS. Modular Electrical and Smart Grid Power Systems (Utilities). (www.edibon.com/en/files/equipment/AEL-MPSS/catalog)
- TDEGC. Computer Controlled Diesel Engine Electricity Generator. (www.edibon.com/en/files/equipment/TDEGC/catalog)
- AEL-MGR. Microgrid Series. (www.edibon.com/en/files/equipment/AEL-MGR/catalog)
- AEL-EESD. Advanced Digital Synchronization Trainer. (www.edibon.com/en/files/equipment/AEL-EESD/catalog)
- AEL-MOSC. Manual Operations of Synchronization Circuits. (www.edibon.com/en/files/equipment/AEL-MOSC/catalog)

SCADA software:

- AEL-BSGC/CCSOF. Computer Control + Data Acquisition + Data Management Software.

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

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



COMPLETE TECHNICAL SPECIFICATIONS (FOR MAIN ITEMS)

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-BSGC. Application:

The application includes the following modules:

• 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 32 A 400 V connecting plug.

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



N-ALI01

• N-PPIM1. Instrumentation Module 1.

Three-Phase wattmeter:

Measured range: 0 - 1.5 KW.

Three-Phase varmeter:

Measured range: 0 - 1.5 KVar.

Voltmeter:

Measured range: 0 - 500 V.

Frequency meter:

Measured range: 45 - 55 Hz.

DC meter:

Measured range: 0 - 10 A.



N-PPIM1

• N-PPCM1. Control and Protection of Turbine-Generator Group Module 1.

Automatic speed and voltage controller:

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.



N-PPCM1

• **N-PSUB1. Power Generation Substation Module 1.**

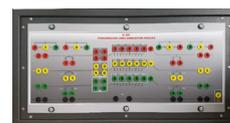
- Supply voltage: 400 VAC, 3PH+N.
- ON / OFF switch.
- Power and signal connections:
 - Auxiliary connection.
- Three-phase turbine supply hose with IP44 3PN+E 32A 400V connecting plug.
- Three-phase generator supply hose with IP44 3PN+E 32A 400V connecting plug.
- Three switches to choose between the 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.



N-PSUB1

• **N-AE1. Transmission Lines Simulation Module.**

- Supply voltage: 400 VAC, 3PH+N.
- Three-phase line with variable parameters.
- Concentrated parameters line.
- Four capacitances benches between lines with three capacitances of 1 μ F each one.
- Two capacitances benches between line and ground composed by two capacitances of 1 and 2 μ F.
- Resistance of the line that can be wiring independently:
 - Three resistors of 15 Ω .
 - Three resistors of 30 Ω .
- Inductance of the line with several set values: 33 mH, 78 mH, 140 mH, 193 mH and 236 mH.
- Neutral resistor of 10 Ω .



N-AE1

• **N-EALD. Network Analyzer Unit with Computer Data Acquisition (2 units).**

- 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: 3 x10 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.



N-EALD

• **N-MPS. Motor Protection Module.**

- ON/OFF switch.
- Limit thermal current:
 - From 1,6 A to 2,5 A.
- Input power terminals:
 - Power input connections: L1, L2, L3.
- Output power terminals:
 - Power output connections: L1, L2, L3
 - Ground Terminal.



N-MPS

- **N-REFT/3C. 3 x 300 W Three-Phase Configurable Resistors Module.**

Configurable Star and Delta connections.
 Three banks with three three-phase resistors of 1600 Ω.
 Nominal voltage: 400 VAC.
 Nominal power: 3 x (3 x 100) W.



N-REFT/3C

- **N-INDT/3C. 3 x 300 VAR Three-Phase Configurable Inductances Module.**

Configurable Star and Delta connection.
 Three banks with three three-phase inductances of 5 H.
 Nominal voltage: 400 VAC.
 Nominal power: 3 x (3 x 100) VAR.



N-INDT/3C

- **N-CAR19T/3C. 3 x 300 VAR Three-Phase Configurable Capacitors Module.**

Configurable Star and Delta connection.
 Three banks with three three-phase capacitors of 2 μF.
 Nominal voltage: 400 VAC.
 Nominal power: 3 x (3 x 100) VAR.



N-CAR19T/3C

- **EMT6/1K. 1 kW/1P Three-Phase Synchronous Generator.**

Nominal power: 1000 VA.
 Power factor: 0.8
 Nominal output voltage: 3x 400 VAC.
 Frequency: 50/60 Hz.
 Speed: 3000 r.p.m.
 Nominal output current: 0.8 A.
 Nominal excitation current: 5 A.



EMT6/1K

- **EMT7/1K. 1 kW/1P Asynchronous Three-Phase Motor of Squirrel Cage.**

Nominal power: 1100 W.
 Nominal voltage: 3 x 230/400 VAC Δ/Y.
 Frequency: 50/60 Hz
 Number of poles: 2.
 Speed: 2730 r.p.m.
 Nominal current: 2.52 / 1.45 A.



EMT7/1K

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

The complete unit includes as well:

Real and complete control of a Smart-Grid.

Power Generator, Transmission and Load consumption studies.

Analysis of energy requirements in a Smart-Grid.

Study of energy balance: energy production VS load consumption.

Manual and automatic speed and excitation control of the generator-motor group.

Synchronous generator Stand-Alone operation studies.

Synchronous generator parallel operation studies.

Transmission lines energy losses according to length line.

Power factor compensation effects.

Visualization of power generation waves through SCADA Control System.

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.

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-BSGC/CCSOF. Computer Control + Data Acquisition + Data Management Software:

The two 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.

