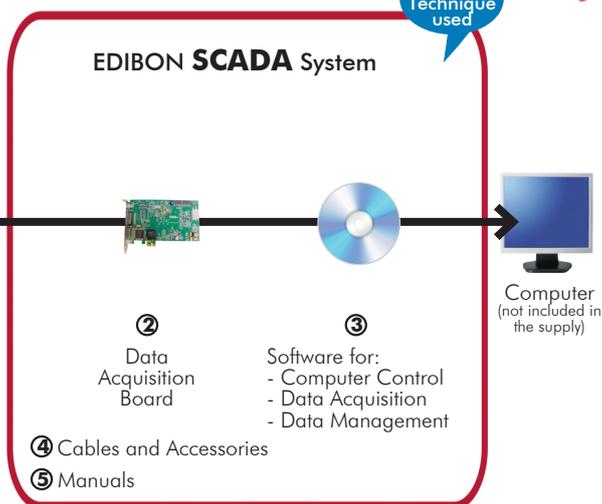


**EDIBON PATENT**

Teaching  
Technique  
used



① Unit: EM-SCADA. Control and Data Acquisition System Software for Electrical Machines



\* Minimum supply always includes: 1 + 2 + 3 + 4 + 5 + 6  
(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).**
- **Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.**
- **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**



**www.edibon.com**  
PRODUCTS  
4 - ELECTRICITY

For more information about Key Features, click here



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



European Union Certificate (total safety)



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



"Worlddidac Quality Charter" and Platinum Member of Worlddidac

## INTRODUCTION

Nowadays it is fundamental to know the performances of the electrical machines (induction motors and transformers) to determinate if these are suitable for the application field which they have been designed for. Electric motors and transformers are induction electrical machines designed to work large periods and sometimes, they must operate beyond its nominal values. For this reason, it is carried out electrodynamic tests in high power rotating electrical machines whose purpose is to operate over a long period of time, supporting important mechanical loads. In the case of transformers, it is needed carry out static tests to find performance and torque curves and several quality parameters to verify that these machines meet all expected requirements.

## GENERAL DESCRIPTION

The Control and Data Acquisition System Software for Electrical Machines, "EM-SCADA", has been developed by Edibon to study and analyze the performance of rotating and static electrical machines such as three-phase and single-phase AC motors, synchronous generators, DC motor-generators or three-phase and single phase transformers.

The "EM-SCADA" is designed to work with both rotating electrical machines and transformers. For this purpose, this system has an interface for the data acquisition of all control and power signals, which are acquired and analyzed with the SCADA System afterwards

In the case of rotating machines, the interface has the corresponding connections to control a servomotor that is coupled to the motor's shaft to be tested. The included SCADA Software has several algorithms, which allow the user to transfer different load profiles to test electric motors under different load conditions. In this way, it can be simulated different load profiles with lineal, constant or exponential slope. During the motor testing procedure with the servomotor working as load, electrical and mechanical parameters are monitored in real time (currents, voltages, power, torque, speed, etc.) to obtain the corresponding results (torque vs speed curve, performance etc.).

In order to carry out transformers testing, the interface has the properly connections to fulfill the electrical parameters measurement when undergoing unloaded and short-circuit test. The results are stored for further analysis with the SCADA System.

The EM-SCADA includes the following elements:

- Control Interface Box.
- Data acquisition board.

This Software is supplied with the EDIBON Computer Control System (SCADA), and includes: The software itself + a Control Interface Box + a Data Acquisition Board + 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, 4 and 5.
- Optional items: 6, 7, 8 and 9.

Let us describe first the main items (1 to 5):

① **EM-SCADA. Unit:**

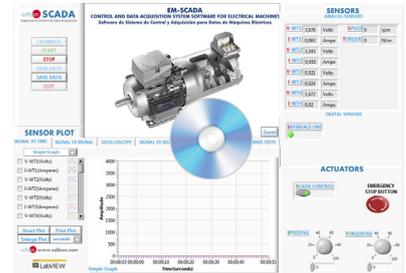
Power supply: 230 VAC.

Input Signals:

- Current signal (x2).
- RMS current signal (x2).
- Voltage signal (x2).
- RMS voltage signal (x2).
- Torque and speed signals.

Output Signals:

- Torque and speed control signal for the servomotor control.



**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.**

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).**

**Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.**

**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 EM-SCADA/CIB. Control Interface Box:

The Control-Interface Box is part of the SCADA system:

Supply voltage: 230 VAC.

Data acquisition speed: 250 KS/s.

Maximum measurable current : 5 A.

Maximum measurable voltage: 500 VDC.

Wire among the control interface-box and the computer.



EM-SCADA/CIB

The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.

Simultaneous visualization in the computer of all parameters involved in the process.

Real time curves representation about system responses.

Storage of all the process data and results in a file.

Graphic representation, in real time, of all the process/system responses.

All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.

All the actuators and sensors values and their responses are displayed on only one screen in the computer.

Shield and filtered signals to avoid external interferences.

Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.

Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

## ③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

PCI Express Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI Express.

Analog input:

Number of channels= 16 single-ended or 8 differential. Resolution= 16 bits, 1 in 65536.

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

Input range (V)= ±10 V. Data transfers=DMA, interrupts, programmed I/O. DMA channels=6.

Analog output:

Number of channels=2. Resolution= 16 bits, 1 in 65536.

Maximum output rate up to: 900 KS/s.

Output range (V)= ±10 V. Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output:

Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency: 0 to 100 MHz.

Timing: Number of Counter/timers=4. Resolution: Counter/timers: 32 bits.



DAB

④ Cables and Accessories, for normal operation.

⑤ Manuals:

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

\*References 1 to 5 are the main items: EM-SCADA + EM-SCADA/CIB + DAB + 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

Exercises for DC/AC motors:

- 1.- Analysis of starting currents and voltages of the rotating machines.
- 2.- Analysis of mechanical parameters (torque and speed) of the rotating machines.
- 3.- Comparison of starting and operating parameters between different motors.
- 4.- Obtaining monitored parameters in terms of different types of graphs such as signal vs signal or signal vs time.
- 5.- Real time display of the torque waveform.
- 6.- Real time display of the speed waveform.
- 7.- Real time display of the current and voltage waveforms.
- 8.- Electrodynamics study of different rotating machines.
- 9.- Manual and automatic braking test and real time monitoring of the results.
- 10.- Obtaining the characteristic curves for different motors (torque-speed curve, torque-current curve).
- 11.- Storage, display and comparison of the fulfilled test.

Exercises for single-phase and three-phase transformers:

- 12.- Three-Phase transformer short-circuit test.
- 13.- Three-phase transformer unloaded test.
- 14.- Single-Phase transformer short-circuit test.
- 15.- Single-Phase transformer unloaded test.

Other possibilities to be done with this unit:

- 16.- Many students can view results simultaneously, real time, by means of a projector or an electronic whiteboard
- 17.- The Computer Control System with SCADA allows a real industrial simulation.
- 18.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
- 19.- This unit can be used for doing applied research.

20.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

21.- Control of the EM-SCADA unit process through the control interface box without the computer.

21.- Visualization of all the sensors values used in the EM-SCADA unit process.

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

### REQUIRED SERVICES

- Electrical supply: single phase, 220 V/50 Hz or 110 V/60 Hz.
- Computator.

### DIMENSIONS AND WEIGHTS

EM-SCADA:

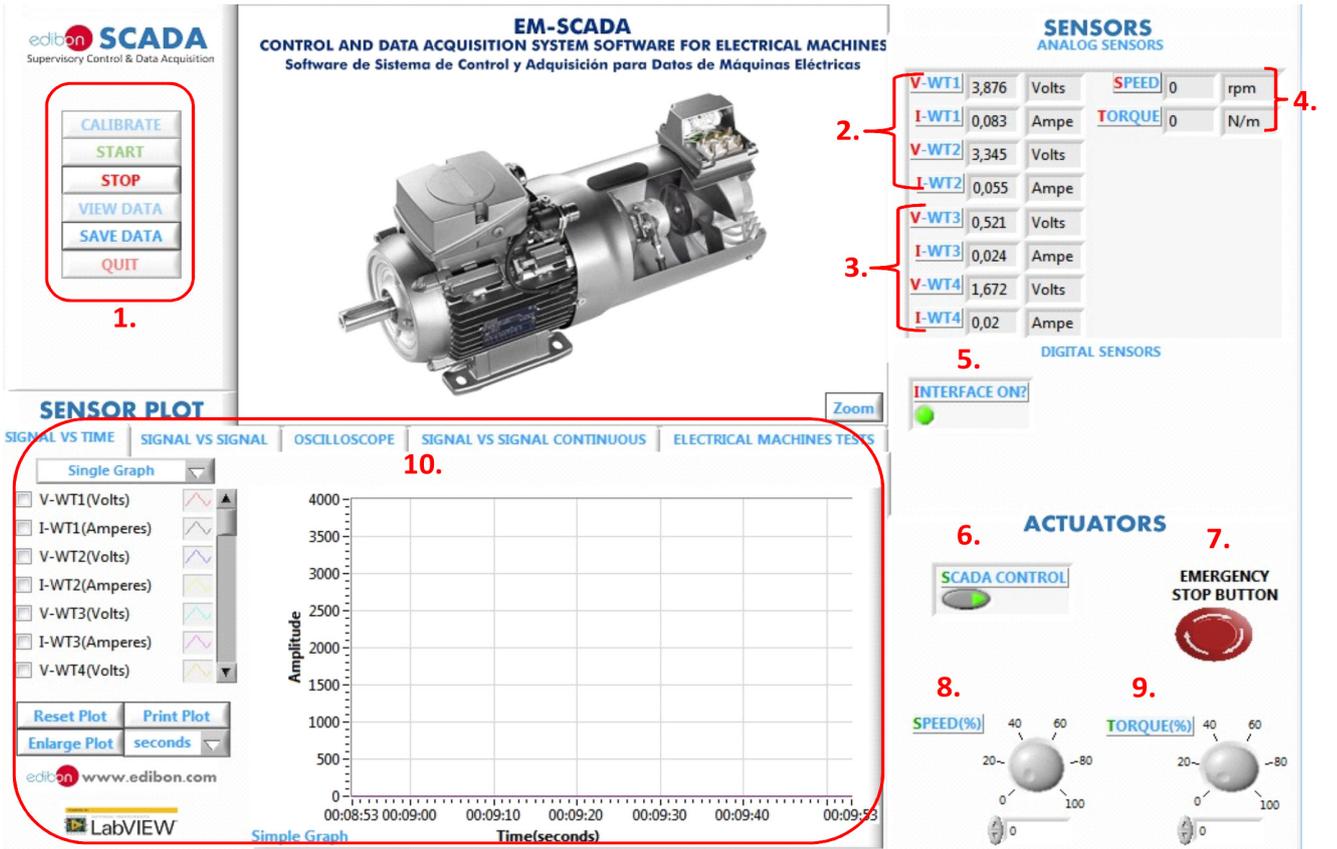
Control Interface Box:

- Dimensions: 490 x 330 x 310 mm approx.  
(19.29 x 12.99 x 12.20 inches approx)
- Weight: 3 Kg approx.  
(6 pounds approx).

### AVAILABLE VERSIONS

- AEL-ACEMT. Advanced AC Electrical Motors Application.
- AEL-DCENT. DC Electrical Motors Application.
- AEL-SPTT. Single-Phase Transformer Application.
- AEL-TPTT. Three-Phase Transformer Application.

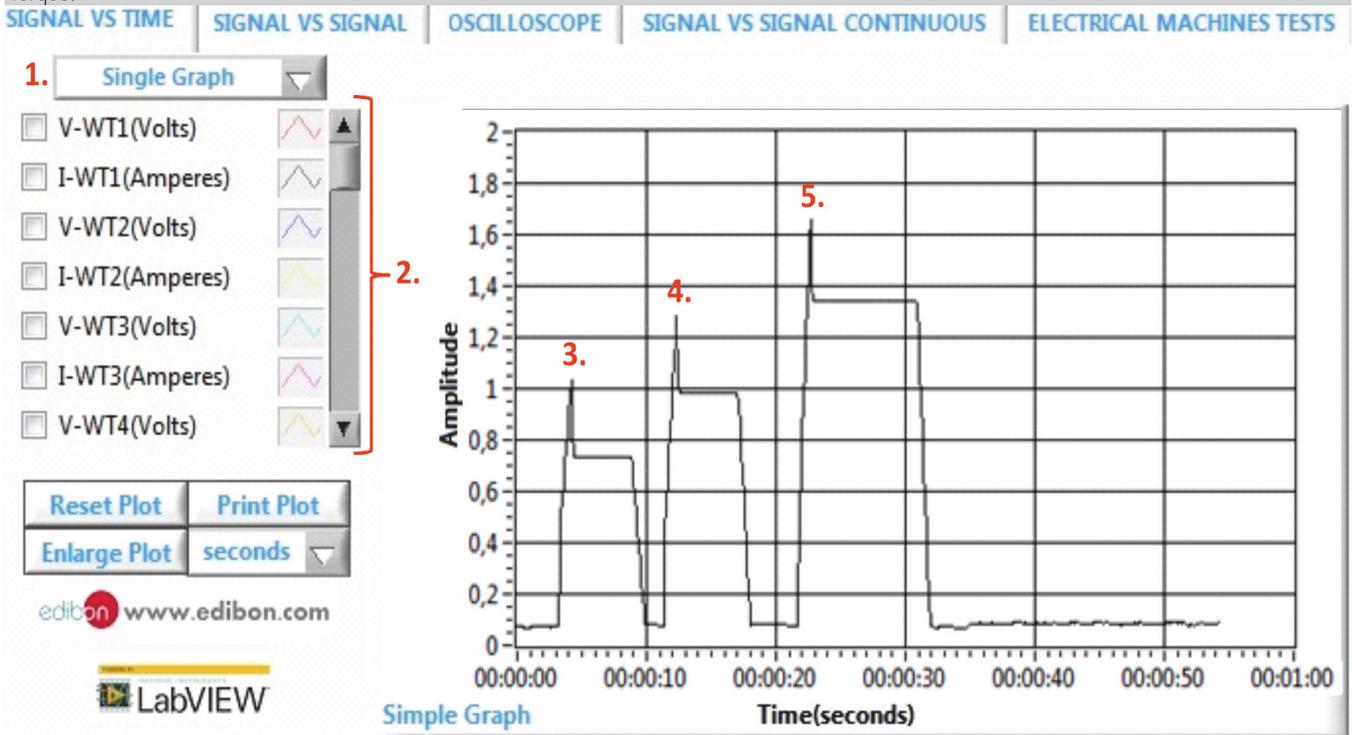
## MAINS SCREENS



- ① Main menu. Start-up, stop, view data, save data and quit.
- ② RMS voltages and currents measurements. It shows RMS values for the real time measured voltages and currents.
- ③ Real voltages and currents measurements. It shows the exact values for the real time measured voltages and currents.
- ④ Torque and speed measurements. It shows the machine torque and speed real time values.
- ⑤ Interface ON pilot light indicator. The green pilot means the right operation of the control-interface box.
- ⑥ SCADA control switch. To enable the actuators control from the software.
- ⑦ Emergency stop button.
- ⑧ Speed actuator. In order to set the desired speed value through the potentiometer or entering the exact value.
- ⑨ Torque actuator. In order to set the desired torque value through the potentiometer or entering the exact value.
- ⑩ Screen selector.

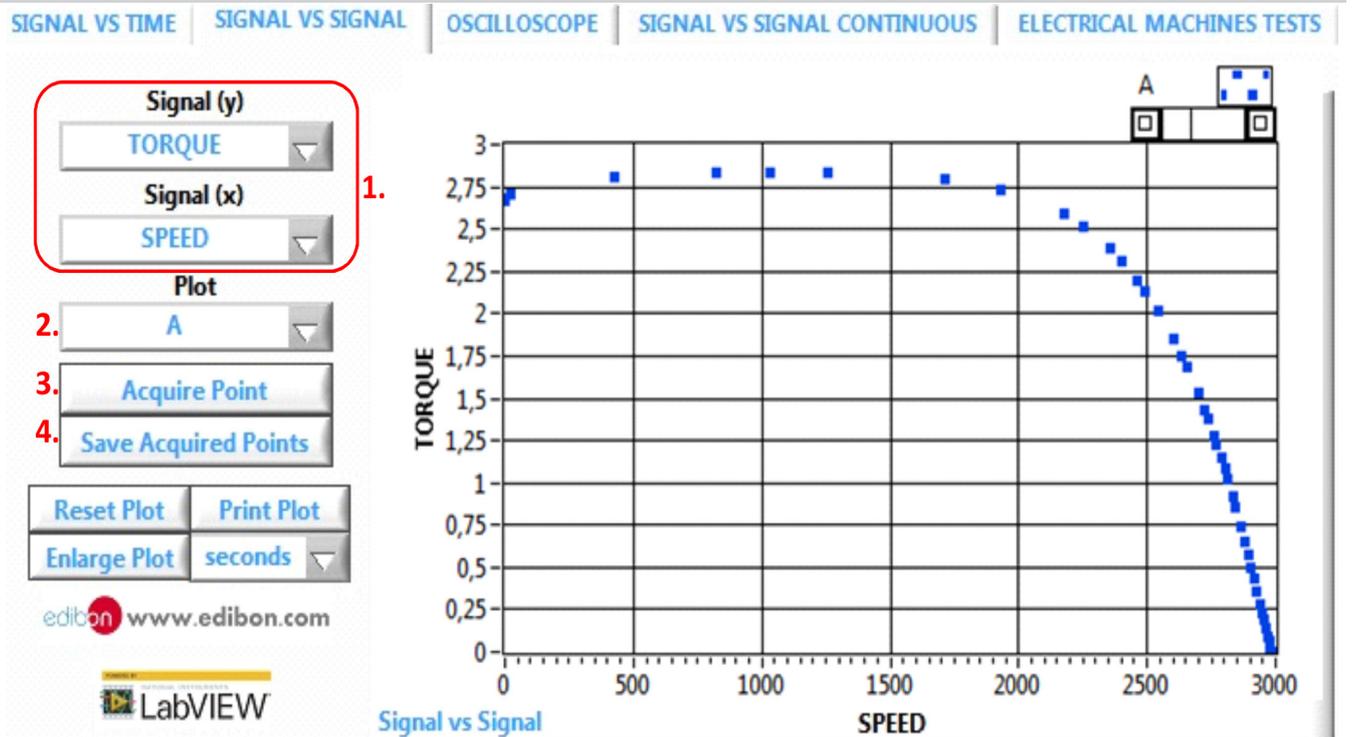
## SOME REAL RESULTS OBTAINED FROM THIS APPLICATION

Signal vs Time chart for the RMS value of the starting current for the Three-Phase Asynchronous Squirrel Cage Motor, with 10%, 20 % and 30 % applied torque.



- ① Type of graph selector. Simple or several signals overlapping.
- ② Parameters selection. It allows choosing the parameters to be displayed and the setting for its display.
- ③ Starting current for 10% of brake torque.
- ④ Starting current for 20% of brake torque.
- ⑤ Starting current for 30% of brake torque.

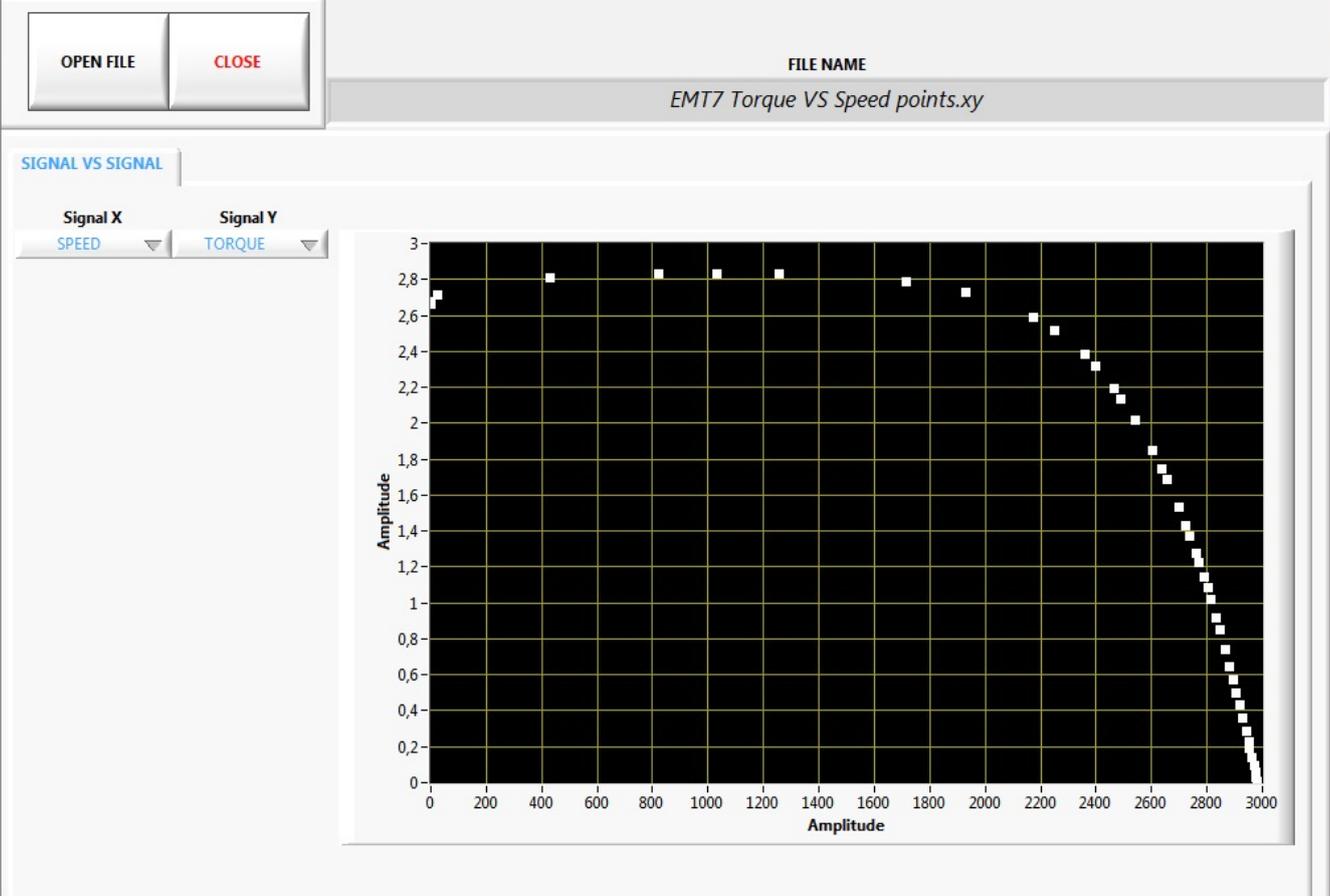
Representation of the torque-speed curve for the Three-Phase Asynchronous Squirrel Cage Motor. Notice that the motor nominal speed and the maximum torque can be appreciated.



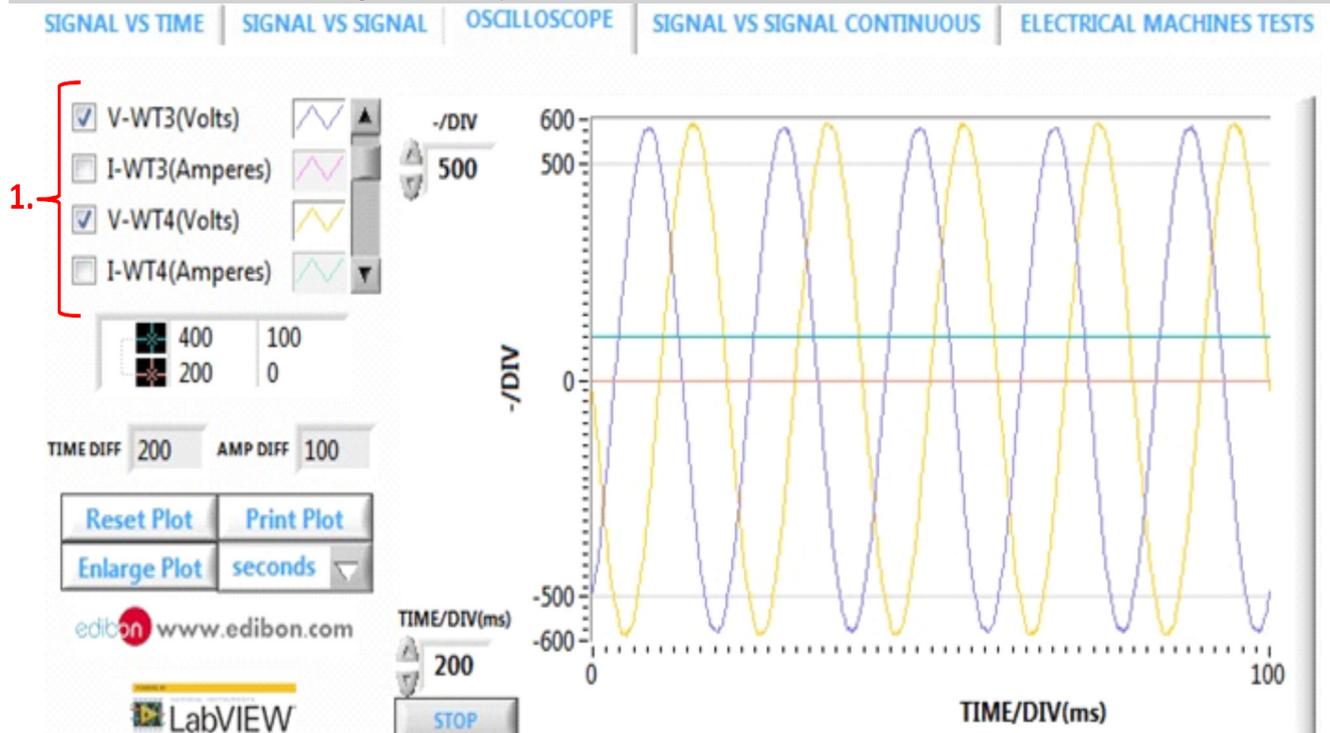
- ① Axis signal selector. It allows selecting the parameter to be monitored in each axis.
- ② Type of graph selector.
- ③ Acquire points. It allows displaying in the graph the point corresponding to the time when it is pressed.
- ④ Save acquired points. It allows saving the acquired points, which will start erasing automatically after 500 samples.

Some **real** results obtained from this Application

Representation and display of the stored data.



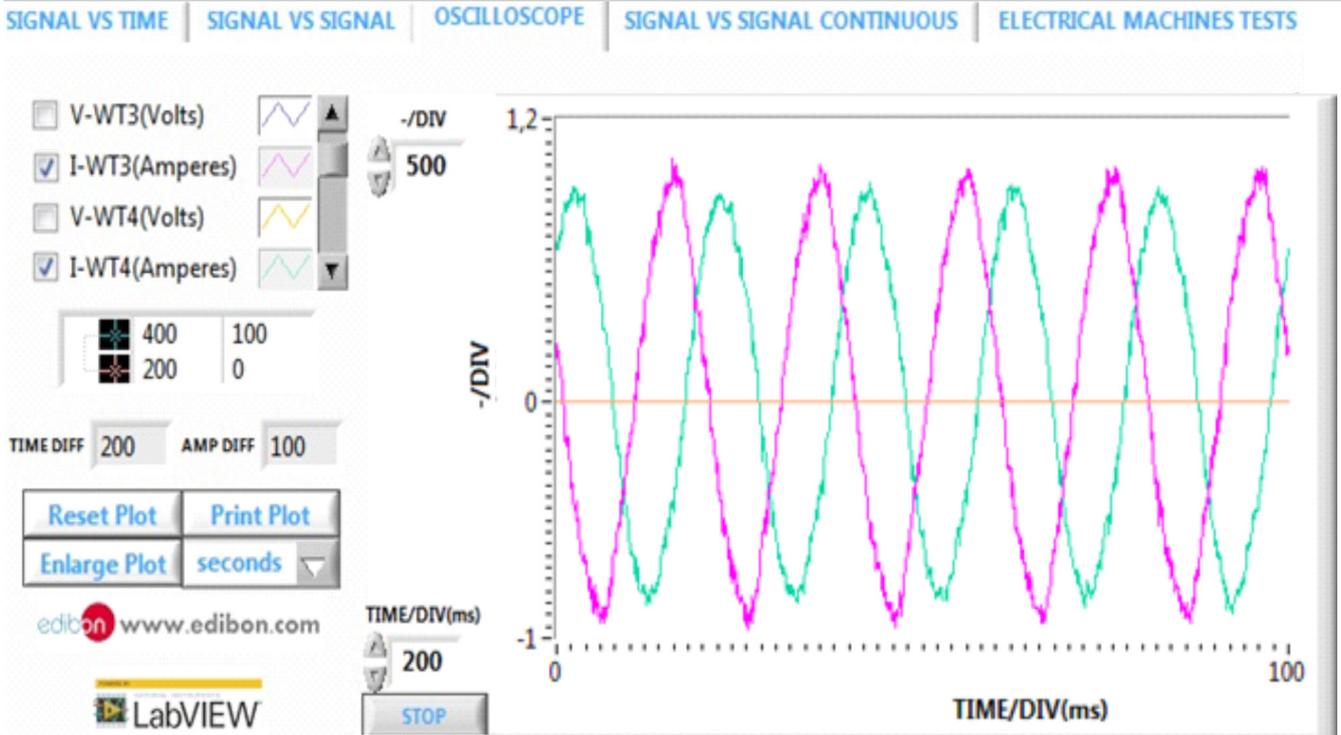
Waveform chart for the real time voltages measured by the interface.



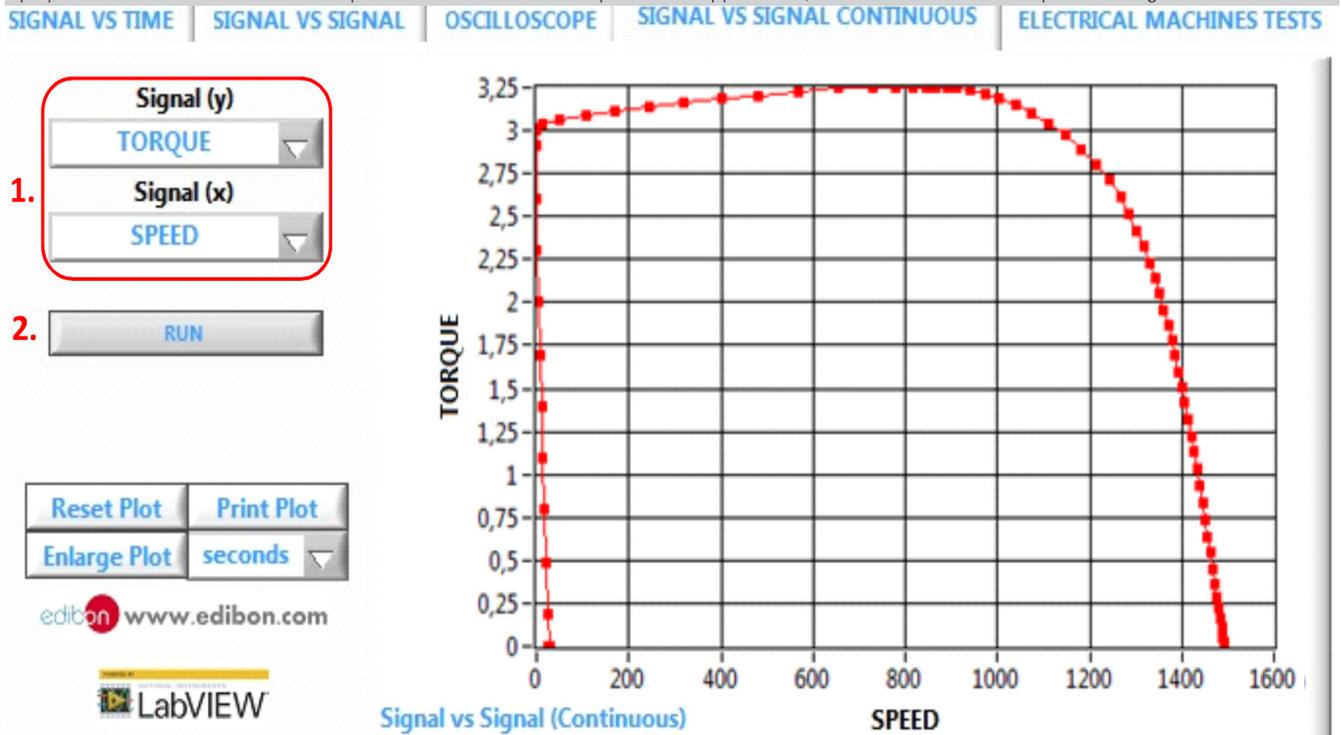
① Parameters selector. It allows choosing the parameters whose waveforms want to be displayed.

Some **real** results obtained from this Application

Waveform chart for the real time currents measured by the interface.



Representation of the torque-speed curve for the manual braking test with the Three-Phase Asynchronous Motor of two speeds, no load speed (1500 rpm). Notice that the motor nominal speed and the maximum torque can be appreciated, as well as the motor complete braking.

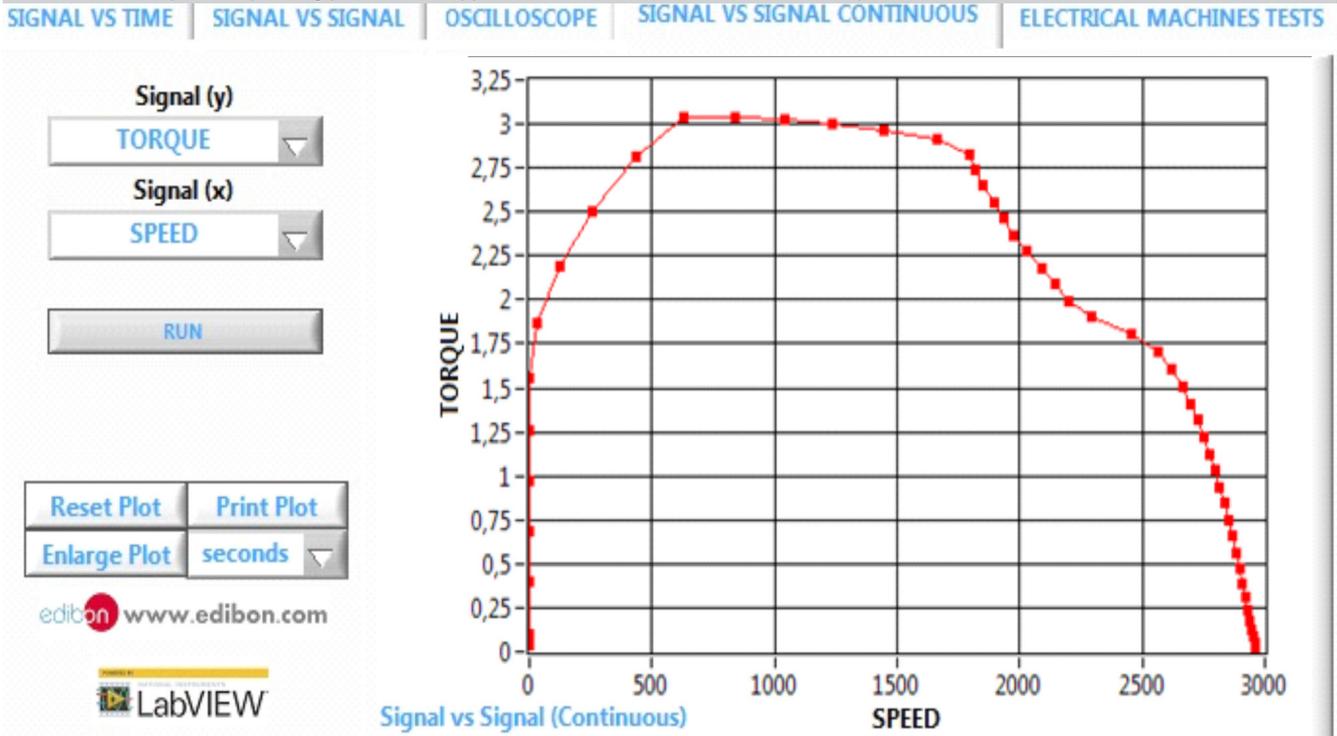


① Axis signal selector. It allows selecting the parameter to be monitored in each axis.

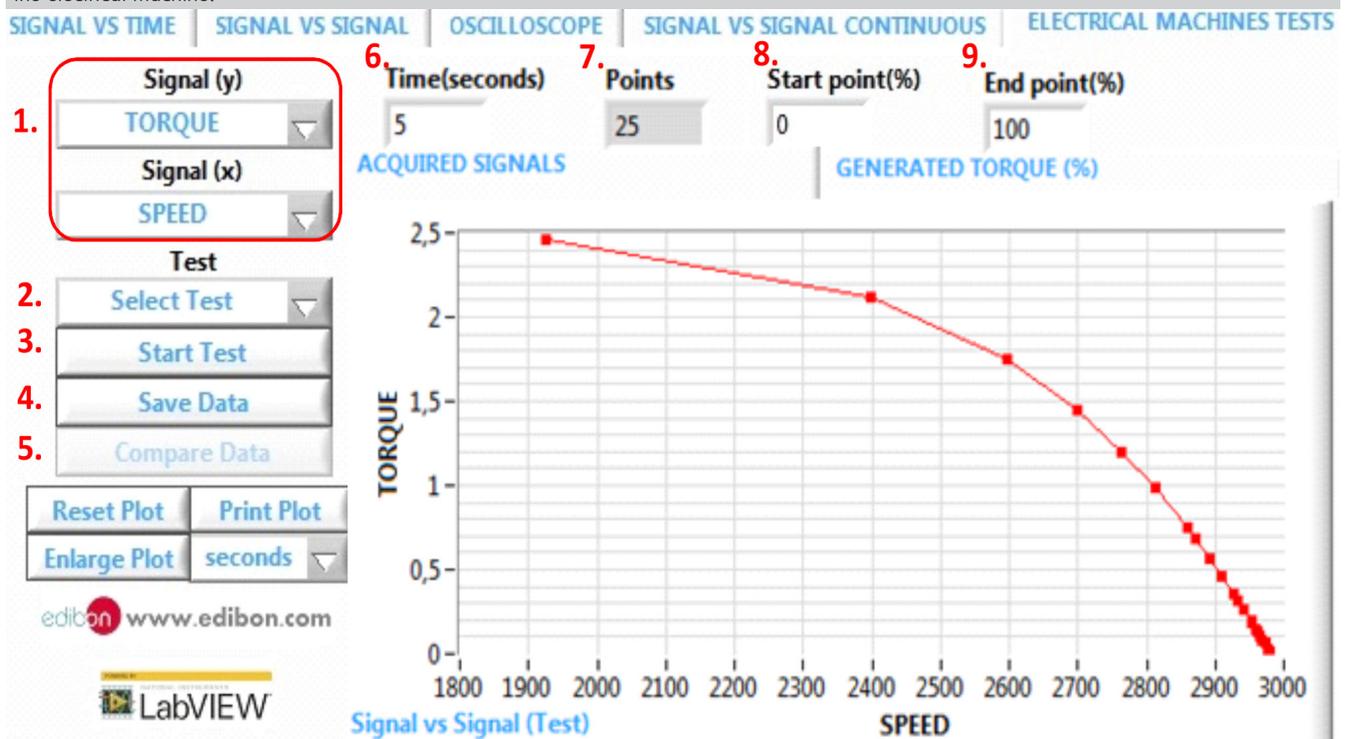
② Run. It allows starting the manual braking test.

Some **real** results obtained from this Application

Representation of the torque-speed curve for the manual braking test with the Single-Phase Asynchronous Motor with starting and running capacitor. Notice that the capacitor operating point can be appreciated, as well its effect on the machine parameters.



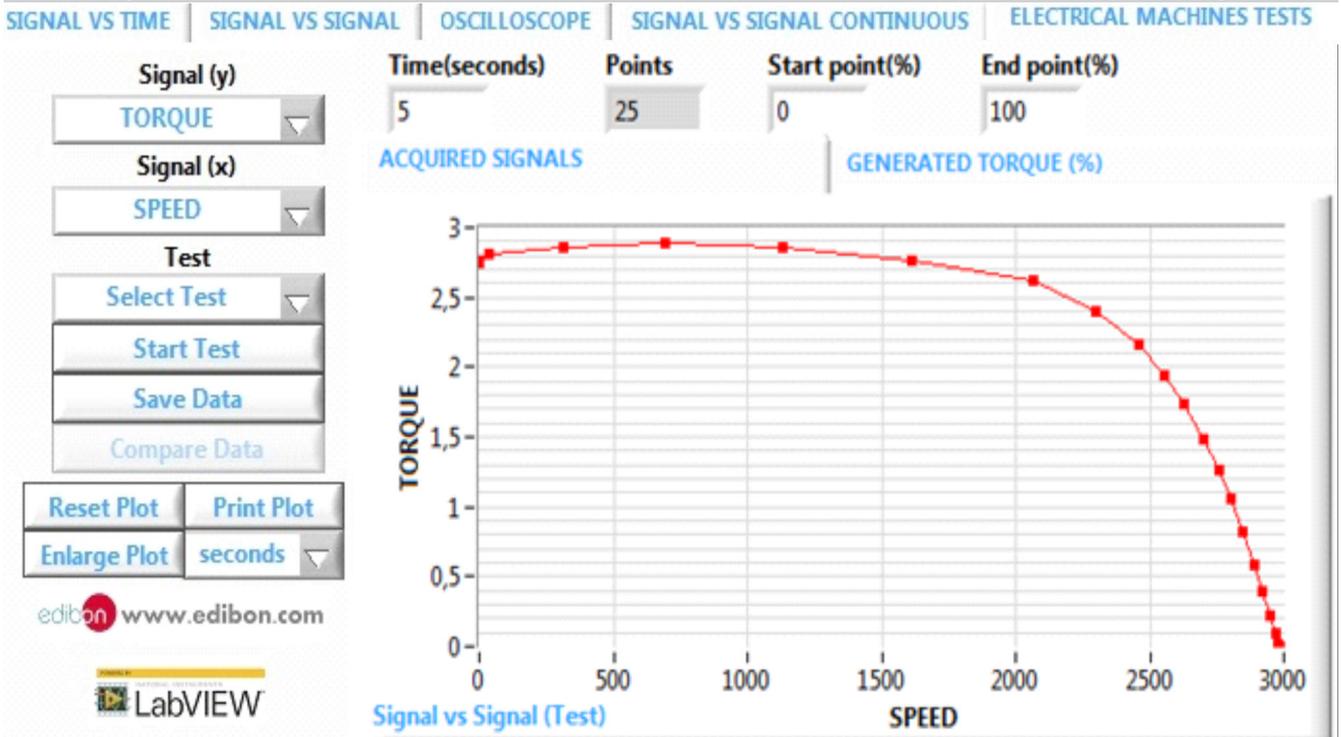
Obtained results for the automatic braking test with the Three-Phase Asynchronous Squirrel Cage Motor, with delta connection, from 0 to 100% and exponential braking slope. The motor nominal speed can be appreciated as well as the fact that the exponential slope is not enough to brake completely the electrical machine.



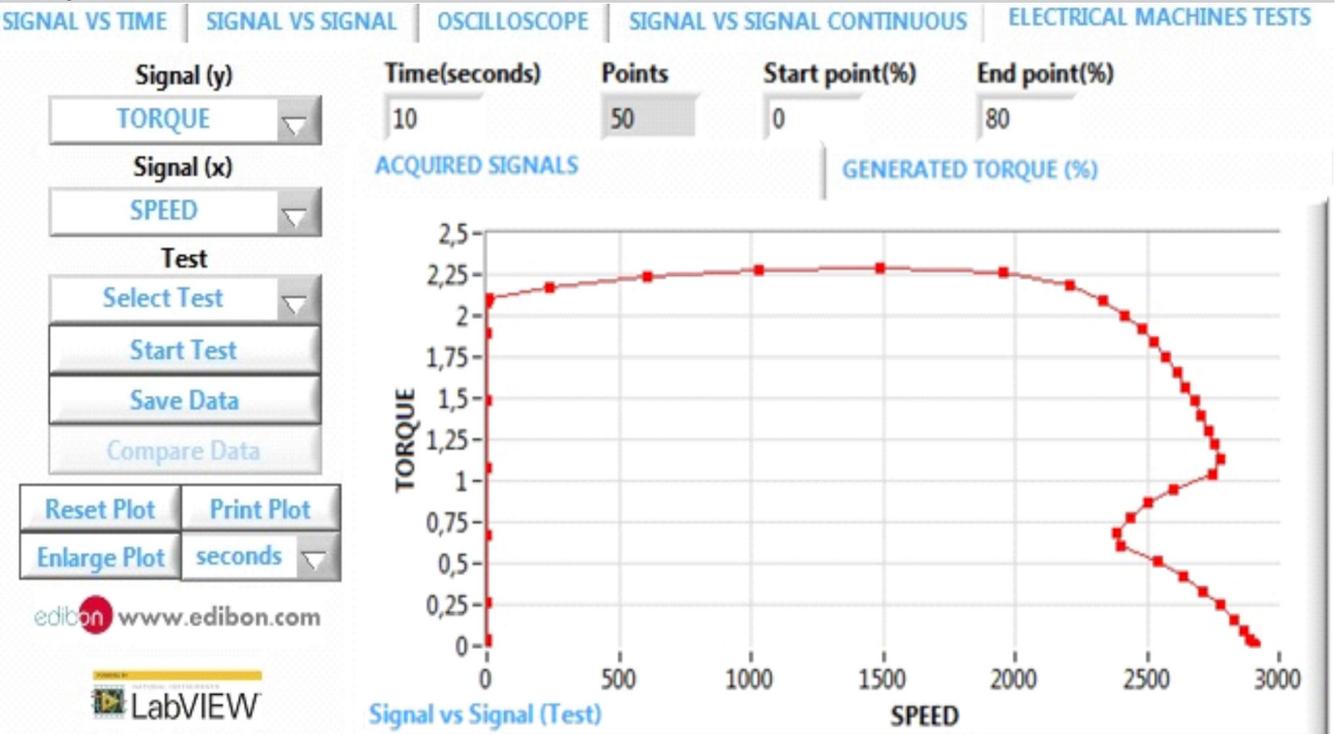
- ① Axis signal selector. It allows selecting the parameter to be monitored in each axis.
- ② Type of test selector. It allows selecting the type of automatic braking test to be fulfilled; lineal, constant or exponential slope.
- ③ Inicial test.
- ④ Save data. It allows saving the obtained test results.
- ⑤ Compare data. It allows comparing in the same graph up to three different test.
- ⑥ Test time. It allows selecting the length of the test to be fulfilled.
- ⑦ Points. It shows the number of points that will define the resulting plot.
- ⑧ Start point. It allows selecting (as a percentage) the start point for the test to be fulfilled.
- ⑨ End point. It allows selecting (as a percentage) the end point of the test to be fulfilled.

Some **real** results obtained from this Application

Obtained results for the automatic braking test with the Three-Phase Asynchronous Squirrel Cage Motor, with delta connection, from 0 to 100% and linear braking slope. Notice that the motor nominal speed and the maximum torque can be seen, as well as the motor complete braking.

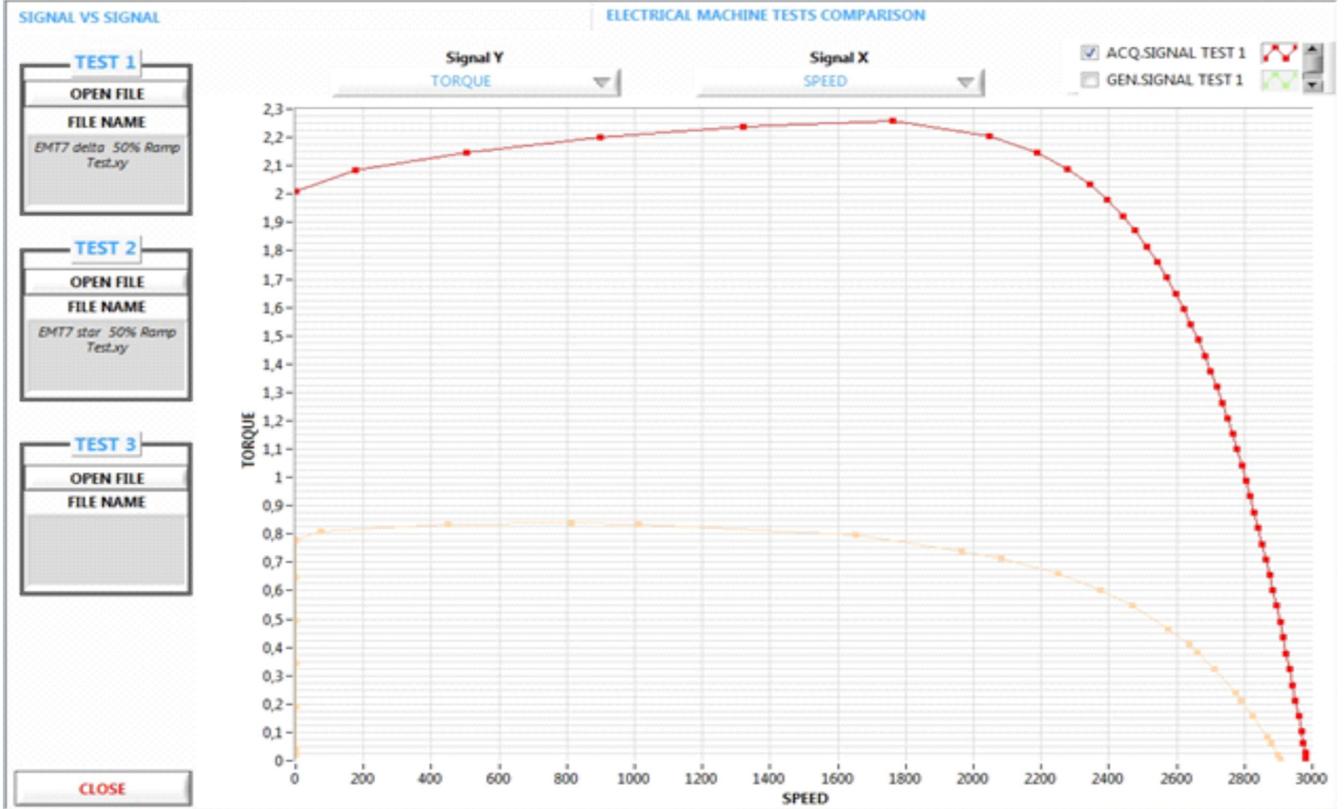


Obtained results for the automatic braking test with the Three-Phase Asynchronous Squirrel Cage Motor, with star-delta starting, from 0 to 80% and linear braking slope. Notice that the condenser operating point condenser can be appreciated, as well as the motor nominal speed and its complete braking.

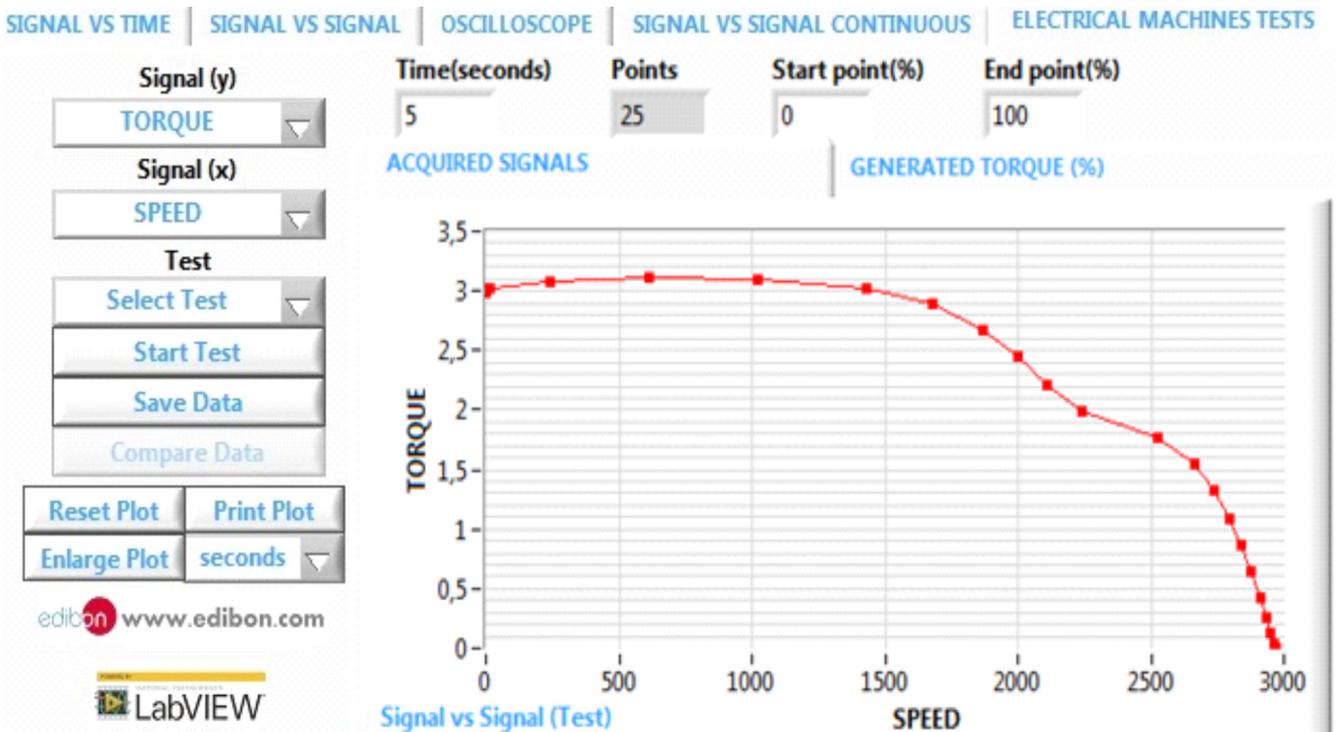


Some **real** results obtained from this Application

This picture shows the comparison between the results obtained in the two test carried out with the Three-Phase Asynchronous Squirrel Cage Motor, one with star connection ,the other one with delta connection and both from 0% to 50 % with lineal slope.



Obtained results for the automatic braking test with the Single-Phase Asynchronous Motor with starting and running capacitor, from 0 to 100 % linear braking slope. The capacitor operating point and the effects on the machine parameters can be appreciated, as well as the motor nominal speed and its complete braking.



## COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

Additionally to the main items (1 to 5) described, we can offer, as optional, other items from 6 to 9.

All these items try to give more possibilities for:

- a) Technical and Vocational Education configuration. (ICAI and FSS)
- b) Multipost Expansions options. (MINI ESN and ESN)

### a) Technical and Vocational Education configuration

#### ⑥ EM-SCADA/ICAI. Interactive Computer Aided Instruction Software System.

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

This software is optional and can be used additionally to items (1 to 5).

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

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

Innovative features:

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

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

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

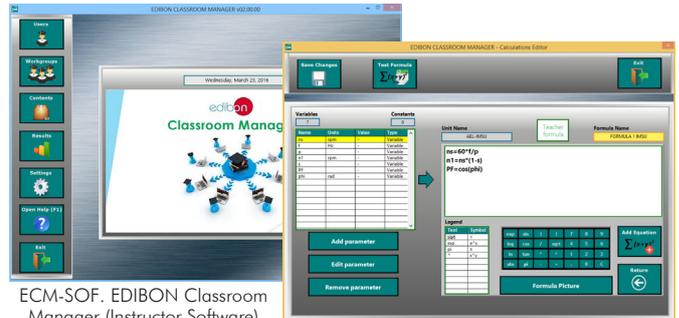
Innovative features:

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

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

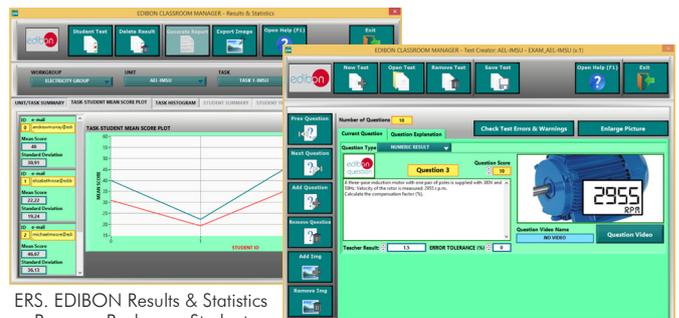
[www.edibon.com/en/files/expansion/ICAI/catalog](http://www.edibon.com/en/files/expansion/ICAI/catalog)

#### Instructor Software



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

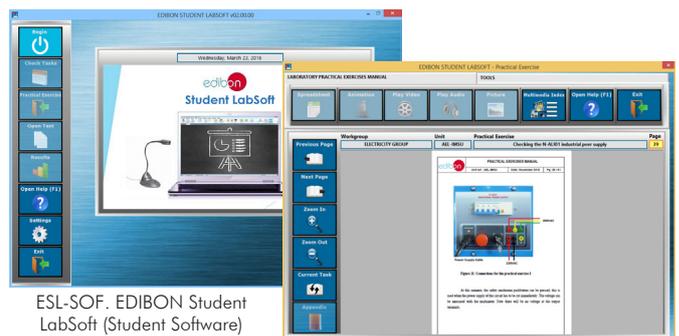
ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

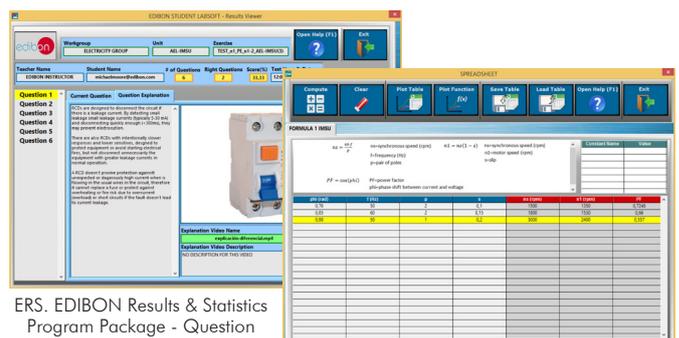
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

#### Student Software



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

EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation

ECAL. EDIBON Calculations Program Package Main Screen

⑦ **EM-SCADA/FSS. Faults Simulation System.**

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

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

Faults affecting the sensors measurement:

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

Faults affecting the actuators:

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

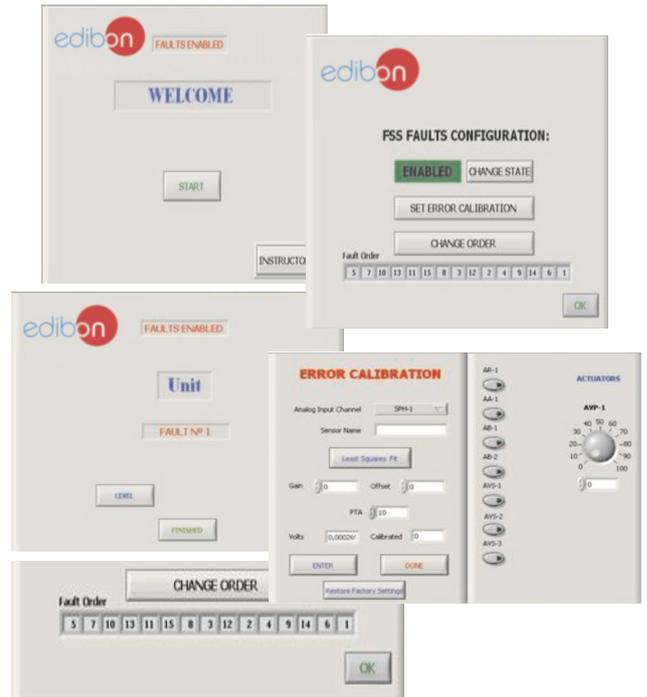
Faults in the controls execution:

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

On/off faults:

- Several on/off faults can be included.

Example of some screens



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

[www.edibon.com/en/files/expansion/FSS/catalog](http://www.edibon.com/en/files/expansion/FSS/catalog)

b) Multipost Expansions options

⑧ **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:

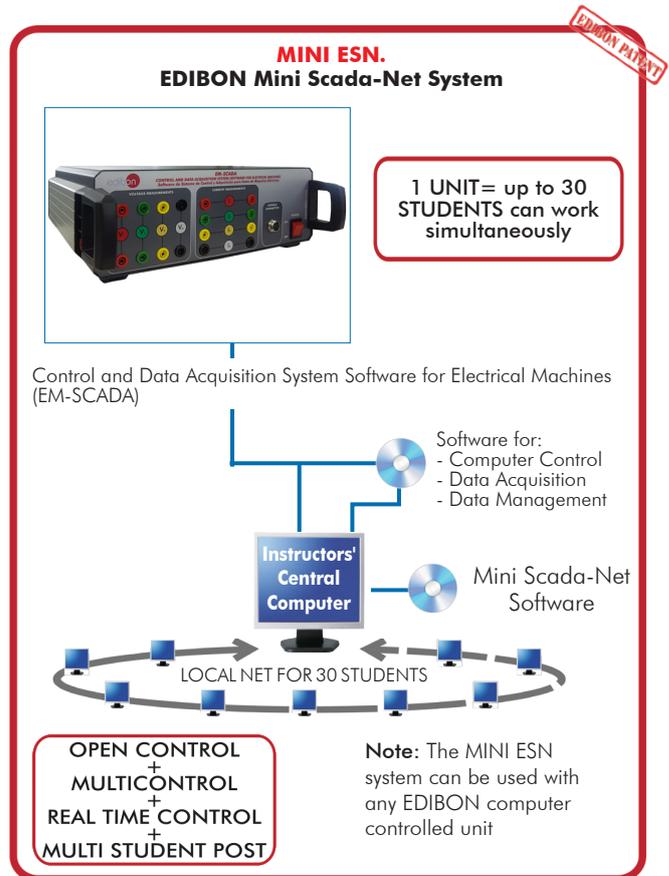
[www.edibon.com/en/files/expansion/MINI-ESN/catalog](http://www.edibon.com/en/files/expansion/MINI-ESN/catalog)

⑨ **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/files/expansion/ESN/catalog](http://www.edibon.com/en/files/expansion/ESN/catalog)



## ORDER INFORMATION

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

Minimum supply always includes:

- ① **Unit: EM-SCADA. Control and Data Acquisition System Software for Electrical Machines.**
- ② **EM-SCADA/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **Cables and Accessories**, for normal operation.
- ⑤ **Manuals.**

\***IMPORTANT:** Under EM-SCADA we always supply all the elements for immediate running as 1, 2, 3, 4 and 5.

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

#### a) Technical and Vocational Education configuration

- ⑥ EM-SCADA/ICAL. Interactive Computer Aided Instruction Software System.
- ⑦ EM-SCADA/FSS. Faults Simulation System.

#### b) Multipost Expansions options

- ⑧ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.
- ⑨ ESN. EDIBON Scada-Net Systems.

**① EM-SCADA. Unit:**

Power supply: 230 VAC.

Input Signals:

Current signal (x2).

RMS current signal (x2).

Voltage signal (x2).

RMS voltage signal (x2).

Torque and speed signals.

Output Signals:

Torque and speed control signal for the servomotor control.

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.

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).

Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.

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 EM-SCADA/CIB. Control Interface Box:**

The Control Interface Box is part of the SCADA system.

Supply voltage: 230 VAC.

Data acquisition speed: 250 KS/s.

Maximum measurable current : 5 A.

Maximum measurable voltage: 500 VDC.

Wire among the control interface-box and the computer.

The unit control elements are permanently computer controlled.

Simultaneous visualization in the computer of all parameters involved in the process.

Real time curves representation about system responses.

All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.

Shield and filtered signals to avoid external interferences.

Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.

Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

**③ DAB. Data Acquisition Board:**

The Data Acquisition board is part of the SCADA system.

PCI Express Data acquisition board (National Instruments) to be placed in a computer slot.

Analog input: Channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).

Analog output: Channels=2. Resolution=16 bits, 1 in 65536.

Digital Input/Output: Channels=24 inputs/outputs.

**④ Cables and Accessories, for normal operation.**

**⑤ Manuals:**

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

### Exercises and Practical Possibilities to be done with the Main Items

Exercises for DC/AC motors:

- 1.- Analysis of starting currents and voltages of the rotating machines.
- 2.- Analysis of mechanical parameters (torque and speed) of the rotating machines.
- 3.- Comparison of starting and operating parameters between different motors.
- 4.- Obtaining monitored parameters in terms of different types of graphs such as signal vs signal or signal vs time.
- 5.- Real time display of the torque waveform.
- 6.- Real time display of the speed waveform.
- 7.- Real time display of the current and voltage waveforms.
- 8.- Electrodynamics study of different rotating machines.
- 9.- Manual and automatic braking test and real time monitoring of the results.
- 10.- Obtaining the characteristic curves for different motors (torque-speed curve, torque- current curve).
- 11.- Storage, display and comparison of the fulfilled test.

Exercises for single-phase and three-phase transformers:

- 12.- Three-Phase transformer short-circuit test.
- 13.- Three-phase transformer unloaded test.
- 14.- Single-Phase transformer short-circuit test.
- 15.- Single-Phase transformer unloaded test.

Other possibilities to be done with this unit:

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

### a) Technical and Vocational Education configuration

#### ⑥ EM-SCADA/ICAI. Interactive Computer Aided Instruction Software System.

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

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

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

Innovative features:

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

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

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

Innovative features:

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

#### ⑦ EM-SCADA/FSS. Faults Simulation System.

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

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

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

Faults affecting the sensors measurement:

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

Faults affecting the actuators:

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

Faults in the controls execution:

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

On/off faults:

- Several on/off faults can be included.

b) Multipost Expansions options

③ **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.



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