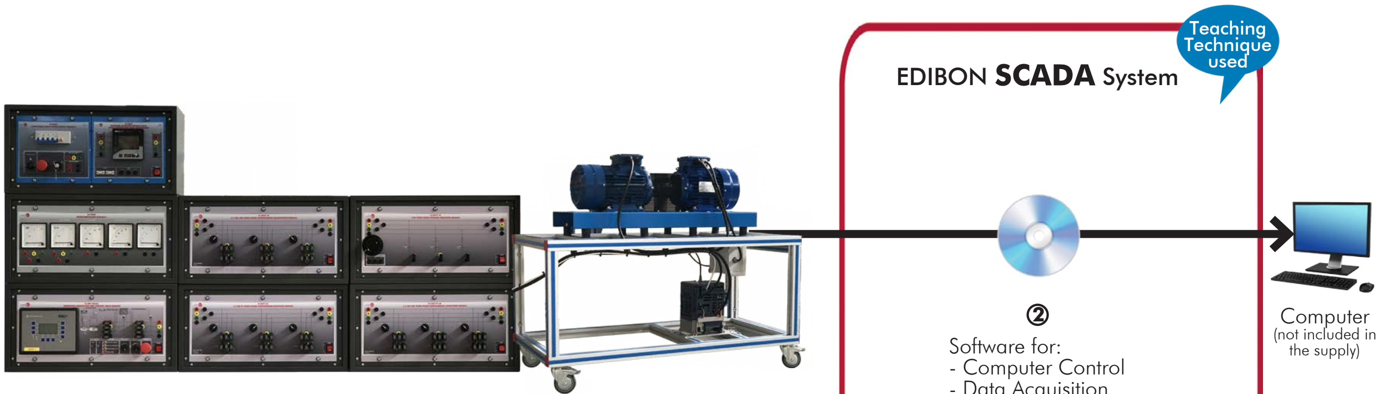
Engineering and Technical Teaching Equipment

Computer Controlled **Wind Power Plants Application with Induction Generator,** with SCADA

AEL-WPPIC



① Unit: AEL-WPPIC. Computer Controlled Wind Power Plants Application with Induction Generator

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

Key features:

- **Advanced Real-Time SCADA.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON Control Software based on LabVIEW.**
- **National Instruments Data Acquisition board (250 KS/s, kilo samples per second).**
- **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**
- **Capable of doing applied research, real industrial simulation, training courses, etc.**
- **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**
- **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**
- **Designed and manufactured under several quality standards.**
- **Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.**
- **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

POWERED BY NATIONAL INSTRUMENTS LabVIEW™

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PRODUCTOS
2.- ELECTRÓNICA,
5.- ENERGÍA Y
6.- MECATRÓNICA, AUTOMATIZACIÓN Y COMPUMECATRÓNICA

For more information about Key Features, click here

Certificate of Approval of the Quality Management System (LRQA CERTIFIED ISO 9001)

European Union Certificate (total safety)

UL and CSA Regulations (All our products are manufactured according to current UL and CSA regulations)

Certificate of Approval of the Environmental Management System (LRQA CERTIFIED ISO 14001)

Worlddidac Association Certificate of Membership

INTRODUCTION

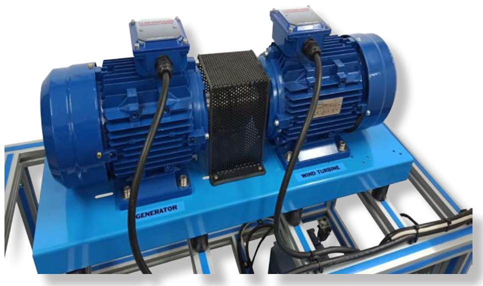
Wind energy has become a key source of electricity generation for the change to a more clean and sustainable energy model. The solution of asynchronous generators for wind turbines, whether in weak or strong grids, is the most widespread due to its reliability and simple operation, maintenance and cost.

GENERAL DESCRIPTION

The Computer Controlled Wind Power Plants Application with Induction Generator, "AEL-WPPIC", has been designed by EDIBON to study of the main characteristics and behavior of the induction generators used in wind turbines which inject the generated power into the grid.

Automatic voltage and speed controller (AVR, ASC) detail

The "AEL-WPPIC" application allows the user to become familiar with the electrical scheme and the operating characteristics of wind turbines which use squirrel cage rotor three-phase generators in wind power plants connected to the main grid. For this, the application includes a squirrel cage induction generator coupled to a three-phase motor (turbine), whose speed is controlled through a variable frequency drive. This application allows simulating different wind conditions and the drive train of a wind turbine. It also includes a module with a turbine controller for the automatic control of the turbine-generator group electrical parameters and speed, as well as for the carrying out the automatic synchronization process of the three-phase induction generator with the grid. This control module is at the same time an advanced protection for generators and turbines. It meets the ANSI standards regarding the protection parameters for generators and turbines (ANSI 81O, ANSI 81U, ANSI 59, ANSI 27, ANSI 50/51, ANSI 32R/F, ANSI IOP 32, ANSI MOP 32, ANSI 46, voltage asymmetry, generator ground fault, phase rotation, generator lagging power factor, among others). In addition, it is included a three-phase capacitors bank which will generate the required reactive energy so that the induction generator do not consume it from the grid and a network analyzer to monitor the generation electrical parameters.



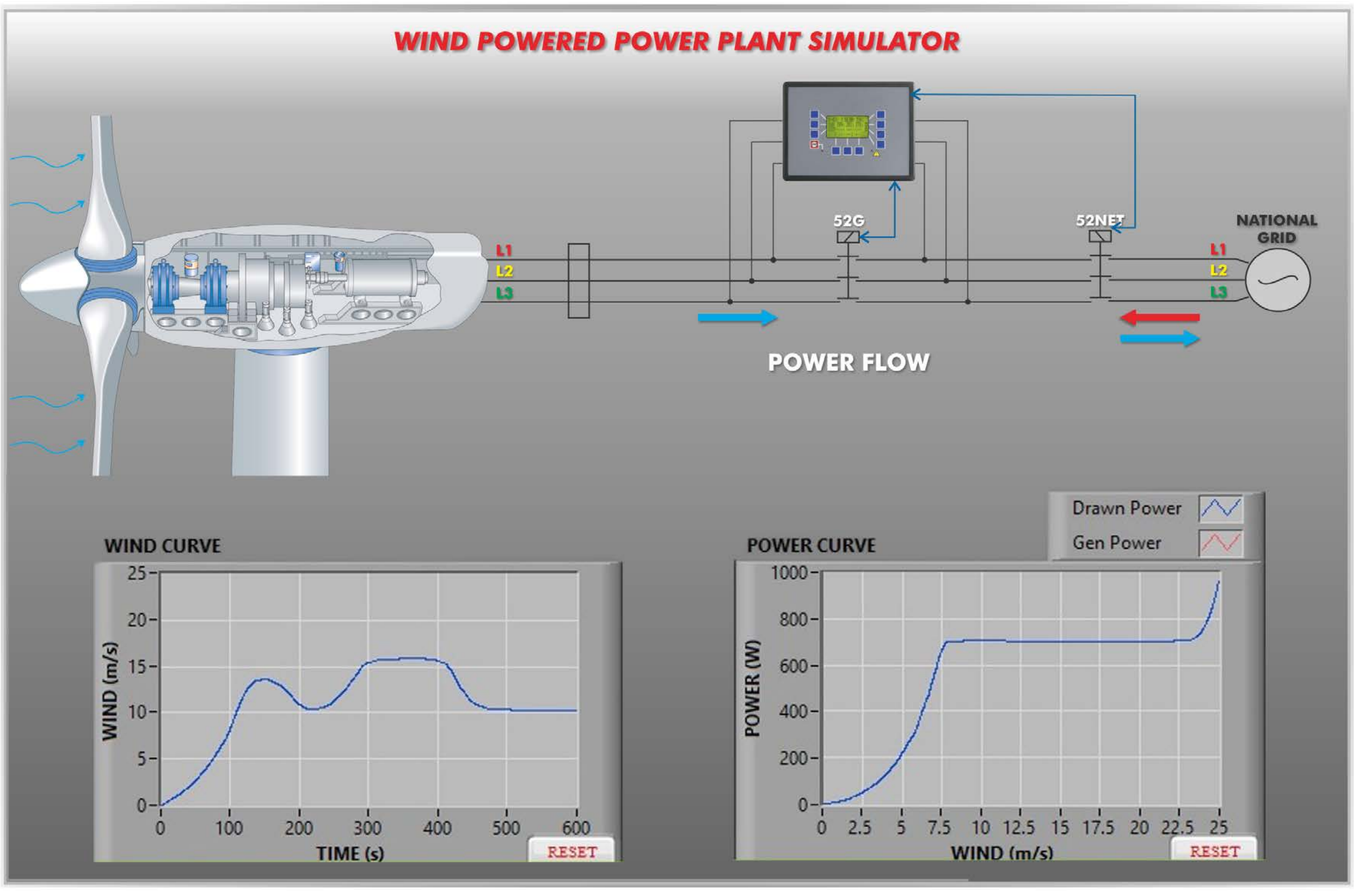
Motor-Generator Group detail

On the other hand, the essential part of this application is the wind power plant simulation software, "PSV-WPPP-SOF". This tool allows the user to carry out remotely the control and automatic synchronization maneuvers with the turbine-generator group and at the same time to monitor every curves of the generator electrical parameters, the energy losses and voltage drops. In addition, it allows saving all the acquired data to watch and compare it later. It is possible to see clearly and with accuracy the effects of reactive power compensation on the monitored power curves, maximum and minimum energy demand, load unbalances and the variation of the power factor. In addition, the "PSV-WPPP-SOF" software, allows carrying out the simulation of pre-configured wind curves for a real time or later analysis of the induction generator response. In this way, the user will be able to obtain and analyze the speed and power curves of the simulated wind turbine regarding the pre-configured values, for an in-depth study of this type of wind power plants.

Software detail

To acquire more experience in the study of wind turbines with three-phase squirrel cage generators, it is recommended to acquire the modules of resistors and inductances oriented to the study of the island operation of the three-phase induction generator and the manual compensation of the reactive power consumed by it. In addition, the analog instrumentation module for the measurement of the most relevant electrical parameters of the generator (P, Q, V, f) is also recommended.

Example of configuration



The "AEL-WPPIC" application includes the following elements:

- N-ALI01. Industrial Main Power Supply Module.
- N-ERP-PGC02. Turbine Protection and Control Module.
- N-EALD. Electrical Network Analyzer Module with Oscilloscope and Data Acquisition.
- PSV-WPPP-SOF. Wind Powered Power Plant Simulator.
- N-CAR19T/3C. 3 x 300 Var Three-Phase Configurable Capacitors Module.
- GMG1.25K3PH. 1.25 kW Generator-Motor Group.

Required elements (Not included):

- AEL-PC. Touch Screen and Computer.

Additional recommended elements (Not included):

- N-REVT/1K. 1 kW Three-Phase Variable Resistors Module.
- N-INDT/3C. 3 x 300 Var Three-Phase Configurable Inductances Module.
- N-PPIM1. Instrumentation Module 1.

The application "AEL-WPPIC" can be mounted on rack (option A) or on rail (option B):

Option A:

This application needs the following racks:

- N-RACK-B (3 units).

Optionally the AEL-WBR, Electrical workbench (rack) can be supplied to place the rack/s.

Option B:

This application can be mounted on rail.

Optionally the AEL-WBMP, Electrical workbench (small mobile) can be supplied to mount the modules.

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

With this unit there are several options and possibilities:

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

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

① AEL-WPPIC. Application:

- N-ALI01. **Industrial Main Power Supply Module.**

  Supply voltage: 400 VAC, 3PH + N.

  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, 30 mA AC 6 KA.

  Emergency stop push button.

N-ALI01

- N-ERP-PGC02. **Turbine Protection and Control Module.**

  Generator protection relay module.

  Single-phase supply voltage: 230 VAC.

  "Island grid/parallel grid" control switch.

  "Local/remote" control switch.

  Manual control switches of the relay:

  SW1, emergency stop.

  SW2, automatic start of the generator-motor group.

  SW3, protections reset pushbutton.

  SW4, generator frequency control activation.

  SW5, 52 G1 synchronization circuit breaker closure manual permission.

  State light indicators.

  Alarm light indicators.

  Synchronization safety key.

  Emergency stop pushbutton.

  ON / OFF switch.

  Connection terminals.

  The "N-ERP-PGC-02" Turbine Protection and Control Module:

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

  Enables to connect one generator in parallel with the grid.

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

  Includes analogical outputs to control voltage and frequency regulators available in the market.

  Three-phase measurement of the grid and generator voltage.

  Three-phase measurement of the generator current and power.

  Single-phase measurement of the grid current.

  Protections:

  Generator protections: max/min. voltage (59/27), max/min. frequency (81O/U), voltage asymmetry, dead bus detection, overload (32), unbalance load (46/F), reverse power/reduce (32R/F), overcurrent time define curve (50/51), inverse time overcurrent (IEC255), fault ground (50N/51N), phases, breakers fault.

  Motor: over/sub speed (12).

  Mains: max/min. voltage (59/27), max/min. frequency (81O/U), vector surge.

N-ERP-PGC02

- N-EALD. **Electrical Network Analyzer Module with Oscilloscope and Data Acquisition.**

N-EALD

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:

Three-phase and single-phase voltage. Up to 690 VAC L-L.

Line and neutral nominal current: 10 A.

Active, reactive and apparent power.

Suitable frequencies: 25 Hz, 50 Hz, 60 Hz and 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.

Voltage and current THD, TDD and K-Factor.

Maximums and minimums display.

Waveforms display, 128 samples/sec.

Events and data storage:

Harmonics analyzer:

Voltage and current THD, current TDD 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, four energy/demand records of total tariffs.

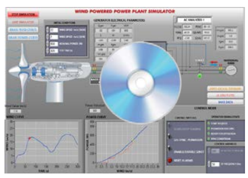
Eight tariffs, four seasons and four types of days.

Automatic daily report of energy consumption maximums and minimums.

Communications:

RS – 485 communication port.

- PSV-WPPP-SOF. **Wind Powered Power Plant Simulator.**



PSV-WPPP-SOF

The **PSV-WPPP-SOF** software has been designed by EDIBON to show the user the basic principles of operation of wind power plants, exposing in a didactic way the elements and parameters present in the generation process, as well as the interrelations between these parameters thanks to the mathematical models integrated in the simulator.

The application offers various levels of training that will provide the user with the essential knowledge and skills on the fundamental principles of control, operation and functioning of this type of power plant. Consequently, it will be possible to carry out a previous configuration of the plant's operating conditions, for subsequent control and management based on these factors.

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

N-CAR19T/3C

Three three-phase banks with capacitors of 2 μF each one.

Configurable star and delta connection.

Nominal voltage: 400 VAC.

Nominal power: 3 x (3 x 300) Var.

- GMG1.25K3PH. **1.25 kW Generator-Motor Group.**

  Nominal generator power: 1.1 kVA.

  Nominal generator current: 2.28 A.

  Speed: 1500 rpm.

  Nominal motor power: 1.5 kVA.

  Nominal motor current: 2.85 A.

  Note: technical characteristics of the machines may vary due to product improvement.

GMG1.25K3PH

<u>Required elements</u> (Not included):

- AEL-PC. **Touch Screen and Computer.**

  Touch screen:

    Energy efficiency class: A.

    Screen diagonal: 68.6 cm (27 inch (s)).

    Power consumption (operating): 26 watts.

    Annual energy consumption: 38 kWh.

    Power consumption (standby/off): 0.49 watts.

    Screen resolution: 1920 x 1080 pixels.

  Computer:

    Processor number: Intel Core i7-6600U Processor (4M Cache, up to 3.40 GHz).

    Cache: 4 MB Intel Smart Cache.

    Clock speed: 2.6 GHz.

    # Of cores/# of threads: 2/4.

    Max. TDP/Power: 15 W.

    Memory types: DDR4-2133, LPDDDR3-1866, DDR3L-1600.

    Graphics: Intel HD graphics 530.

    Slot for PCI Express.

AEL-PC

<u>Additional recommended elements</u> (Not included):

- N-REVT/1K. **1kW Three-Phase Resistors Module.**

  Three banks with three-phase variable resistances of 150 – 500 Ohm.

  Supply voltage: 230 VAC.

  Fuses: 3 x 2 A.

  Fan forced cooling.

N-REVT/1K

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

  Three three-phase banks with inductances of 5 H each one.

  Configurable star and delta connection.

  Nominal voltage: 400 VAC.

  Nominal power: 3 x (3 x 300) Var.

N-INDT/3C

- 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

The complete unit includes as well:

- **Advanced Real-Time SCADA.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON Control Software based on LabVIEW.**
- **National Instruments Data Acquisition board (250 KS/s, kilo samples per second).**
- **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.**
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- **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-WPPIC/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.

Sampling velocity up to 250 KS/s (kilo samples per second).

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-WPPIC/CCSOF

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

④ **Manuals:**

This unit is **supplied with 8 manuals**: Required services, Assembly and Installation, Control software, Starting-up, Safety, Maintenance & Practices manuals.

*References 1 to 4 are the main items: AEL-WPPIC + AEL-WPPIC/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.- Startup of the induction generator.
2.- Automatic speed control of the turbine-generator group speed.
3.- Automatic synchronization of the three-phase induction generator with the grid.
4.- Monitoring the three-phase induction generator electrical parameters with the grid (P, Q, S, PF).
5.- Control of the active power injected into the grid.
6.- Compensation of the reactive power by means of capacitor banks.
7.- Remote automatic control of the turbine-generator group.
8.- Real time monitoring of current and voltage values and waveforms.
9.- Real time monitoring of the active, reactive and apparent powers.
10.- Visualization of the curves for the measured values as a function of time.
11.- Visualization of the phasor diagrams of the generator electrical parameters.
12.- Customized setting of the wind speed curves.
13.- Visualization of the power curve for the pre-configured wind speed values.
14.- Real time monitoring of the obtained results.
15.- Storage and comparison of the obtained results.

Practical possibilities with the recommended elements:

16.- Stand-alone of the three-phase induction generator.
17.- Study of the generation and demand in isolated systems.
18.- Measurement of the electrical parameters of the generator (P, Q, V, f) by analog instrumentation.

Other possibilities to be done with this unit:

19.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
20.- 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.
21.- The Computer Control System with SCADA allows a real industrial simulation.
22.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
23.- This unit can be used for doing applied research.
24.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
25.- Visualization of all the sensors values used in the AEL-WPPIC unit process.

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

REQUIRED SERVICES

- Electrical supply: three-phase, 380 VAC – 400 VAC/50 Hz or 190 VAC – 240/60 Hz, 2 KW.

DIMENSIONS AND WEIGHTS

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

REQUIRED ELEMENTS (Not included)

- AEL-PC. Touch Screen and Computer.

ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- N-REVT/1K. 1 kW Three-Phase Variable Resistors Module.
- N-INDT/3C. 3 x 300 VAr Three-Phase Configurable Inductances Module.
- N-PPIM1. Instrumentation Module 1.

SIMILAR UNITS AVAILABLE

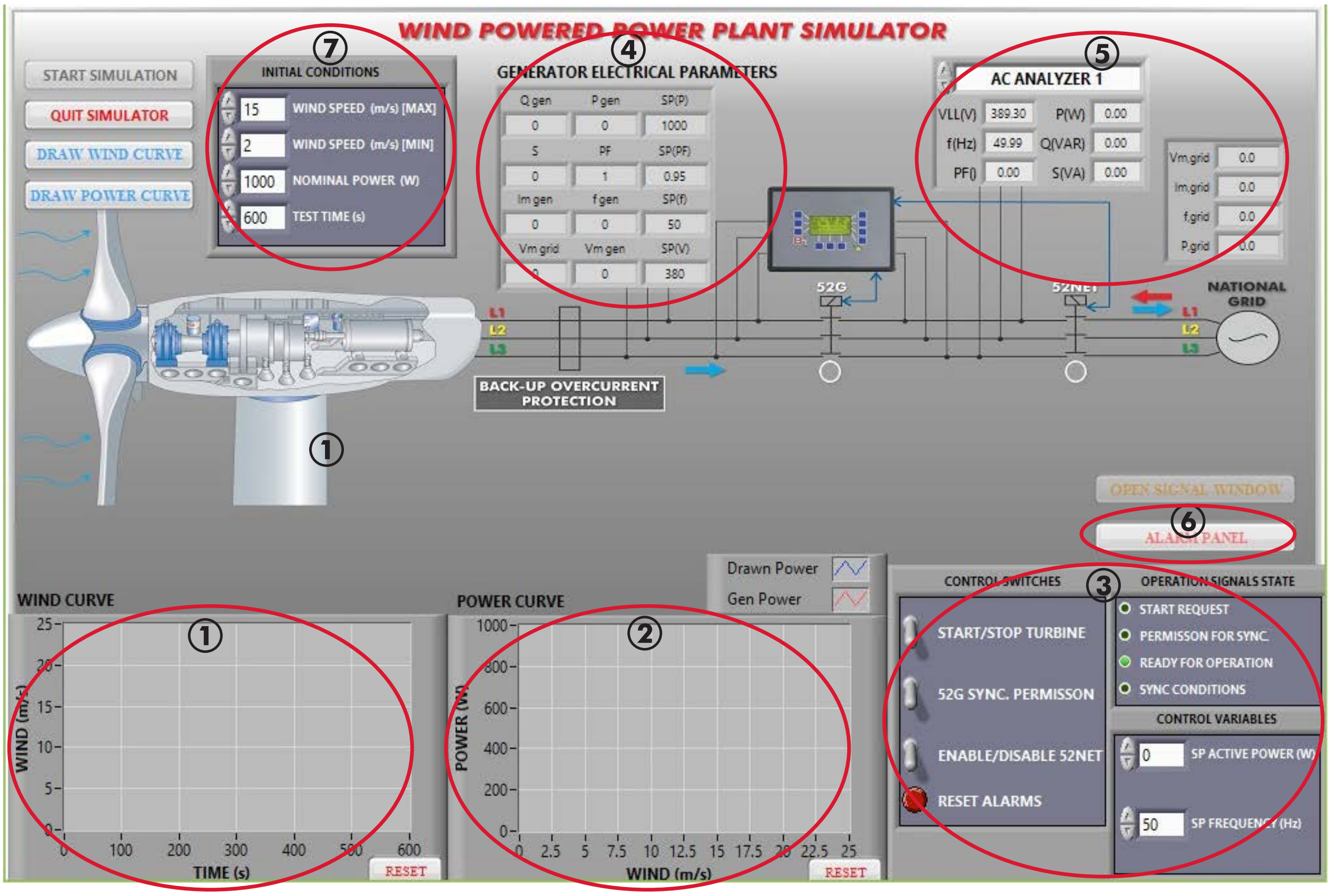
Offered in this catalog:

- AEL-WPPIC. Computer Controlled Wind Power Plants Application with Induction Generator.

Offered in other catalogs:

- AEL-WPPI. Wind Power Plants with Induction Generator Application.
- AEL-WPTC. Wind Power Application with Permanent Magnets Synchronous Generator, with SCADA.
- AEL-WPT. Wind Power Application with Permanent Magnets Synchronous Generator.
- EEEC. Computer Controlled Wind Energy Unit.
- EEE. Wind Energy Unit.
- MINI-EEEC. Computer Controlled Wind Energy Basic Unit.
- MINI-EEE. Wind Energy Basic Unit.
- EESFC. Computer Controlled Photovoltaic Solar Energy Unit.

SCADA
Main screen



① Wind profile editing graph.

② Wind turbine theoretical power curve editing graph.

③ Turbine-generator group control panel.

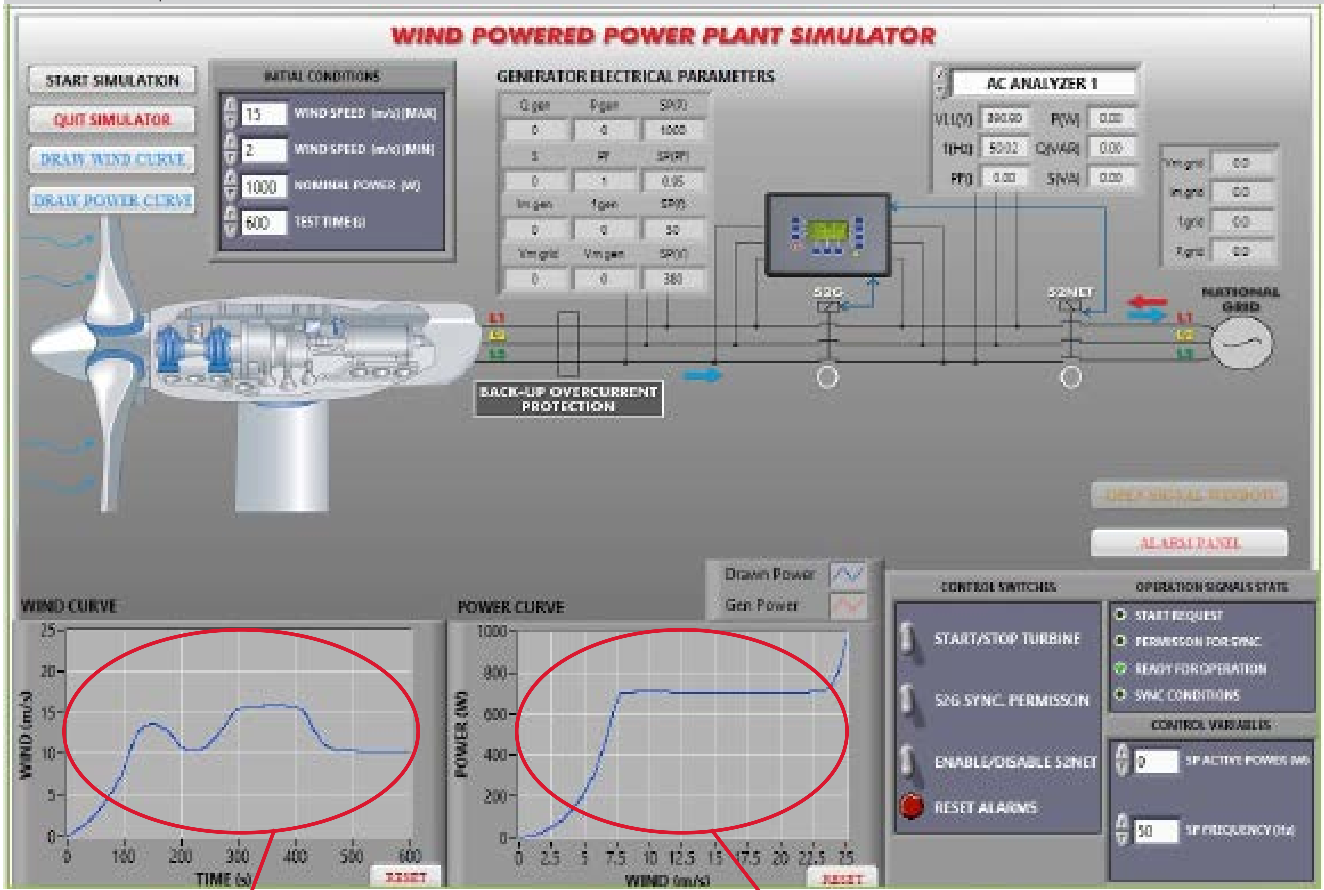
④ Electrical parameters of the induction generator.

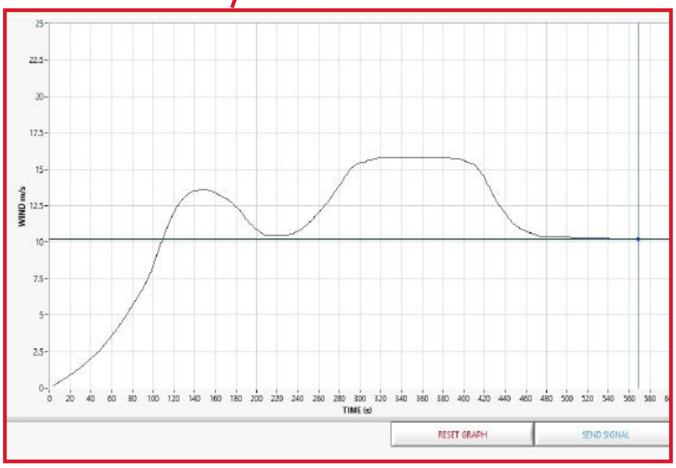
⑤ Electrical parameters of the network.

⑥ Alarm panel.

⑦ Initial parameters configuration panel: maximum wind speed, minimum wind speed, nominal power of the generator and time of the test.

Example of a 600 second test carried out in which the wind turbine is tested by means of a variable wind profile and a theoretical power curve of 700 W nominal power.



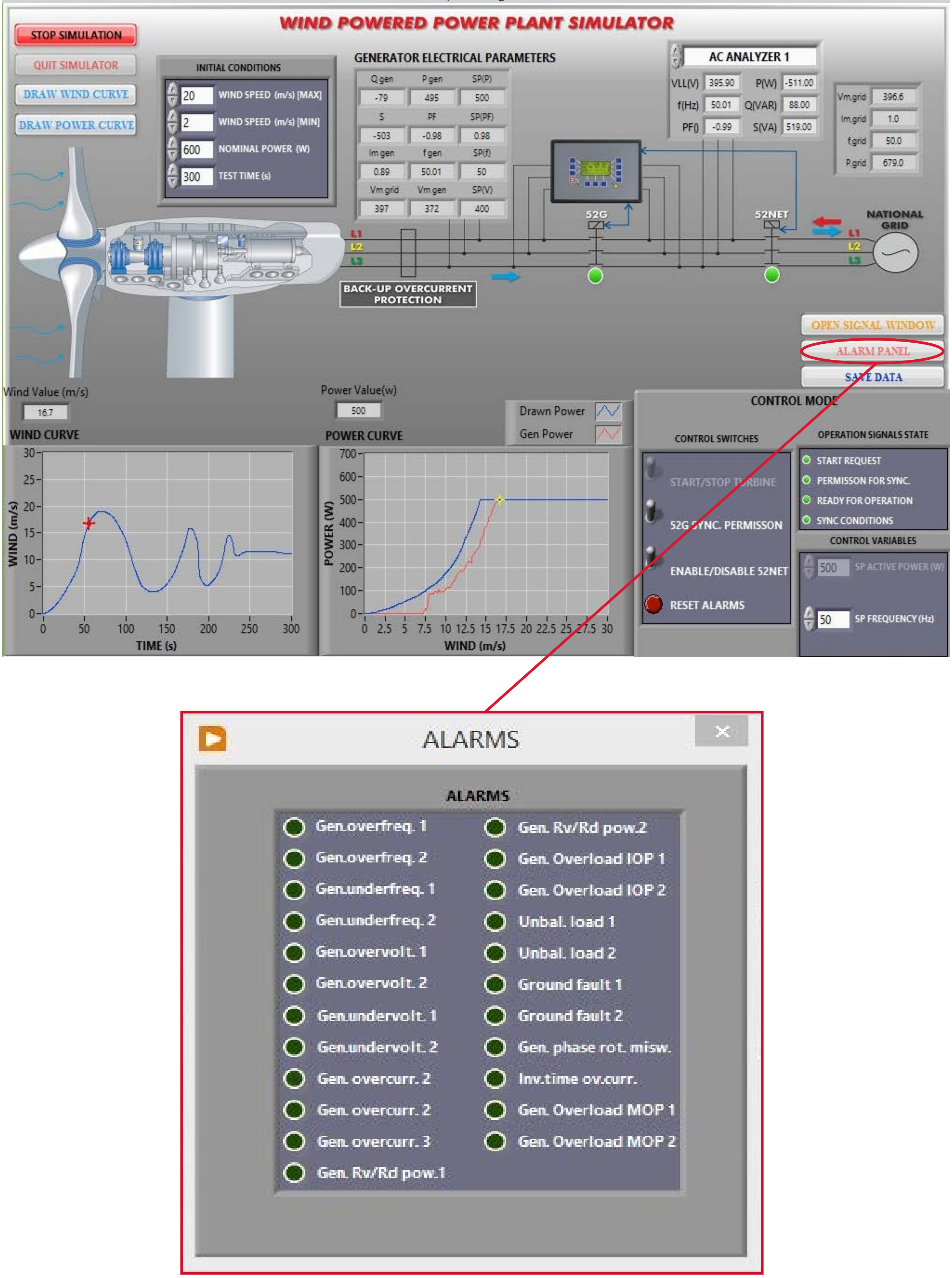


Example of wind profile loaded into the simulation software.

Example of theoretical wind turbine power curve loaded into the simulation software.

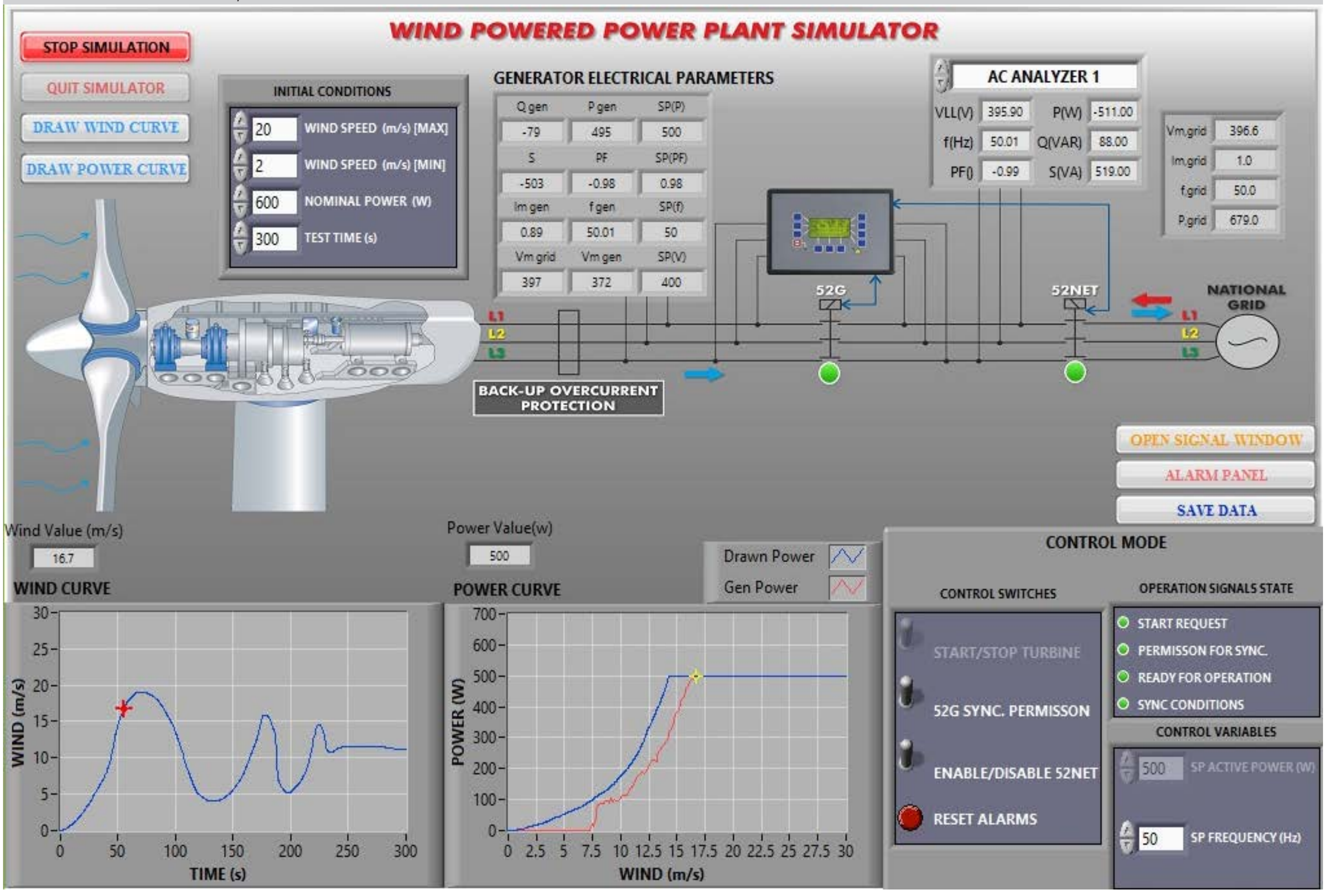
The following example is a real case where a highly variable wind profile has been introduced. Due to the enormous fluctuations, some warning alarms are triggered.

While the left graph shows the variable wind profile, the right graph shows the theoretical power curve versus the actual power curve (red). As in real situations, due to the enormous wind fluctuations, the controller will try to bring the turbine to ideal conditions.

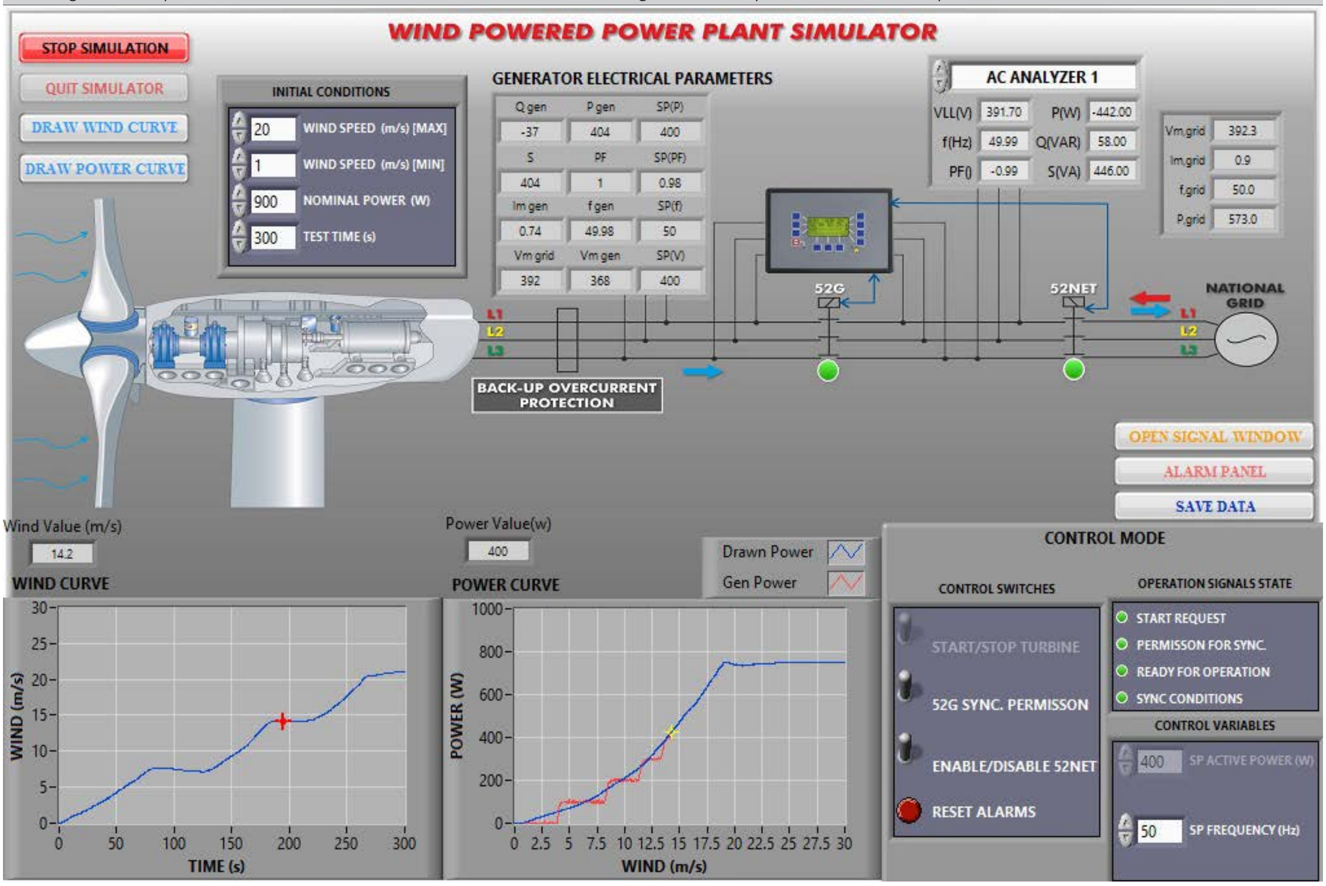


Generator alarm panel.

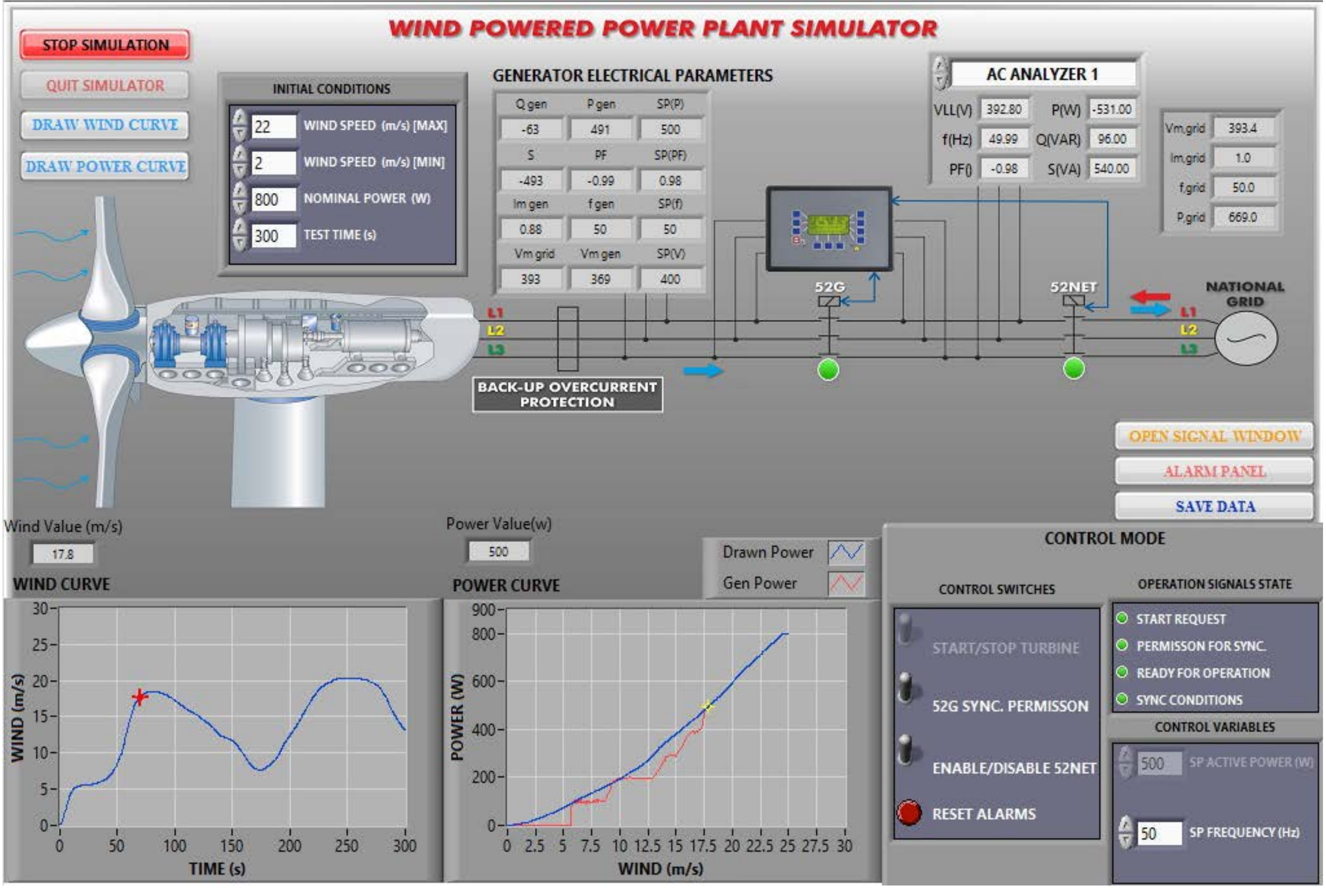
This example, the generator is in synchronism with the grid. The 52G and 52NET breakers are closed allowing the power flow from the generator to the grid. Notice the electrical parameters of the generator can be seen as well as the Set Point pre-set in the controller (P = 500 W, PF = 0.98, f = 50 Hz, V = 400 VAC).

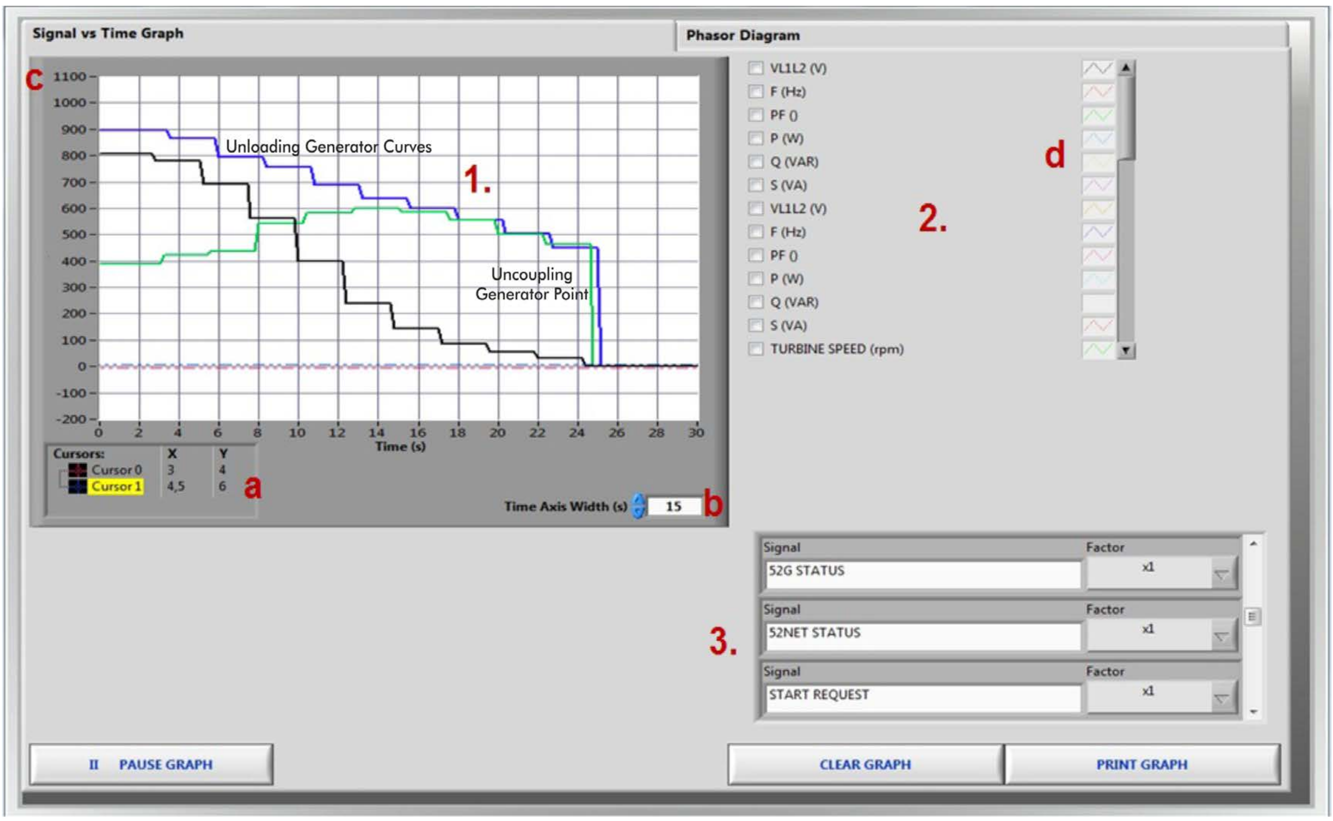


In this example, a much more stable wind profile can be seen and this leads to the power produced being much closer to the theoretical power curve. This is due to the inertias that are simulated in the software. When wind fluctuations are very strong, the inertias of the system penalize the accuracy of the generated power and when wind fluctuations are moderate, a higher accuracy is achieved in the system.



In this example, despite the oscillations of the wind profile, a fairly accurate control of the optimum system power is achieved.

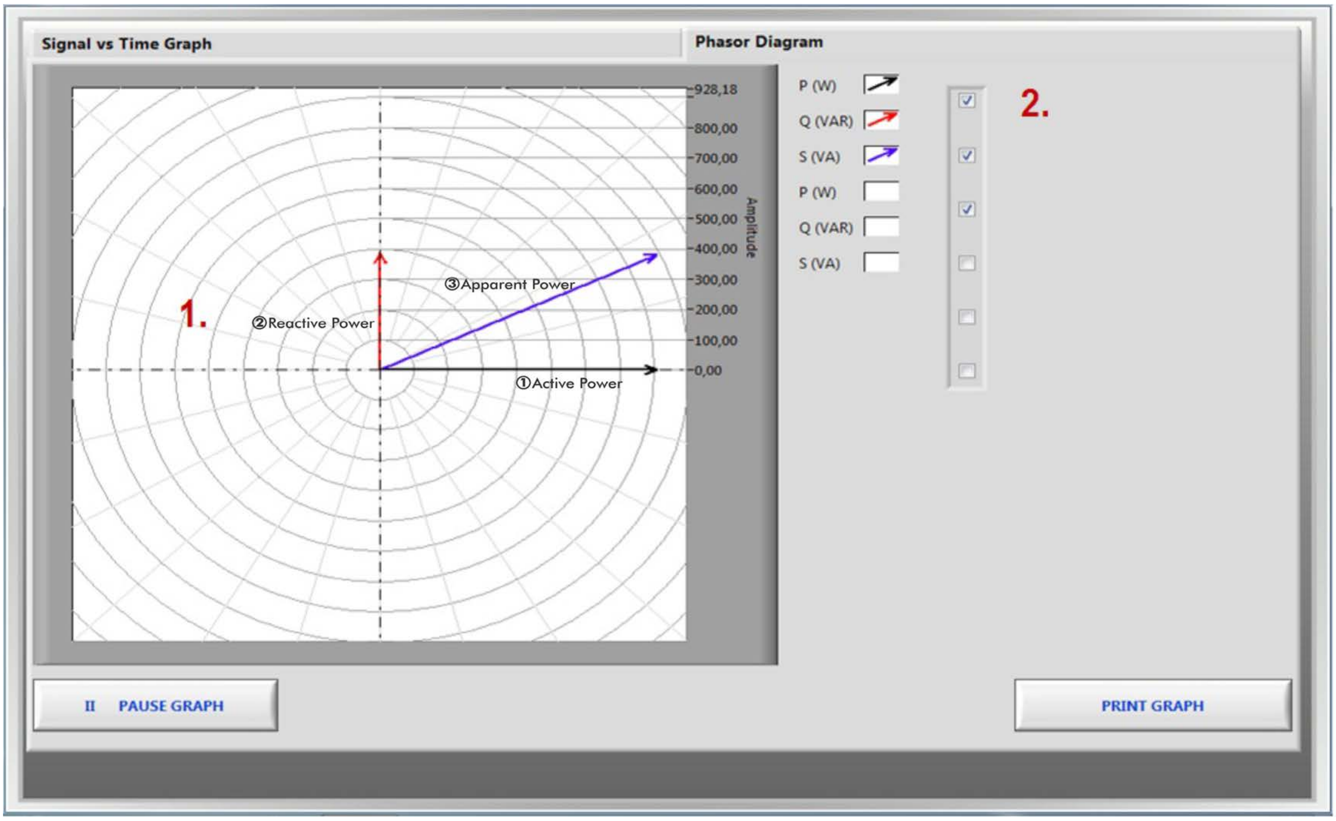




① **Real time graph.** It displays the selected variables and it is possible to take measurements by means of two cursors (a) and to modify the time scales (b) and amplitude (c). These three curves (apparent, active and reactive powers) represent the decoupling process of the generator and the grid.

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

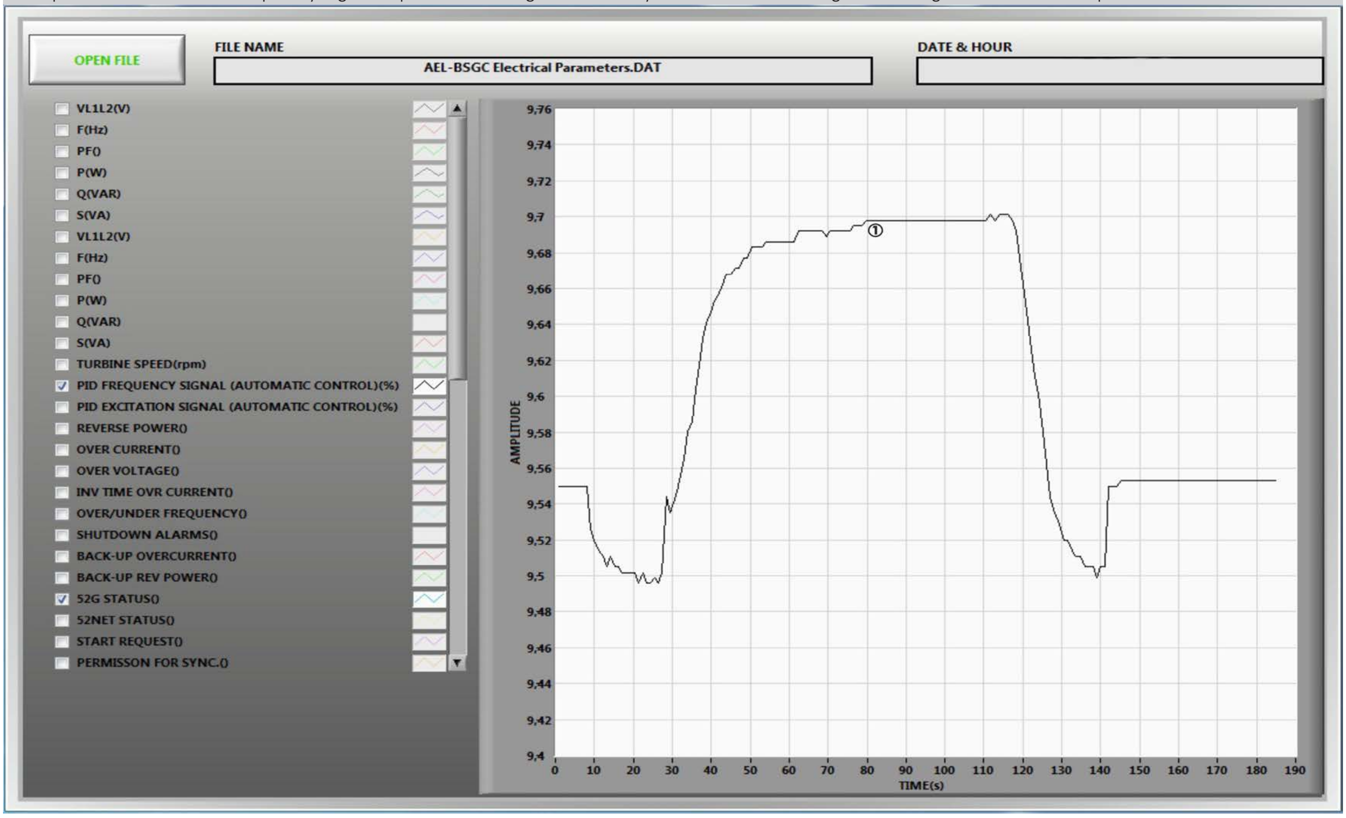
③ **Multiplier of digital variables.**



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.

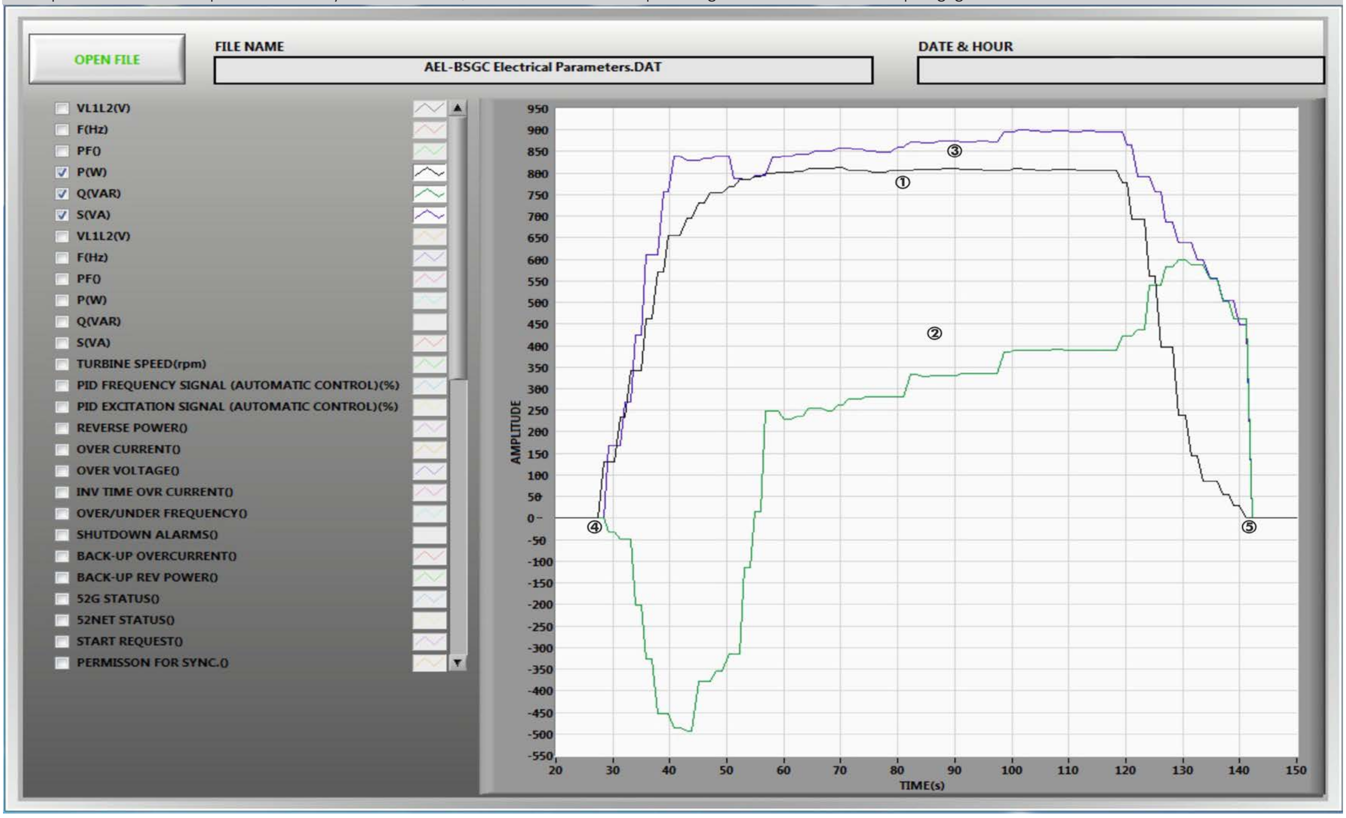
This picture shows a PID frequency signal report since the generator is synchronized with the grid till the generator is uncoupled of it.



① PID frequency signal reported.

Some **real** results obtained from this unit

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



① Generator active power curve.

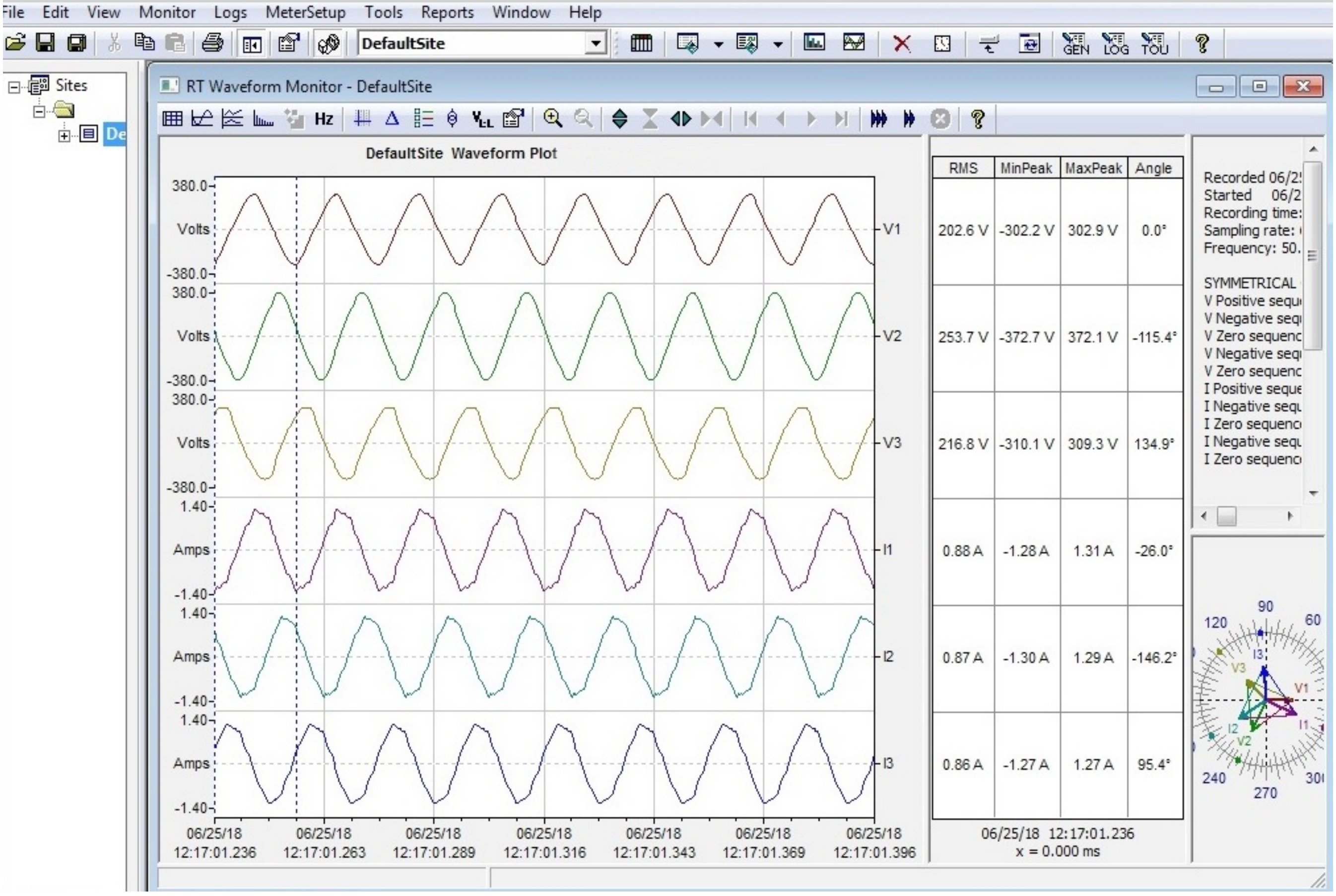
② Generator reactive power curve.

③ Generator apparent power curve.

④ Synchronization.

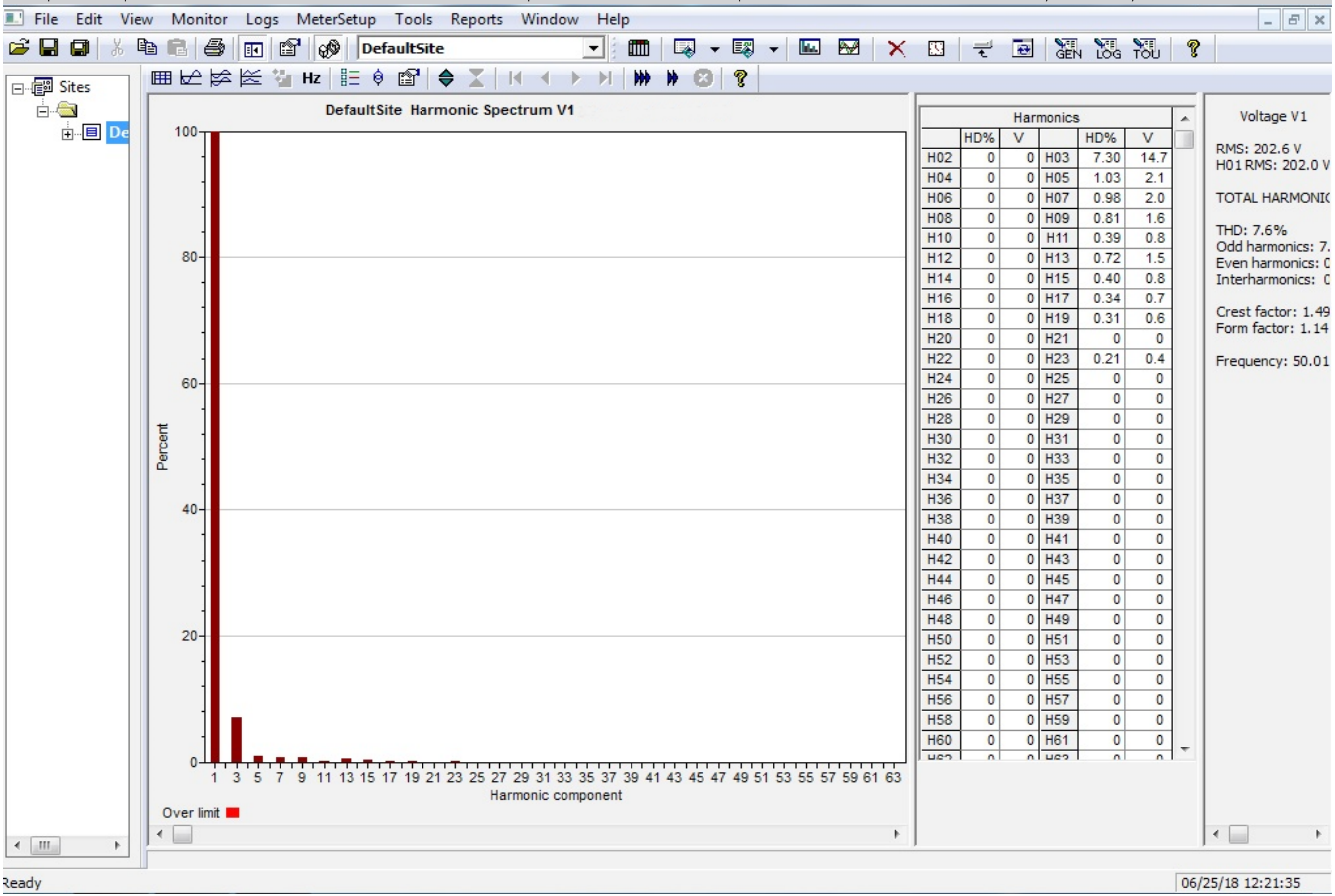
⑤ Uncoupling generator.

Graphical representation of the waveform of the currents and voltages measured in real time by the analyser, showing the angular, maximum, minimum and effective (RMS) values, and the phasors corresponding to such electrical parameters.

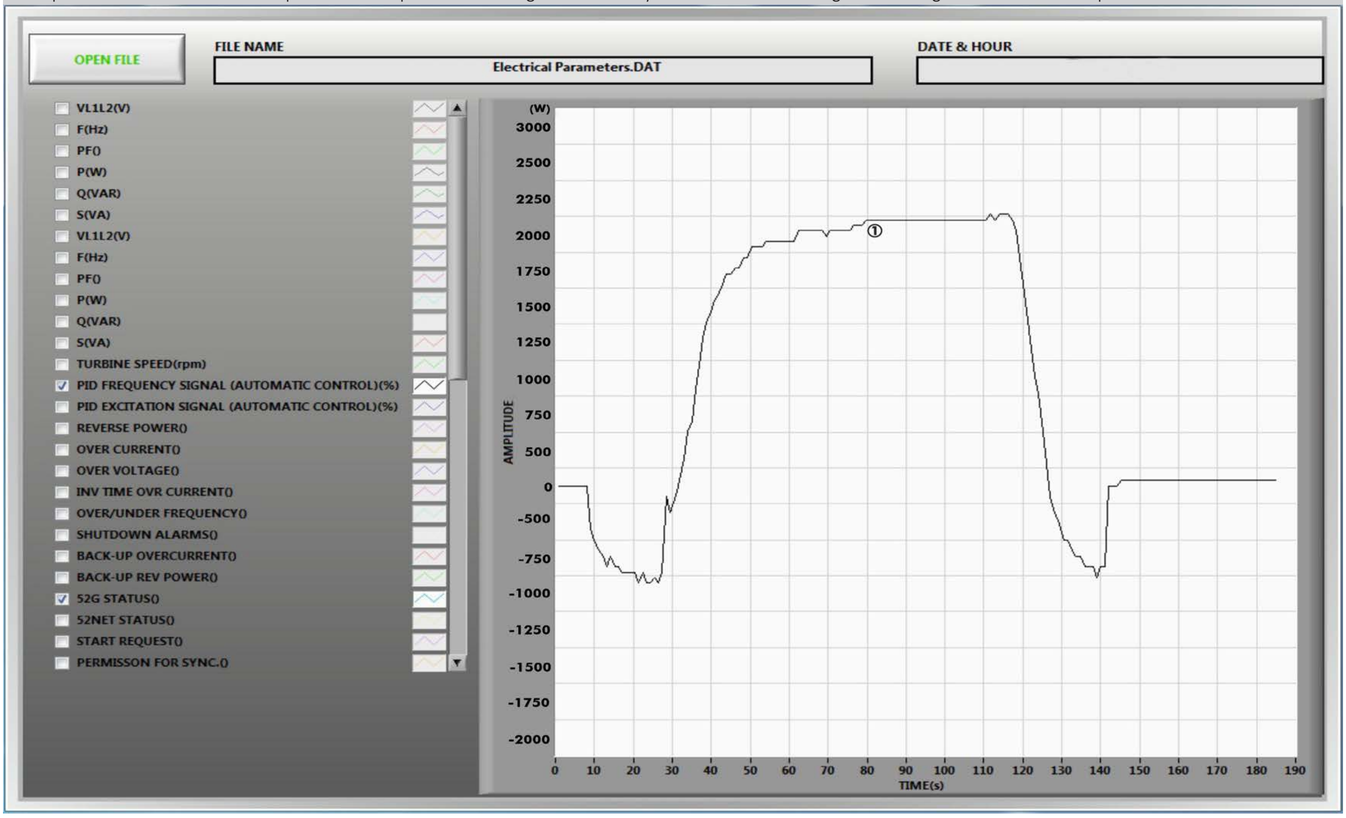


Some **real** results obtained from this unit

Graphical representation and data table of the harmonic spectrum of the selected parameter measured in real time by the analyser.

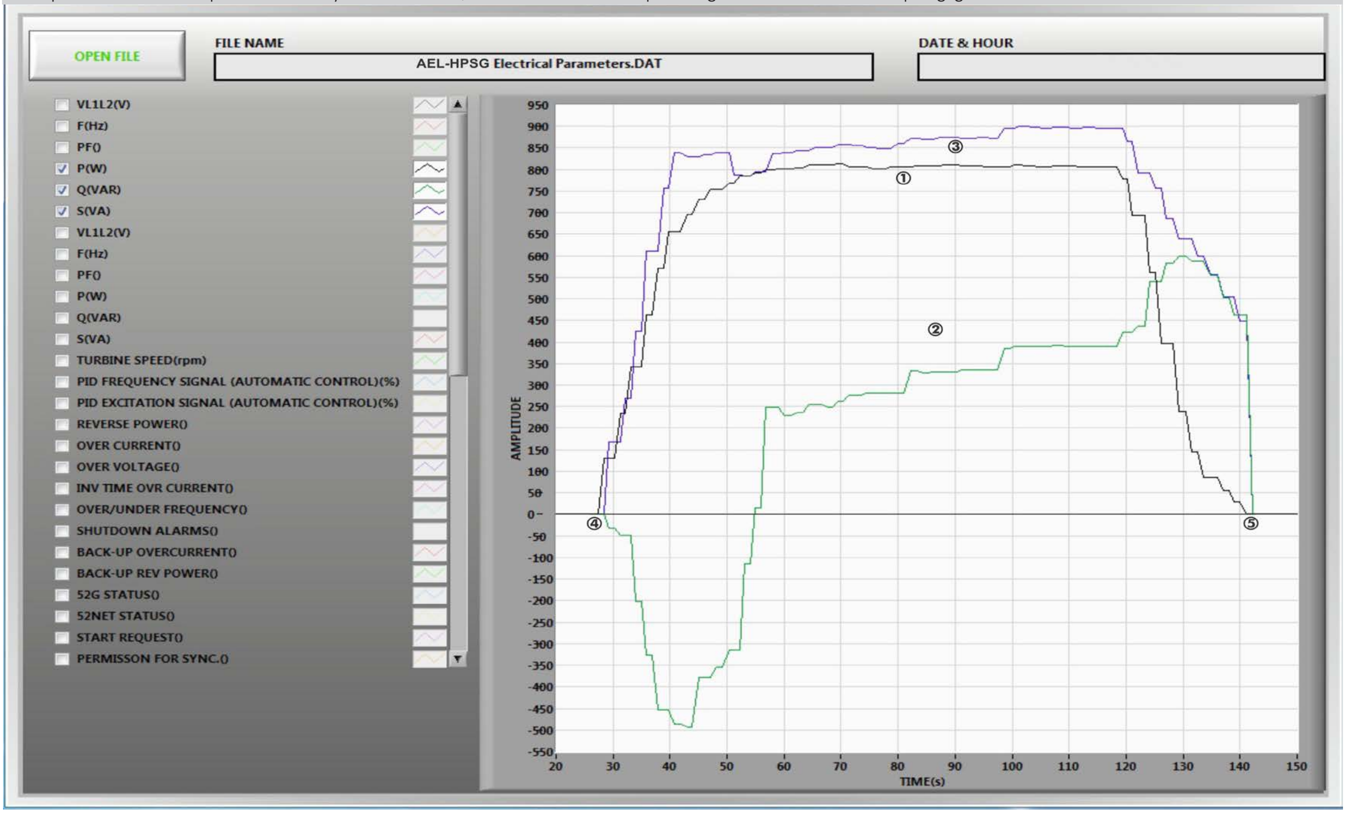


This picture shows a the active power curve port since the generator is synchronized with the grid till the generator is uncoupled of it.



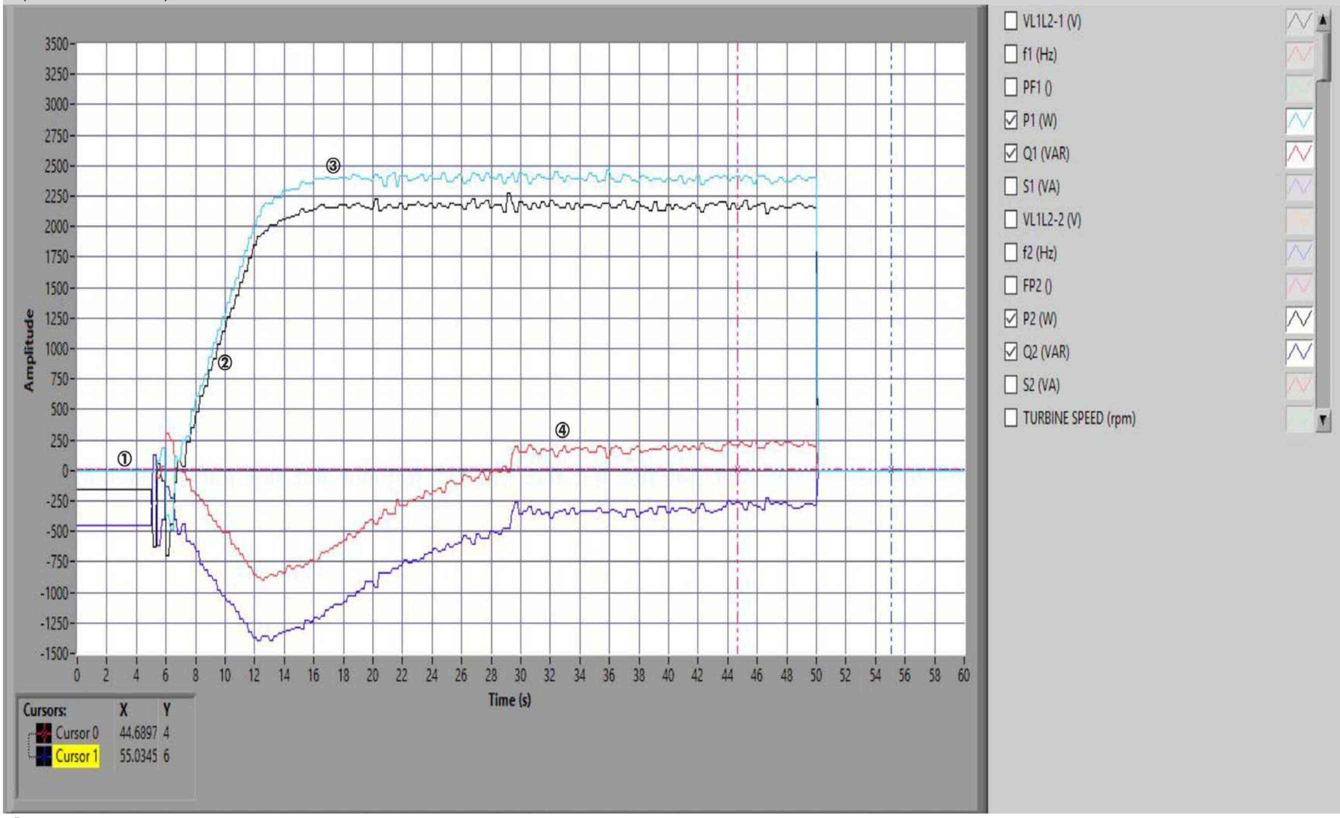
① Generator active power curve.

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



① Generator active power curve.
② Generator reactive power curve.
③ Generator apparent power curve.
④ Synchronization.
⑤ Uncoupling generator.

This image shows the synchronization process of the generator with the power grid. There is a first stage of turbine instability (0 - 6 seconds) and fluctuations in power P and Q up to 6 seconds. From this point on, the generator load ramp can be observed up to 18 seconds. Finally, the generator operates in steady state.



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.

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 and ESN)

a) Technical and Vocational Education configuration

⑤ AEL-WPPIC/ICAI. Interactive Computer Aided Instruction Software.

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

This software is optional and can be used additionally to items (1 to 4).

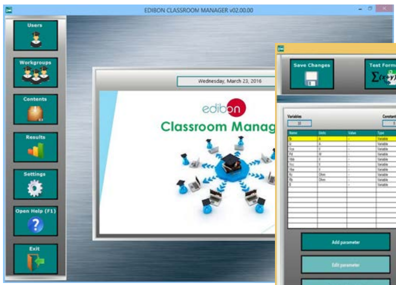
- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

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

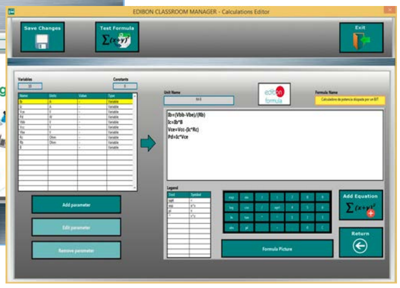
Innovative features:

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

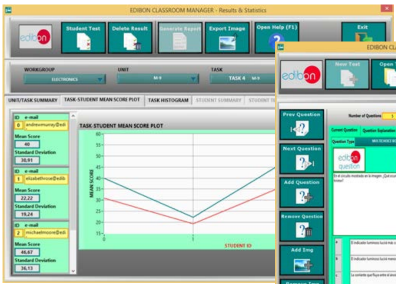
Instructor Software



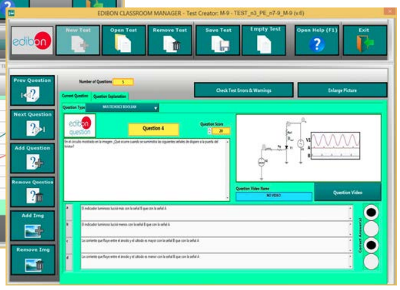
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



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

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

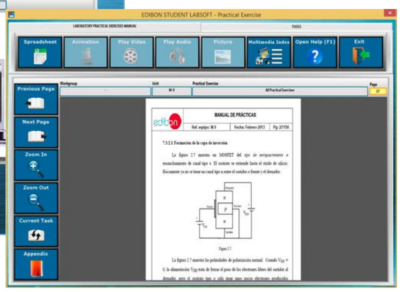
ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are 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:

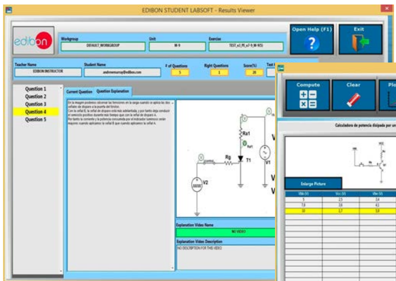
- **Student Log-In & Self-Registration.**
- **Existing Tasks checking & Monitoring.**
- **Default contents & scheduled tasks available to be used from the first session.**
- **Practical Exercises accomplishment by following the Manual provided by EDIBON.**
- **Evaluation Methods to prove your knowledge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

Student Software

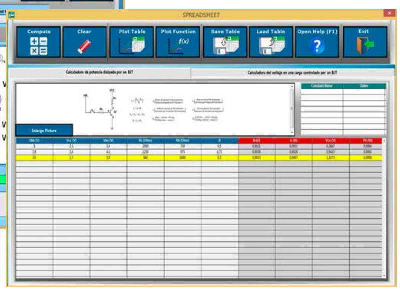
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

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

www.edibon.com/en/interactive-computer-aided-instruction-software

b) Multipost Expansions options

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

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

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

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

Main characteristics:

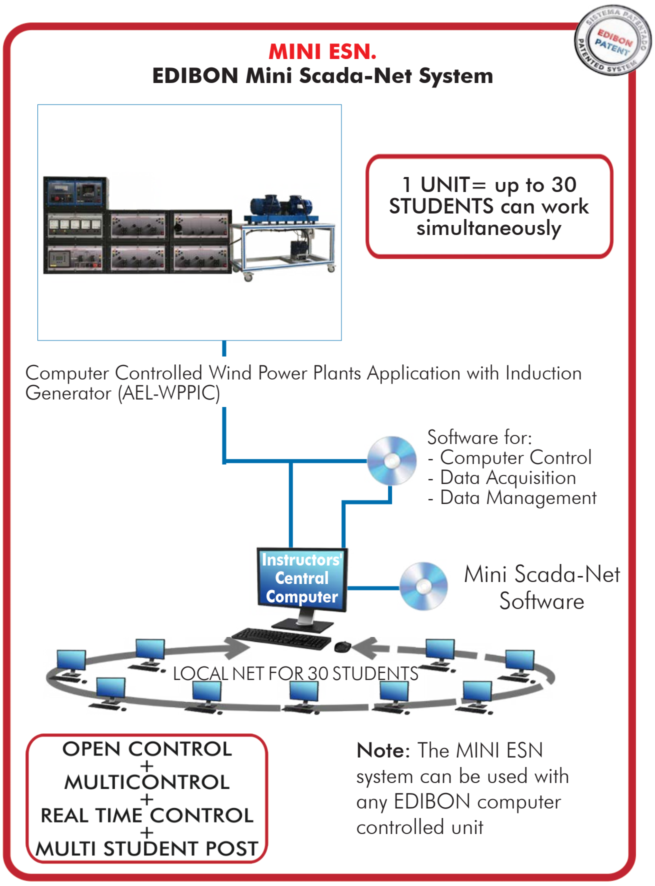
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work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

Main advantages:

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

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

www.edibon.com/en/edibon-scada-net



⑦ ESN. EDIBON Scada-Net Systems.

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

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

www.edibon.com/en/edibon-scada-net

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: AEL-WPPIC. Computer Controlled Wind Power Plants Application with Induction Generator.**

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

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

④ **Manuals.**

*IMPORTANT: Under AEL-WPPIC 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-WPPIC/ICAI. Interactive Computer Aided Instruction Software.

b) Multipost Expansions options

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

⑦ ESN. EDIBON Scada-Net Systems.

①AEL-WPPIC. Application:

- N-ALI01. Industrial Main Power Supply Module.
  - Supply voltage: 400 VAC, 3PH + N.
  - 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, 30 mA AC 6 KA.
  - Emergency stop push button.
- N-ERP-PGC02. Turbine Protection and Control Module.
  - Generator protection relay module.
  - Single-phase supply voltage: 230 VAC.
  - "Island grid/parallel grid" control switch.
  - "Local/remote" control switch.
  - Manual control switches of the relay:
    - SW1, emergency stop.
    - SW2, automatic start of the generator-motor group.
    - SW3, protections reset pushbutton.
    - SW4, generator frequency control activation.
    - SW5, 52 G1 synchronization circuit breaker closure manual permission.
  - State light indicators.
  - Alarm light indicators.
  - Synchronization safety key.
  - Emergency stop pushbutton.
  - ON/OFF switch.
  - Connection terminals.
  - The "N-ERP-PGC-02" Turbine Protection and Control Module:
    - Enables to connect up to 16 generators in parallel-island with distribution of active and reactive load and start/stop operation control in function of the load demand.
    - Enables to connect one generator in parallel with the grid.
    - Enables different switches control modes, such as opening, closing and synchronization.
    - Includes analogical outputs to control voltage and frequency regulators available in the market.
    - Three-phase measurement of the grid and generator voltage.
    - Three-phase measurement of the generator current and power.
    - Single-phase measurement of the grid current.
  - Protections:
    - Generator protections: max/min. voltage (59/27), max/min. frequency (81O/U), voltage asymmetry, dead bus detection, overload (32), unbalance load (46/F), reverse power/reduce (32R/F), overcurrent time define curve (50/51), inverse time overcurrent (IEC255), fault ground (50N/51N), phases, breakers fault.
    - Motor: over/sub speed (12).
    - Mains: max/min. voltage (59/27), max/min. frequency (81O/U), vector surge.
- N-EALD. Electrical Network Analyzer Module with Oscilloscope and Data Acquisition.
  - The network analyzer module allows fulfilling measurements, displaying and analyzing all the parameters of the AC electrical networks. It has an LCD screen and push-buttons for the navigation through the different menus. It includes specific software for monitoring current and voltage curves, harmonics display, tariffs programming, alarms programming and electrical parameters storage.
  - Features:
    - Multifunctional three-phase power meter:
      - Three-phase and single-phase voltage. Up to 690 VAC L-L.
      - Line and neutral nominal current: 10 A.
      - Active, reactive and apparent power.
      - Suitable frequencies: 25 Hz, 50 Hz, 60 Hz and 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.
      - Voltage and current THD, TDD and K-Factor.
      - Maximums and minimums display.
      - Waveforms display, 128 samples/sec.
    - Events and data storage:
      - Harmonics analyzer:
        - Voltage and current THD, current TDD 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, four energy/demand records of total tariffs.
        - Eight tariffs, four seasons and four types of days.
        - Automatic daily report of energy consumption maximums and minimums.
      - Communications:
        - RS – 485 communication port.

- PSV-WPPP-SOF. Wind Powered Power Plant Simulator.

  The PSV-WPPP-SOF software has been designed by EDIBON to show the user the basic principles of operation of wind power plants, exposing in a didactic way the elements and parameters present in the generation process, as well as the interrelations between these parameters thanks to the mathematical models integrated in the simulator.

  The application offers various levels of training that will provide the user with the essential knowledge and skills on the fundamental principles of control, operation and functioning of this type of power plant. Consequently, it will be possible to carry out a previous configuration of the plant's operating conditions, for subsequent control and management based on these factors.
- N-CAR19T/3C. 3 x 300 Var Three-Phase Configurable Capacitors Module.

  Three three-phase banks with capacitors of 2 μF each one.

  Configurable star and delta connection.

  Nominal voltage: 400 VAC.

  Nominal power: 3 x (3 x 300) Var.
- GMG1.25K3PH. 1.25 kW Generator-Motor Group.
  Nominal generator power: 1.1 kVA.
  Nominal generator current: 2.28 A.
  Speed: 1500 rpm.
  Nominal motor power: 1.5 kVA.
  Nominal motor current: 2.85 A.
  Note: technical characteristics of the machines may vary due to product improvement.

Required elements (Not included):

- AEL-PC. Touch Screen and Computer.
  Touch screen:
    Energy efficiency class: A.
    Screen diagonal: 68.6 cm (27 inch (s)).
    Power consumption (operating): 26 watts.
    Annual energy consumption: 38 kWh.
    Power consumption (standby/off): 0.49 watts.
    Screen resolution: 1920 x 1080 pixels.
  Computer:
    Processor number: Intel Core i7-6600U Processor (4M Cache, up to 3.40 GHz).
    Cache: 4 MB Intel Smart Cache.
    Clock speed: 2.6 GHz.
    # Of cores/# of threads: 2/4.
    Max. TDP/Power: 15 W.
    Memory types: DDR4-2133, LPDDDR3-1866, DDR3L-1600.
    Graphics: Intel HD graphics 530.
    Slot for PCI Express.

Additional recommended elements (Not included):

- N-REVT/1K. 1kW Three-Phase Resistors Module.
  Three banks with three-phase variable resistances of 150 – 500 Ohm.
  Supply voltage: 230 VAC.
  Fuses: 3 x 2 A.
  Fan forced cooling.
- N-INDT/3C. 3 x 300 Var Three-Phase Configurable Inductances Module.
  Three three-phase banks with inductances of 5 H each one.
  Configurable star and delta connection.
  Nominal voltage: 400 VAC.
  Nominal power: 3 x (3 x 300) Var.
- 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.

The complete unit includes as well:

Advanced Real-Time SCADA.
Open Control + Multicontrol + Real-Time Control.
Specialized EDIBON Control Software based on LabVIEW.
National Instruments Data Acquisition board (250 KS/s, kilo samples per second).
Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
Capable of doing applied research, real industrial simulation, training courses, etc.
Remote operation and control by the user and remote control for EDIBON technical support, are always included.
Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
Designed and manufactured under several quality standards.
Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

②**AEL-WPPIC/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.
Sampling velocity up to 250 KS/s (kilo samples per second).
It allows the registration of the alarms state and the graphic representation in real time.
Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.
This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

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

④**Manuals:**

This unit is supplied with 8 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.- Startup of the induction generator.
2.- Automatic speed control of the turbine-generator group speed.
3.- Automatic synchronization of the three-phase induction generator with the grid.
4.- Monitoring the three-phase induction generator electrical parameters with the grid (P, Q, S, PF).
5.- Control of the active power injected into the grid.
6.- Compensation of the reactive power by means of capacitor banks.
7.- Remote automatic control of the turbine-generator group.
8.- Real time monitoring of current and voltage values and waveforms.
9.- Real time monitoring of the active, reactive and apparent powers.
10.- Visualization of the curves for the measured values as a function of time.
11.- Visualization of the phasor diagrams of the generator electrical parameters.
12.- Customized setting of the wind speed curves.
13.- Visualization of the power curve for the pre-configured wind speed values.
14.- Real time monitoring of the obtained results.
15.- Storage and comparison of the obtained results.

Practical possibilities with the recommended elements:

16.- Stand-alone of the three-phase induction generator.
17.- Study of the generation and demand in isolated systems.
18.- Measurement of the electrical parameters of the generator (P, Q, V, f) by analog instrumentation.

Other possibilities to be done with this unit:

19.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
20.- 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.
21.- The Computer Control System with SCADA allows a real industrial simulation.
22.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
23.- This unit can be used for doing applied research.
24.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
25.- Visualization of all the sensors values used in the AEL-WPPIC unit process.

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

a) Technical and Vocational Education configuration

⑤ AEL-WPPIC/ICAI. Interactive Computer Aided Instruction Software.

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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.

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

Innovative features:

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

b) Multipost Expansions options

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

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

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

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

Main characteristics:

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

Main advantages:

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

The system basically will consist of:

This system is used with a Computer Controlled Unit.

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

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

edibon

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

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