Engineering and Technical Teaching Equipment

Electrical Machines Soft Starters Application

AEL-EMSS

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PRODUCTS
4.- ELECTRICITY

Example of configuration of the AEL-EMSS application with the additional recommended elements EM-SCADA, N-SERV1K, N-VVCA, N-VVCC/M, N-EALD, N-ARR01 and N-TRANS03

INTRODUCTION

The electric machines are devices capable of transforming electrical energy into mechanical energy or vice versa. The squirrel cage motor is 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.

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

GENERAL DESCRIPTION

The Electrical Machines Soft Starters Application, "AEL-EMSS", has been designed by EDIBON to instruct the student in managing soft-starters of three-phase electrical machines. This application basically consists of three types of optional starters: electronic soft starter (Electronic Soft Starter Module (N-ARR16)), frequency controller (Advanced AC Motors Speed Controller (N-VVCA)) and star/delta starter Three-Phase Autotransformer 400/230 VAC, 1 kVA, Module (N-TRANS03) y Manual Star-Delta Starter (N-ARR01). The students will learn to configure these type of starters and they will compare the characteristics and functionality observing the induction motor behavior with each starter.

Description of the soft starter types:

N-ARR16. Electronic Soft Starter Module: through the electronic soft starter, the user will learn to configure the most important parameters that allow considerably reduce the induction motor starting/stopping currents. These parameters are, for example, the staring voltage, the acceleration ramp time and the deceleration ramp time.

N-VVCA. Advanced AC Motors Speed Controller: through the advanced frequency controller, the user will learn to configure several parameters to get different induction motor functionalities. Thus different parameters can be set such as torque limiter, frequency limiter, acceleration and deceleration ramps, starting voltage and much more parameters explained in the user´s manual. It is very important to understand how a motor works with a frequency controller because it is the most important method used in the industry for induction motor control to get a maximum control and performance. Besides, the user can visualize, program the alarms and associate them to relays in order to get a complex control circuit. The frequency controller module has some digital signals which can be programed to get more than 100 different functions.

N-TRANS03. Three-Phase Autotransformer 400/230 VAC, 1 kVA, Module and N-ARR01. Manual Star-Delta Starter: through the manual star/delta starter, the user will take experience on this type of maneuvers and how the response of the induction motor is.

This application includes an eddy current brake to study the induction motor response to different load conditions.

On the other hand, for more advanced studies of induction motor dynamics, it is recommended to acquire the "N-SERV1K" servomotor, which includes a controller to perform different braking tests with greater precision. This controller can work together with the "EM-SCADA" module.

When the braking torque is increased, the power consumption of the induction motor is increased too, the power factor changes, etc. In order to analyze the power consumption of the induction motor a network analyzer is included. It shows the main electrical parameters which are relevant in industrial installations: voltages, currents, frequencies, Power Factor, active power, reactive power, apparent power, etc.

This aplication can be supplied with theControl and Data Acquisition System Software for Electrical Machines, "EM-SCADA", a Data Control and Acquisition Software developed by EDIBON that allows monitoring all voltage, current and torque waves shape. This allows studying the behavior of the three-phase induction motor via different soft starters offered in this application. The servomotor can be controlled from the PC with EM-SCADA to generate different load curves on the induction motor shaft. In this way it is possible to graphically obtain the characteristic curves of this type of motor.

The "AEL-EMSS" application includes the following modules:

- N-ALI01. Industrial Main Power Supply Module.
- EMT7/1K. 3PH Squirrel-Cage Motor, 1 kW.
- FRECP. Eddy Current Brake.
- N-VVCC/M. DC Motor Speed Controller (Intermediate option).
- N-MED82. AC Voltmeter (0-500 V).
- N-MED10. AC Ammeter (0-5 A).
- N-ARR12. Direct Starter Module.

Additional recommended elements (Not included):

- EM-SCADA. Control and Data Acquisition System Software for Electrical Machines.
- N-VVCA. Advanced AC Motors Speed Controller.
- N-ARR16. Electronic Soft Starter Module.
- N-ARR01. Manual Star-Delta Starter. (Module is required N-TRANS03)
- N-TRANS03. Three-Phase Autotransformer 400/230 VAC, 1 kVA, Module. (Module is required N-ARR01).
- FLYW. Flywheel.
- N-SERV1K. 1 kW Servomotor Module.
- N-EALD. Network Analyzer Module with Oscilloscope and Data Acquisition.

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

Option A:

This application needs the following racks:

- N-RACK-M.

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-EMSS" includes the following modules:

- N-ALI01. **Industrial Main Power Supply Module.**
  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 400V connecting plug.
  Differential magnetothermal, 4 poles, 25 A, 300 mA AC 6 KA.


N-ALI01

- EMT7/1K. **1 kW/1P Asynchronous Three-Phase Motor of Squirrel Cage.**
  Nominal power: 1100 W.
  Nominal voltage: 3 x 230/400 VAC Δ/Y.
  Frequency: 50/60 Hz
  Number of poles: 2.
  Speed: 2730 rpm.
  Nominal current: 2.52 / 1.45 A.


EMT7/1K

- FRECP. **Eddy Current Brake.**
  Maximum supply voltage: 60 VDC.
  Nominal current: 1.67 A.
  Maximum current: 1.8 A.
  Maximum braking torque: 1.4 Nm.


FRECP

- N-VVCC/M. **DC Motor Speed Controller (Intermediate option).**
  Supply voltage: 230 VAC.
  Variable output voltage: 0 – 300 VDC.
  Fuse: 2 A.
  GND terminal.


N-VVCC/M

- N-MED82. **AC Voltmeter (0-500V).**
  Measuring range: 0-500 VAC.
  Terminals:
  Measurement terminal.
  GND terminal.


N-MED82

- N-MED10. **AC Ammeter (0-5 A).**
  Measuring range: 0-5 A.
  Terminals:
  Measurement terminal.
  GND terminal.


N-MED10

- N-ARR12. **Direct Starter Module.**
  Nominal voltage: 400 VAC.
  Maximum contacts current: 10 A.
  Two positions commutator (ON-OFF):
  0: Open circuit.
  1: Closed circuit.


N-ARR12

Additonal recommended elements (Not included):


EM-SCADA

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


N-VVCA

- N-VVCA. **Advanced AC Motor Speed Controller.**
  - Supply voltage: 230 VAC.
  - Nominal power: 0,75 kW.
  - PWM output voltage connections:
    - Three-Phases: 230 VAC.
  - Digital inputs control panel: 5 configurable digital inputs.
  - Analog inputs control panel:
    - 0-10 V analog input for speed control.
    - 4-20 mA analog input for speed control.
  - 10 K, potentiometer for the induction motor control speed.
  - 2 relay outputs for alarms configuration: 2 outputs NO/NC.
  - 50 mA, 2 transistor outputs for alarms configuration.
  - Setting and visualization display of the machine parameters.


N-ARR16

- N-ARR16. **Electronic Soft Starter. Nominal Voltage: 400 VAC.**
  - Nominal current: 3.6 A.
  - Nominal Power: 1.5 kW.
  - IP: IP20.
  - Three poles.
  - Regulating potentiometer for setting the acceleration/deceleration ramp.
  - Regulating potentiometer for starting voltage.