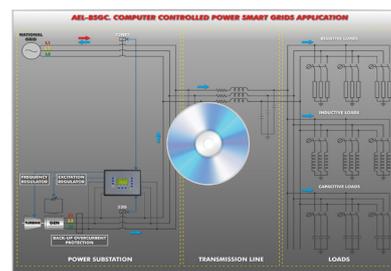
Management, processing, comparison and storage of data.

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-BSGC/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-BSGC + AEL-BSGC/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.- Basic concepts of Smart Isolated Grids.
- 2.- Manual control of voltage and frequency of the generator in a Smart Stand-Alone Grid.
- 3.- Automatic control of voltage and frequency of the generator in a Smart Stand-Alone Grid.
- 4.- Study of energy requirements and energy generation in a Smart Stand-Alone Grid.
- 5.- Smart Metering of the generated and transported energy.
- 6.- Study of synchronous generator response when a resistive load variation occurs.
- 7.- Study of synchronous generator response when an inductive load variation occurs.
- 8.- Study of synchronous generator response when a capacitive load variation occurs.
- 9.- Synchronization operations with the synchronous generator and the grid.
- 10.- Study of energy losses in transmission lines.
- 11.- Representation of power generation waves through the Data Acquisition System.
- 12.- Comparison of energy losses according to the line length.
- 13.- Visualization and comparison of the reactive load curves with and without power factor compensation.
- 14.- Display of measured values of the synchronous generator.
- 15.- Display of measured values upstream and downstream of the transmission line for different line lengths and energy losses comparison.
- 16.- Plotting of measured values vs time.
- 17.- Data processing, analyzing and exporting of generation, lines and load electrical parameters.

Other possibilities to be done with this Unit:

- 18.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
 - 19.- 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.
 - 20.- The Computer Control System with SCADA allows a real industrial simulation.
 - 21.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
 - 22.- This unit can be used for doing applied research.
 - 23.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
 - 24.- Control of the AEL-BSGC unit process through the control interface box without the computer.
 - 25.- Visualization of all the sensors values used in the AEL-BSGC unit process.
- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

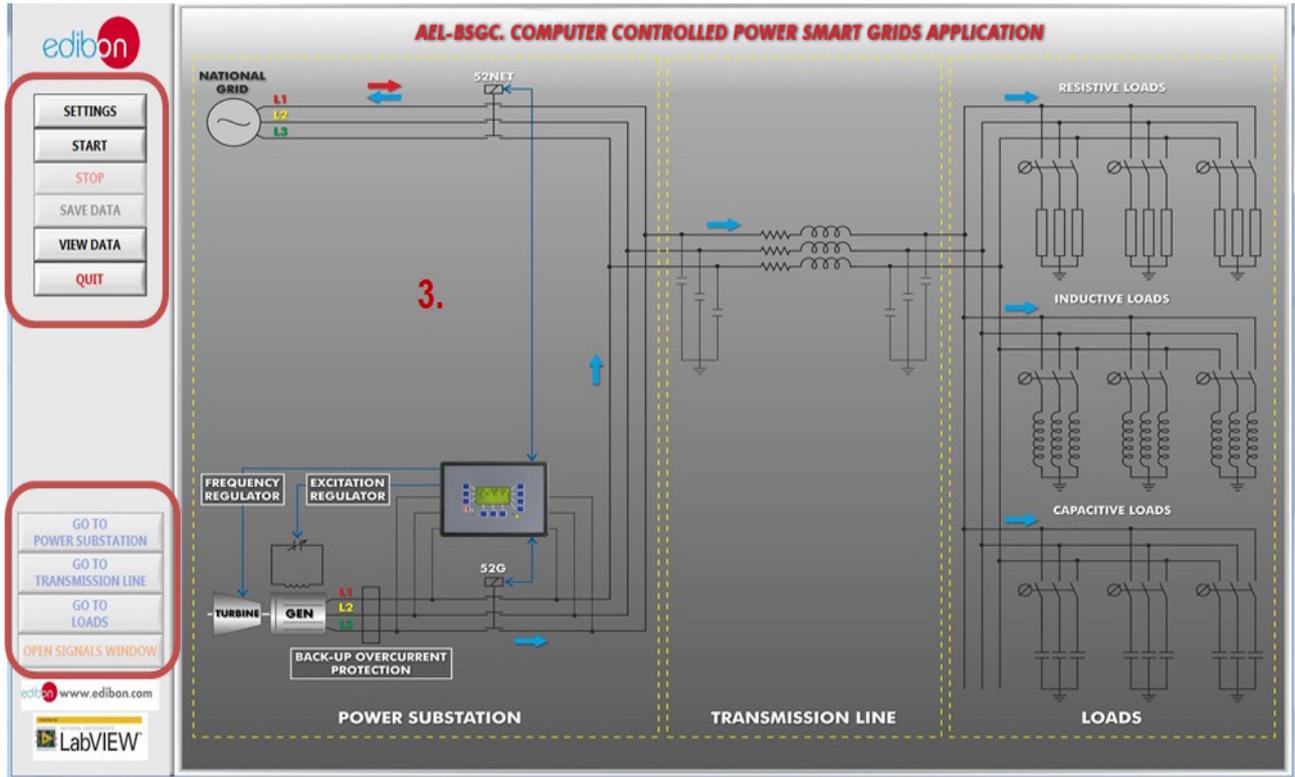
- Electrical supply: three-phase, 380V./50 Hz. or 208V./60 Hz., 20 Kw.
- Computer (PC).

DIMENSIONS AND WEIGHTS

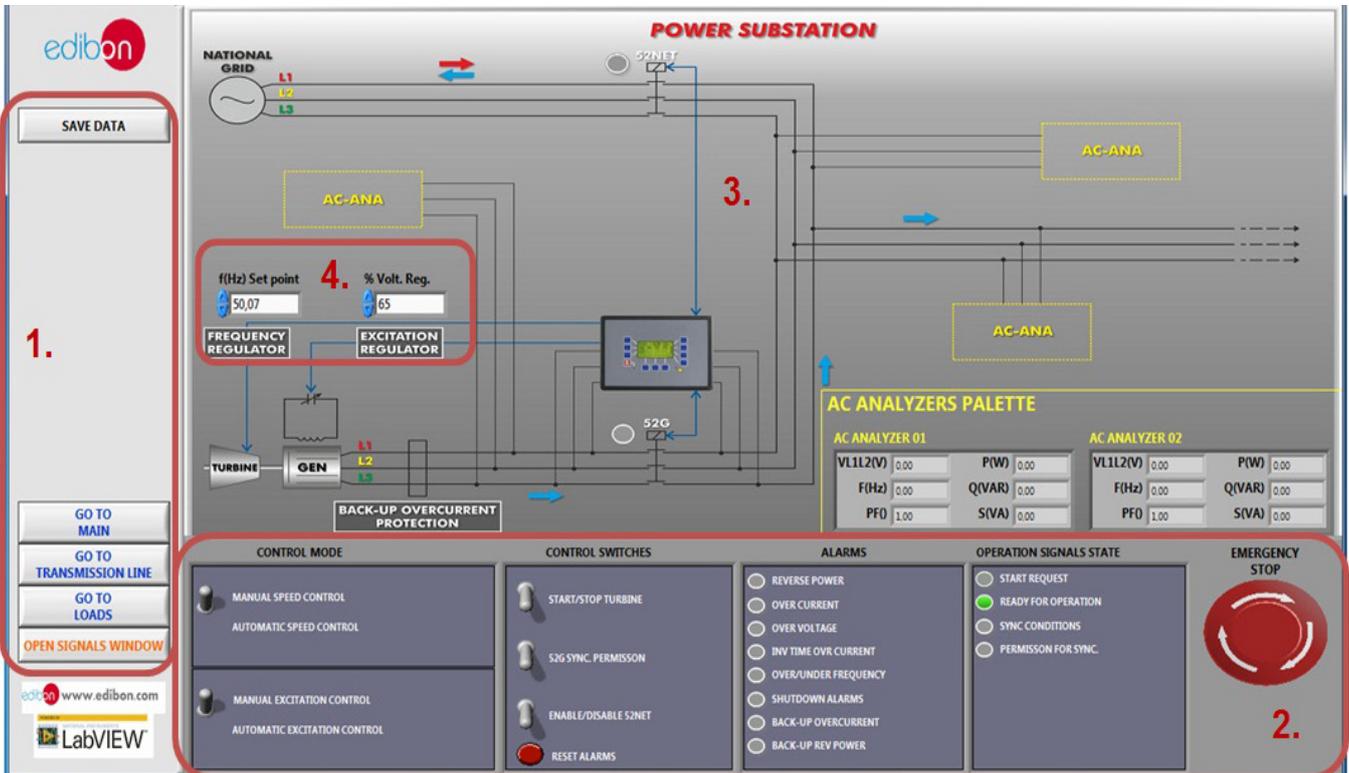
- AEL-BSGC:
- Dimensions: 2000 x 400 x 2000 mm. approx.
(78.74 x 15.75 x 78.74 inches approx.)
 - Weight: 100 Kg. approx.
(220 pounds approx.)

SOFTWARE MAIN SCREENS

SCADA Main screen



- ① SCADA control menu. It contains the main commands of the system: alarms configuration, start and stop of the system, data saving and viewing saved data.
- ② Screen navigation menu. It is used to change between the specific screens of the system (power substation, transmission line and loads) and to visualize the signals measured in real time (open signals window).
- ③ Diagram of the application.



- 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.

Transmission Line menu. This screen shows a three-phase diagram where the concentrated parameters of the transmission line can be visualized. The impedance of each phase line can be modified changing the resistances, inductances and capacitances values.

AC ANALYZERS PALETTE

AC ANALYZER 01		AC ANALYZER 02	
VL1L2(V)	0.00	P(W)	0.00
F(Hz)	50.00	Q(VAR)	0.00
PFO	1.00	S(VA)	0.00

CALCULATIONS			
	AC ANALYZER 1 (y1)	AC ANALYZER 2 (y2)	y1 - y2
VLL (V)	0,00	0,00	0,00
P (W)	0,00	0,00	0,00

- ① Navigation menu and save data button.
- ② AC analyzers palette and calculations. These tables show the measures taken by the analyzers and the different between them with the aim of obtain the line losses. The analyzers can be moved to the positions named as AC-ANA in the three-phase diagram.
- ③ Diagram of the transmission line. It has two buttons to save the configuration of the transmission line and to reset them to the factory values.

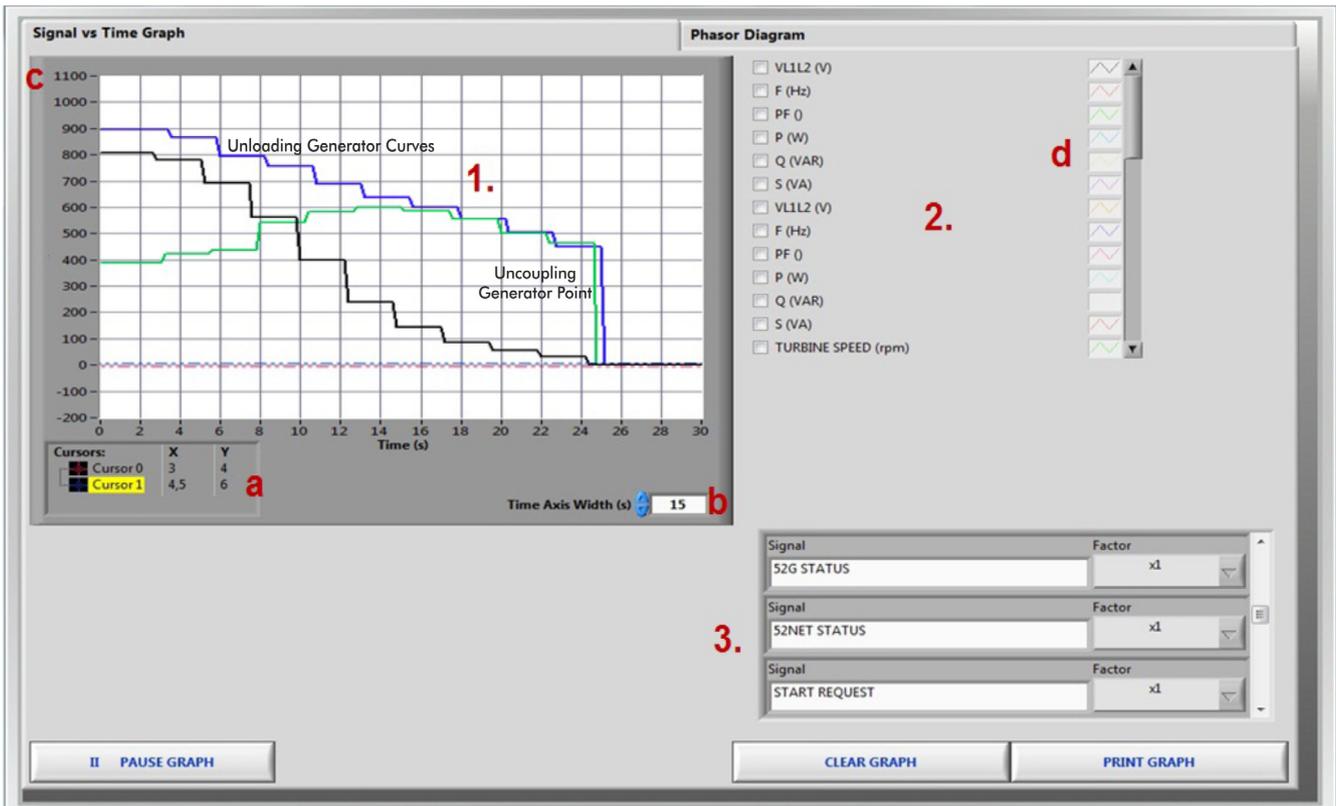
Loads menu. This screen shows a three-phase diagram where the resistive, inductive and capacitive loads can be visualized.

AC ANALYZERS PALETTE

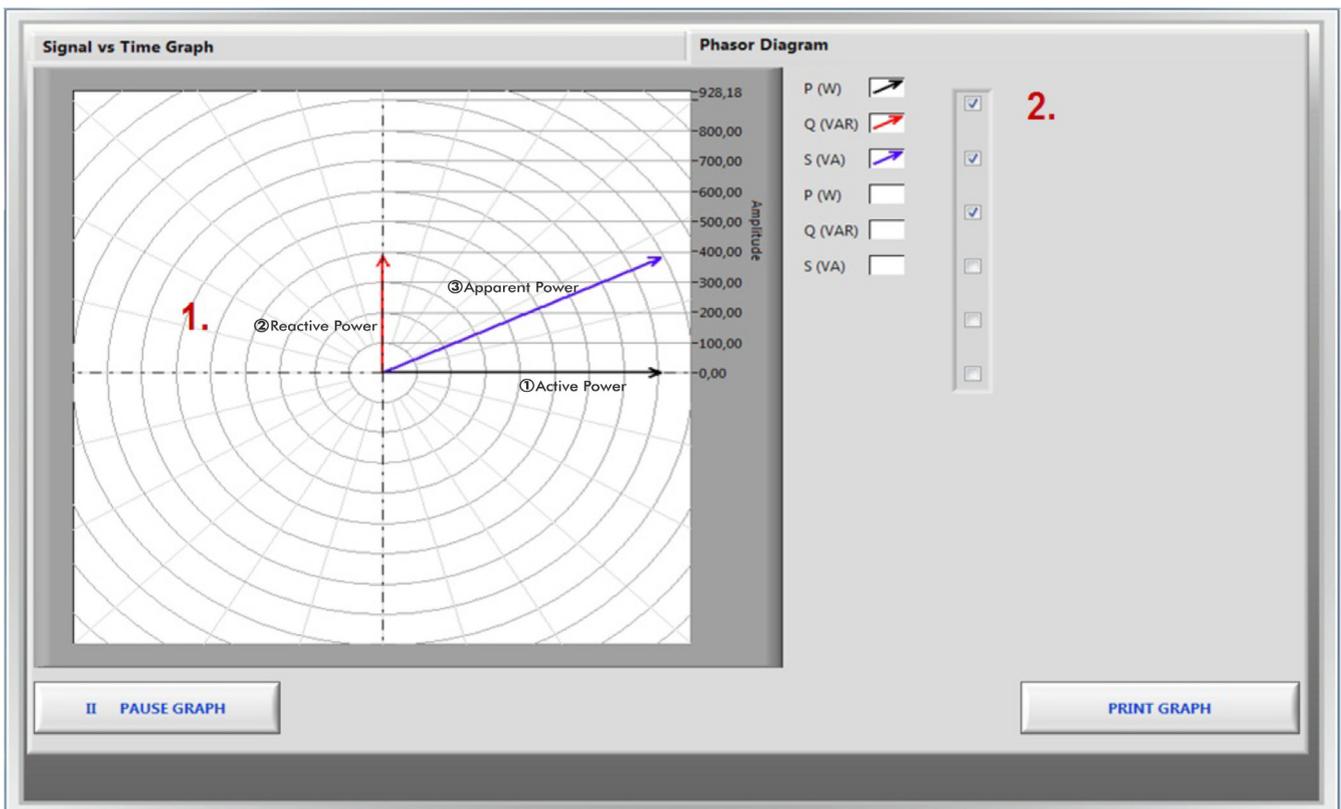
AC ANALYZER 01		AC ANALYZER 02	
VL1L2(V)	0.00	P(W)	0.00
F(Hz)	50.00	Q(VAR)	0.00
PFO	1.00	S(VA)	0.00

- 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.

SOME REAL RESULTS OBTAINED FROM THIS UNIT



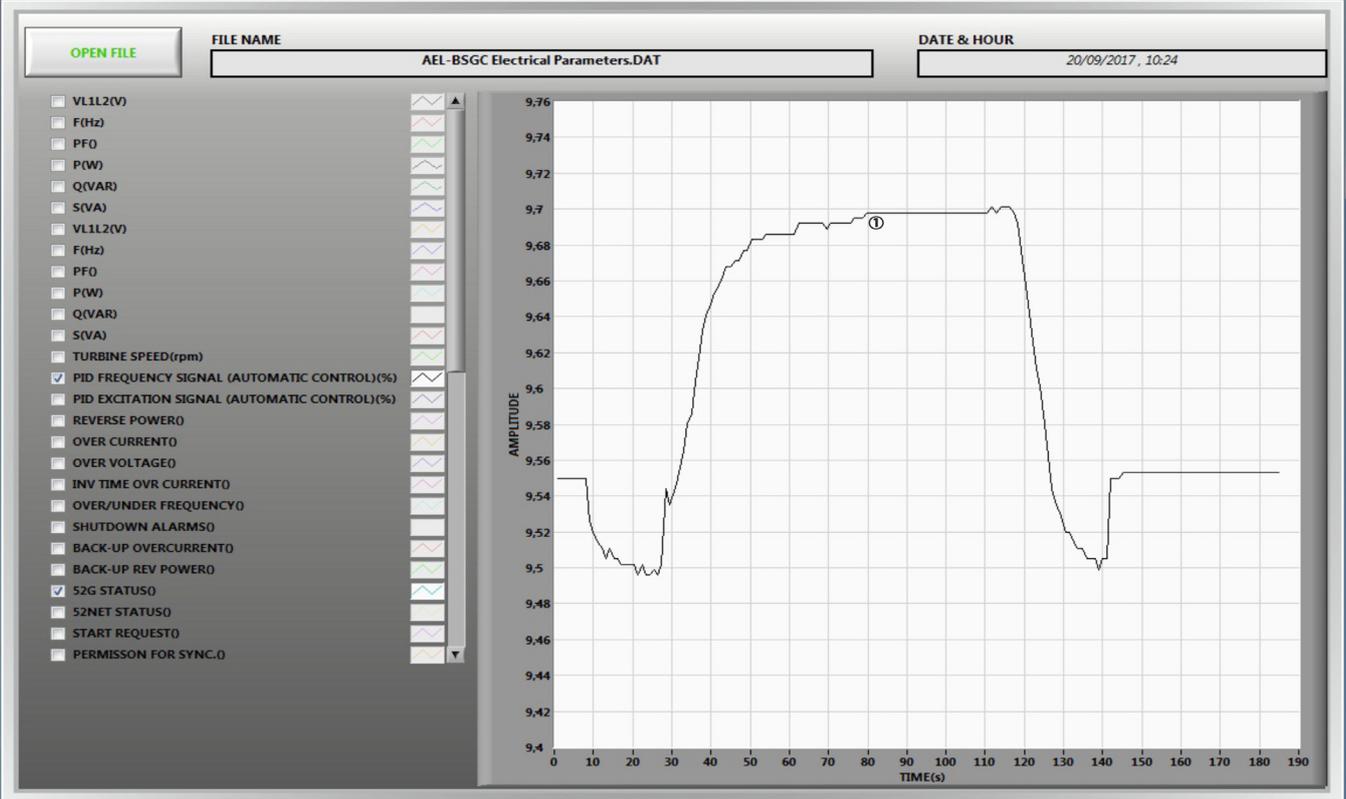
- ① **Real time graph.** It displays the variables selected and it is possible to take measures using two cursors (a) and modify the time (b) and the amplitude (c) scales. These three curves (apparent, active and reactive powers) represent uncoupling process of the generator and grid.
- ② **Variable 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.

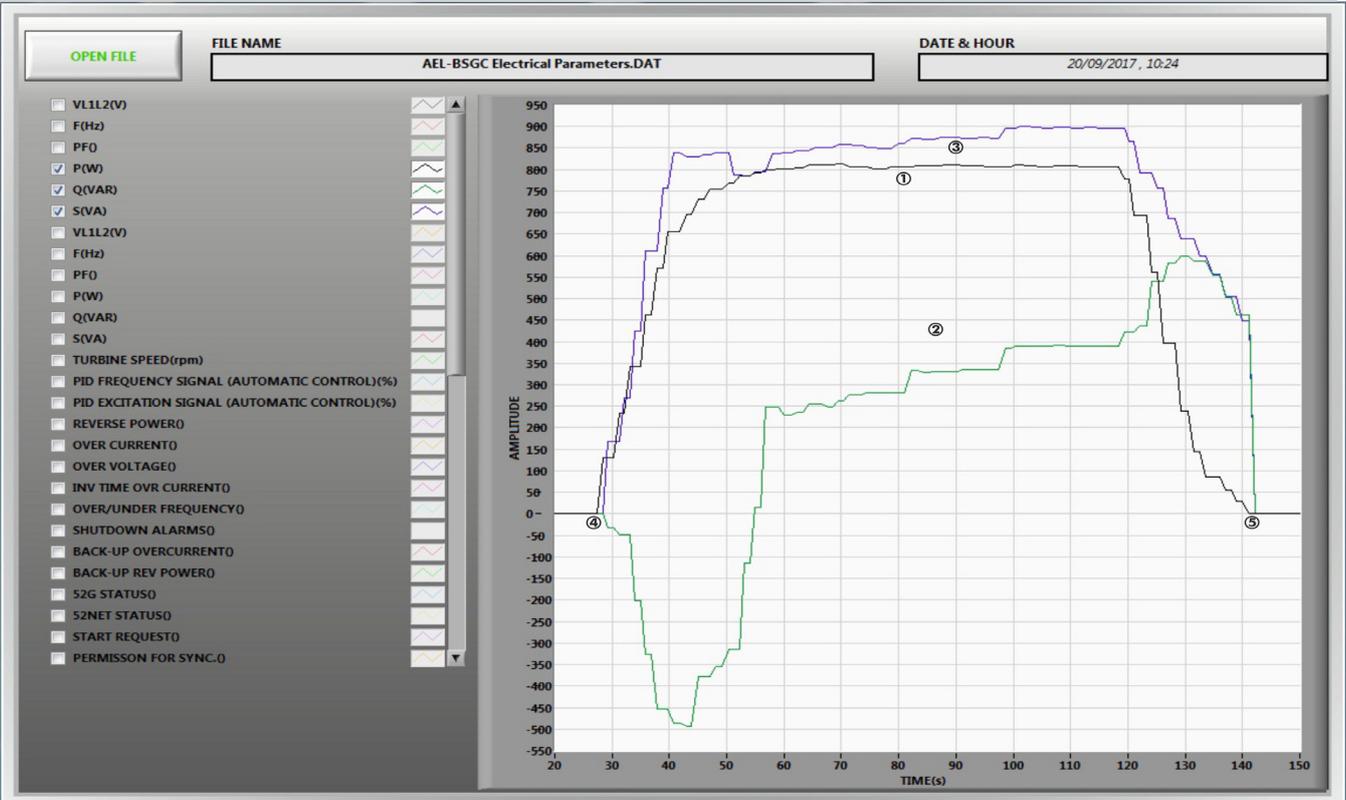
Some **real** results obtained from this Unit

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 Active power wave.
- ② Reactive power wave.
- ③ Apparent power wave.
- ④ Synchronization.
- ⑤ Uncoupling generator.

COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

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. (ICAI)
- b) Multipost Expansions options. (Mini ESN)

a) Technical and Vocational Education configuration

5) AEL-BSGC/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 6).

- 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.

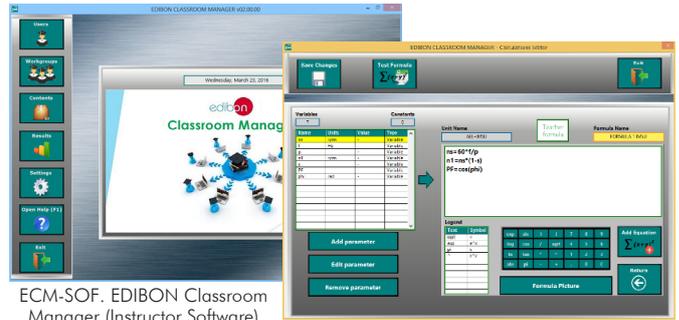
Innovative features:

- 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:

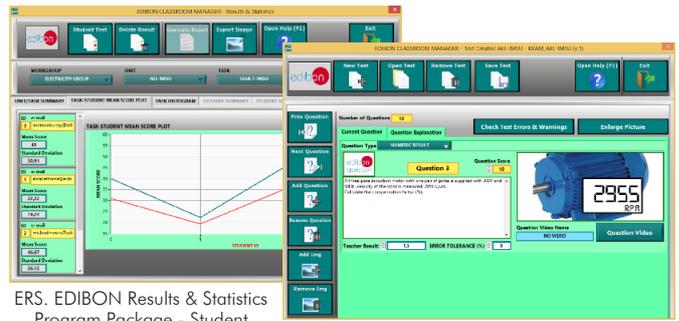
www.edibon.com/en/files/expansion/ICAI/catalog

Instructor Software



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

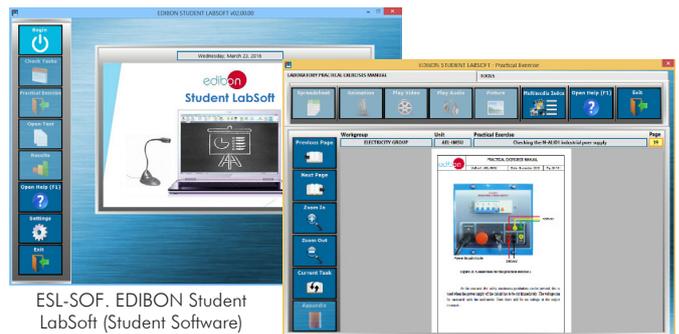
ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

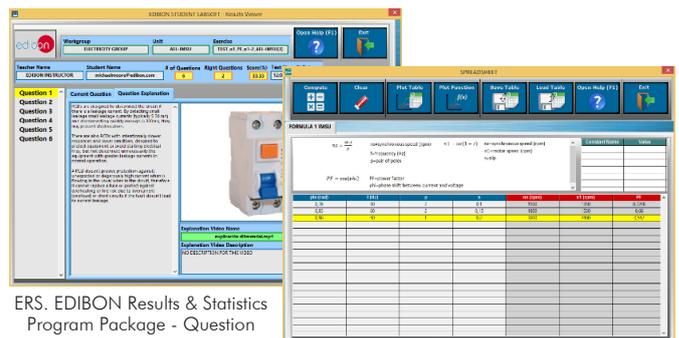
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

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

⑥ **AEL-BSGC/FSS. Faults Simulation System.**

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit. It is useful for Technical and Vocational level.

The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them. There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:

- Actuators channels interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

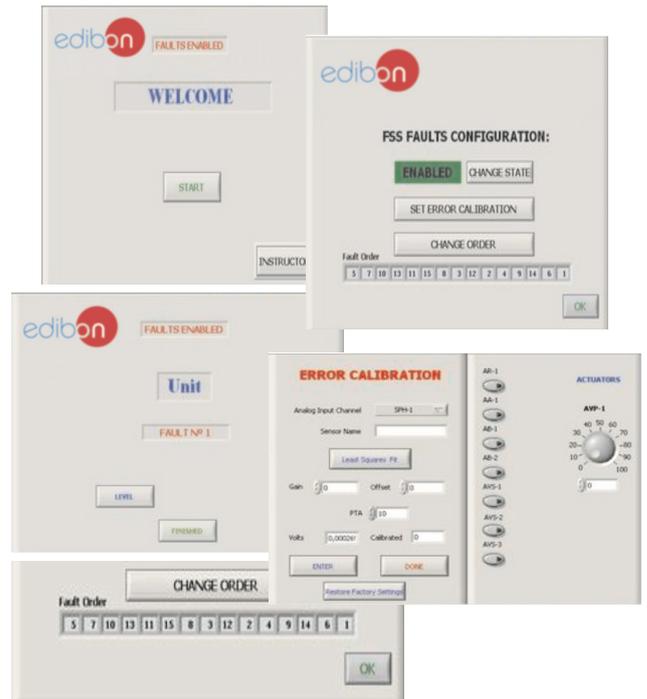
On/off faults:

- Several on/off faults can be included.

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

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

Example of some screens



b) Multipost Expansions options

⑦ **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. 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:

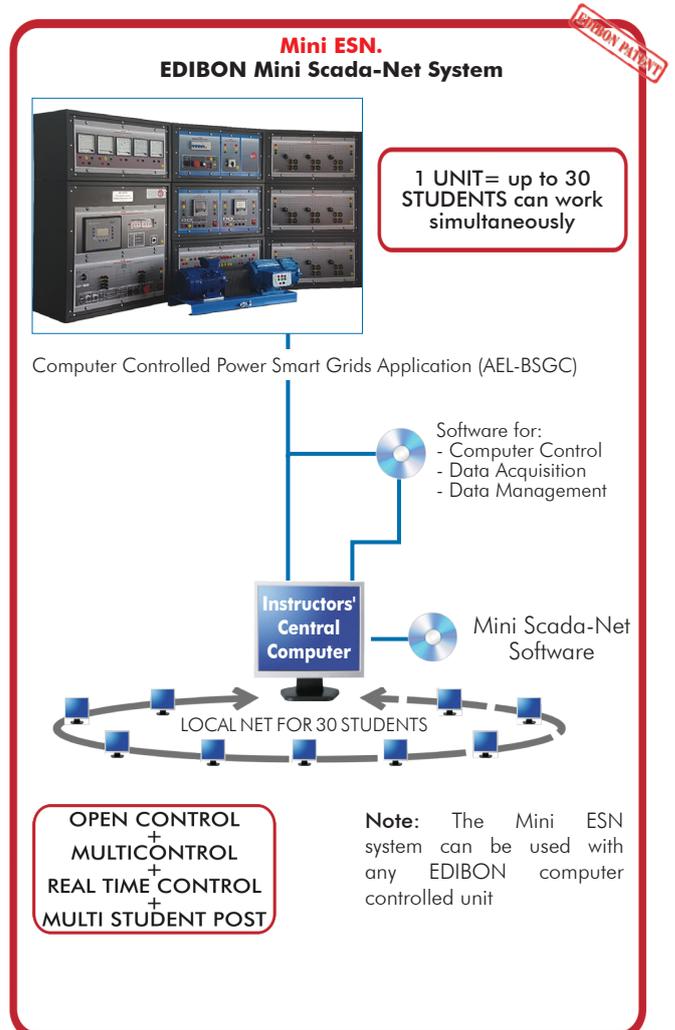
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work 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



ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

- ① **Unit: AEL-BSGC. Computer Controlled Power Smart Grids Application.**
- ② **AEL-BSGC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
- ③ **Cables and Accessories**, for normal operation.
- ④ **Manuals.**

*IMPORTANT: Under AEL-BSGC 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-BSGC/ICAI. Interactive Computer Aided Instruction Software System.
- ⑥ AEL-BSGC/FSS. Faults Simulation System.

b) Multipost Expansions options

- ⑦ Mini ESN. EDIBON Mini Scada-Net System.

① **AEL-BSGC. Application:**

The application includes the following modules:

- N-ALIO1. 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, 25 A, 300 mA AC 6 KA.
- N-PPIM1. Instrumentation Module 1.
 - Three-Phase wattmeter:
 - Measured range: 0 - 1.5 KW.
 - Three-Phase varmeter:
 - Measured range: 0 - 1.5 KVar.
 - Voltmeter:
 - Measured range: 0 - 500 V.
 - Frequency meter:
 - Measured range: 45 - 55 Hz.
 - DC meter:
 - Measured range: 0 - 10 A.
- N-PPCM1. Control and Protection of Turbine-Generator Group Module 1.
 - Automatic speed and voltage controller:
 - 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.

Tender Specifications (for main items)

- N-PSUB1. Power Generation Substation Module 1.
 - Supply voltage: 400 VAC, 3PH+N.
 - ON / OFF switch.
 - Power and signal connections:
 - 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.
- N-AE1. Transmission Lines Simulation Module.
 - Supply voltage: 400 VAC, 3PH+N.
 - Three-phase line with variable parameters.
 - Concentrated parameters line.
 - Four capacitances benches between lines with three capacitances of 1 μF each one.
 - Two capacitances benches between line and ground composed by two capacitances of 1 and 2 μF .
 - Resistance of the line that can be wiring independently:
 - Three resistors of 15 Ω .
 - Three resistors of 30 Ω .
 - Inductance of the line with several set values: 33 mH, 78 mH, 140 mH, 193 mH and 236 mH.
 - Neutral resistor of 10 Ω .
- N-EALD. Network Analyzer Unit with Computer Data Acquisition (2 units).
 - 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: 3 x10 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.
- N-MPS. Motor Protection Module.
 - ON/OFF switch.
 - Limit thermal current:
 - From 1,6 A to 2,5 A.
 - Input power terminals:
 - Power input connections: L1, L2, L3.
 - Output power terminals:
 - Power output connections: L1, L2, L3
 - Ground Terminal.
- N-REFT/3C. 3 x 300 W Three-Phase Configurable Resistors Module.
 - Configurable Star and Delta connections.
 - Three banks with three three-phase resistors of 1600 Ω .
 - Nominal voltage: 400 VAC.
 - Nominal power: 3 x (3 x 100) W.

Tender Specifications (for main items)

- N-INDT/3C. 3 x 300 VAr Three-Phase Configurable Inductances Module.
Configurable Star and Delta connection.
Three banks with three three-phase inductances of 5 H.
Nominal voltage: 400 VAC.
Nominal power: 3 x (3 x 100) VAr.
- N-CAR19T/3C. 3 x 300 VAr Three-Phase Configurable Capacitors Module.
Configurable Star and Delta connection.
Three banks with three three-phase capacitors of 2 μ F.
Nominal voltage: 400 VAC.
Nominal power: 3 x (3 x 100) VAr.
- EMT6/1K. 1 kW/1P Three-Phase Synchronous Generator.
Nominal power: 1000 VA.
Power factor: 0.8
Nominal output voltage: 3x 400 VAC.
Frequency: 50/60 Hz.
Speed: 3000 r.p.m.
Nominal output current: 0.8 A.
Nominal excitation current: 5 A.
- EMT7/1K. 1 kW/1P Asynchronous Three-Phase Motor of Squirrel Cage.
Nominal power: 1100 W.
Nominal voltage: 3 x 230/400 VAC Δ /Y.
Frequency: 50/60 Hz
Number of poles: 2.
Speed: 2730 r.p.m.
Nominal current: 2.52 / 1.45 A.
- All necessary cables to realize the practical exercises are included.

The complete unit includes as well:

- Real and complete control of a Smart-Grid.
- Power Generator, Transmission and Load consumption studies.
- Analysis of energy requirements in a Smart-Grid.
- Study of energy balance: energy production VS load consumption.
- Manual and automatic speed and excitation control of the generator-motor group.
- Synchronous generator Stand-Alone operation studies.
- Synchronous generator parallel operation studies.
- Transmission lines energy losses according to length line.
- Power factor compensation effects.
- Visualization of power generation waves through SCADA Control System.
- 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.
- 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-BSGC/CCSOF. Computer Control + Data Acquisition + Data Management Software:

- The two 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.

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.- Basic concepts of Smart Isolated Grids.
- 2.- Manual control of voltage and frequency of the generator in a Smart Stand-Alone Grid.
- 3.- Automatic control of voltage and frequency of the generator in a Smart Stand-Alone Grid.
- 4.- Study of energy requirements and energy generation in a Smart Stand-Alone Grid.
- 5.- Smart Metering of the generated and transported energy.
- 6.- Study of synchronous generator response when a resistive load variation occurs.
- 7.- Study of synchronous generator response when an inductive load variation occurs.
- 8.- Study of synchronous generator response when a capacitive load variation occurs.
- 9.- Synchronization operations with the synchronous generator and the grid.
- 10.- Study of energy losses in transmission lines.
- 11.- Representation of power generation waves through the Data Acquisition System.
- 12.- Comparison of energy losses according to the line length.
- 13.- Visualization and comparison of the reactive load curves with and without power factor compensation.
- 14.- Display of measured values of the synchronous generator.
- 15.- Display of measured values upstream and downstream of the transmission line for different line lengths and energy losses comparison.
- 16.- Plotting of measured values vs time.
- 17.- Data processing, analyzing and exporting of generation, lines and load electrical parameters.

Other possibilities to be done with this Unit:

- 18.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
 - 19.- 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.
 - 20.- The Computer Control System with SCADA allows a real industrial simulation.
 - 21.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
 - 22.- This unit can be used for doing applied research.
 - 23.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
 - 24.- Control of the AEL-BSGC unit process through the control interface box without the computer.
 - 25.- Visualization of all the sensors values used in the AEL-BSGC unit process.
- Several other exercises can be done and designed by the user.

a) Technical and Vocational Education configuration

⑤ AEL-BSGC/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.

⑥ AEL-BSGC/FSS. Faults Simulation System.

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit.

The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them.

There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:

- Actuators channels interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

On/off faults:

- Several on/off faults can be included.

b) Multipost Expansions options

⑦ **Mini ESN. EDIBON Mini Scada-Net System.**

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.



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Edition: ED01/17
Date: October/2017

REPRESENTATIVE: