Engineering and Technical
Teaching Equipment

Application of AC Three-Phase Induction Motor of Squirrel Cage

AEL-ACINA

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↳PRODUCTS
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INTRODUCTION

The electric motors are devices capable of transforming electrical energy into mechanical energy. The squirrel cage motors are very used in industrial installations due to its great robustness, reliability and low cost.

The starting current consumed by these motors is very high, being harmful to the machine and the protections. The soft starters aim at reducing these currents close to the nominal values. For this purpose it is very important to know several operations carried out with these electrical machines.

GENERAL DESCRIPTION

The Application of AC Three-Phase Induction Motor of Squirrel Cage, "AEL-ACINA", has been designed by EDIBON to the study of the main operations performed in the industrial field with three-phase squirrel cage induction motors. The student will learn the most important operations of these electrical machines faithfully by using commutators, timers and contactors.

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

- N-ALI01. Industrial Main Power Supply Module.
- N-PUL48. Module with Three Dual Camera Push Buttons.
- N-LAM02. Auxiliary Lamps Module.
- N-CON01. Three-Pole Contactor Module (24 VAC). (4 units)
- N-ARR01. Star-Delta Manual Start Module.
- N-REL30. Synchronization Relay Module. (3 units)
- N-ALI03. AC Auxiliary Power Supply (24 Vac) Module.
- N-TRANS03. Three-Phase Autotransformer 400/230 VAC, 1 kVA, Module.
- N-ARR13. Direct Starter with Inversion Module.
- FLYW. Flywheel.
- EMT7. 3PH Squirrel-Cage Motor.

Additional recommended elements (Not included):

- Digital Instrumentation:
  - N-EALD. Electrical Network Analyzer Module with Oscilloscope and Data Acquisition.
  - EM-SCADA. Control and Data Acquisition System Software for Electrical Machines.
- Analog Instrumentation:
  - N-MED10. AC Ammeter (0-5 A) Module.
  - N-MED22. AC Voltmeter (0-400 V) Module.
  - N-MED33. Balanced Three-Phase Wattmeter Module (350-0-350W, 440VAC, 500mA).
  - N-MED31. Three-Phase Phase Meter Module 400V.
  - N-MED39. Balanced Three-Phase Var Meter Module 440V.

If the Option A (modules mounted on rack) is chosen, the rack/s required will depend on the optional modules requested by the customer.

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

Option A:

This application needs the following racks:

- N-RACK-A.
- N-RACK-B.

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-WBC, Electrical workbench (rail) can be supplied to mount the modules.

SPECIFICATIONS

The application "AEL-ACINA" 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-PUL48. **Module with Three Dual Camera Push Buttons.**
  - Two independent chambers.
  - Nominal voltage: 24 VAC.
  - Three double chamber push-buttons (green and red).
  - Contacts:
    - Three normally open contacts (NO) for green switch.
    - Three normally close contacts (NC) for red switch.

N-PUL48

- N-LAM02. **Auxiliary Lamps Module.**
  - Nominal voltage: 24 VAC.
  - Three lamps (red, yellow and green).

N-LAM02

- N-CON01. **Three-Pole Contactor Module (24 VAC). (4 units)**
  - Nominal voltage for power contacts: 400 VAC.
  - Nominal voltage for control contacts: 24 VAC.
  - Nominal voltage for the control coil: 24 VAC.
  - Contacts:
    - Three-phase normally open contact (NO) for power circuit.
    - Three normally open contacts (NO) for control circuit.
    - Two normally close contacts (NC) for control circuit.

N-CON01

- N-ARR01. **Star-Delta Manual Start Module.**
  - Nominal voltage: 400 VAC.
  - Maximum contacts current: 10 A.
  - Star-delta three positions commutator:
    - 0: Open circuit.
    - Y: Star connection.
    - Δ: Delta connection.

N-ARR01

- N-REL30. **Synchronization Relay Module. (3 units)**
  - Nominal voltage for power contacts: 400 VAC.
  - Nominal voltage for control contacts: 24 VAC.
  - Nominal voltage for the control coil: 24 VAC.
  - Contacts:
    - One three-phase normally open contact (NO) for power circuit.
    - Three auxiliary contacts:
      - One instantaneous normally open contact (NO).
      - One time normally open contact (NO).
      - One time normally close contact (NC).

N-REL30

- N-ALI03. **AC Auxiliary Power Supply (24 Vac) Module.**
  - Voltage supply (single-phase): 230 VAC, 1PH + N.
  - Output voltage:
    - Single–Phase 24 VAC / 12 VAC.
    - 24 VDC.
    - 0 – 24 VDC through potentiometer.

- N-TRANS03. **Three-Phase Autotransformer 400/230 VAC, 1 kVA, Module.**
  Three-phase autotransformer.
  Nominal supply voltage: 400 VAC (3 PH).
  Nominal output voltage: 3 x 230 VAC (3 PH + N).
  Nominal power: 1 kVA.
  Transformer connection: YY0.
  Start/stop commutator for instantaneous connection/disconnection of the grid transformer.
  Fuses: 3 x 5 A.


N-ALI03

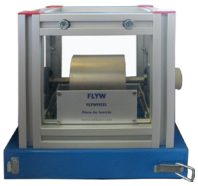
- N-ARR13. **Direct Starter with Inversion Module.**
  Nominal voltage: 400 VAC.
  Three input terminals for power supply connection.
  Six output terminals for motor connection.
  Maximum contacts current: 10 A.
  Three position switch:
  0: Open circuit.
  1: Direct connection.
  2: Reverse connection.


N-TRANS03

- FLYW. **Flywheel.**
  Weight: 2 kg.
  Maximum recommended speed: 4000 rpm.
  Moment of inertia: 0.0025 kgm^2.


N-ARR13

- EMT7. **3PH Squirrel-Cage Motor.**
  Nominal power: 370 W.
  Nominal voltage: 3 x 230 / 400 VAC Δ/Y.
  Frequency: 50 / 60 Hz.
  Number of poles: 2.
  Speed: 2730 rpm.
  Nominal current: 1.67 / 0.97 A.
  Shaft height: 71 mm.


FLYW

Additional recommended elements (Not included):

- Digital Instrumentation:

- 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.


EMT7


N-EALD

- EM-SCADA. **Control and Data Acquisition System Software for Electrical Machines.**

EM-SCADA

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 control signal for the servomotor.

Speed control signal for the servomotor.

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.

Management, processing, comparison and storage of data.

It allows graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

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.

- Analog Instrumentation:

- N-MED10. **AC Ammeter (0-5 A) Module.**

N-MED10

Measuring range: 0 – 5 A.

Terminals:

Measurement terminal.

- N-MED22. **AC Voltmeter (0-400 V) Module.**

N-MED22

Measurement range: 0 – 400 VAC.

Terminals:

Measurement terminals.

- N-MED33. **Balanced Three-Phase Wattmeter Module (350-0-350W, 440VAC, 500mA).**

N-MED33

Nominal voltage: 440 VAC.

Terminals:

Measurement terminal.

- N-MED31. **Three-Phase Phase Meter Module 400V.**

N-MED31

3 meters of phase.

400 VAC.

CAP 0.5 - 1 - 0.5 IND.

Accuracy: 1.5 % of 90°.

50 or 60 Hz.

- N-MED39. **Balanced Three-Phase Var Meter Module 440V.**

N-MED39

Balanced Three-phase valve.

440 VAC.

Scale 90°.

Accuracy 1.5 %.

50 or 60 Hz.

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

Cables and accessories, for normal operation.

Manuals:

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

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Checking the Industrial Main Power Supply (N-ALI01).
2.- Checking the AC Auxiliary Main Power Supply (N-ALI03).
3.- Checking the lamps.
4.- Study of the control elements of alternating current motors.
5.- Manual star-delta circuit of three-phase induction motor.
6.- Manual reversing operations of three-phase induction motor.
7.- Automatic star-delta starter of three-phase induction motor.
8.- Automatic star-delta reversing circuit of three-phase induction motor.
9.- Use of the flywheel.

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-ACINA:
- Dimensions: 640 x 320 x 920 mm approx.
  (25.19 x 12.59 x 36.22 inches approx.)
- Weight: 35 kg approx.
  (77 pounds approx.)

ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- Digital Instrumentation:
  - N-EALD. Electrical Network Analyzer Module with Oscilloscope and Data Acquisition.
  - EM-SCADA. Control and Data Acquisition System Software for Electrical Machines.
- Analog Instrumentation:
  - N-MED10. AC Ammeter (0-5 A) Module.
  - N-MED22. AC Voltmeter (0-400 V) Module.
  - N-MED33. Balanced Three-Phase Wattmeter Module (350-0-350W, 440VAC, 500mA).
  - N-MED31. Three-Phase Phase Meter Module 400V.
  - N-MED39. Balanced Three-Phase Var Meter Module 440V.

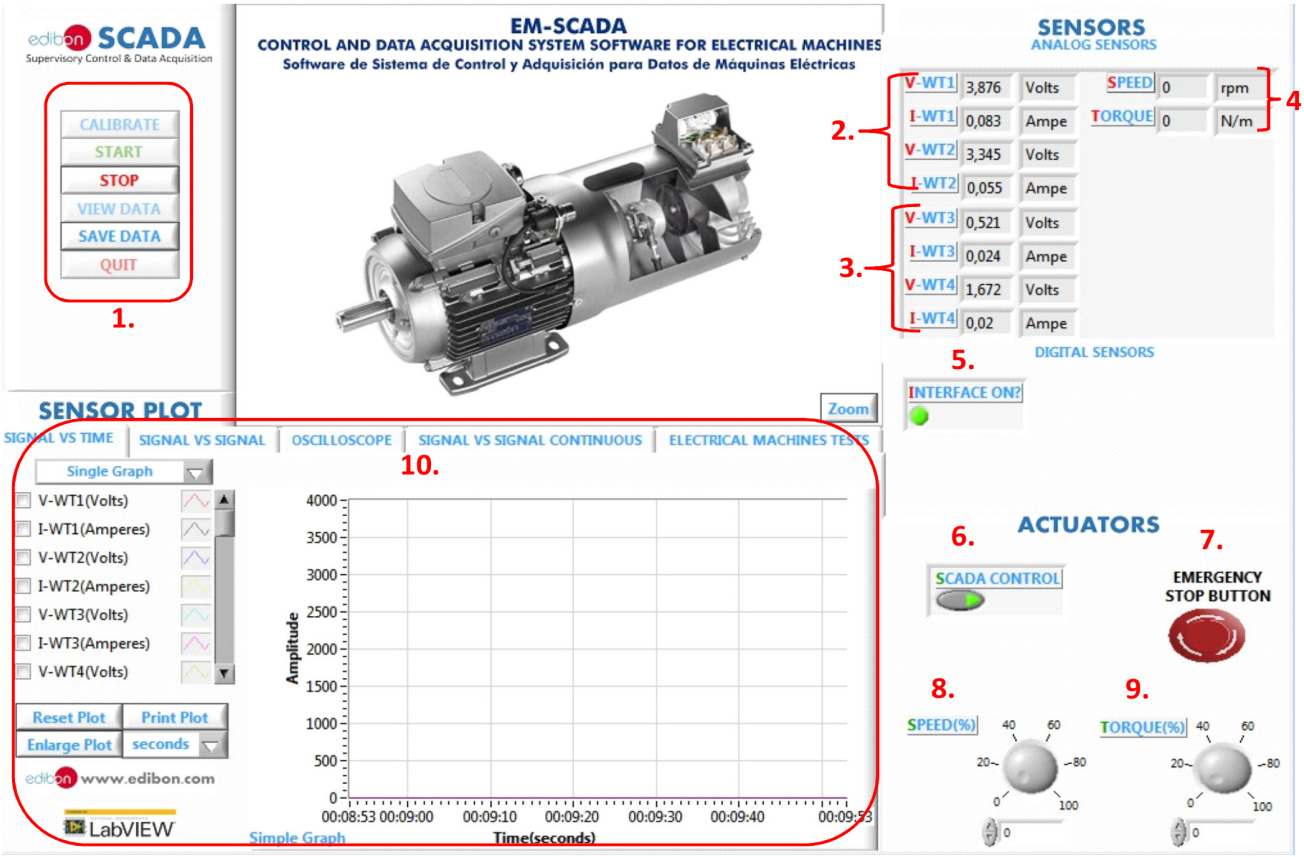
REQUIRED ELEMENTS (Not included)

Required (at least one):
- AEL-AI12. Alternating Current Motors Application.
- AEL-ACWRA. Application of AC Three-Phase Induction Motor of Wound Rotor.
- AEL-MMRT. Motor Management Relays Application.
- AEL-UMA. Universal Motor Application.
- AEL-ACEMT. Advanced AC Electrical Motors Application.
- EMT6-AC-KIT. Independent Excitation 3PH Synchronous Motor-Generator Study Kit.
- AEL-ACEM. AC Three-Phase Induction Motors Application.
- AEL-SCIMS. Squirrel Cage Induction Motors Starter Application.

SIMILAR UNITS AVAILABLE

Offered in this catalog:
- AEL-ACINA. Application of AC Three-Phase Induction Motor of Squirrel Cage.

Offered in other catalog:
- AEL-ACEMT. Advanced AC Electrical Motors Application.
- AEL-ACEMA. AC Electrical Motors Application.
- AEL-DCEMT. DC Electrical Motors Application.



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.

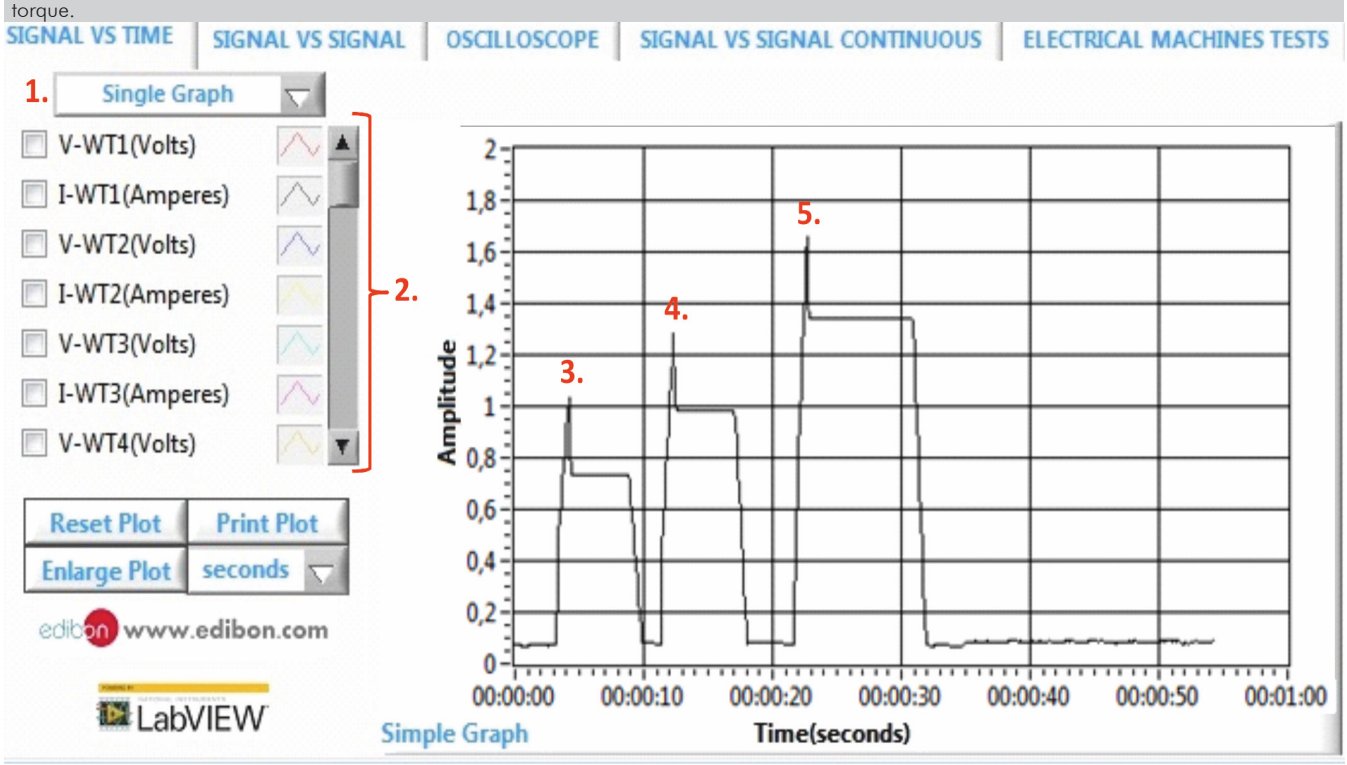
⑦ **Emergency stop buttton.**

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.

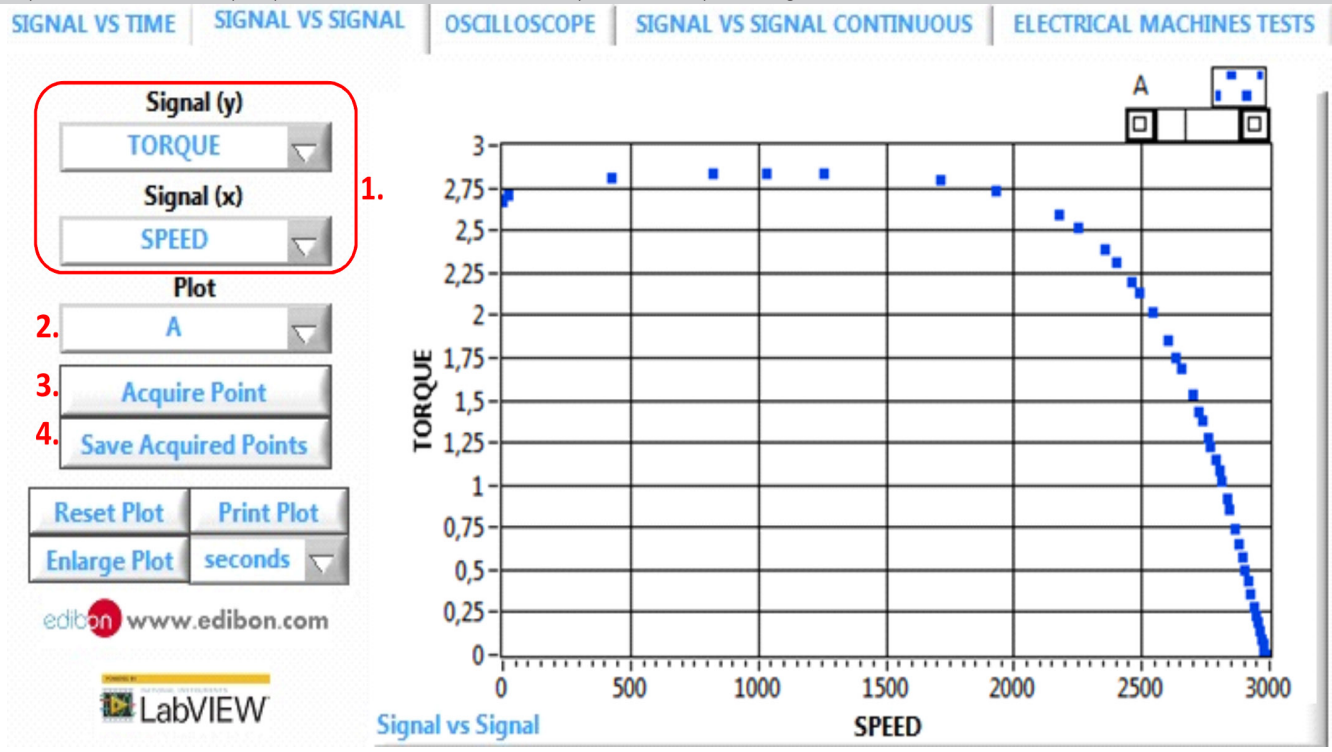
⑩ **Screen selector.**

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 % appllied torque.



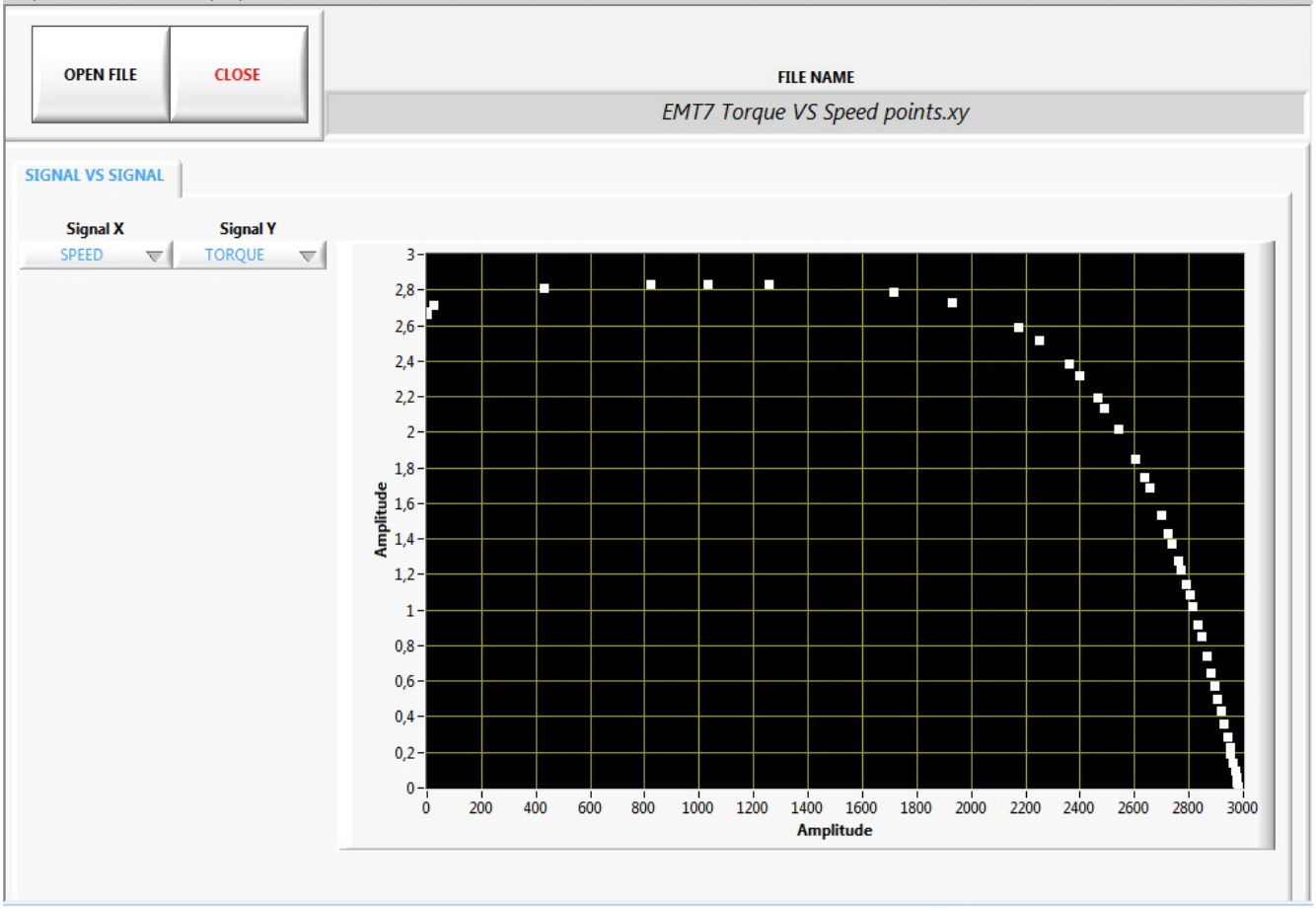
① **Type of graph selector.** Simple or several signals overlapping.
② **Parameters selection.** It allows choosing the parameters to be displayed and the setting for its display.
③ **Starting current for 10% of brake torque.**
④ **Starting current for 20% of brake torque.**
⑤ **Starting current for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

Representation of the torque-speed curve for the Three-Phase Asynchornous Squirrel Cage Motor.

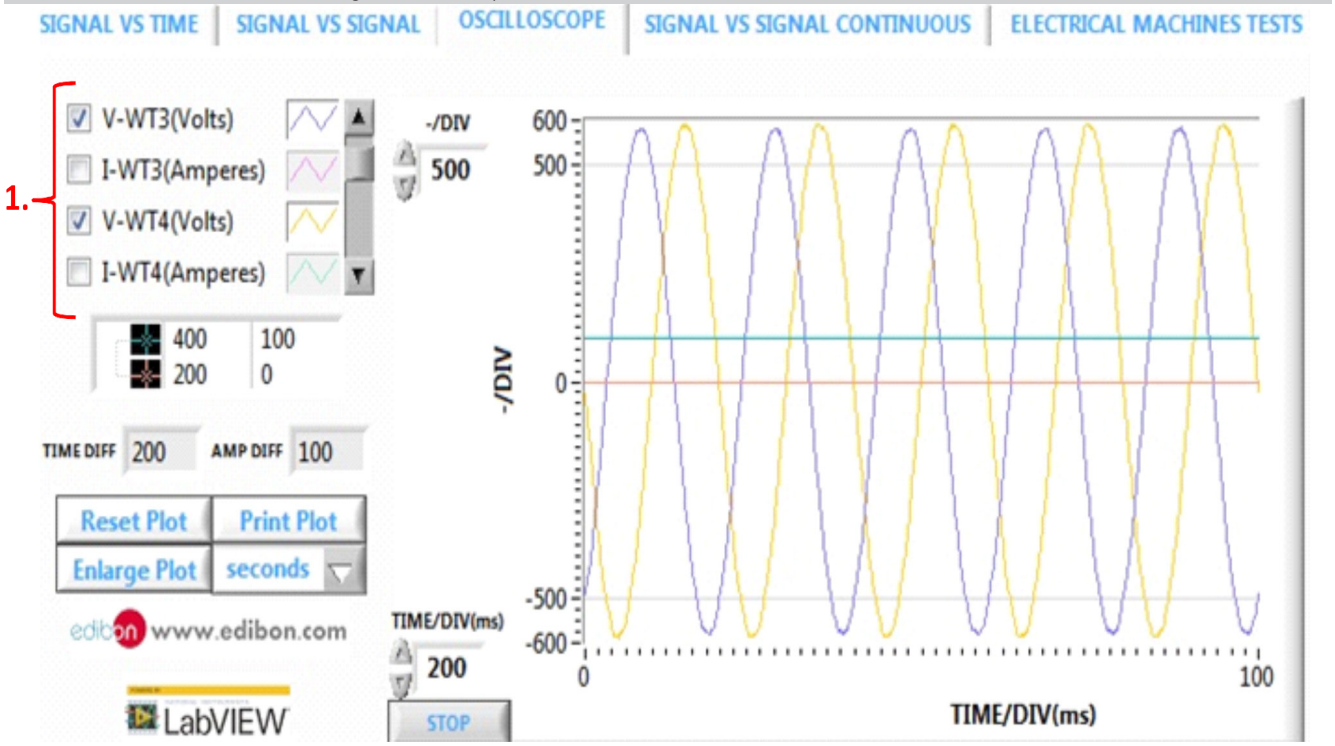


① **Axis signal selector.** It allows selecting the parameter to be monitored in each axis.
② **Type of graph selector.**
③ **Acquire points.** It allows displaying in the graph the point corresponding to the time when it is pressed.
④ **Save acquired points.** It allows saving the acquired points, which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

Representation and display of the stored data.

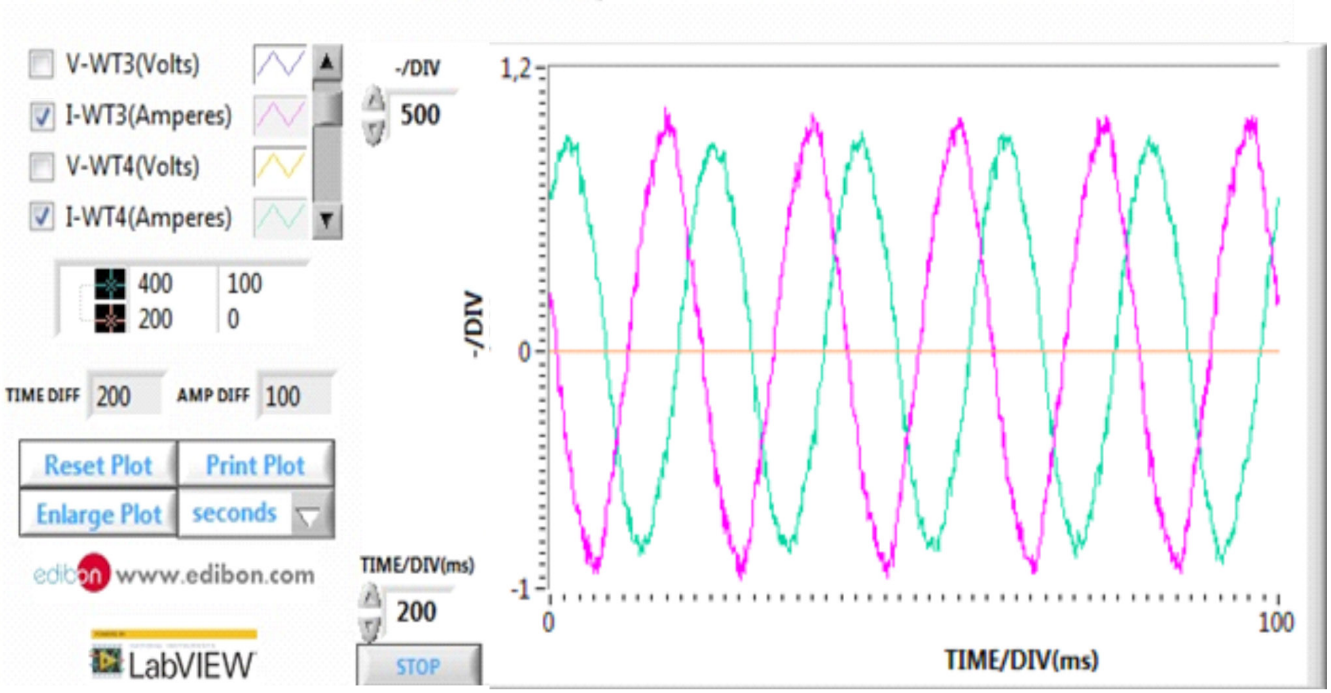


Waveform chart for the real time voltages measured by the interface.

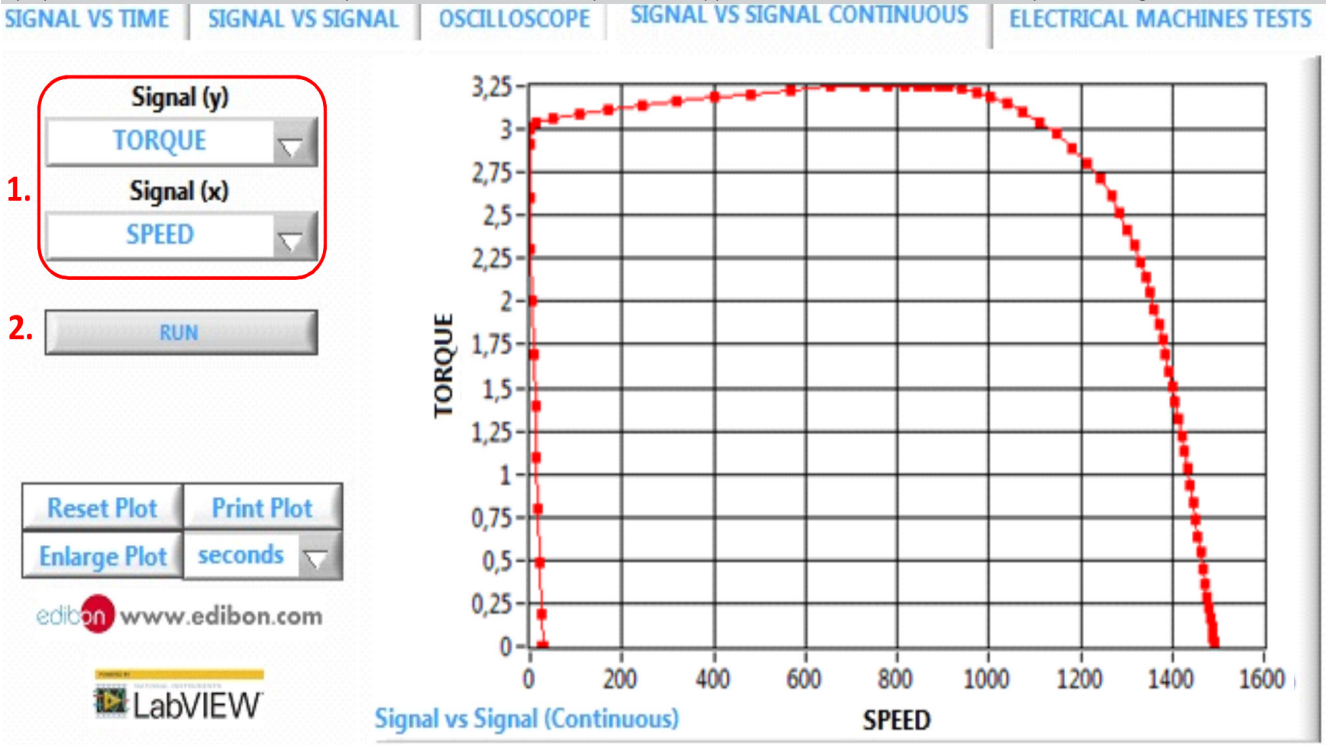


① **Parameters selector.** It allows choosing the parameters whose waveforms want to be displayed.

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



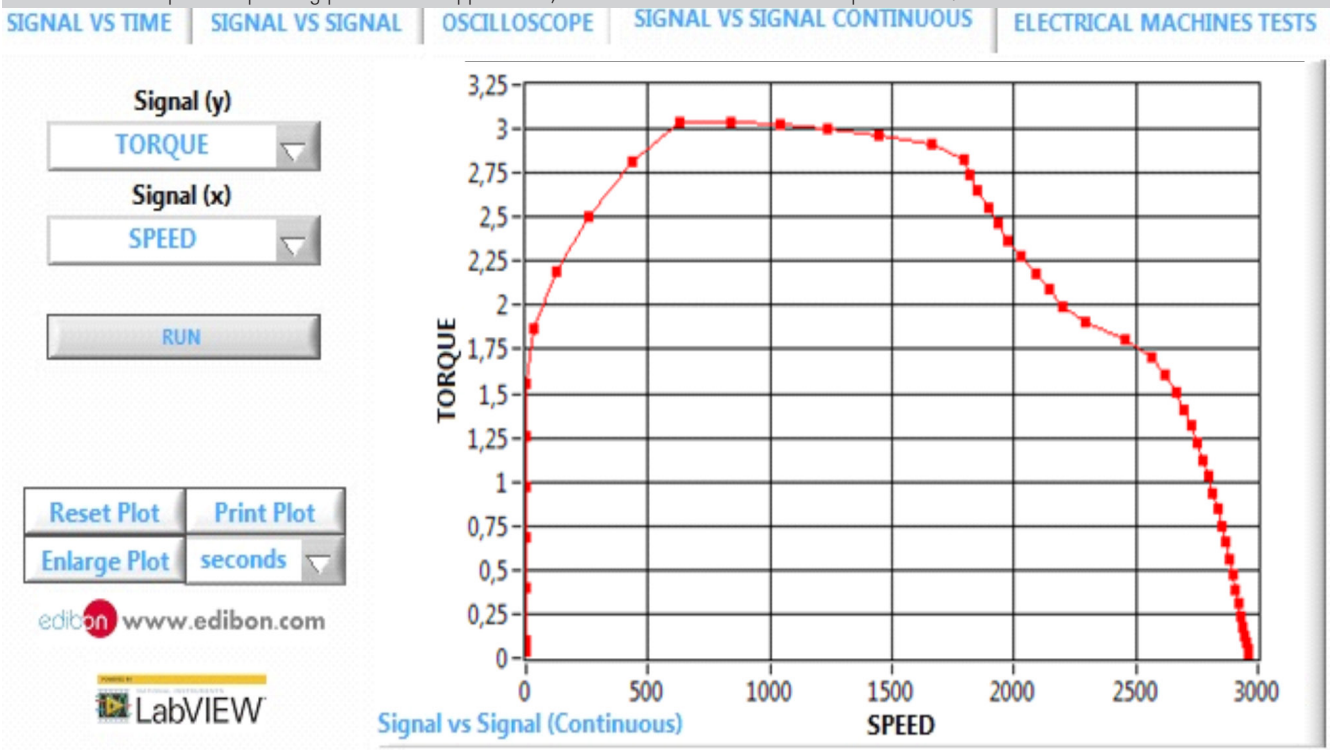
Representation of the torque-speed curve for the manual braking test with the Three-Phase Asynchronous Motor of two speeds, no load speed (1500 rpm). Notice that the motor nominal speed and the maximum torque can be appreciated, as well as the motor complete braking.



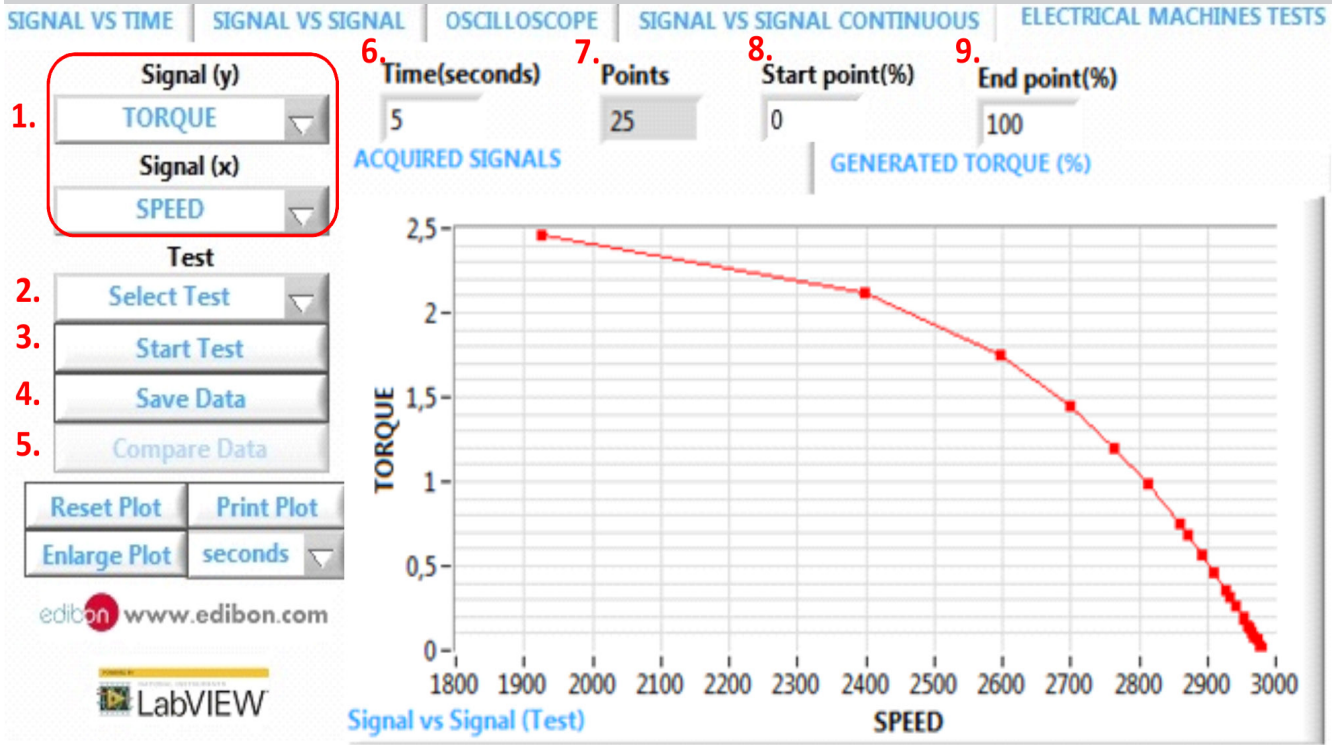
① **Axis signal selector.** It allows selecting the parameter to be monitored in each axis.

② **Run. It allows starting the manual braking test.**

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 exponetial braking slope. The motor nominal speed can be appreciated as well as the fact that the exponetial 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 **Iniciar 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.

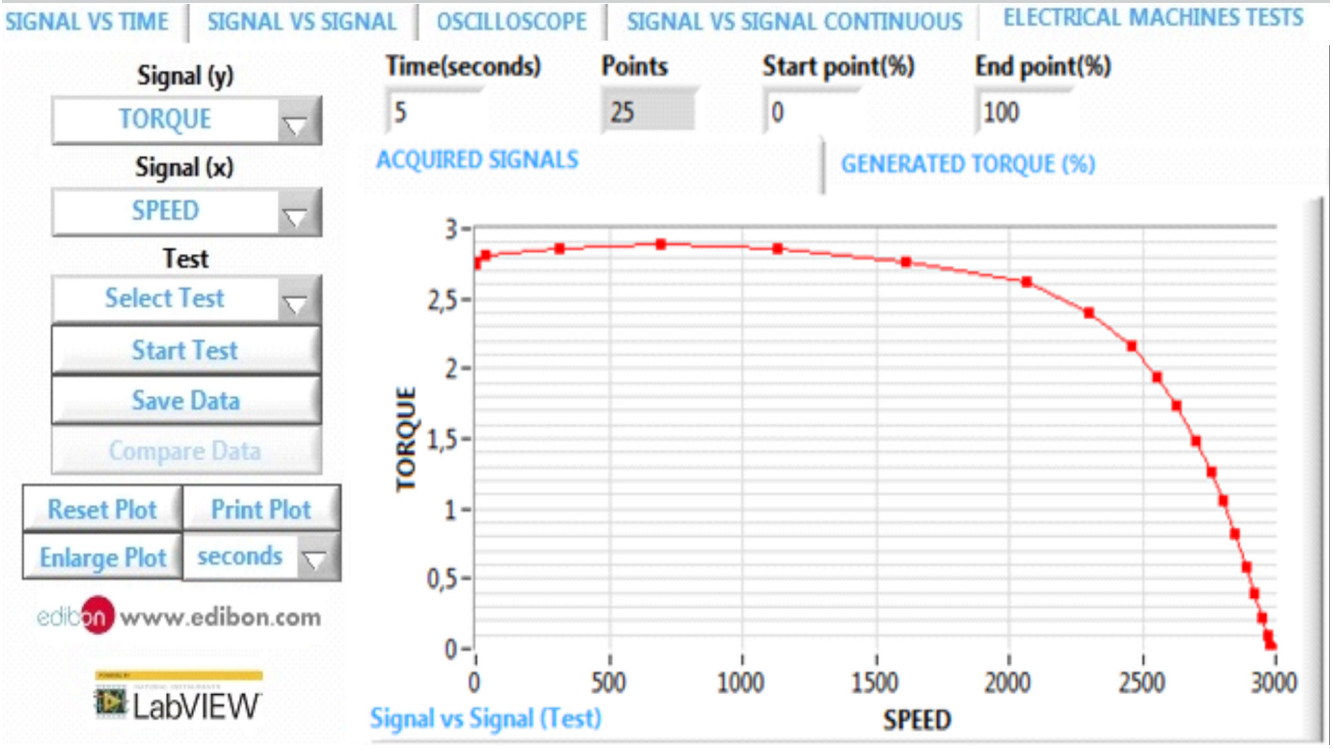
⑥ **Test time.** It allows selecting the length of the test to be fulfilled.

⑦ **Points.** It shows the number of points that will define the resulting plot.

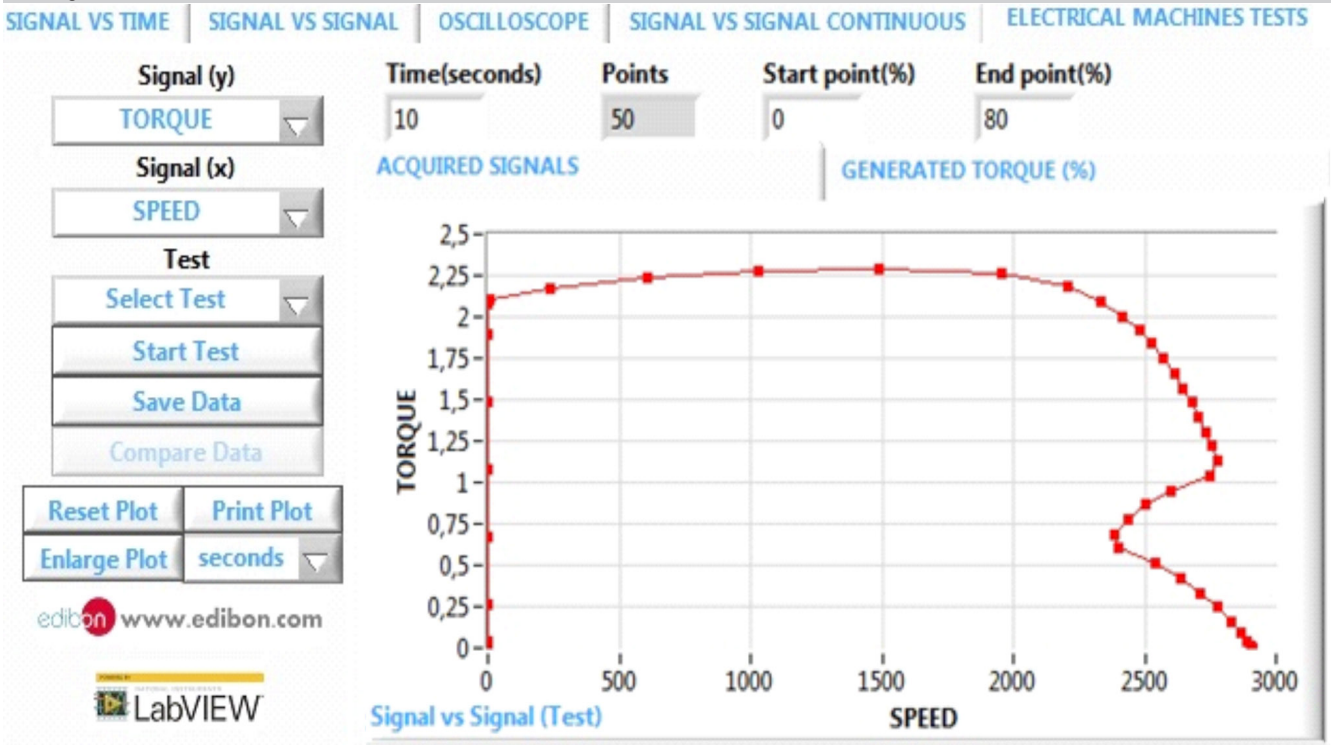
⑧ **Start point.** It allows selecting (as a percentage) the start point for the test to be fulfilled.

⑨ **End point.** It allows selecting (as a percentage) the end point of the test to be fulfilled.

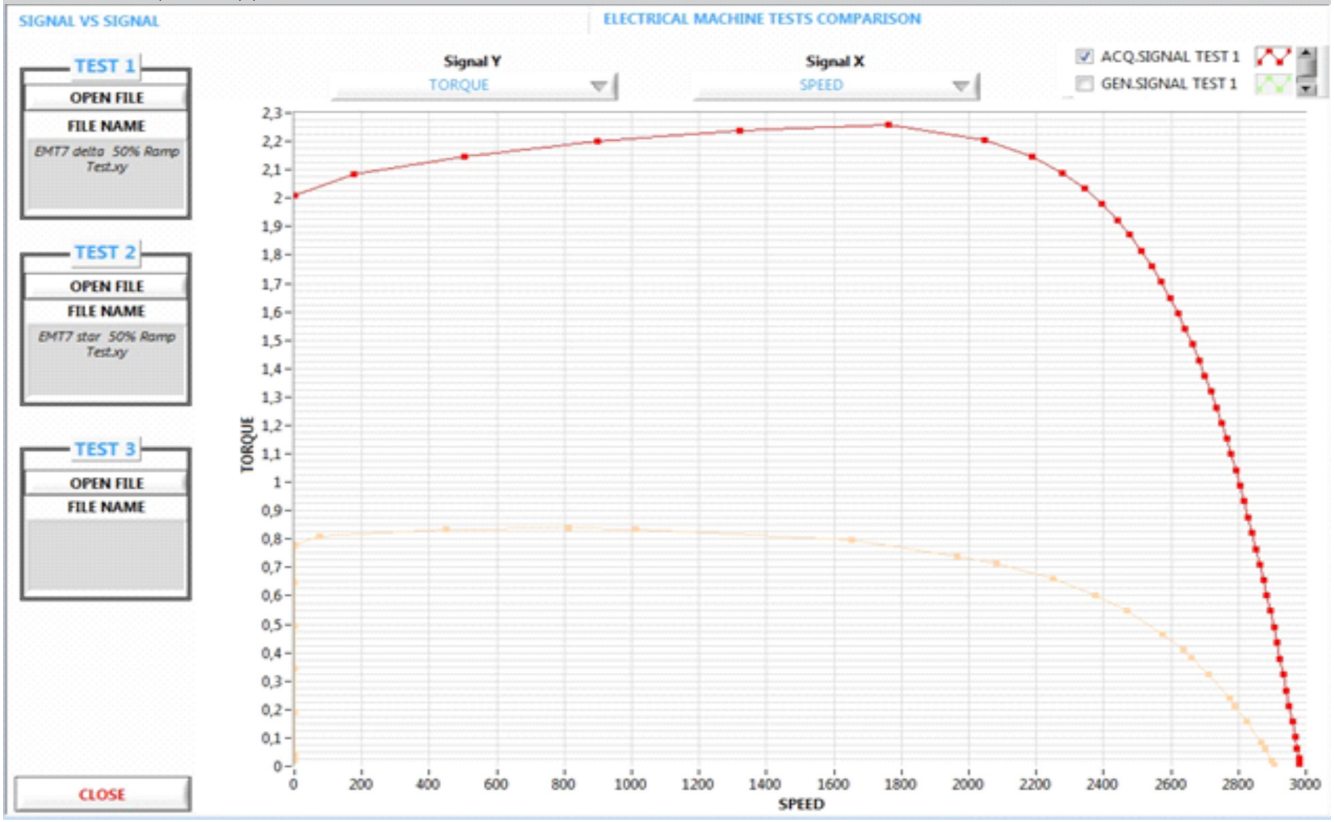
Obtained results for the automatic braking test with the Three-Phase Asynchronous Squirrel Cage Motor, with delta connection , from 0 to 100 % and linear braking slope. Notice that the motor nominal speed and the maximum torque can be seen, as well as the motor complete braking.



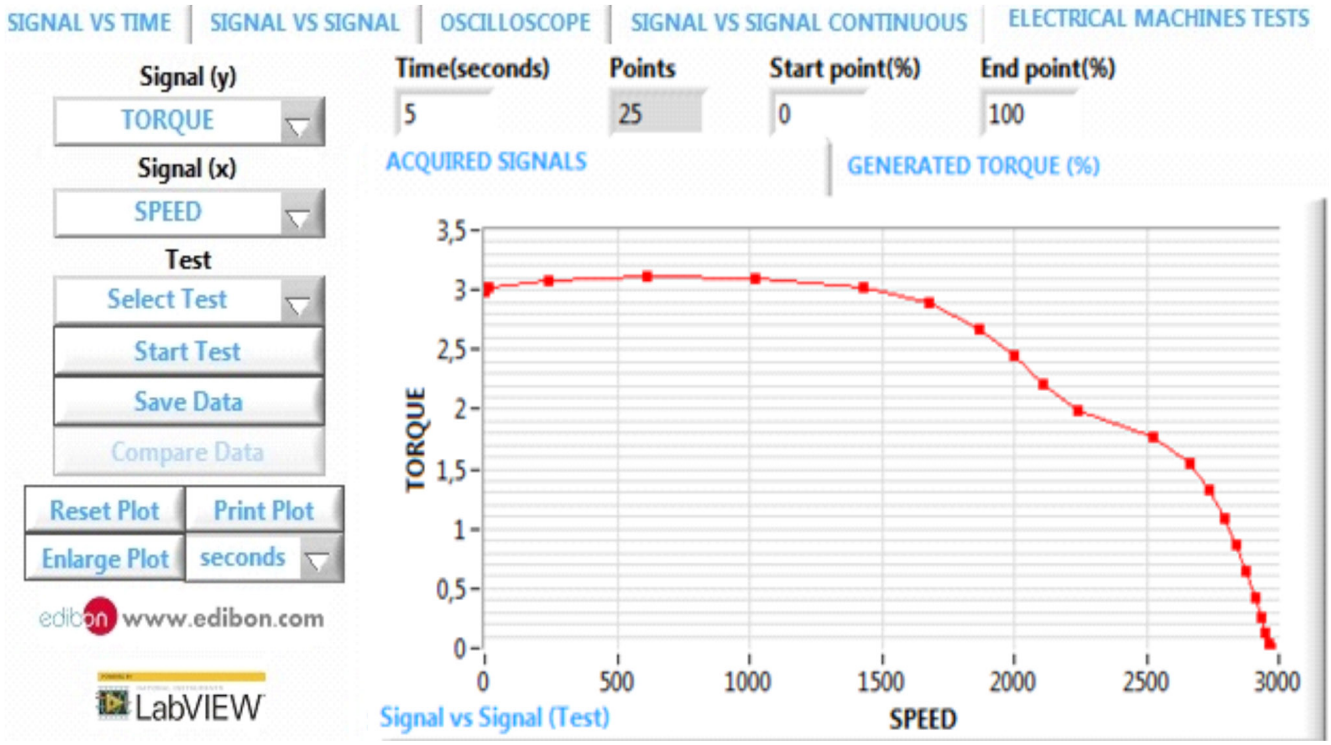
Obtained results for the automatic braking test with the Three-Phase Asynchronous Squirrel Cage Motor, with star-delta starting, from 0 to 80 % and linear braking slope. Notice that the condenser operating point condenser can be appreciated, as well as the motor nominal speed and its complete braking.



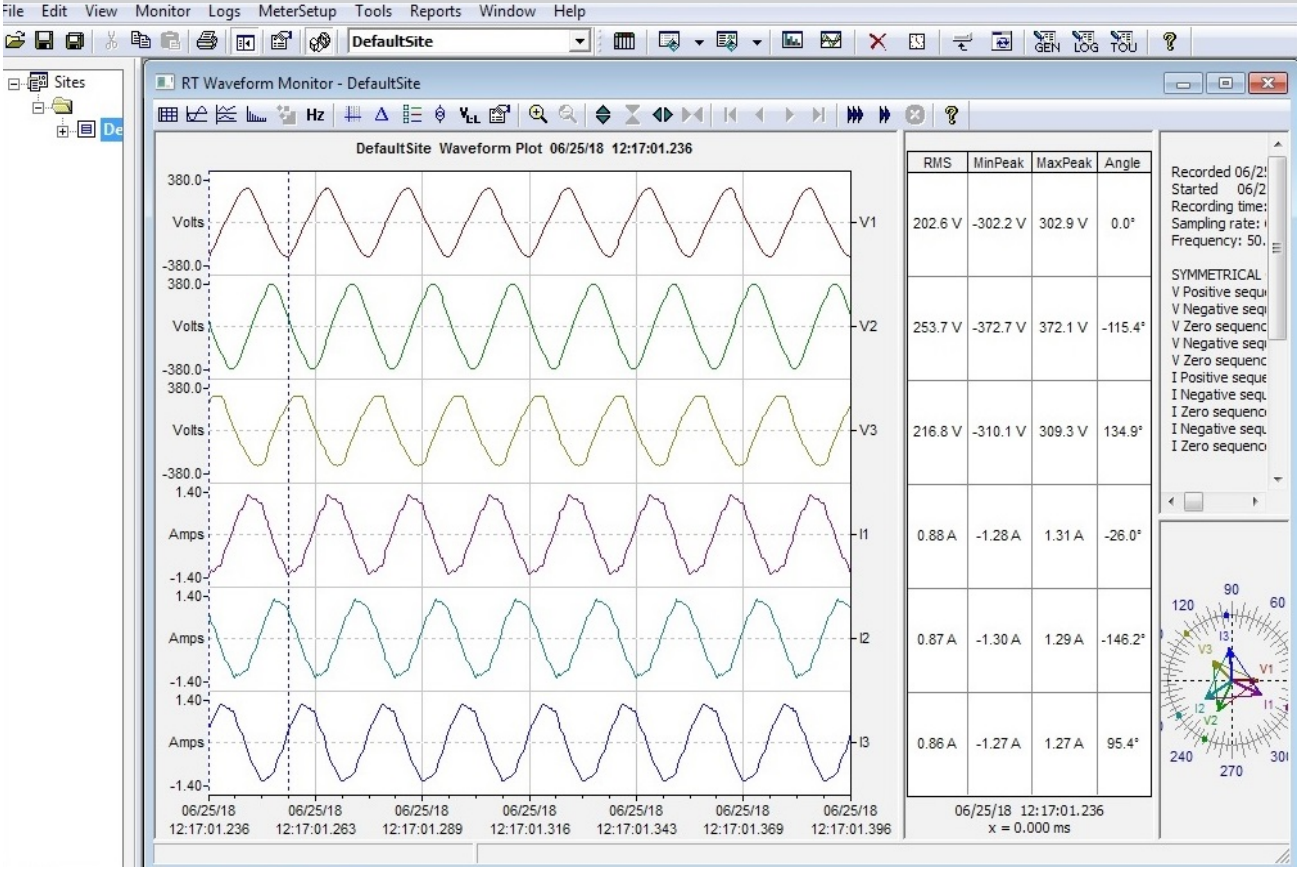
Purchase of two previously performed and stored tests.



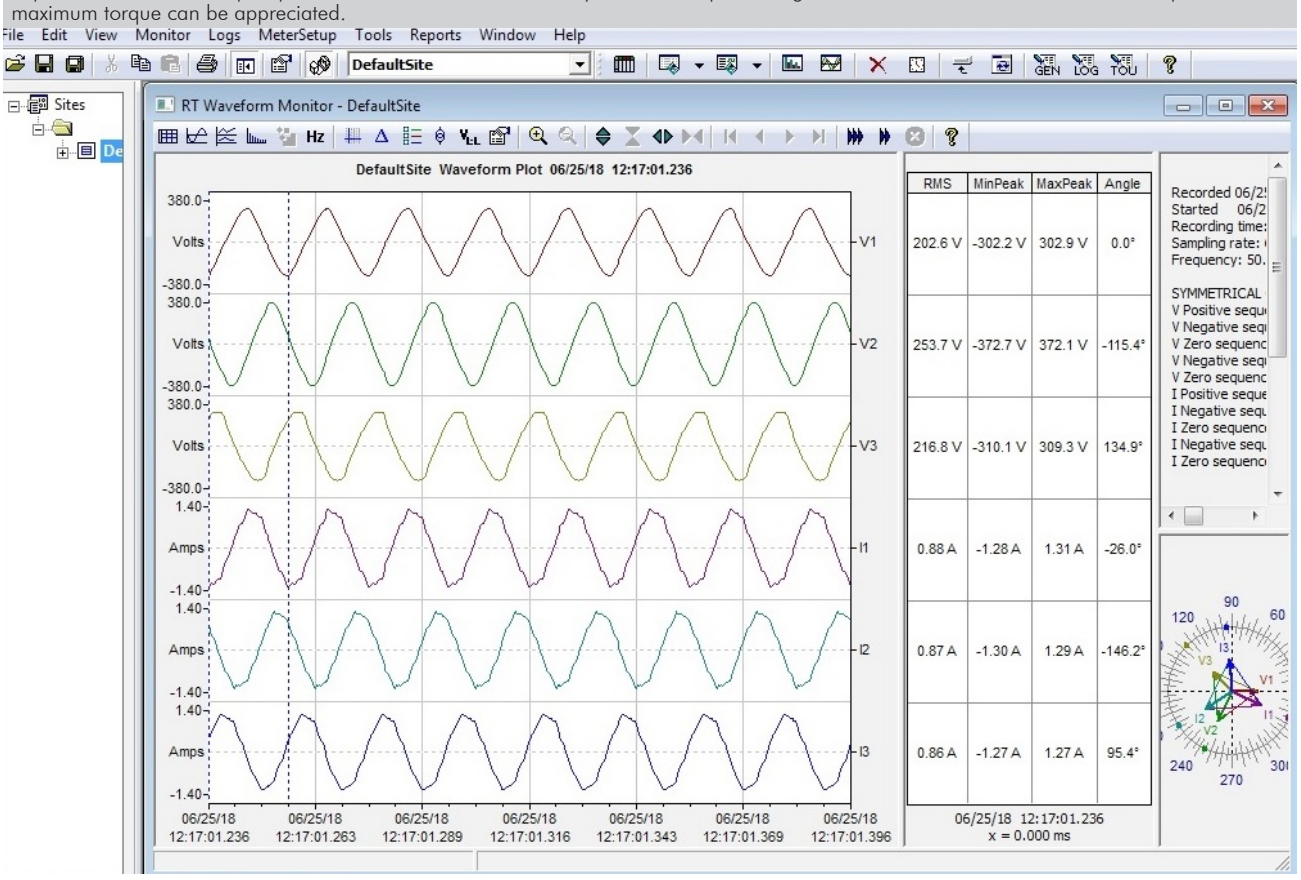
Obtained results for the automatic braking test with the Single-Phase Asynchronous Motor with starting and running capacitor,from 0 to 100 % linear braking slope. The capacitor operating point and the effects on the machine parameters can be appreciated, as well as the motor nominal speed and its complete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



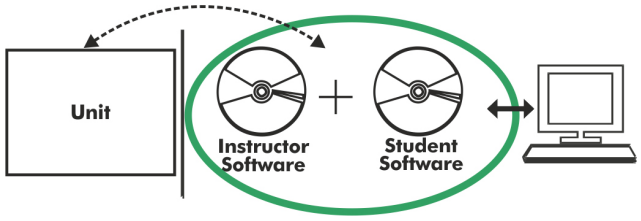
Waveform plot of the real time currents and voltages measured by the analyzer, showing the angular, maximum, minimum and RMS values, and the phasors corresponding to such electrical parameters.



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



AEL-ACINA/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.

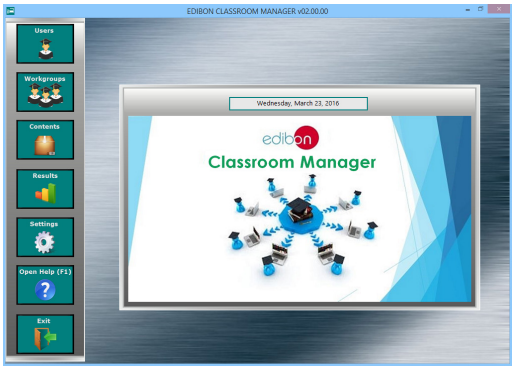
Instructor Software

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

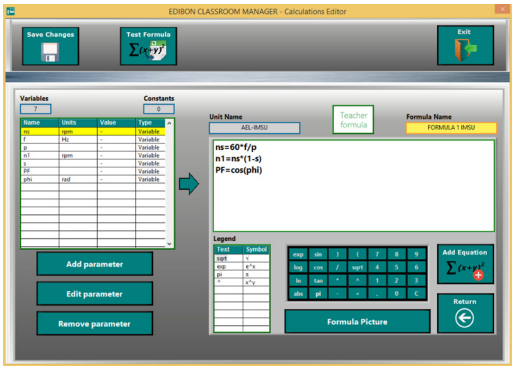
ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual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

Innovative features:

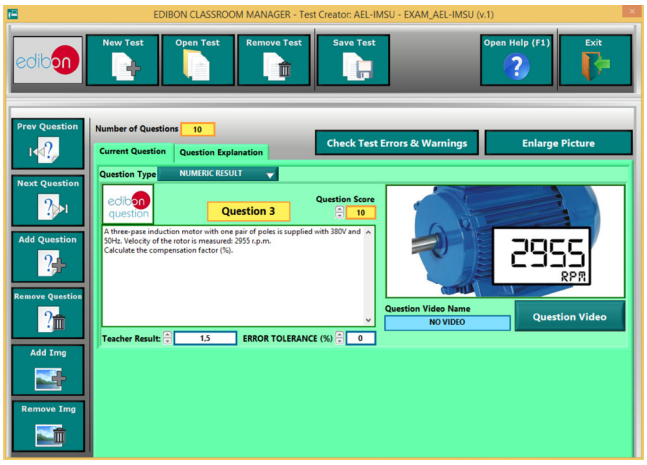
- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.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



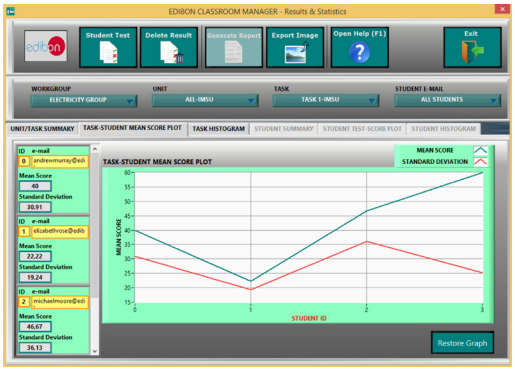
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



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).

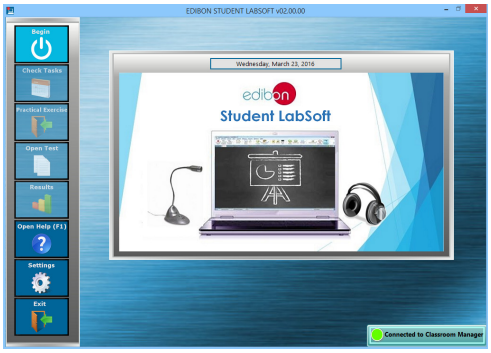
ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are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

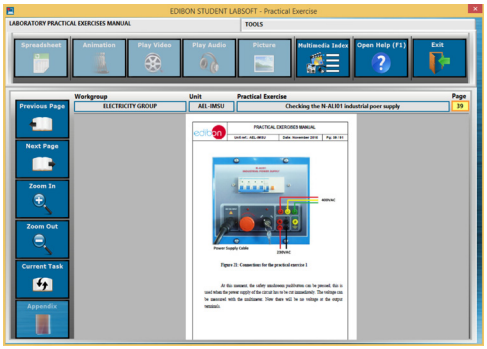
- **Student Log-In & Self-Registration.**
- **Existing Tasks checking & Monitoring.**
- **Default contents & scheduled tasks available to be used from the first session.**
- **Practical Exercises accomplishment by following the Manual provided by EDIBON.**
- **Evaluation Methods to prove your knowledge 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

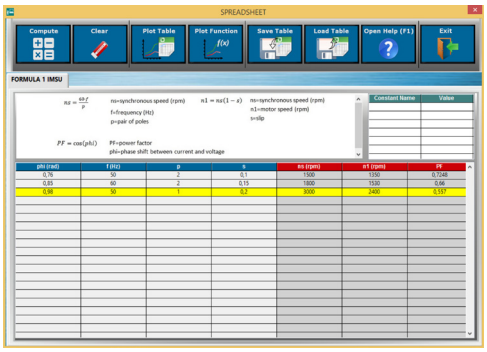


ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



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.

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