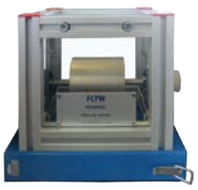

N-ARR01

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

- N-TRANS03. **Three-Phase Autotransformer Module 400/230 VAC, 1KVA.**
  - Three-phase autotransformer.
  - Nominal supply voltage: 400 VAC (3PH).
  - Nominal output voltage: 3 x 230 VAC (3PH+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-TRANS03

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


FLYW

- N-SERV1K. **1 kW Servomotor Module.**
  - Dynamic and static four-quadrant operation.
  - Speed and torque displays.
  - Four-quadrant monitor.
  - Thermal monitoring of the machine under test.
  - Testing for the presence of a shaft cover.
  - Connection voltage: 400 V.
  - Frequency: 50 Hz.
  - Maximum power output: 10 kVA.
  - Maximum speed: 4000 rpm.
  - Maximum torque 4 Nm.
  - Temperature monitoring.


N-SERV1K

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

  The network analyzer module allows fulfilling measurements, displaying and analyzing all the parameters ofthe 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

- **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

Additional practical possibilities with Electronic Soft starter:

1.- Wiring of electronic soft starter.
2.- Setting of the starting voltage parameter.
3.- Measuring of the induction motor electrical parameters with different starting voltage configurations.
4.- Setting of acceleration ramp parameter.
5.- Measuring of the induction motor electrical parameters with different acceleration ramp configurations.
6.- Setting of deceleration ramp parameter.
7.- Comparing the starting methods through frequency controller, electronic osft starter and star/delta starter (depending on the acquired options).
8.- Braking test with the servomotor and its controller.
9.- Starting of the induction motor with constant load.
10.-Starting of the induction motor with variable load.
11.-Visualization of Torque VS Speed, Current VS Speed with the additional recommended element EM-SCADA.

Additional practical possibilities with Frequency Controller:

12.-Wiring of the frequency controller.
13.-Basic programming of the frequency controller.
14.-Soft starting of the induction motor through manual speed control.
15.-Run investment soft control of the induction motor.
16.-Setting of acceleration time.
17.-Setting of deceleration time.
18.-Braking test with servomotor and controller.
19.-Starting of the induction motor with constant load.
20.-Starting of the induction motor with variable load.
21.-Comparing the starting methods through frequency controller, electronic soft starter and star/delta starter (depending on the acquired options).
22.-Visualization of Torque VS Speed, Current VS Speed with the additional recommended element EM-SCADA.

Additional practical possibilities with Star-delta Starter and Autotransformer:

23.-Wiring of the manual star/delta starter.
24.-Star/Delta starting of the induction motor of squirrel cage.
25.-Measuring of electrical parameters of the induction motor of squirrel cage durgin star/delta starting procedure.
26.-Comparing the starting methods through frequency controller, electronic soft starter and star/delta starter (depending on the acquired options).

Additional practical possibilities with the Servo motor and EM-SCADA:

27.-Braking test with the servomotor and its controller.
28.-Starting of the induction motor with constant load.
29.-Starting of the induction motor with variable load.
30.-Visualization of Torque VS Speed, Current VS Speed with the additional recommended element EM-SCADA.

Additional practical possibilities with the EM-SCADA:

31.-Visualization of torque/current VS speed of the induction motor with the electronic soft starter.
32.-Visualization of torque/current VS speed of the induction motor with the advanced frequency controller.
33.-Visualization of torque/current VS speed of the induction motor with the star/delta starter.
34.-Comparison of graphs of the different starting types.

REQUIRED SERVICES

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

DIMENSIONS AND WEIGHTS

AEL-EMSS:

- Dimensions: 1380 x 840 x 2010 mm approx.
  (54.33 x 33.07 x 79.13 inches approx.).
- Weight: 85 Kg approx.
  (187 pounds approx.).

ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- EM-SCADA. Control and Data Acquisition System Software for Electrical Machines.
- N-VVCA. Advanced AC Motors Speed Controller.
- N-ARR16. Electronic Soft Starter Module.
- N-ARR01. Manual Star-Delta Starter. (Module is required N-TRANS03)
- N-TRANS03. Three-Phase Autotransformer 400/230 VAC, 1 kVA, Module. (Module is required N-ARR01).
- FLYW. Flywheel.
- N-SERV1K. 1 kW Servomotor Module.
- N-EALD. Network Analyzer Module with Oscilloscope and Data Acquisition.

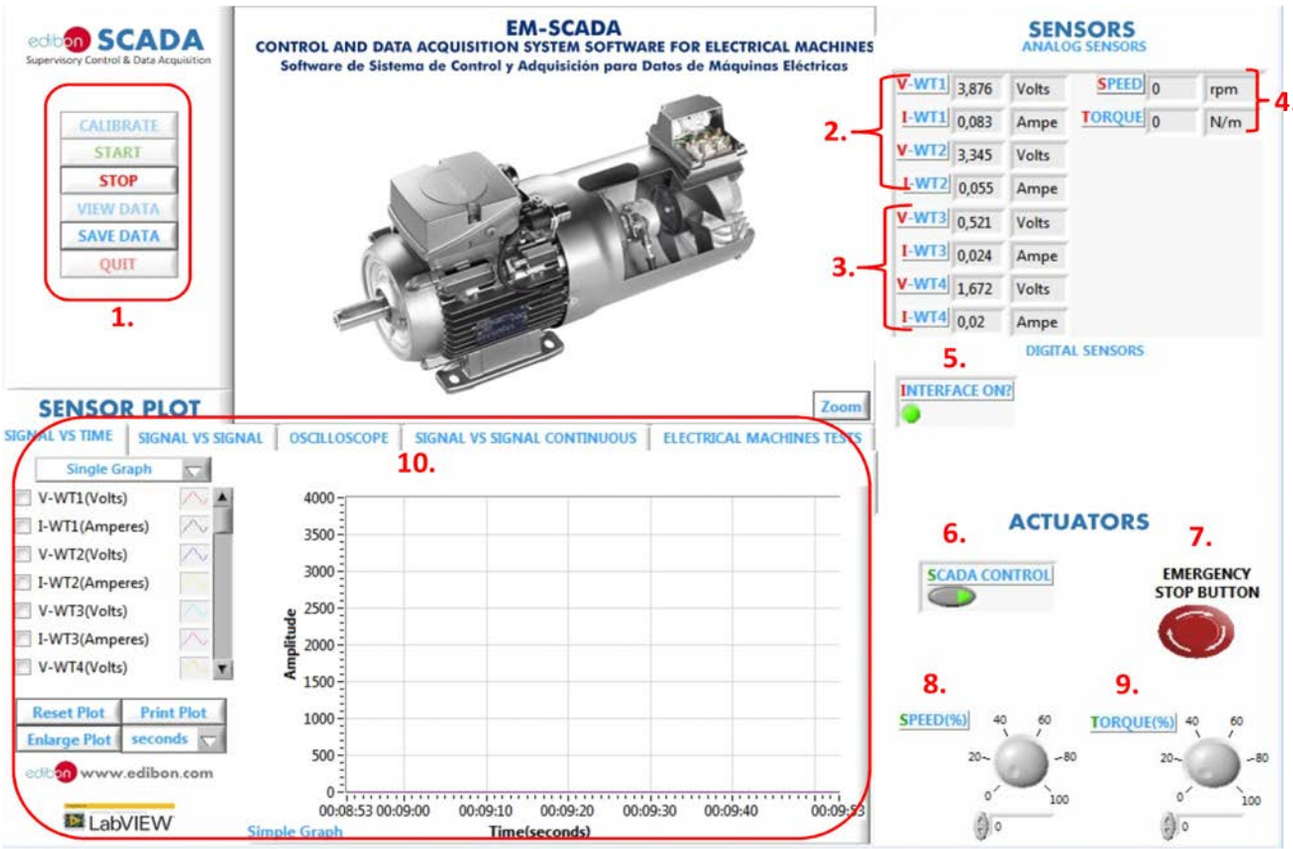
SIMILAR UNITS AVAILABLE

Offered in this catalog:

- AEL-EMSS. Electrical Machines Soft Starters Application.

Offered in other catalog:

- AEL-EMCF. Electrical Machines Control through Frequency Controller 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.

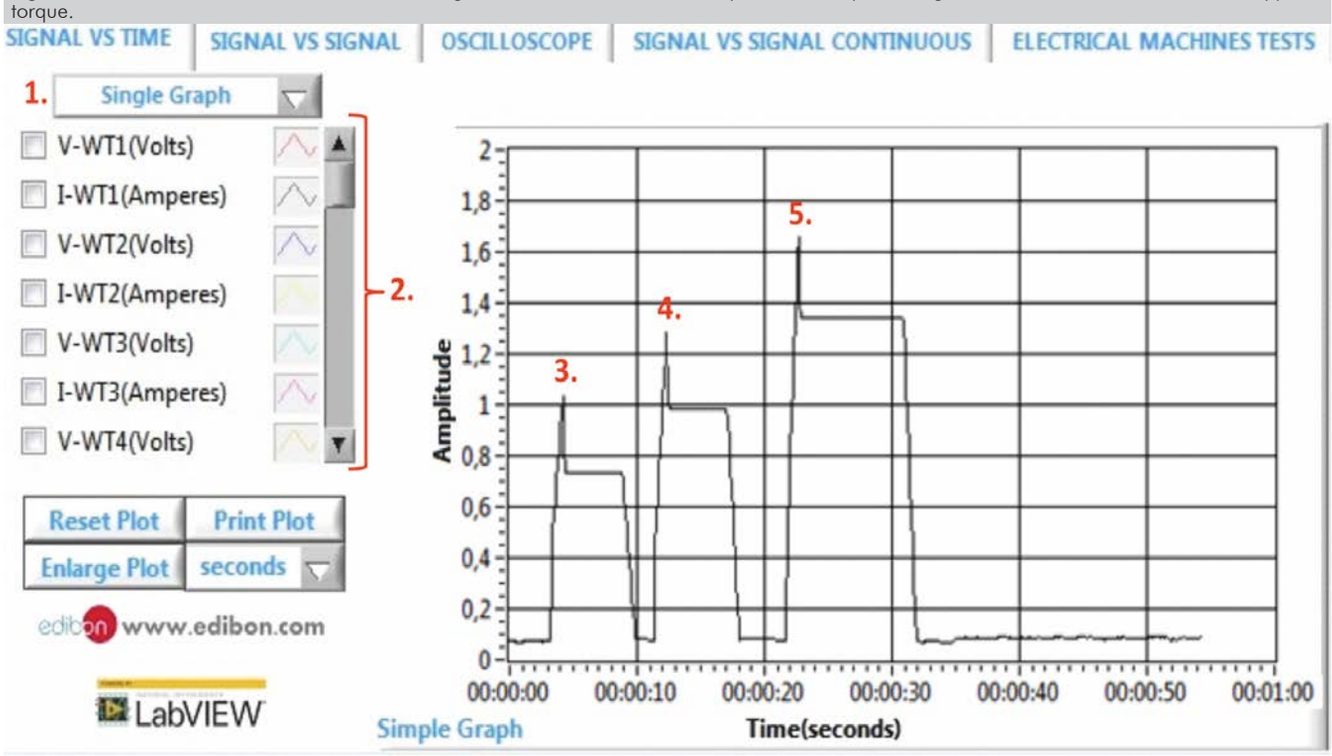
⑦ **Emergency stop buttton.**

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.

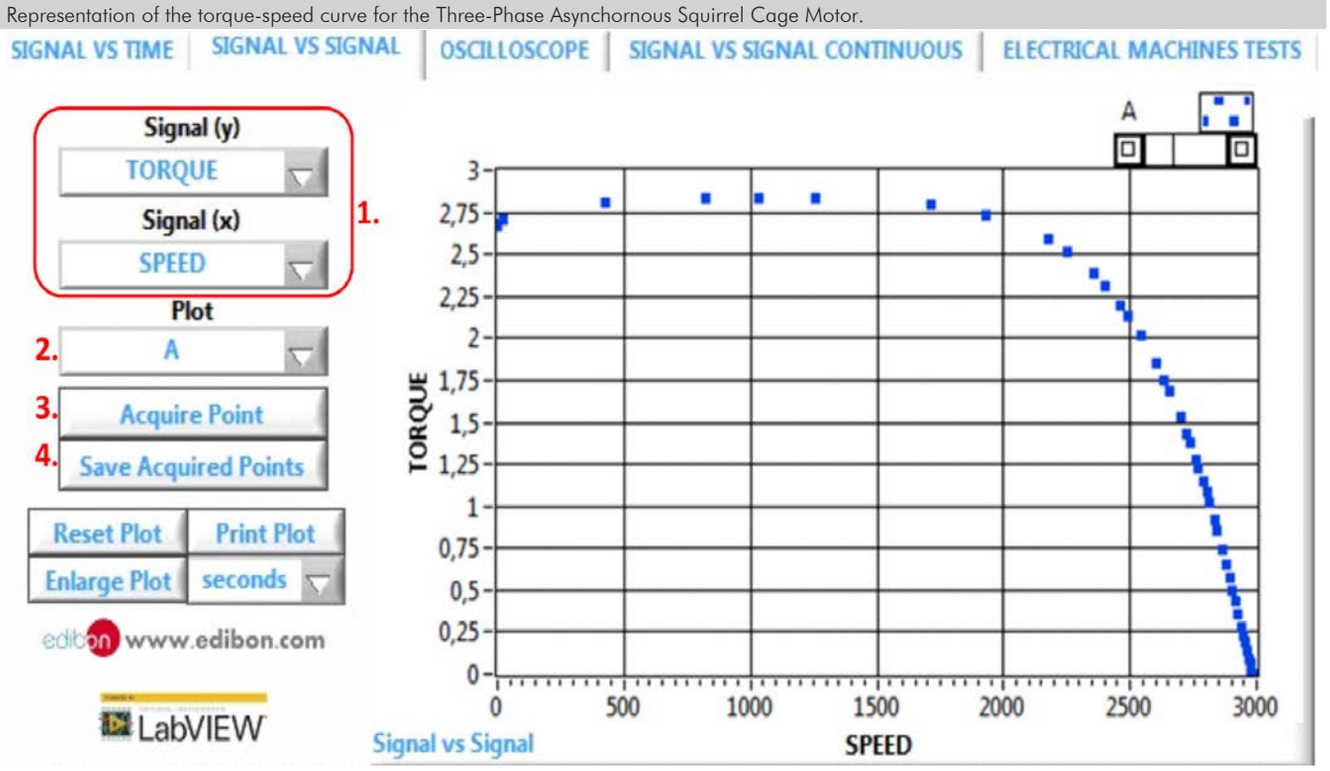
② **Parameters selection.** It allows choosing the parameters to be displayed and the setting for its display.

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.



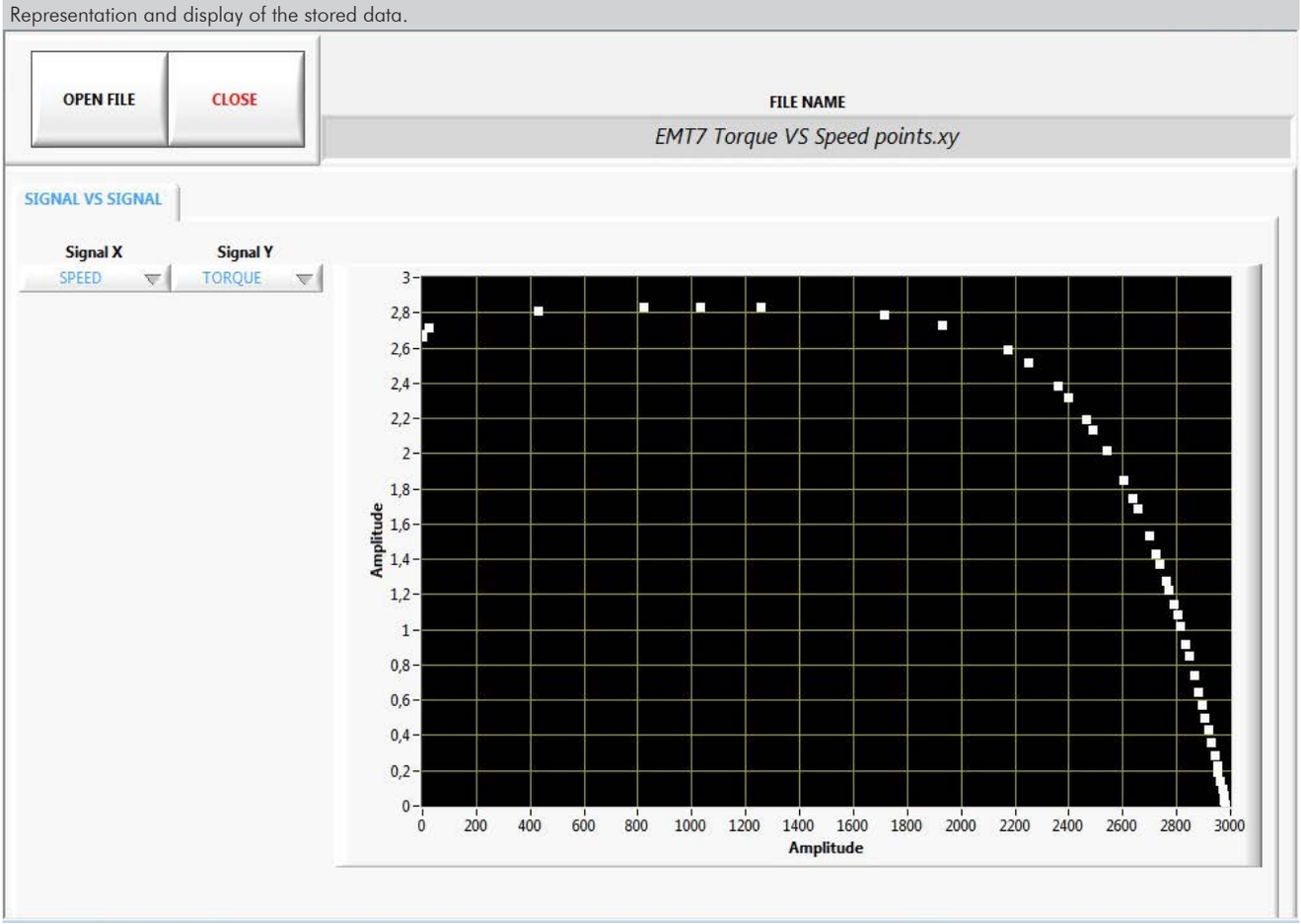
① **Axis signal selector.** It allows selecting the parameter to be monitored in each axis.

② **Type of graph selector.**

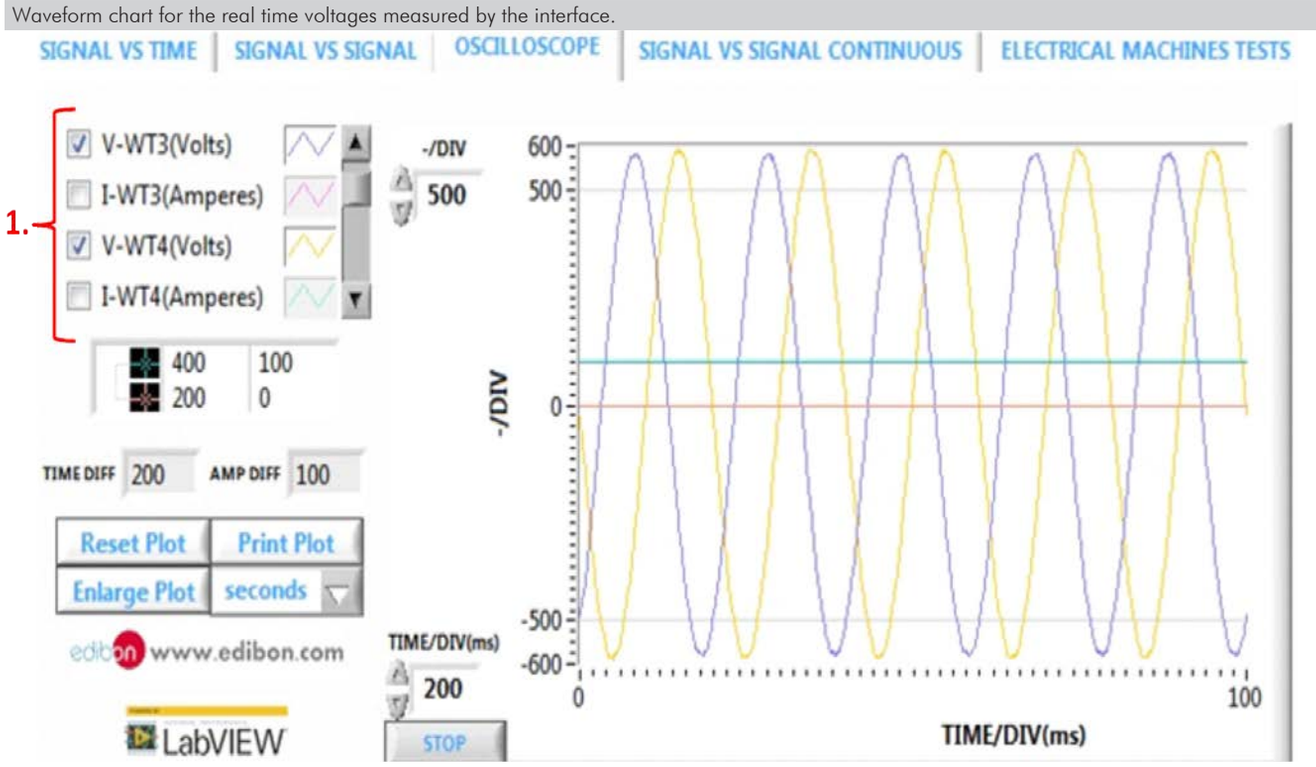
③ **Acquire points.** It allows displaying in the graph the point corresponding to the time when it is pressed.

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.

