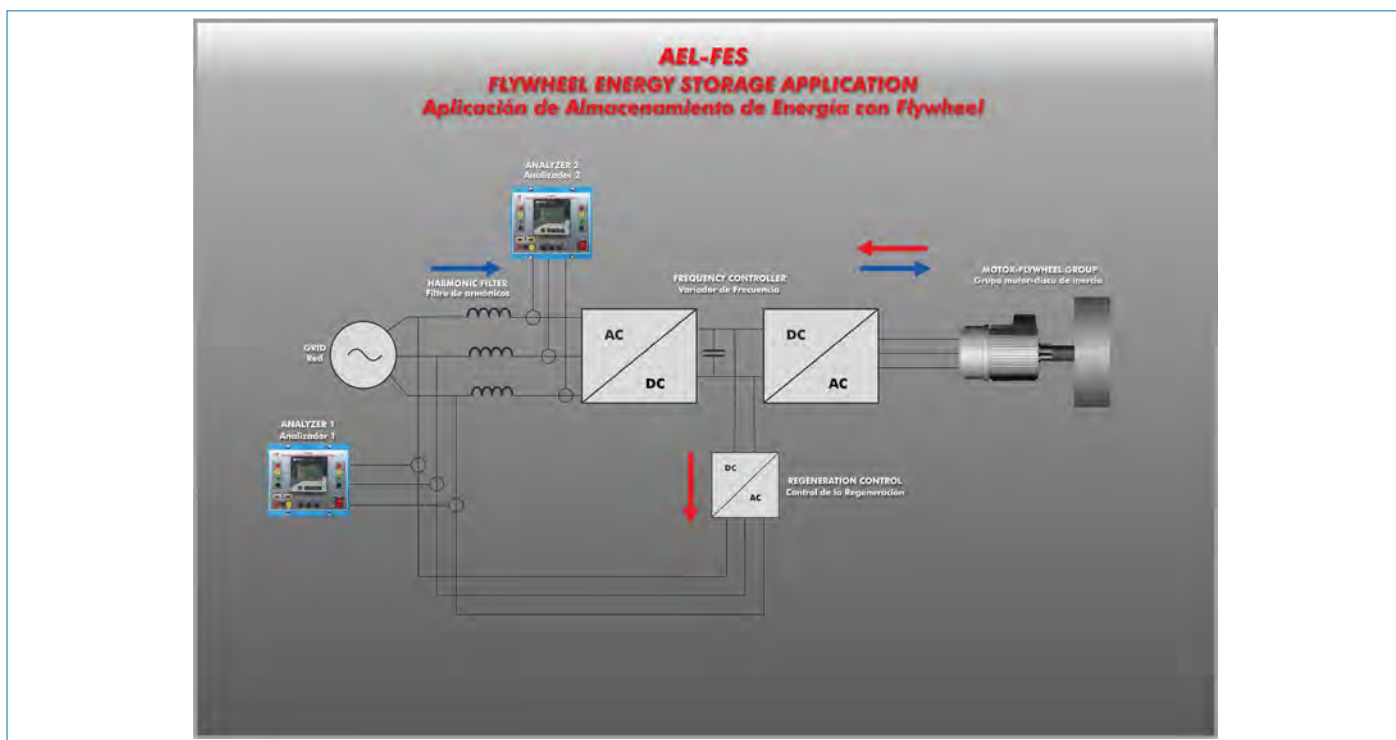




PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



ISO 9001: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)



European Union Certificate (total safety)



Certificates ISO 14001 and ECO-Management and Audit Scheme (environmental management)



"Worlddidac Quality Charter" and Platinum Member of Worlddidac

INTRODUCTION

Nowadays, power generation from different sources is essential in order to achieve a reliable and robust electrical power system. The problem arises when, occasionally, not all the generated energy is consumed (off-peak hours) and that energy surplus is required to be stored somehow so it is returned to the grid when the energy demand increases (peak-hours).

One of the currently used storage systems is the flywheel. Whenever there is electrical energy overproduction, an electric motor coupled to a big mass flywheel is connected to the electrical grid to consume part of that surplus. The flywheel will rotate faster and faster and accumulate the electric energy absorbed from the grid in the form of kinetic energy. Due to the low friction losses, the flywheel will rotate indefinitely until its energy returns to the grid by means of an electric generator.

GENERAL DESCRIPTION

The Flywheel Energy Storage Application, "AEL-FES", has been designed by EDIBON for the theoretical and practical training in the field of energy storage systems based on inertial systems such as the inertial disk (Flywheel) and the elevators with energy regeneration. These systems allow the kinetic or potential energy storage and return it to the grid at a certain moment in the form of electrical energy.

The application "AEL-FES" offers different training levels, providing the user with the essential knowledge and abilities about the fundamental principles of working and operation for the power systems which store energy by means of inertial disks.

Basically, the application consists of a big mass inertial disk coupled to a squirrel cage induction motor. Initially, the induction motor will be coupled to the electrical grid through a frequency controller which will make the disk speed up progressively. At this stage, the user will be able to carry out measurements of the electrical energy provided to the motor (off-peak hours). Once the motor reaches its nominal speed, the disk can be no longer speeded up and the existing consumption will be consequence of the system mechanical losses. This is its limit of stored energy. At the second stage, by means of a regenerative controller, the user will be able to return part of this kinetic energy to the grid (peak-hours). For this purpose, the application includes two network analyzers, one for measuring the energy consumed from the grid and the other one for measuring the energy generated by the electric generator through the previously stored kinetic energy at the flywheel.

The "AEL-FES" includes the following modules:

- N-ALI01. Industrial Main Power Supply.
- N-EALD/A. Advanced Network Analyzer Module. (2 unidades)
- N-WCA7k. 5.5 kW AC Motor Control Module.
- FMG/5k. 5 kW Flywheel-Motor Group.
- N-ERC. Electrical Regeneration Control Module
- TECNEL/TM. Hand Tachometer.

SPECIFICATIONS

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

Supply voltage: 400 VAC, 3 PH+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.



N-ALI01

- **N-EALD/A. Advanced Network Analyzer Module. (2 unidades).**

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-EALD/A

- **N-WCA7k. 5.5 kW AC Motor Control Module.**

Supply voltage: 400 VAC.

Nominal power: 7 kW.

PWM output voltage connections: Three-phases, 230 VAC.

Digital inputs control panel.

Analog inputs control panel.

Setting and visualization display of the machine parameters.



N-WCA7K

Specifications

- **FMG/5k. 5 kW Flywheel-Motor Group.**

Flywheel:

Weight: 30 kg.

Maximum recommended speed: 4000 rpm.

Three-phase squirrel cage motor:

Nominal power: 5 kW.

Nominal voltage: 3x 230/400 VAC Δ /Y.

Frequency: 50/60 Hz.

Number of poles: 2.

RPM: 2730 rpm.



FMG/5k

- **N-ERC. Electrical Regeneration Control Module.**

Module for electric regeneration.

Input and regenerative power with sinusoidal and square current.

Adjustable input and regenerative power control.

Configurable control terminals.



N-ERC

- **TECNEL/TM. Hand Tachometer.**

Two AA batteries.

Three Positions switch to choice the measurement method.

Speed recording push button.

Speed measurement push button.

Disassemble pieces for different shafts.

Speed digital display.



TECNEL/TM

- **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.- Study of the different components of the energy storage system.
 - 2.- Setting of the frequency regulator, acceleration curves of the induction motor and inertia disk.
 - 3.- Measurement of power consumption during inertia disc loading.
 - 4.- Setting of the energy regeneration module.
 - 5.- Measurement of the energy regenerated by the inertia disk.
 - 6.- Relationship between the electrical and mechanical parameters of the inertia disk.
 - 7.- Calculation of the performance of the flywheel regeneration system.
 - 8.- Display of the power consumption curves of the flywheel.
 - 9.- Display of the energy regeneration curves injected into the grid.
- Additional practical possibilities:
- 10.-Several students can visualize the results simultaneously.

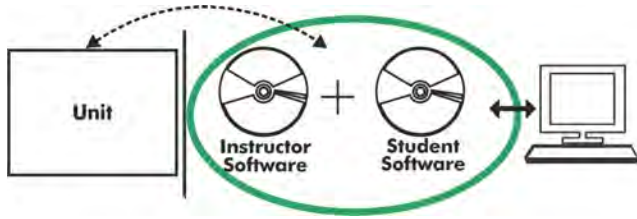
REQUIRED SERVICES

- Electrical supply: three-phase, 380 VAC – 400 VAC/50 Hz or 190 VAC – 240 VAC/60 Hz, 1 kW.

DIMENSIONS AND WEIGHTS

- AEL-FES:
- Dimensions: 490 x 330 x 310 mm approx.
(19.29 x 12.99 x 12.20 inches approx.)
 - Weight: 10 kg approx.
(22 pounds approx.)

AEL-FES/ICAI. Interactive Computer Aided Instruction Software System:



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.

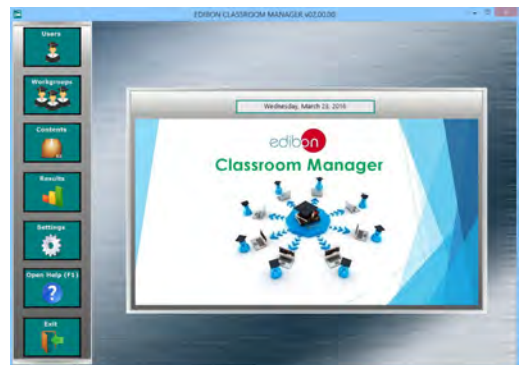
Instructor Software

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

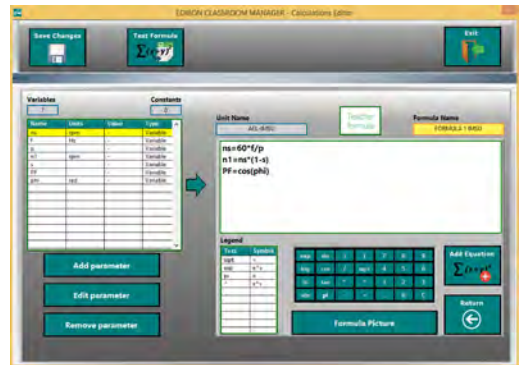
ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual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

Innovative features:

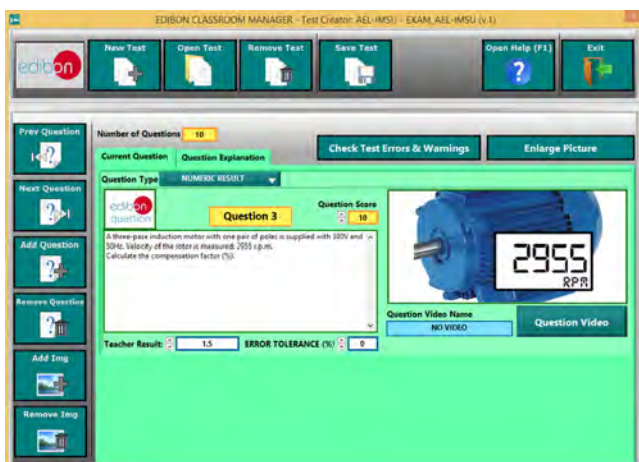
- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.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



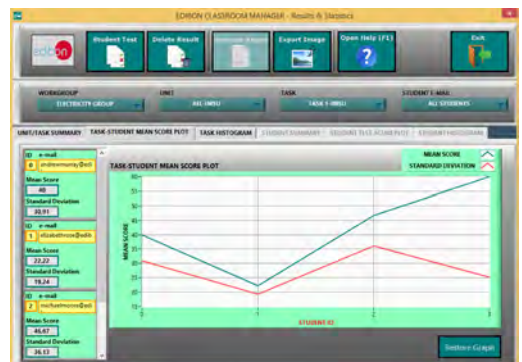
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



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/files/expansion/ICAI/catalog



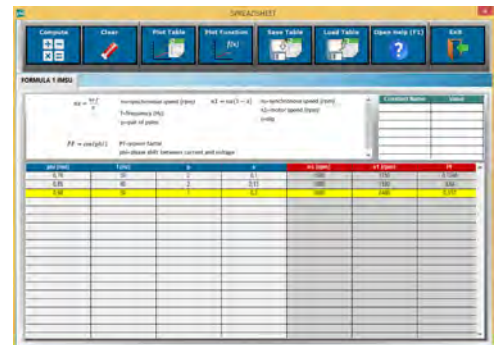
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



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, 10-12-14. 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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REPRESENTATIVE:

