EDIBON SCADA System (Supervision, Control and Data Acquisition) always included.
Smart Grid devices.
Micro-Grids.
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.

For more information about Key Features, click here
GENERAL DESCRIPTION

The Smart Grid Power System Application, with Automatic Control Generation, Transmission Line and Loads, with SCADA, “AEL-CPSS-01S”, has been designed by Edibon for the training at both the theoretical and practical levels in the field of Power Generation, Transmission, Distribution, Consumption, protections relays and Micro-Grids Power Systems.

The AEL-CPSS-01S application provides several levels of training to give the user full knowledge and experiences about the most important principles of control, operation and functioning of Generation, Transmission, Distribution and Load Consumption. For this purpose, this application includes a specific manual, which explains at theoretical level the subjects relating to high voltage power systems. The thematic of the manual covers from basic principles of functioning, control and operation of electric generators and energy transmission up to energy consumption. On the other hand, it is provided a series of modules to put into practice all theoretical concepts previously studied in this manual.

One of the advantages of this application is its modularity and flexibility. This allows carry out different real power systems configurations. For example, the user can configure the classical power system formed by “Generation + Transmission/Distribution + Consumption” or he can configure a Micro-Grid with “Generation + Consumption” working in stand-alone too. At any moment the user can synchronize the electric generator with the laboratory mains and he can develop a real energy distribution network.

In functional terms the whole system can be controlled either locally through the operation of switches, breakers and signals, and remotely through Data Acquisition and Control Software.

The AEL-CPSS-01S application includes a Data Control and Data Acquisition Software (AEL-CPSS-01S/CCSOF) for remote control of the power system. The SCADA control software allows carrying out the most important operations of real power systems such as speed and voltage control of the turbine and synchronous generator, coupling maneuvers of the generator with the mains (synchronization), stand-alone operations with the generator, loads commutation, current and voltage measurements in different points of the power system, etc.

The following is a description of the most important modules included in this application:

- Generator Protection and Control Relay Unit: it is an industrial control and protection device of power generator groups with more than 150 configurable variables. The Relay Unit provides different levels of access to be configured. For example, the user can adjust the protection thresholds of overcurrent (50/51), over/under-voltage, over/under-frequency (81), inverse power, over/underspeed of the turbine (12), number of poles of the machine, nominal power, etc. In addition, for more advanced settings, it is possible to set the PID control system parameters under different operation conditions of the turbine-generator group. For example, when the generator is working in stand-alone or in parallel operation modes are used different PIDs. During commissioning of generator the provided software allows monitoring voltage and frequency PID signals, perturbations, analysis and real time settings. During motor-generator group start-up, it is possible to monitor the PID signals, to analyze the generator disturbances and to remake real time setting adjustments through the provided relay configuration software.

- Due to the versatility of the Generator Protection and Control Relay Unit, Edibon provides configured this device to work properly from scratch with the generator-motor group. In addition, it is provided a relay setting file to restore the relay to the initial configuration. On this way, the user can change any relay parameter and recovery the initial setting.

- Automatic Voltage Regulator: this device is designed for manual and automatic control of the current excitation of the synchronous generator. The regulator has a switch that allows the user to select the control mode. If manual control mode is selected, the current excitation of the synchronous generator can be controlled manually with a potentiometer and the effects of the generator output voltage can be seen. Automatic control mode allows the Generator Protection and Control Relay Unit to take the control of the current excitation.

On this way, the user can study the operation of the complete system working autonomously, as a real power station works, or he can take the control of the installation to study the effects of the excitation change of the synchronous generator in the electrical system.

- Transmission Line Simulation Module: This module represents basic concepts of the electric energy high-voltage three-phase transmission lines operation. It consists of resistors, inductances and capacitances that can be configured to simulate different transmission lines. Each one of the phases is represented following the concentrated parameters theoretical model, through a resistance series association and inductances, along with a parallel association between each one of them in a capacitance effect. In addition this module has several switches to provoke one, two or three broken lines to study unbalance effects in the electrical system.

- Network Analyzer Unit with Data Acquisition: This device allows measuring all electrical parameters of the synchronous generator such as phase and line voltages, line currents, active, reactive and apparent powers, frequency, harmonics, etc.

- Three-Phase bank of Commutable Resistors Module: this module is designed in order to carry out local consumption of the generated energy by the synchronous generator. This module has three switches to introduce three active power consumption stages. In addition, this loads module can be controlled from the SCADA.

- Three-Phase bank of Commutable Inductances Module: this module is designed in order to carry out local consumption of the generated energy by the synchronous generator. This module has three switches to introduce three reactive power consumption stages. In addition, this loads module can be controlled from the SCADA.
General Description

- Three-Phase bank of Commutable Inductances Module: this module is designed in order to carry out local consumption of the generated energy by the synchronous generator. This module has three switches to introduce three reactive power consumption stages. In addition, this loads module can be controlled from the SCADA.
- Analog instrumentation module to measure Active and Reactive Powers, Frequency and Current excitation of the generator.
- Faults injection module: this module allows to inject different kind of faults such as single-pole short circuit, two-pole short circuit and three-pole short circuit. All these faults can be injected with and without impedance.

Example of configurations

Example of a conventional power system configuration.

Example of a Micro-Grid Configuration.
The AEL-CPSS-01S application includes the following elements:

- N-ALI01. Industrial Main Power Supply.
- N-PPIM2. Instrumentation Module 2.
- N-EALD. Network Analyzer Unit with Data Acquisition (2 units).
- N-BUS08. Distribution Busbar Module (4 units).
- TRANS3/5KRM. Three-Phase Autotransformer with Motor Voltage Regulator, 400/400VAC, 5KVA.
- TRANS3/5KGR. Grid Transformer, 400/400 VAC, 5 kVA.
- TRANS3/5KSU. Three-Phase step-up Transformer, 400/400 VAC, 5 kVA.
- N-AE1CD. Transmission Lines Simulation Digital Unit.
- GMG4.5K3PH. 4.5 kW Generator-Motor group.
- AEL-WBMP. Electrical Workbench (Mobile Small).
- AEL-WBMG. Electrical Workbench (Mobile Big).
- AEL-PC. Touch Screen and Computer.

Recommended elements:

- N-ERP-PD01. Distance Protection Relay Module.
- N-PSM. Power Switch Module.

This application 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-CPSS-01. Unit.**

   - **N-ALI01. Industrial Main Power Supply.**
     Supply voltage: 400 VAC, 3PH+N+G.
     ON-OFF removable key. 
     Output voltage connections:
     Three-Phase + Neutral: 400 VAC.
     Single-Phase: 230 VAC.
     Three-Phase supply hose with IP44 3PN+E 32A 400 V connecting plug.
     Differential magnetothermal, 4 poles, 25 A, 30 mA AC 6 KA.
     Emergency stop push button.
     GND terminal.

   - **N-PPIM2. Instrumentation Module 2.**
     Three-Phase wattmeter:
     Measured range: 0 - 5 kW.
     Three-Phase varmeter:
     Measured range: 0 - 5 kVar.
     Voltmeter:
     Measured range: 0 - 500 VAC.
     Frequency meter:
     Measured range: 45 - 55 Hz.
     DC meter:
     Measured range: 0 - 5 A.

   - **N-PPCM1. Control and Protection of Turbine-Generator Group Module 1.**
     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 (810/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 (810/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: RJ4S communication port.
• **N-PSUB3. Power Generation Substation Module 3.**
  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.

• **N-EALD. Network Analyzer Unit with Data Acquisition (2 units).**
  The network analyzer module allows fulfilling measurements, displaying and analyzing all the parameters of the AC electrical networks. It has an LCD screen and push-buttons for the navigation through the different menus. It includes specific software for monitoring current and voltage curves, harmonics display, tariffs programming, alarms programming and electrical parameters storage.
  Features:
  - Multifunctional three-phase power meter:
    - Single and three-phase voltage. Up to 690 VAC L-L.
    - Phase and line current. Current range up to 200%. Measurement from 0-10 A.
    - Active, reactive and apparent power.
    - Suitable frequencies: 25 Hz, 50 Hz, 60 Hz y 400 Hz.
    - Display of the V-I vector diagram.
  - Supply voltage: 85-265 VAC.
  - Energy quality control:
    - Current and voltage individual harmonics measurement. Up to the 40th harmonic.
    - THD voltage and current, TDD and K-factor.
    - Maximums and minimums display.
    - Waveforms display, 128 samples/sec.
  - Events and data storage.
  - Harmonics analyzer:
    - THD voltage and current, TDD current and K-factor, up to the 40th harmonic.
    - Current and voltage harmonic spectrum and angles.
  - Tariff programming:
    - Class 0.5S IEC 62053-22, active and reactive power in four quadrants.
    - Measurement of the total and per phase three-phase active, reactive and apparent powers.
    - Usage time, 4 energy/demand records of total tariffs.
    - 8 tariffs, 4 seasons, 4 types of days.
    - Automatic daily report of energy consumption maximums and minimums.
  - Communications:
    - Modbus TCP communication protocol with Ethernet interface.

• **N-BUS08. Distribution Busbar Module (4 units).**
  Supply Voltage: 230 VAC.
  Double busbar topology, with two disconnectors and one 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.

• **N-BUS09. Coupling Busbar Module.**
  Supply Voltage: 230 VAC.
  Double busbar topology, with two disconnectors and one circuit breaker. The circuit breaker open and close the circuit between the two busbars.
  Two interconnection terminals.
  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.
Complete Technical Specifications (for main items)

• **N-REG16. Voltage Regulation Module 1.**
  - 230 VAC + GND Power Supply terminals.
  - 24 VDC output terminal.
  - 24 VDC input terminal (up voltage).
  - 24 VDC input terminal (down voltage).
  - Slide commutator with three positions.
  - Power connector.
  - Signal connector.
  - Fuses: 3 x 10 A.
  - Input power terminals:
    - Power input connections: L1, L2, L3, N.
  - Output power terminals:
    - Power output connections: L1, L2, L3, N.
  - Ground Terminal.

• **TRANS3/5KRM. Three-Phase Autotransformer with Motor Voltage Regulator, 400/400 VAC, 5 kVA.**
  - 5 KVA distribution autotransformer.
  - Rated power: 5 KVA.
  - Voltage in primary winding: 400 VAC star.
  - Voltage in secondary winding: 400 VAC delta.
  - Signal connection to receive step up and down signals from the voltage regulator module.

• **TRANS3/5KGR. Grid Transformer, 400/400 VAC, 5 kVA.**
  - 5KVA Three-Phase Grid transformer.
  - Rated Power: 5 KVA.
  - Rated Primary Voltage: 400 VAC Star.
  - Rated Secondary Voltage: 400 VAC Delta.

• **TRANS3/5KSU. Three-Phase step-up Transformer, 400/400 VAC, 5 kVA.**
  - 5KVA Step-Up transformer.
  - Rated Power: 5 KVA.
  - Rated Primary Voltage: 400 VAC Star.
  - Rated Secondary Voltage: 400 VAC Delta.

• **N-ERP-MF01. Digital Fault Simulator Module.**
  - Enables injecting one, two or three pole different faults at the desired location through fault and line terminals.
  - Supply voltage: 230 VAC.
  - Trip time potentiometer.
  - Ethernet connection: Two communication ports for SCADA remote control.

• **N-AE1CD. Transmission Lines Simulation Digital Unit.**
  - Power supply voltage: 230 VAC + GND.
  - Line Voltages: 400 VAC + N.
  - Three-phase line with variable parameters.
  - Concentrated parameters line.
  - Two capacitances Banks between line and ground composed by three capacitances of 2 µF.
  - Resistance of the line that can be wired independently:
    - One resistor of 15 Ω.
    - One resistor of 33 Ω.
  - Inductance of the line with several values: 32 mH, 72 mH.
  - Neutral resistor of 15 Ω.
  - Fuse: 1 A.

• **N-CAR35T3D. Three-phase Digital Bank of Commutable Resistors Module.**
  - Configurable Star and Delta connections.
  - Three banks with three-phase resistors of 1600 Ω each one.
  - Nominal voltage: 400 VAC.
  - Nominal power: 3 x (3 x 300) W.
  - Digital bank of commutable resistors module.

• **N-CAR36T3D. Three-phase Digital Bank of Commutable Inductances Module.**
  - Configurable Star and Delta connection.
  - Three Banks with three-phase inductances of 5 H each one.
  - Nominal voltage: 400 VAC.
  - Nominal power: 3 x (3x300) VAr.

• **N-CAR19T3D. Three-phase Digital Bank of Commutable Capacitors Module.**
  - Configurable Star and Delta connection.
  - Three Banks with three-phase capacitors of 2 µF each one.
  - Nominal voltage: 400 VAC.
  - Nominal power: 3 x (3 x 300) VAr.
• GMG4.5K3PH. 4.5 KW Generator-Motor group.
  Generator-Motor group coupled in an aluminum frame with wheels.
  Rated power of the generator: 4.5 KVA.
  Stator nominal: 6.5 A.
  Excitation nominal: 4 A.
  RPM: 3000 rpm.
  Motor rated power I: 5 KVA.
  Nominal I: 7.2 A.

• AEL-WBMP. Electrical Workbench (Mobile Small).

• AEL-WBMG. Electrical Workbench (Mobile Big).

• AEL-PC. Touch Screen and Computer.
  Touch Screen:
  - Energy efficiency class: A.
  - Screen diagonal: 68.6 cm (27 inch [s]).
  - Power consumption (operating): 26 watts.
  - Annual energy consumption: 38 kWh.
  - Power consumption (standby / off): 0.49 watts.
  - Screen resolution: 1920 x 1080 pixels.
  Computer:
  - Processor Number: Intel Core i7-6600U Processor (4M Cache, up to 3,40 GHz).
  - Cache: 4 MB Intel Smart Cache.
  - Clock speed: 2.6 GHz.
  - # Of Cores/# of Threads: 2/4.
  - Max. TDP/Power: 15 W.
  - Memory Types: DDR4-2133, LPDDR3-1866, DDR3L-1600.

• N-ERP-MA01. Feeder Management Relay Module.
  This protection relay is used to test different short circuits in any point of the power system.
  This protection relay allows investigations into protection and monitoring of overhead lines, underground cables and feeders.
  The connections are via safety sockets.
  The main functions:
  - Four levels of Phase Instantaneous Overcurrent Element (50P).
  - Four levels of Negative-Sequence Overcurrent Element (50Q).
  - Four levels of Residual Overcurrent Element (50G).
  - Four levels of Neutral Overcurrent Element (50G).
  - Two levels of Phase Time-Overcurrent Element (51P).
  - Two levels of Residual Time-Overcurrent Element (51G).
  - Two levels of Ground Time-Overcurrent Element (51G).
  - One level of Negative-Sequence Time-Overcurrent Element (51Q).
  - Phase to Ground Overvoltage (59G).
  - Phase to Phase Overvoltage (59P).
  - Negative-Sequence Overvoltage (59Q).
  - Residual Overvoltage (59G).
  - Phase to Ground Undervoltage (27G).
  - Phase to Phase Undervoltage (27P).
  - Six levels of Secure Overfrequency (81O).
  - Six levels of Secure Underfrequency (81U).
  - Two levels of Negative Power Flow with Definite Time Delay (32).
  - Two levels of Positive Power Flow with Definite Time Delay (32).
  - Station Battery Monitor.
  - Breaker Wear Monitoring.
  - Synchronphasor Protocol.
  - Peak Demand and Demand Metering.
  - Auto-Reclosing.
  - Creating fault and disturbance records.
  The connection to the experimental circuit is via current transformers with ratio to suit the inputs of the relay.
  It allows an effective demonstration of the effect of current and voltage transformer ratio, connection and rating on protective relays.
  - Accuracy: +/- 10%. Current: 5 A (A. C.). Frequency: 50 or 60 Hz.
  - Operating time: typically 10 ms to 25 ms.
• **N-ERP-PD01. Distance Protection Relay Module.**

It is used to enable investigations into protection and monitoring of overhead transmission lines and underground cables. It enables a wide range of test and investigations and it demonstrates the latest relay technology.

Modern industrial application distance protection relay presented in an educational and teaching format.

The connections are via safety sockets.

The main functions:

- Two zones of Phase Mho Distance Protection Element (21P).
- Two zones of Ground Mho Distance Protection Element (21G).
- Directional Phase Overcurrent Protection Element (67P).
- Directional Ground Overcurrent Protection Element (67G).
- Phase Overcurrent Protection Element (50P).
- Ground Overcurrent Protection Element (50G).
- Phase Time-Overcurrent Protection Element (51P).
- Ground Time-Overcurrent Protection Element (51G).
- Event Reports.
- Breaker Wear Monitor.
- Fault Locator.
- Local Display.
- Synchronophasors.
- Load Encroachment.
- Metering and Monitoring Functions.
- Creating fault and disturbance records.
- Blocking of any one protection element.

The connection to the experimental circuit is via current transformers with ratio to suit the inputs of the relay.

It allows an effective demonstration of the effect of current and voltage transformer ratio, connection and rating on protective relays.

- **Accuracy:** +/− 10%.
- **Current:** 5 A (A. C.). **Frequency:** 50 or 60 Hz.
- **Operating time:** typically 10 ms to 25 ms.

• **N-ERP-SFT01. Overcurrent and Earth Fault Protection Relay Module.**

Overcurrent protection relay module.

- **Power supply:** 230 VAC.
- **TRIP indicator lamps.**
- **Overcurrent and Earth fault protection.**
- **Communications connector** DB9 RS-232.
- **Signals connector** SUB-D 62 pin.
- **ON-OFF Switch.**
- **Terminal connections.**

Characteristics:

- Phase, ground and negative sequence overcurrent protection.
- Time-Overcurrent curves of US and IEC.
- Reclosing relays of multiple trips with sequence coordination.
- SELOGIC® enhanced control equations to develop traditional or advanced schemes.
- Logic of local / remote control to change the schemes, operating circuit breakers, etc.
- Recorder of the sequence of events (SER) and reports of events stored in nonvolatile memory.
- Supports ASCII, SEL LMD, and Modbus RTU protocols.
• **N-PSM. Power Switch Module.**
  
  Supply voltage: single-phase 230 VAC.
  
  Power terminals:
  - Four power input terminals (3PH+N).
  - Four power output terminals (3PH+N).
  
  Auxiliary contacts:
  - One “NO” contact.
  - One “NC” contact.
  
  Two push-buttons to open / close the power terminals and auxiliary contacts.
  
  Two control contacts of 24 VDC.
  
  Two voltage supply outputs of 24 VDC.

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

  The complete unit includes as well:

  EDIBON SCADA System (Supervision, Control and Data Acquisition) always included.
  
  Smart Grid devices.
  
  Micro-Grids.
  
  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.

**AEL-CPSS-01S/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.

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

**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-CPSS-01S + AEL-CPSS-01S/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.- Study of generation, transmission and distribution power systems.
2.- Analysis of the measurements of the power flows of the synchronous generator, transmission lines and loads.
3.- Analysis of the active and reactive power of the synchronous generator against load variations.
4.- Automatic synchronization maneuvers of synchronous generator with the mains.
5.- Study of the synchronous generator in island operation mode.
6.- Study of the Micro-Grids.
7.- Study of the synchronous generator in grid parallel operation mode.
8.- Study of excitation/voltage regulation of synchronous generator in island mode.
9.- Study of turbine regulation (frequency control) in island mode.
10.- Study of excitation/voltage regulation of synchronous generator in parallel grid operation mode.
11.- Study of turbine regulation (frequency control) in parallel grid operation mode.
12.- Study of the power factor regulation of synchronous generator in parallel grid operation mode.
13.- Analysis and calculus of energy losses in transmission line according to the line electrical parameters.
14.- Capacitive effect influence in transmission lines.
15.- Analysis of the reactive energy excess in transmission lines.
16.- Analysis of the influence of one or more line losses in the electric system.
17.- Power factor compensation and the effects in the power system.
18.- Single-Pole, Two-Pole and three-Pole faults with and without impedance.
19.- Double busbar coupling maneuver.
20.- Operation logic with circuit breakers and disconnectors in a double busbar substation.
21.- Load sharing with different feeders.
22.- Busbar changeover without interruption.
Some practical exercises possibilities with the SCADA:
23.- Remotely control of generation power systems.
24.- Analysis with the SCADA software of synchronous generator power flows.
25.- Analysis with SCADA software of active and synchronous generator power flows.
26.- Remotely control of manual synchronization of synchronous generator with the mains.
27.- Remotely control of automatic synchronization of synchronous generator with the mains.
28.- Remotely control of synchronous generator in island grid operation mode.
29.- Study of Micro-Grids.
30.- Remotely control of synchronous generator in parallel grid operation mode.
31.- Remotely control of excitation/voltage regulation of synchronous generator in island mode.
Other possibilities to be done with this Unit:
32.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
33.- The Computer Control System with SCADA allows a real industrial simulation.
34.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
35.- This unit can be used for doing applied research.
36.- 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, 380 VAC - 400 VAC/50 Hz o 190 VAC-240/60 Hz, 5 kW.
- Computer.

DIMENSIONS AND WEIGHTS

AEL-CPSS-01S:
- Dimensions: 2000 x 400 x 3000 mm approx.
  (78.74 x 15.75 x 118.10 inches approx.)
- Weight: 200 Kg approx.
  (440 pounds approx.)

AVAILABLE VERSIONS

Offered in this catalogue:
- AEL-CPSS-01S. Smart Grid Power Systems Application, with Automatic Control Generation, Transmission Line and Loads, with SCADA.

Offered in other catalogue:
- AEL-CPSS-02S. Smart Micro-Grids Power Systems Application, with Automatic Control Generation and Loads, with SCADA.
- AEL-CPSS-03S. Smart Grid Power Systems Application, with Two Parallel Generators, Two Distribution Lines and Loads, with SCADA.
SCADA
Main screen

1. Navigation menu and save data button.
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.
**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.

![Diagram of the transmission line.](image)

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.

**Power distribution substation menu.** This screen shows a power distribution system diagram with double bus bar topology. This menu allows carry out all maneuvers relating to these type of power substations, such as coupling bus bars, opening and closing logic of disconnectors and breakers, etc.

![Power distribution substation diagram.](image)

1. Navigation menu and save data button.
2. **AC analyzers palette** for power distribution substation electrical measurements.
3. Power distribution substation diagram. It has the conjunction of lamps which indicate the disconnectors and breakers state.
4. Power distribution substation control panel. It has de function of opening and closing of controlling disconnectors and breakers.
Software Main Screen

**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.
**SOME REAL RESULTS OBTAINED FROM THIS APPLICATION**

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.**

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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.
4. Synchronization.
5. Uncoupling generator.
Some real results obtained from this Application

This picture shows the generator starting, as well as the voltage and frequency 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.
Some **real** results obtained from this Application

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. Finally, 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.
Some **real** results obtained from this Application

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

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


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 Workgroups, Tasks 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:
**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:


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

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

**Main items** (always included in the supply)

Minimum supply always includes:

1. **Unit**: AEL-CPSS-01S. Smart Grid Power Systems Application, with Automatic Control Generation, Transmission Line and Loads, with SCADA.
2. AEL-CPSS-01S/CCSOF. Computer Control + Data Acquisition + Data Management Software.
3. **Cables and Accessories**, for normal operation.
4. **Manuals**.

*IMPORTANT*: Under AEL-CPSS-01S we always supply all the elements for immediate running as 1, 2, 3 and 4.

**Optional items** (supplied under specific order)

1. **Technical and Vocational configuration**

2. **Multiprot Expansions options**
   - Mini ESN. EDIBON Mini Scada-Net System.
   - ESN. EDIBON Scada-Net System.
AEL-CPSS-01. Unit.

- **N-AUD1. Industrial Main Power Supply.**
  - Supply voltage: 400 VAC, 3PH+N+G.
  - ON-OFF removable key.
  - Output voltage connections:
    - Three-Phase + Neutral: 400 VAC.
    - Single-Phase: 230 VAC.
  - Three-Phase supply hose with IP44 3PN+E 32A 400 V connecting plug.
  - Differential magnetothermal, 4 poles, 25 A, 300 mA AC 6 KA.
  - Emergency stop push button.

- **N-PPIM2. Instrumentation Module 2.**
  - Three-Phase wattmeter:
    - Measured range: 0 - 5 kW.
  - Three-Phase varmeter:
    - Measured range: 0 - 5 kVar.
  - Voltmeter:
    - Measured range: 0 - 500 VAC.
  - Frequency meter:
    - Measured range: 45 - 55 Hz.
  - DC meter:
    - Measured range: 0 - 5 A.

- **N-PPCM1. Control and Protection of Turbine-Generator Group Module 1.**
  - 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 (5DN/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-PSUB3. Power Generation Substation Module 3.**
  - 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.
Tender Specifications (for main items)

- **N-EALD. Network Analyzer Unit with Data Acquisition** (2 units).
  
  The network analyzer module allows fulfilling measurements, displaying and analyzing all the parameters of the AC electrical networks. It has an LCD screen and push-buttons for the navigation through the different menus. It includes specific software for monitoring current and voltage curves, harmonics display, tariffs programming, alarms programming and electrical parameters storage.

  **Features:**
  
  Multifunctional three-phase power meter:
  - Single and three-phase voltage. Up to 690 VAC L-L.
  - Phase and line current. Current range up to 200%. Measurement from 0-10 A.
  - Active, reactive and apparent power.
  - Suitable frequencies: 25 Hz, 50 Hz, 60 Hz y 400 Hz.
  - Display of the V-I vector diagram.
  - Supply voltage: 85-265 VAC.

  **Energy quality control:**
  - Current and voltage individual harmonics measurement. Up to the 40th harmonic.
  - THD voltage and current, TDD and K-factor.
  - Maximums and minimums display.
  - Waveforms display, 128 samples/sec.

  **Events and data storage.**

  **Harmonics analyzer:**
  - THD voltage and current, TDD current and K-factor, up to the 40th harmonic.
  - Current and voltage harmonic spectrum and angles.

  **Tariff programming:**
  - Class 0.5S IEC 62053-22, active and reactive power in four quadrants.
  - Measurement of the total and per phase three-phase active, reactive and apparent powers.
  - Usage time, 4 energy/demand records of total tariffs.
  - 8 tariffs, 4 seasons, 4 types of days.
  - Automatic daily report of energy consumption maximums and minimums.

  **Communications:**
  - Modbus TCP communication protocol with Ethernet interface.

- **N-BUS08. Distribution Busbar Module** (4 units).
  
  Supply Voltage: 230 VAC.

  Double busbar topology, with two disconnectors and one 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.

- **N-BUS09. Coupling Busbar Module.**
  
  Supply Voltage: 230 VAC.

  Double busbar topology, with two disconnectors and one circuit breaker. The circuit breaker open and close the circuit between the two busbars.

  Two interconnection terminals.

  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.

- **N-REG16. Voltage Regulation Module 1.**
  
  230 VAC+GND Power Supply terminals.

  24 VDC output terminal.

  24 VDC input terminal (up voltage).

  24 VDC input terminal (down voltage).

  Slide commutator with three positions.

  Power connector.

  Signal connector.

  Fuses: 3 x 10 A.

  Input power terminals:
  - Power input connections: L1, L2, L3, N.

  Output power terminals:
  - Power output connections: L1, L2, L3, N.

  Ground Terminal.

- **TRANS3/5KRM. Three-Phase Autotransformer with Motor Voltage Regulator, 400/400 VAC, 5 kVA.**
  
  5 KVA distribution autotransformer.

  Rated power: 5 kVA.

  Voltage in primary winding: 400 VAC star.

  Voltage in secondary winding: 400 VAC delta.

  Signal connection to receive step up and down signals from the voltage regulator module.

- **TRANS3/5KGR. Grid Transformer, 400/400 VAC, 5 kVA.**
  
  5 kVA Three-Phase Grid transformer.

  Rated Power: 5 KVA.

  Rated Primary Voltage: 400 VAC Star.

  Rated Secondary Voltage: 400 VAC Delta.

- **TRANS3/5KSU. Three-Phase step-up Transformer, 400/400 VAC, 5 kVA.**
  
  5 kVA Step-Up transformer.

  Rated Power: 5 KVA.

  Rated Primary Voltage: 400 VAC Star.

  Rated Secondary Voltage: 400 VAC Delta.
Tender Specifications (for main items)

- **N-ERP-MF01. Digital Fault Simulator Module.**
  Enables injecting one, two or three pole different faults at the desired location through fault and line terminals.
  Supply voltage: 230 VAC.
  Trip time potentiometer.
  Ethernet connection: Two communication ports for SCADA remote control.

- **N-AE1CD. Transmission Lines Simulation Digital Unit.**
  Power supply voltage: 230 VAC + GND.
  Line Voltages: 400 VAC + N.
  Three-phase line with variable parameters.
  Concentrated parameters line.
  Two capacitances Banks between line and ground composed by three capacitances of 2 µF.
  Resistance of the line that can be wired independently:
    - One resistor of 15 Ω.
    - One resistor of 33 Ω.
  Inductance of the line with several values: 32 mH, 72 mH.
  Neutral resistor of 15 Ω.
  Fuse: 1 A.

- **N-CAR3ST3D. Three-phase Digital Bank of Commutable Resistors Module.**
  Configurable Star and Delta connections.
  Three banks with three-phase resistors of 1600 Ω each one.
  Nominal voltage: 400 VAC.
  Nominal power: 3 x (3 x 300) W.

- **N-CAR36T3D. Three-phase Digital Bank of Commutable Inductances Module.**
  Configurable Star and Delta connection.
  Three Banks with three-phase inductances of 5 H each one.
  Nominal voltage: 400 VAC.
  Nominal power: 3 x (3x300) VAr.

- **N-CAR19T3D. Three-phase Digital Bank of Commutable Capacitors Module.**
  Configurable Star and Delta connection.
  Three Banks with three-phase capacitors of 2 µF each one.
  Nominal voltage: 400 VAC.
  Nominal power: 3 x (3 x 300) VAr.

- **GMG4.5K3PH. 4.5 KW Generator-Motor group.**
  Generator-Motor group coupled in an aluminum frame with wheels.
  Rated power of the generator: 4.5 KVA.
  Stator nominal: 6.5 A.
  Excitation nominal: 4 A.
  RPM: 3000 rpm.
  Motor rated power: 5 KVA.
  Nominal I: 7.2 A.

- **AEL-WBMP. Electrical Workbench (Mobile Small).**

- **AEL-WBMB. Electrical Workbench (Mobile Big).**

- **AEL-PC. Touch Screen and Computer.**
  Touch Screen:
    - Energy efficiency class: A.
    - Screen diagonal: 68.6 cm (27 inch (s)).
    - Power consumption (operating): 26 watts.
    - Annual energy consumption: 38 kWh.
    - Power consumption (standby / off): 0.49 watts.
    - Screen resolution: 1920 x 1080 pixels.
  Computer:
    - Processor Number: Intel Core i7-6600U Processor (4M Cache, up to 3.40 GHz).
    - Cache: 4 MB Intel Smart Cache.
    - Clock speed: 2.6 GHz.
    - # Of Cores/# of Threads: 2/4.
    - Max. TDP/Power: 15 W.
    - Memory Types: DDR4-2133, LPDDR3-1866, DDR3L-1600.

- **N-ERP-MA01. Feeder Management Relay Module.**
  This protection relay is used to test different short circuits in any point of the power system. This protection relay allows investigations into protection and monitoring of overhead lines, underground cables and feeders.
  The connections are via safety sockets.
  The main functions:
    - Four levels of Phase Instantaneous Overcurrent Element (50P).
    - Four levels of Negative-Sequence Overcurrent Element (50Q).
    - Four levels of Residual Overcurrent Element (50G).
    - Four levels of Neutral Overcurrent Element (50C).
    - Two levels of Phase Time-Overcurrent Element (51P).
    - Two levels of Residual Time-Overcurrent Element (51G).
    - Two levels of Ground Time-Overcurrent Element (51G).
    - One level of Negative-Sequence Time-Overcurrent Element (51Q).
    - Phase to Ground Overvoltage (59G).
    - Phase to Phase Overvoltage (59P).
    - Negative-Sequence Overvoltage (59Q).
    - Residual Overvoltage (59G).
    - Phase to Ground Undervoltage (27G).
    - Phase to Phase Undervoltage (27P).
    - Six levels of Secure Overfrequency (81O).
    - Six levels of Secure Underfrequency (81U).
    - Two levels of Negative Power Flow with Definite Time Delay (32).
    - Two levels of Positive Power Flow with Definite Time Delay (32).
    - Station Battery Monitor.
    - Breaker Wear Monitoring.
    - Synchronphasor Protocol.
    - Peak Demand and Demand Metering.
    - Auto-Recl osing.
  Creating fault and disturbance records.

  The connection to the experimental circuit is via current transformers with ratio to suit the inputs of the relay.
  It allows an effective demonstration of the effect of current and voltage transformer ratio, connection and rating on protective relays.
  Accuracy: ± 10%.
  Current: 5 A (A. C.).
  Frequency: 50 or 60 Hz.
  Operating time: typically 10 ms to 25 ms.
N-ERP-PD01. Distance Protection Relay Module.
It is used to enable investigations into protection and monitoring of overhead transmission lines and underground cables. It enables a wide range of test and investigations and it demonstrates the latest relay technology.
Modern industrial application distance protection relay presented in an educational and teaching format.
The connections are via safety sockets.
The main functions:
- Two zones of Phase Mho Distance Protection Element (21P).
- Two zones of Ground Mho Distance Protection Element (21G).
- Directional Phase Overcurrent Protection Element (67P).
- Directional Ground Overcurrent Protection Element (67G).
- Phase Overcurrent Protection Element (50P).
- Ground Overcurrent Protection Element (50G).
- Phase Time-Overcurrent Protection Element (51P).
- Ground Time-Overcurrent Protection Element (51G).
- Event Reports.
- Breaker Wear Monitor.
- Fault Locator.
- Local Display.
- Synchronophasors.
- Load Encroachment.
- Metering and Monitoring Functions.
- Creating fault and disturbance records.
- Blocking of any one protection element.
The connection to the experimental circuit is via current transformers with ratio to suit the inputs of the relay.
Accuracy: ± 10%.
Current: 5 A (A.C.).
Frequency: 50 or 60 Hz.
Operating time: typically 10 ms to 25 ms.

N-ERP-SFT01. Overcurrent and Earth Fault Protection Relay Module.
Overcurrent protection relay module.
Power supply: 230 VAC.
TRIP indicator lamps.
Overcurrent and Earth fault protection.
Communications connector DB9 RS-232.
Signals connector SUB-D 62 pin.
ON-OFF Switch.
Terminal connections.
Characteristics:
- Phase, ground and negative sequence overcurrent protection.
- Time-Overcurrent curves of US and IEC.
- Reclosing relays of multiple trips with sequence coordination.
- SELOGIC® enhanced control equations to develop traditional or advanced schemes.
- Logic of local / remote control to change the schemes, operating circuit breakers, etc.
- Recorder of the sequence of events (SER) and reports of events stored in nonvolatile memory.
- Supports ASCII, SEL LMD, and Modbus RTU protocols.

N-PSM. Power Switch Module.
Supply voltage: single-phase 230 VAC.
Power terminals:
- Four power input terminals (3PH+N).
- Four power output terminals (3PH+N).
Auxiliary contacts:
- One "NO" contact.
- One "NC" contact.
- Two push-buttons to open / close the power terminals and auxiliary contacts.
- Two control contacts of 24 VDC.
- Two voltage supply outputs of 24 VDC.

All necessary cables to realize the practical exercises are included.
The complete unit includes as well:
- EDIBON SCADA System (Supervision, Control and Data Acquisition) always included. Smart Grid devices.
  - Micro-Grids.
  - 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 Scado-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.
AEL-CPSS-01S/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.

Cables and Accessories, for normal operation.

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.- Study of generation, transmission and distribution power systems.
2.- Analysis of the measurements of the power flows of the synchronous generator, transmission lines and loads.
3.- Analysis of the active and reactive power of the synchronous generator against load variations.
4.- Automatic synchronization maneuvers of synchronous generator with the mains.
5.- Study of the synchronous generator in island operation mode.
6.- Study of the Micro-Grids.
7.- Study of the synchronous generator in grid parallel operation mode.
8.- Study of excitation/voltage regulation of synchronous generator in island mode.
9.- Study of turbine regulation (frequency control) in island mode.
10.- Study of excitation/voltage regulation of synchronous generator in parallel grid operation mode.
11.- Study of turbine regulation (frequency control) in parallel grid operation mode.
12.- Study of the power factor regulation of synchronous generator in parallel grid operation mode.
13.- Analysis and calculus of energy loses in transmission line according to the line electrical parameters.
14.- Capacitive effect influence in transmission lines.
15.- Analysis of the reactive energy excess in transmission lines.
16.- Analysis of the influence of one or more line losses in the electric system.
17.- Power factor compensation and the effects in the power system.
18.- Single-Pole, Two-Pole and three-Pole faults with and without impedance.
19.- Double busbar coupling maneuver.
20.- Operation logic with circuit breakers and disconnectors in a double busbar substation.
21.- Load sharing with different feeders.
22.- Busbar changeover without interruption.

Some practical exercises possibilities with the SCADA:
23.- Remotely control of generation power systems.
24.- Analysis with the SCADA software of synchronous generator power flows.
25.- Analysis with SCADA software of active and reactive power of synchronous generator.
26.- Remotely control of manual synchronization of synchronous generator with the mains.
27.- Remotely control of automatic synchronization of synchronous generator with the mains.
28.- Remotely control of synchronous generator in island grid operation mode.
29.- Study of Micro-Grids.
30.- Remotely control of synchronous generator in parallel grid operation mode.
31.- Remotely control of excitation/voltage regulation of synchronous generator in island mode.

Other possibilities to be done with this Unit:
32.- Many students view results simultaneously.
   To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
33.- The Computer Control System with SCADA allows a real industrial simulation.
34.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
35.- This unit can be used for doing applied research.
36.- 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.
b) Multipost Expansions options

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.