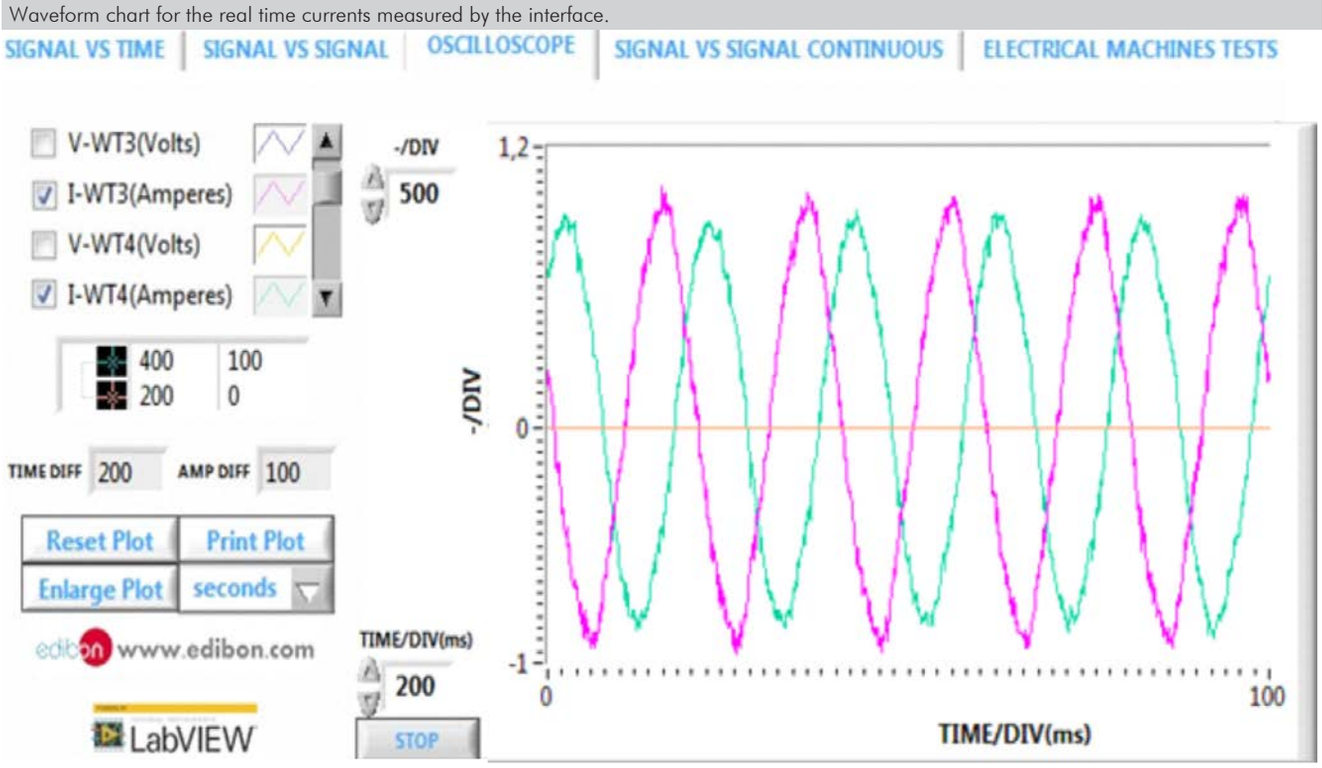


Waveform chart for the real time voltages measured by the interface.

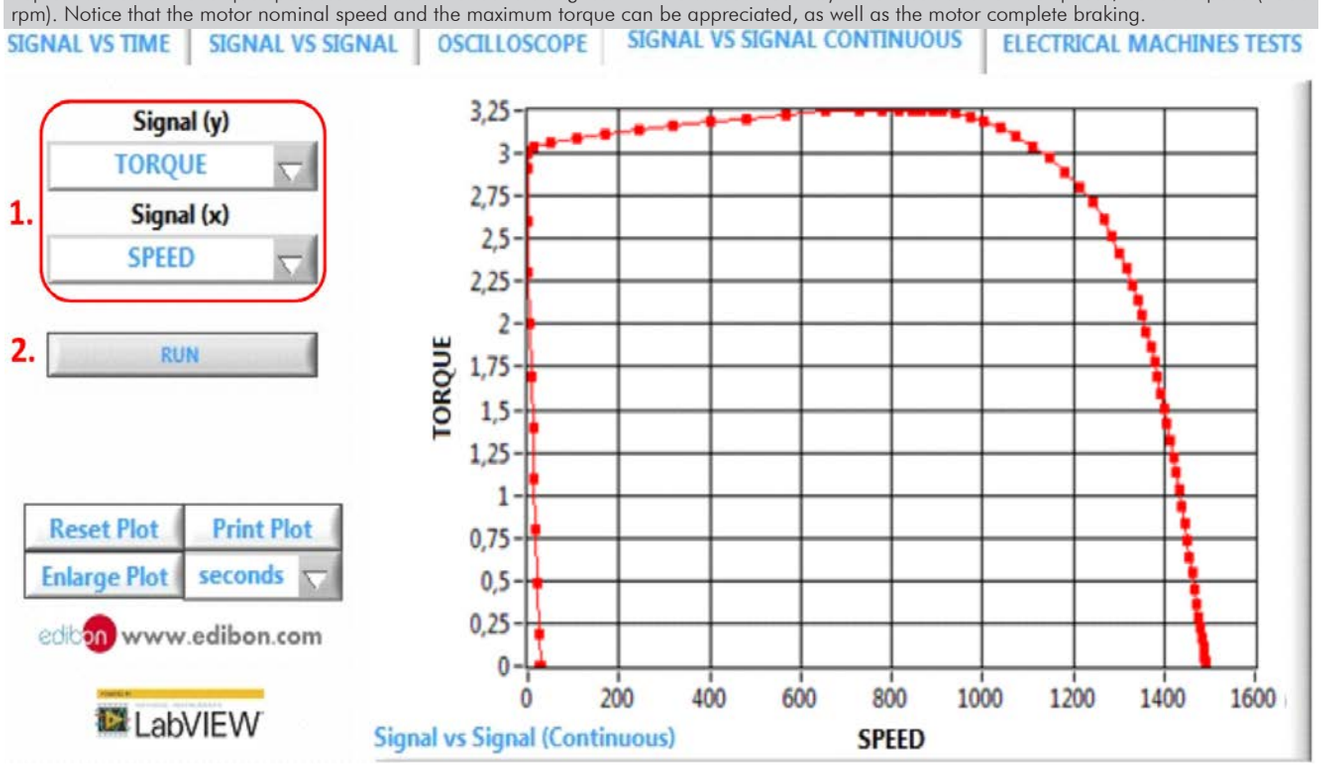


ⓘ **Parameters selector.** It allows choosing the parameters whose waveforms want to be displayed.

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



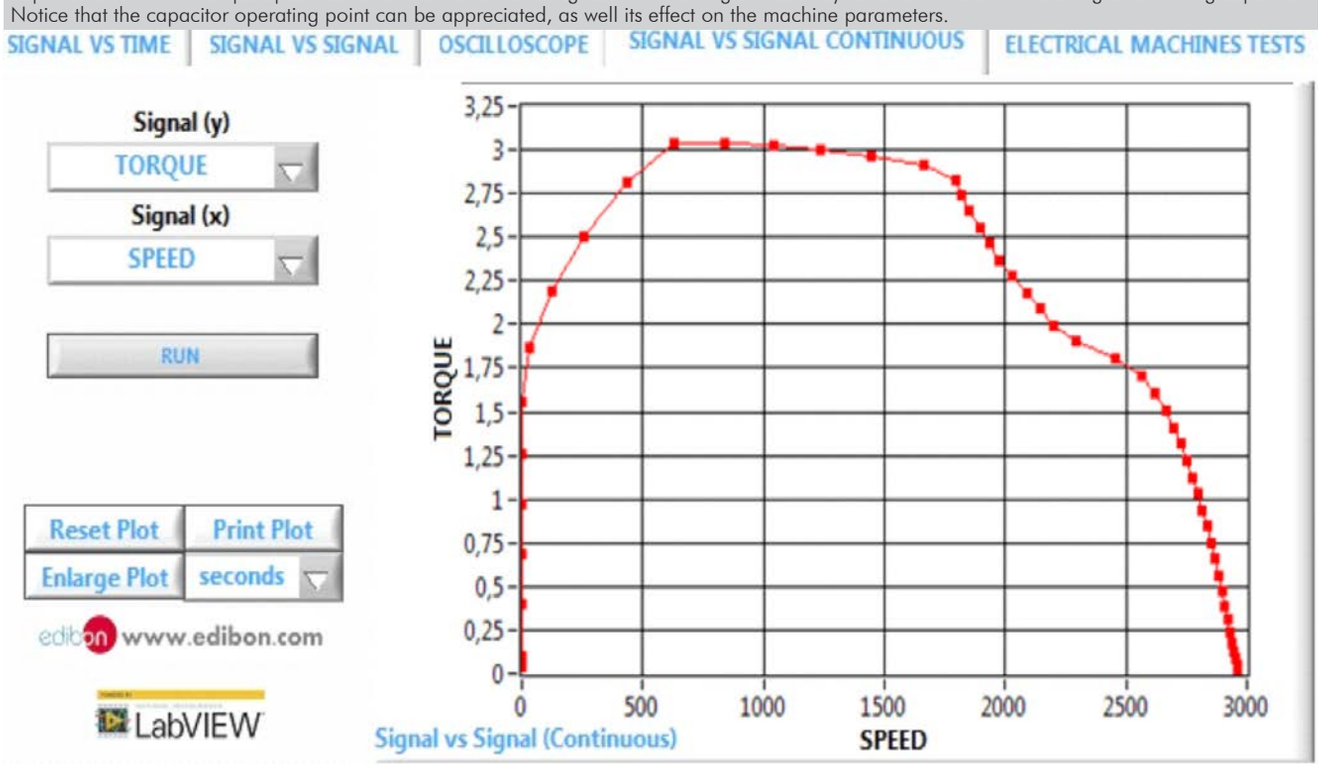
Representation of the torque-speed curve for the manual braking test with the Three-Phase Asynchronous Motor of two speeds, no load speed (1500 rpm). Notice that the motor nominal speed and the maximum torque can be appreciated, as well as the motor complete braking.



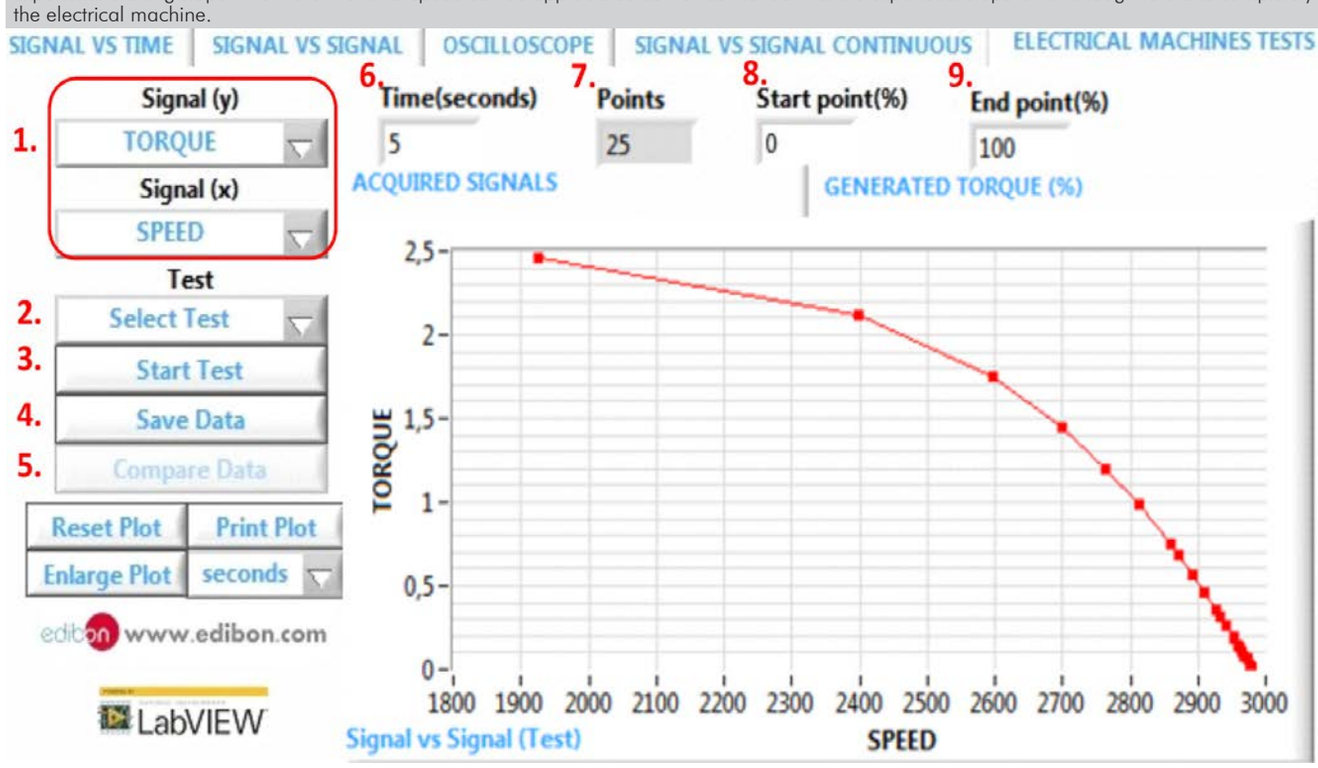
① **Axis signal selector.** It allows selecting the parameter to be monitored in each axis.

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.

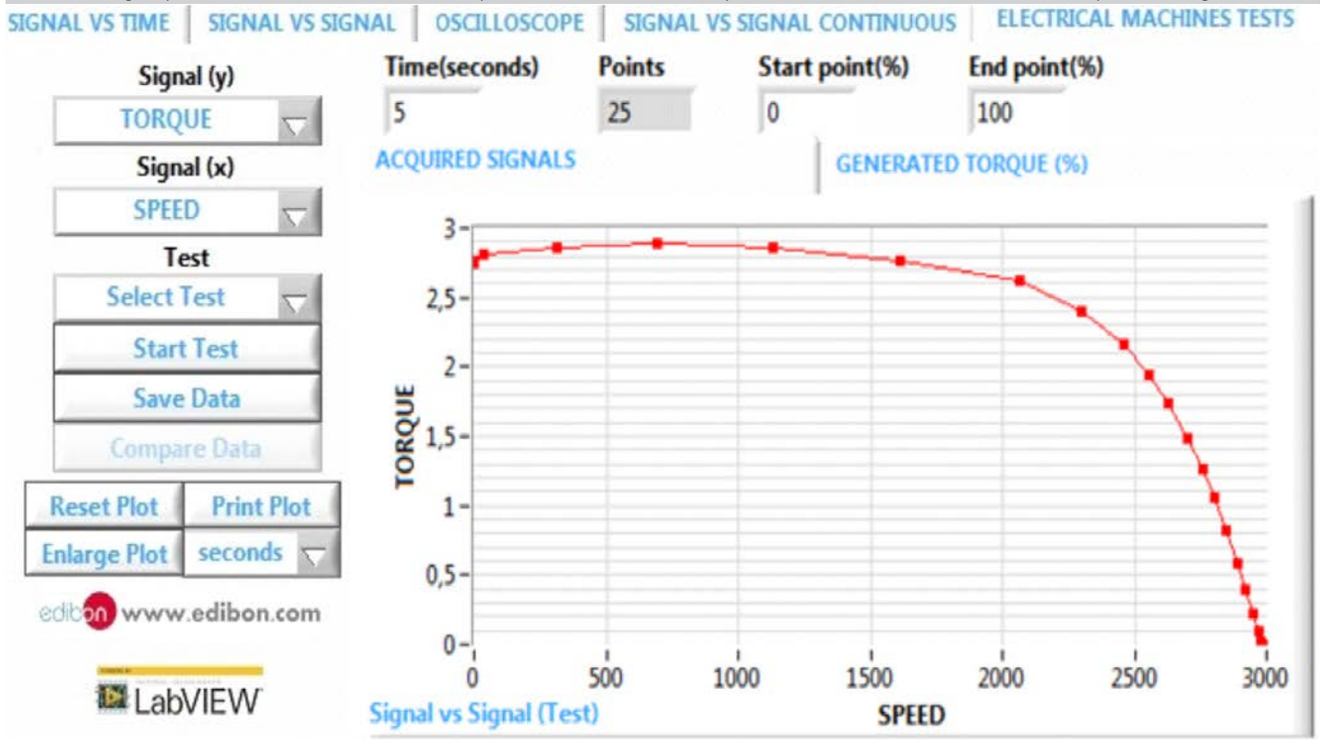
⑦ **Points.** It shows the number of points that will define the resulting plot.

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

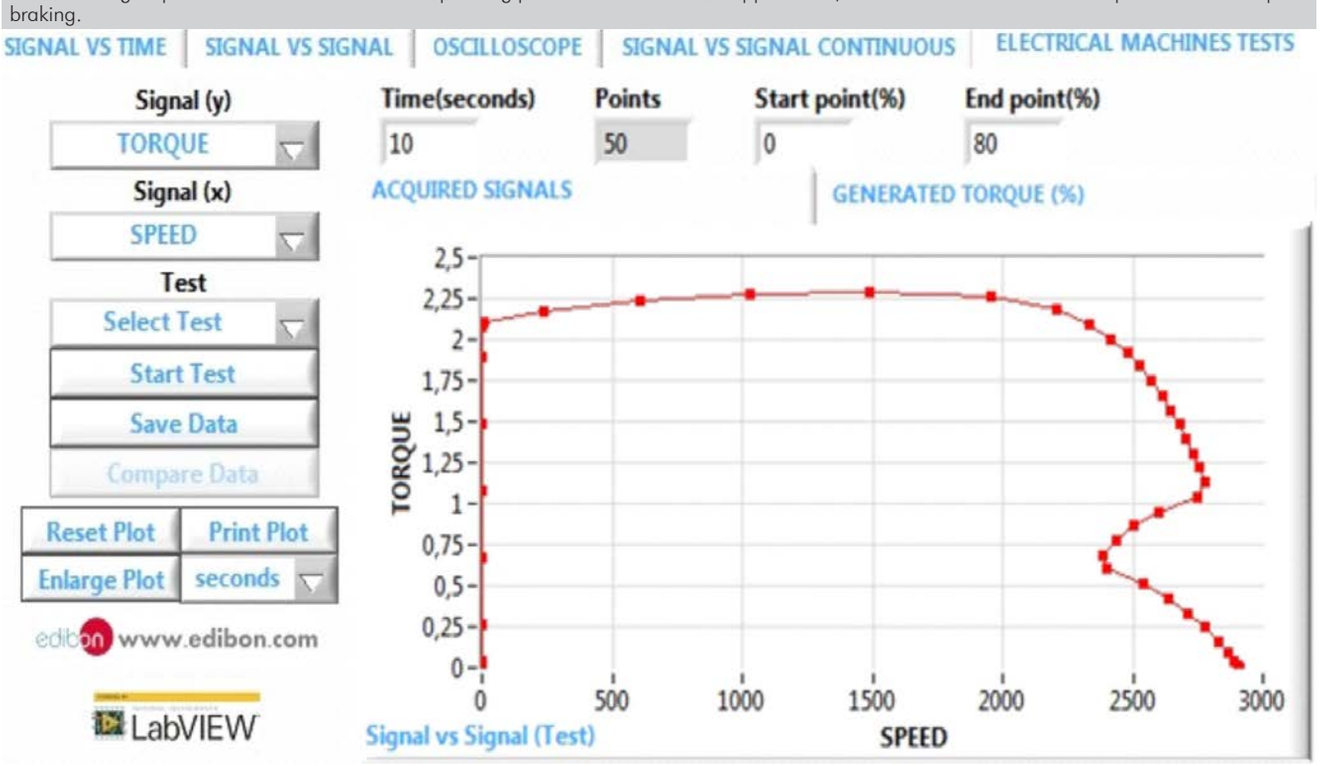
⑨ **End point.** It allows selecting (as a percentage) the end point of the test to be fulfilled.

Some test results with **EM-SCADA** (recommended)

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.

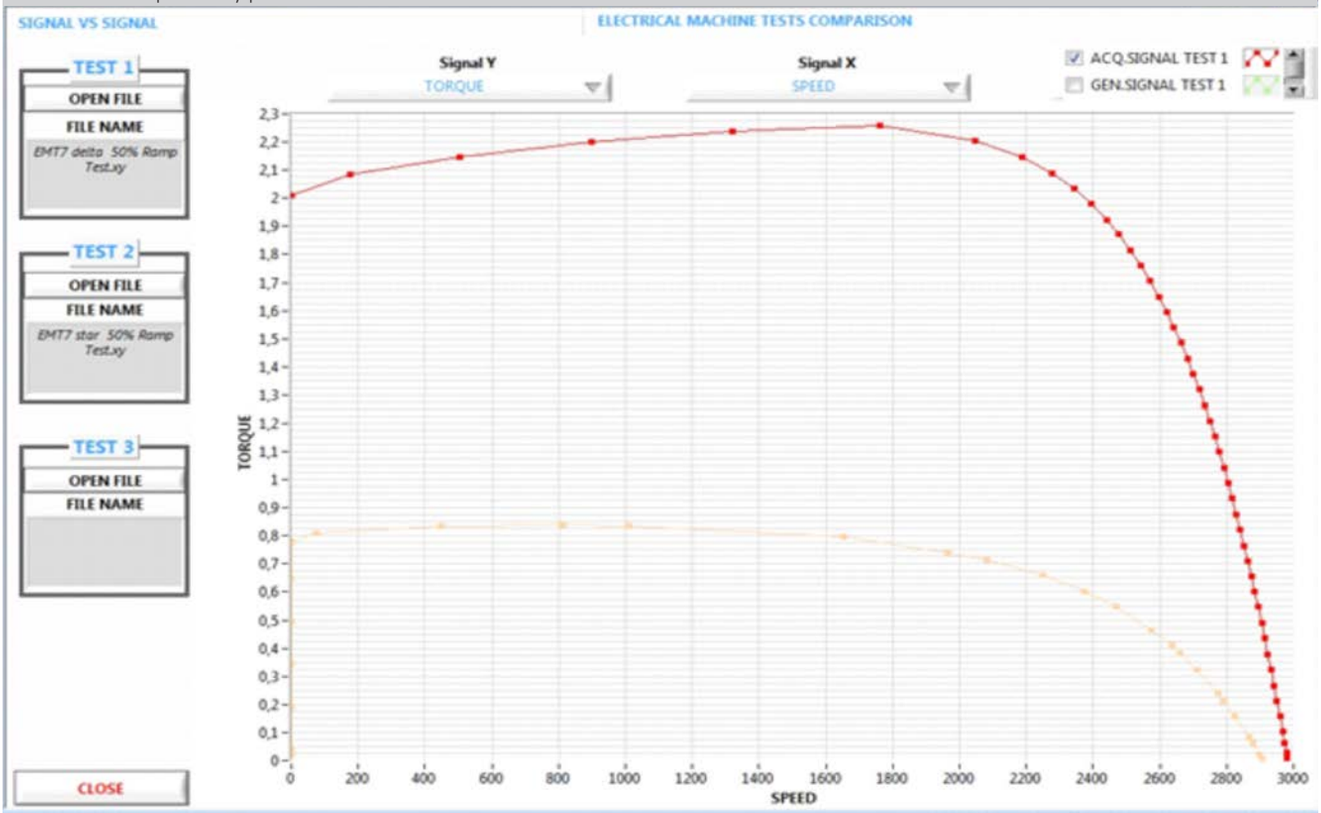


Obtained results for the automatic braking test with the Three-Phase Asynchronous Squirrel Cage Motor, with star-delta starting, from 0 to 80 % and linear braking slope. Notice that the condenser operating point condenser can be appreciated, as well as the motor nominal speed and its complete braking.

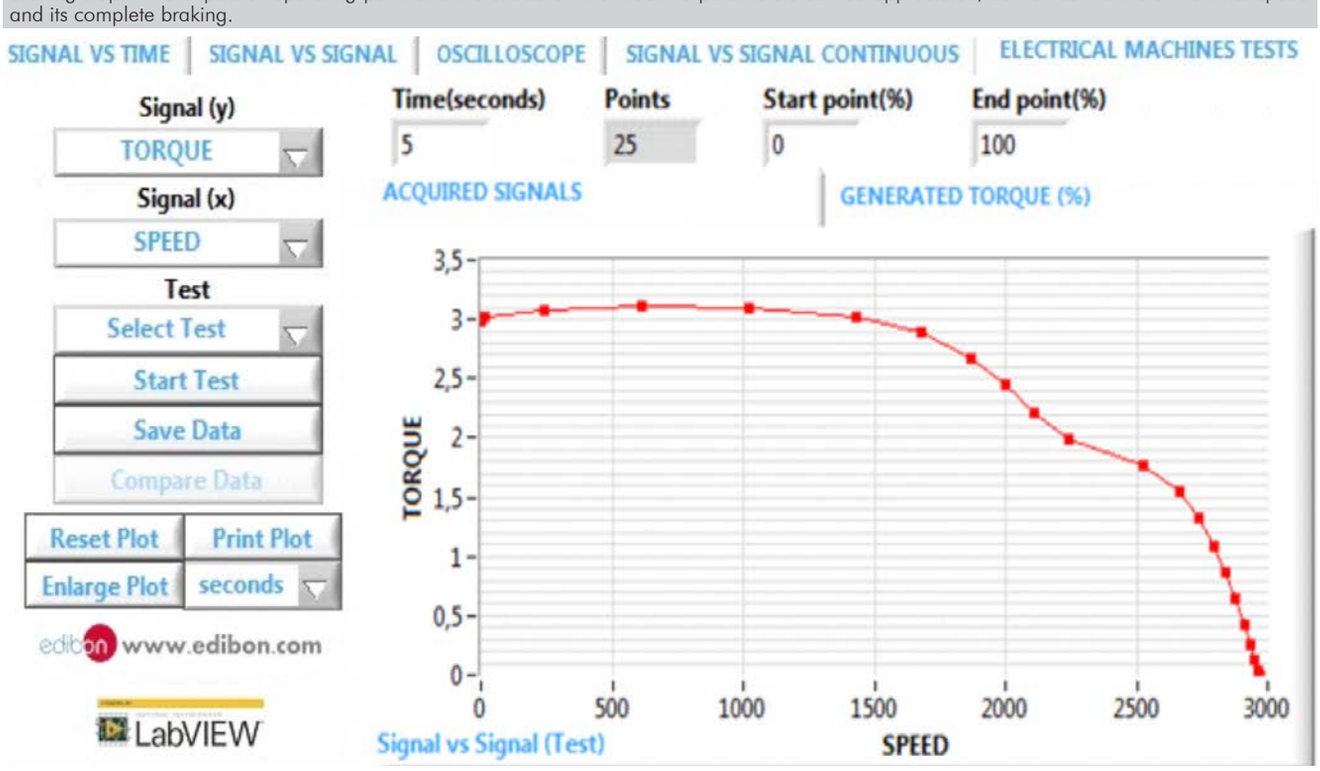


Some test results with **EM-SCADA** (recommended)

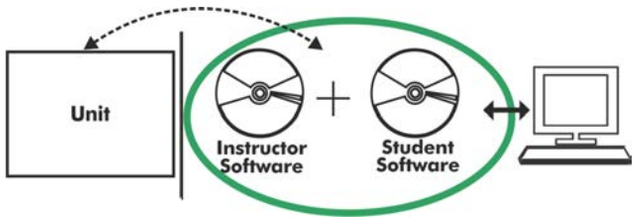
Purchase of two previously performed and stored tests.



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.



AEL-EMSS/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).

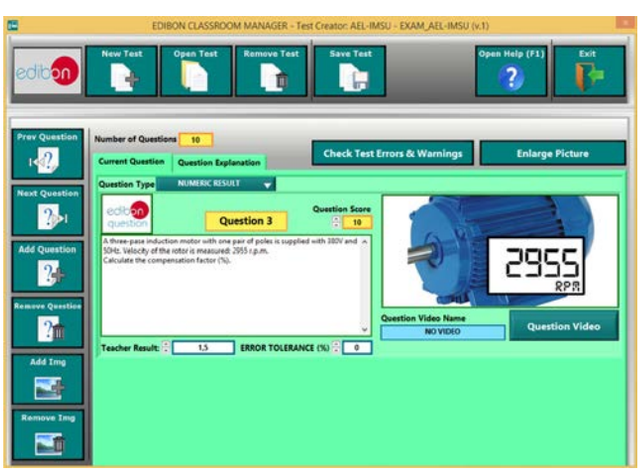
ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual 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.

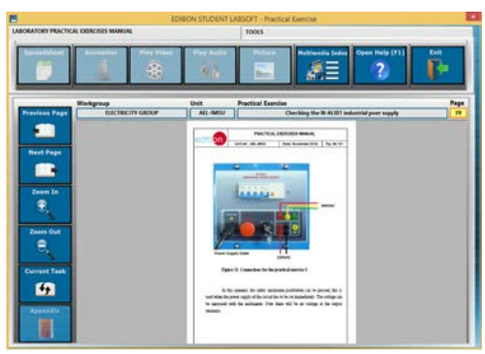
Innovative features:

- **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.**

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

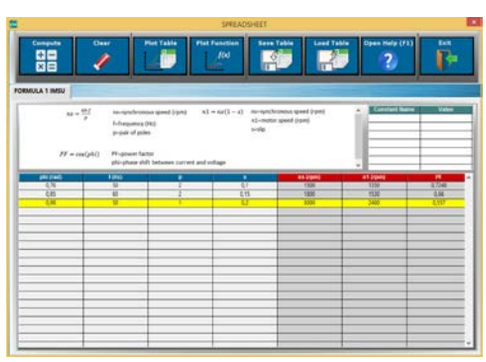
For more information see **ICAI** catalogue. Click on the following link:

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



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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REPRESENTATIVE: