



### 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.



Certificate of Approval of the  
Quality Management System



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



Worlddidac Association  
Certificate of Membership

## GENERAL DESCRIPTION

The Wind Power Plants with Induction Generator Application, "AEL-WPPI", has been designed by EDIBON to study the wind turbines electrical performance with three-phase induction generators of squirrel cage that inject power in the network.

Wind turbines with induction generator have some characteristics, of great interest to the students, which will be studied working with the machine in different regimes: sub-synchronous, synchronous and super-synchronous. Depending on the working regime of the induction generator, different electrical parameters can be analyzed. To analyze these electrical parameters, the wind power plants with induction generator application has an advanced network analyzer that will indicate to the student, among others, the following parameters: positive and negative active, reactive and apparent powers ( $P$ ,  $Q$  and  $S$ ), line and total power factors, line currents, phase and line voltages, current and voltage harmonics, etc.

The wind turbine induction generator is coupled to the three-phase induction motor of squirrel cage in order to simulate different wind speeds. The three-phase induction motor is controlled by mean a frequency variator to vary the wind speed. On this way, the user can simulate different wind speeds and observes the response of the electrical generator coupled to the grid.

The wind power plants induction generator application includes a frequency controller which allow the student to measure the wind turbine speed and the applied torque for it in order to calculate electrical and mechanical parameters, through which the student will go in depth about knowledge of wind turbines with induction generator.

This application has a power factor compensation module in order to analyze the effects of the reactive energy in the induction generator and the grid.

This application has all necessary electrical and mechanical safety elements.

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

- N-ALI01. Industrial Main Power Supply Module.
- N-CAR19T3. Three-Phase Bench of Commutable Capacitors Module.
- N-WCA2K. 2 kW Motor Speed Controller Module.
- N-EALD. Electrical Network Analyzer Module with Oscilloscope and Data Acquisition.
- N-MPS. Motor Protection Module (1.6 A - 2.5 A).
- N-ARS. Automatic Resistors Starter Module.
- GMG1.25K3PH. 1.25 kW Generator-Motor Group.

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

Option A:

This application needs the following racks:

- N-RACK-A.

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.

## SPECIFICATIONS

The “AEL-WPPI” application includes the following elements:

- **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-CAR19T3. Three-Phase Bench of Commutable Capacitors Module.**

ON / OFF switch.

3 x Manual switches to turn on and off the capacitors.

4 x Input voltage terminals: 400 VAC + N.

Capacitors: 3 x (3 x 7)  $\mu$ F.

Three LED indicators.



N-CAR19T3

- **N-WCA2K. 2 kW Motor Speed Controller Module.**

ON / OFF switch.

Micro connector of 8 pins.

Supply terminals:

Supply: 400 VAC.

Supply terminals L1, L2, L3 and N from the module to the frequency variator.

Output connector.

Motor speed potentiometer.



N-WCA2K

- **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.



N-EALD

## Specifications

- **N-MPS. Motor Protection Module (1.6 A - 2.5 A).**

ON / OFF commutator.

Limit thermal current:

From 1.6 A – 2.5 A.

Input power terminals:

Power input connections: L1, L2, L3.

Output power terminals:

Power output connections: L1, L2, L3.



N-MPS

- **N-ARS. Automatic Resistors Starter Module.**

ON / OFF switch.

Supply voltage: 230 VAC.

Fuses: 3 x 5 A.

Pre-insertion resistance: 3 x (3 x 33) Ohm.

Push button for machine connection.

Resistance switch push button.

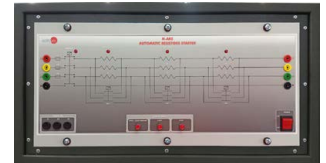
Resistor disconnection push button.

Input power terminals:

Input power connections: L1, L2, L3 and N.

Output power terminals:

Output power connections: L1, L2, L3 and N.



N-ARS

- **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

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

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

### Manuals:

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

## EXERCISES AND PRACTICAL POSSIBILITIES

- 1.- Commissioning of the induction generator.
  - 2.- Wiring procedure of the induction generator to the grid.
  - 3.- Study of operation regimes of the wind turbines with three-phase induction generator of squirrel cage.
  - 4.- Analysis of the induction generators coupled to the grid in sub-synchronous state.
  - 5.- Analysis of the induction generators coupled to the grid in synchronous state.
  - 6.- Analysis of the induction generators coupled to the grid in super-synchronous state.
  - 7.- Study of electrical parameters of the induction generator coupled to the grid in sub-synchronous state.
  - 8.- Study of electrical parameters of the induction generator coupled to the grid in synchronous state.
  - 9.- Study of electrical parameters of the induction generator coupled to the grid in super-synchronous state.
  - 10.- Efficiency study of the induction generator comparing the injected power in the grid with the mechanical power shaft of the turbine.
  - 11.- Power factor influence with the speed variations and analysis of the possible solutions to automate the regulation of the power factor.
  - 12.- Active power compensation by mean capacitor banks and electrical measurement of the electrical machine response.
- 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-WPPI:
- Dimensions: 1600 x 550 x 2000 mm approx.  
(62.99 x 21.65 x 78.74 inches approx.)
  - Weight: 120 Kg approx.  
(264 pounds approx.)

### SIMILAR UNITS AVAILABLE

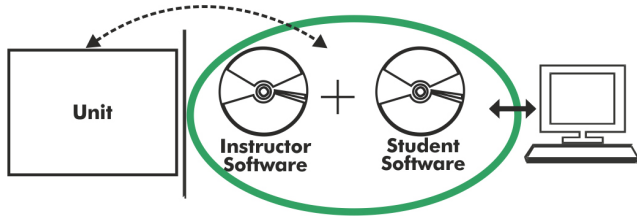
Offered in this catalog:

- AEL-WPPI. Wind Power Plants with Induction Generator Application.

Offered in other catalogs:

- AEL-WPPIC. Computer Controlled Wind Power Plants Application with Induction Generator.
- AEL-WPP. Wind Power Plants with Double Feed 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.
- EEEEC. Computer Controlled Wind Energy Unit.
- EEE. Wind Energy Unit.
- MINI-EEEC. Computer Controlled Wind Energy Basic Unit.
- MINI-EEE. Wind Energy Basic Unit.
- AEL-EPP. Energy Power Plants Application.
- AEL-SWT. Stand-Alone Wind Turbine Application.

**AEL-WPPI/ICAI. Interactive Computer Aided Instruction Software:**



With no physical connection between unit and computer, 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.

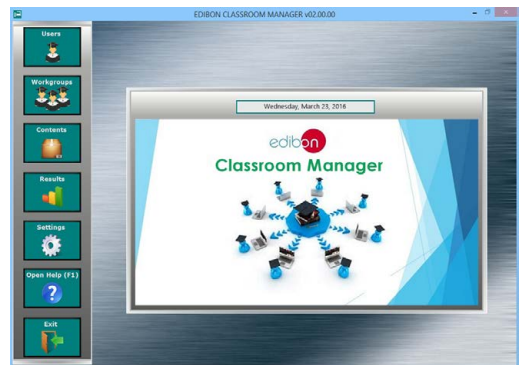
Instructor Software

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

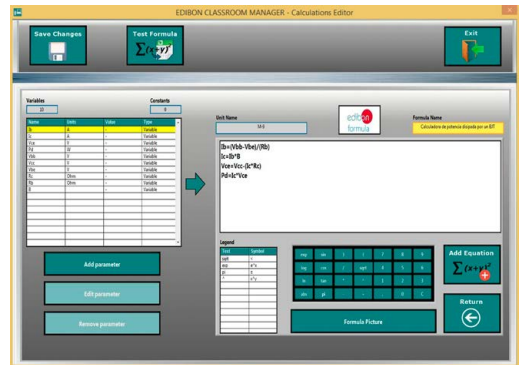
ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual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

Innovative features:

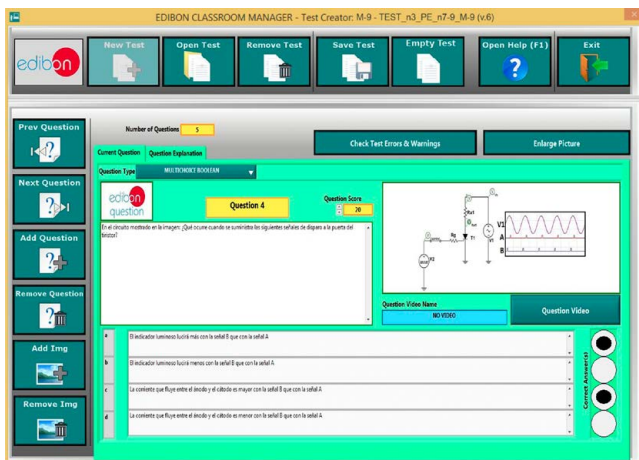
- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.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



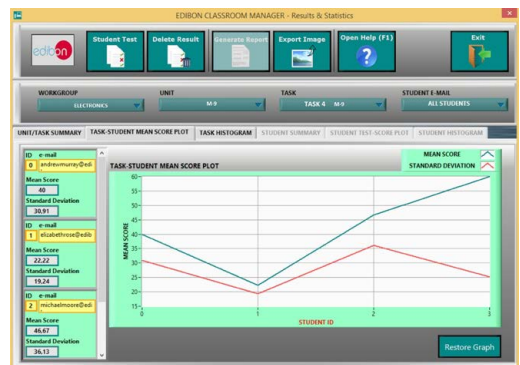
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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



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

Optional  
Student Software

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

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

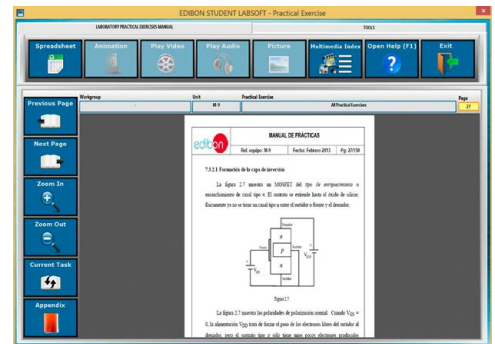
Innovative features:

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

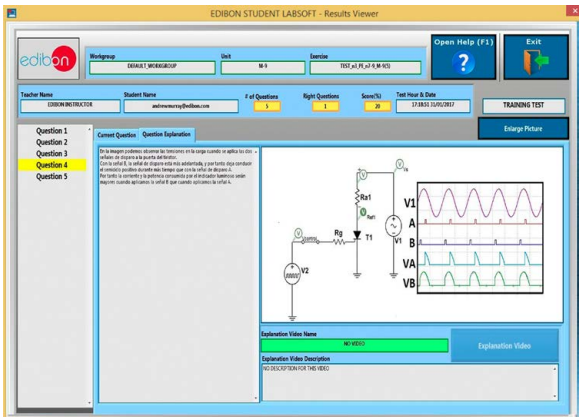
For more information see ICAI catalogue. Click on the following link:  
[www.edibon.com/en/interactive-computer-aided-instruction-software](http://www.edibon.com/en/interactive-computer-aided-instruction-software)



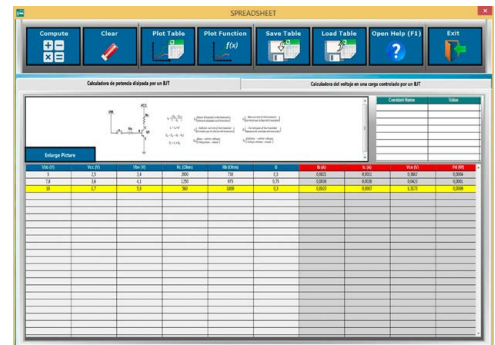
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

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



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](http://www.edibon.com)

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REPRESENTATIVE:

