

\* Minimum supply always includes: 1 + 2 + 3 + 4  
(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.**
- **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  
AND  
5.- ENERGY

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

Global climate change and the depletion of fossil fuels make electric mobility one of the most innovative areas of automotive technology. In recent years, the automotive sector is undergoing major changes, focusing on various technologies that will lead us to achieve a 100% electric vehicle with great autonomy.

Many brands already have their own electric or hybrid cars, such as Tesla, Audi, BMW, Toyota, Nissan, Renault, Citroën, Hyundai, etc. One of the biggest challenges facing these companies is to achieve maximum range, and that is why the development of sophisticated batteries and regeneration systems (energy recovery) are crucial to extend the range of these vehicles. At present, the real range of an electric car is capable of exceeding 300 km, but due to the few existing recharging points and the time required for a full charge, it is difficult to undertake long distances outside the cities.

Due to the rapid evolution of electric mobility, there is a strong need for training in this particular field, in which professionals in the sector lack the appropriate technical training to handle this cutting-edge technology. For this reason, Edibon offers the education sector one of the most complete equipment on the market for the study of electric vehicles.

## GENERAL DESCRIPTION

The Computer Controlled Hybrid and Electric Vehicles Application, "AEL-EHV", is an application designed by EDIBON for the theoretical and practical training of the different topologies of electric/hybrid vehicles most used today.

Given the diversity of electric vehicle configurations that can be studied, this application has been developed under a modular format so that the user, student or researcher can implement the topology of the electric/hybrid vehicle to be studied. This is a great advantage over other similar applications on the market, as it makes it possible to compare the operation, efficiency and way of working of each of the existing electric vehicle topologies.

The "AEL-EHV" application basically consists of three parts:

- 100% electric vehicle (included): it is formed by a series of modules included in the "AEL-EHV" application that allow studying the operation of the 100% electric vehicle.
- Hybrid vehicle (recommended): it is formed by a module recommended to work with the "AEL-EHV" application that will allow studying the operation of hybrid vehicles.
- Electric vehicle recharging point (recommended): this is a real recharging system for electric vehicles recommended to work with modules of point 1.

From the functional point of view of this application, it is important to note that for the study of the hybrid vehicle, the combustion engine is simulated by means of a servo motor because of the advantages that this involves: the dimensions of the equipment are much smaller and it can also be used inside any laboratory or classroom as it does not produce emissions.

With this application the user can easily assemble the main parts of the electric vehicle such as the combustion engine, the frequency controller with regeneration system and the electric traction motor with the capacity to regenerate energy in situations of braking or downhill. Because it is the user who assembles each of the configurations, the learning and knowledge acquired with this application goes far beyond the standard. The application includes an electrical analyzer that, among many other parameters, show the electrical power flows from the battery to the electric motor (traction mode) or from the electric motor to the battery (regenerative braking mode).

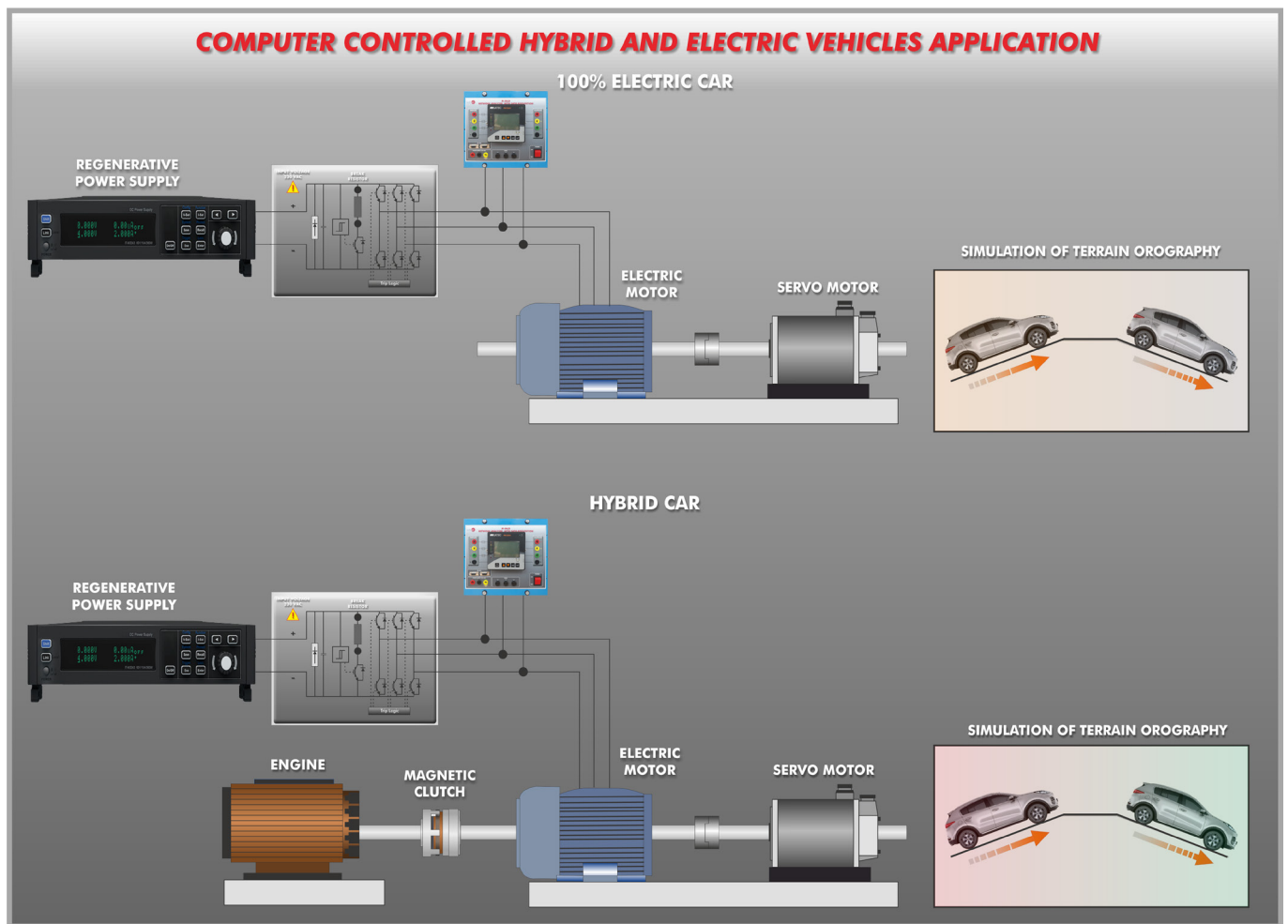
Apart from the elements already mentioned, in order to study the behavior of EVs in depth, it is essential to have a system that can simulate the terrain's orography. This makes it possible to recreate in the laboratory real situations faced by a vehicle. These situations can be summarized as acceleration, braking and up and down ramps. Each of these situations can be realistically studied thanks to the servomotor coupled to the shaft of the main electric traction motor. The servomotor receives the commands from a servo-driver, a device included in this application that will control the servomotor dynamics to recreate real situations in the laboratory.

Finally, in order to understand how power flows are distributed in an electric vehicle, this application incorporates an intelligent regenerative DC power supply. Its purpose is to simulate the behavior of a high-voltage EV battery. The great advantage of this DC power supply is that it can simulate the operation of a lithium battery without the disadvantages that these have: heating risks, risk of toxic gas emissions, explosion risks and limited lifetime.

Optionally, the "AEL-EHV" application recommends the purchase of the electric vehicle charging module. This device is completely real, identical to those used in electric vehicle charging stations.

## General Description

Below are some reference diagrams to understand some of the topologies that can be studied with this equipment:



The "AEL-EHV" application includes data acquisition, control and supervision software. Through this SCADA system the user can control from the PC the behavior of the vehicle's electrical system, monitor power curves, simulate acceleration and deceleration ramps, visualize the regeneration system, monitor the charging and discharging stages of the simulated battery during regenerative acceleration and braking, etc.

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

- EMT7. 3PH Squirrel-Cage Motor.
- N-RGTR. Regenerative Powertrain Module.
- N-DYTS. Dynamic Ground Simulation Module.
- N-DCPWS/R. Regenerative DC Power Supply Module.

Additional recommended elements to study the hybrid vehicle (Not included):

- N-ENGs. Petrol Engine Simulation Module.

Additional recommended electric vehicle charger (Not included):

- EVCH. Electric Vehicle Charger.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + Computer Control, 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 and 4.
- Optional items: 5, 6, and 7.

Let us describe first the main items (1 to 4):

**① AEL-EHV. Application:**

• **EMT7. 3PH Squirrel-Cage Motor.**

Nominal power: 370 W.  
 Nominal voltage: 3 x 230/400 VAC Δ/Y.  
 Frequency: 50/60 Hz.  
 Poles number: 2.  
 RPM: 2730 rpm.  
 Shaft height: 71 mm.



EMT7

• **N-RGTR. Regenerative Powertrain Module.**

Power supply: 230 VAC.  
 ON/OFF switch.  
 Internal frequency drive with speed and torque control.  
 Safety key "Start/Stop".  
 Power analyzer:

The network analyzer module allows fulfilling measurements, displaying and analyzing all the parameters of the AC electrical networks. It has an LCD screen and push-buttons for the navigation through the different menus. It includes specific software for monitoring current and voltage curves, harmonics display, tariffs programming, alarms programming and electrical parameters storage.

Features:

Multifunctional three-phase power meter:

Single and three-phase voltage. Up to 690 VAC L-L.  
 Line and neutral nominal current: 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.  
 Voltage and current THD, TDD & 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, four types of days.  
 Automatic daily report of energy consumption maximums and minimums.

Communications:

RS-495 communications port.

Speed/brake control potentiometer.  
 DC battery input terminals.  
 AC motor output terminals.



N-RGTR

• **N-DYTS. Dynamic Ground Simulation Module.**

Power supply: 400 VAC+N+GND.  
 Frequency: 50/60 Hz.  
 ON/OFF switch.  
 Servo motor and driver:  
 Dynamic and static operating regime in four quadrants.  
 Speed and torque control.  
 Nominal power: 1 kW.  
 Maximum power: 3 kW.  
 Nominal torque: 3.18 Nm.  
 Maximum torque: 9.55 Nm.  
 Temperature control.  
 Slope selector: uphill/flat terrain/downhill.  
 % slope control potentiometer.



N-DYTS

- **N-DCPWS/R. Regenerative DC Power Supply Module.**

- ON/OFF switch.
- Voltage range: 0 - 350 VDC
- Current range: 0 - 6 A.
- Power: 800 W.
- Control panel for battery mode configuration:
  - Source mode.
  - Charging mode.
- Integrated overcurrent protections.
- Integrated overvoltage protections.



N-DCPWS-R

Additional recommended elements to study the hybrid vehicle (Not included):

- **N-ENG.S. Petrol Engine Simulation Module.**

- Power supply: 230 VAC.
- ON/OFF switch.
- Internal frequency drive with speed and torque control.
- Starter motor input signal.
- Magnetic clutch.
- Magnetic clutch control signal.
- Servo motor and driver:
  - Dynamic and static operating regime.
  - Speed and torque control.
  - Nominal power: 1 kW.
  - Maximum power: 3 kW.
  - Nominal torque: 3.18 Nm.
  - Maximum torque: 9.55 Nm.
  - Temperature control.



N-ENG.S

Additional recommended electric vehicle charger (Not included):

- **EVCH. Electric Vehicle Charger.**

- Basic recharge box.
- IP54 enclosure.
- Single-phase Schuko socket (230 V, 16 A, 3.6 kW).
- Single-phase energy meter (kWh).



EVCH

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

The complete unit includes as well:

**Advanced Real-Time SCADA.**

**Open Control + Multicontrol + Real-Time Control.**

**Specialized EDIBON Control Software based on LabVIEW.**

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 **AEL-EHV/CCSOF. Computer Control + Data Acquisition + Data Management Software:**

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.**

**Calibration system for the sensors involved in the process.**

**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.**



AEL-EHV/CCSOF

③ **Cables and Accessories**, for normal operation.

④ **Manuals:**

This unit is **supplied with 7 manuals**: Required Services, Assembly and Installation, Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

\*References 1 to 4 are the main items: AEL-EHV + AEL-EHV/CCSOF + 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

- 1.- Study of the 100% electric vehicle, torque-speed relationship, regenerative braking, operation of a driving cycle simulating different situations. Current and voltage measurements at different points of the circuits.
- 2.- Configuration of the terrain orography in uphill mode to study the response of the 100% electric vehicle system.
- 3.- Configuration of the terrain orography in horizontal mode to study the response of the 100% electric vehicle system.
- 4.- Configuration of the terrain orography in downhill mode for the study of the response of the 100% electric vehicle system.

Some practical exercises with the recommended additional hybrid vehicle element (N-ENG5):

- 5.- Study of the hybrid-parallel vehicle, torque-speed relationship, regenerative braking, operation of a driving cycle simulating different situations. Current and voltage measurements at different points of the circuits.
- 6.- Configuration of the terrain orography in uphill mode to study the response of the parallel hybrid vehicle system.
- 7.- Configuration of the terrain orography in horizontal mode for the study of the response of the parallel hybrid vehicle system.
- 8.- Configuration of the terrain orography in downhill mode for the study of the response of the parallel hybrid vehicle system.
- 9.- Integration of different maps of the torque-speed curves of the combustion engine.
- 10.- Comparison of the 100% gasoline vehicle with the hybrid vehicle.

Some practical exercises with the electric vehicle charger (EVCH):

- 11.- Connection to the vehicle network for charging. Voltage and charging current measurements.
- 12.- Theoretical analysis of the different existing charging levels: level 1, level 2 and level 3.

- 13.- Study of the different charging times according to the capacity of the battery and the existing types of connection.
- 14.- Study of the importance of the C-rate for the charging of the batteries of electric vehicles.

Other possibilities to be done with this unit:

- 15.- Many students view results simultaneously.  
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
  - 16.- The Computer Control System with SCADA allows a real industrial simulation.
  - 17.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
  - 18.- This unit can be used for doing applied research.
  - 19.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
  - 20.- Visualization of all the sensors values used in the AEL-EHV unit process.
- Several other exercises can be done and designed by the user.

### REQUIRED SERVICES

- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz, 2 kW.
- Computer.

### DIMENSIONS AND WEIGHTS

AEL-EHV:

- Dimensions: 2000 x 1000 x 300 mm approx.  
(78.73 x 39.36 x 11.81 inches approx.)
- Weight: 90 Kg approx.  
(198 pounds approx.)

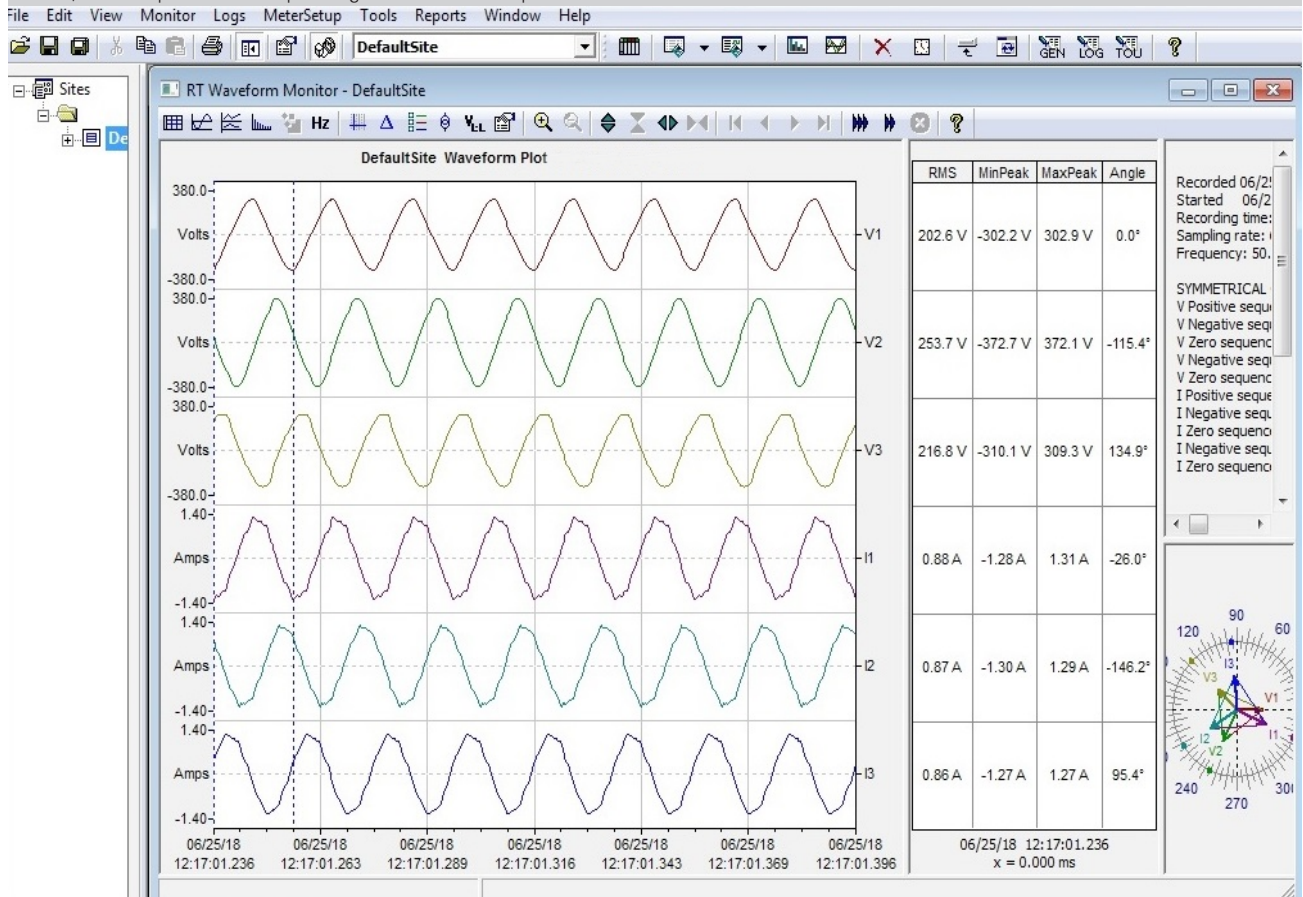
### ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- N-ENG5. Petrol Engine Simulation Module.
- EVCH. Electric Vehicle Charger.

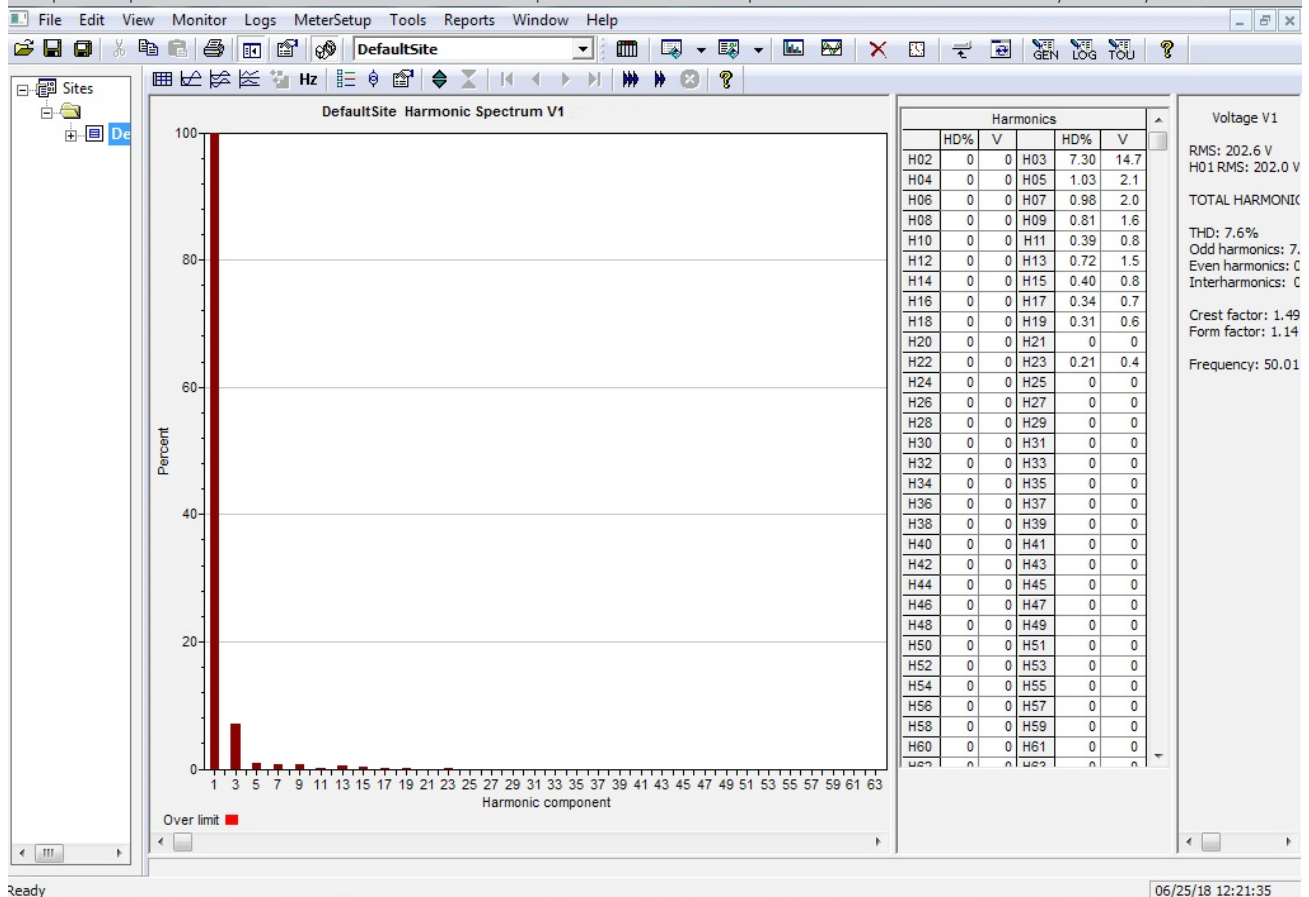


## SOME REAL RESULTS OBTAINED FROM THIS UNIT

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



Graphical representation and data table of the harmonic spectrum of the selected parameter measured in real time by the analyser.





## COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

Additionally to the main items (1 to 4) described, we can offer, as optional, other items from 5 to 7.

All these items try to give more possibilities for:

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

### a) Technical and Vocational Education configuration

#### ⑤ AEL-EHV/ICAI. Interactive Computer Aided Instruction Software.

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.

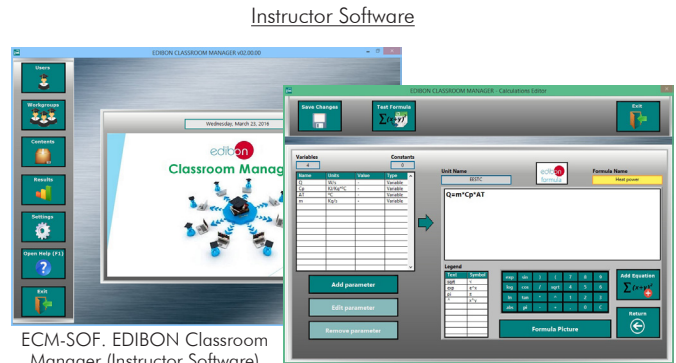
This software is optional and can be used additionally to items (1 to 4).

#### - 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.

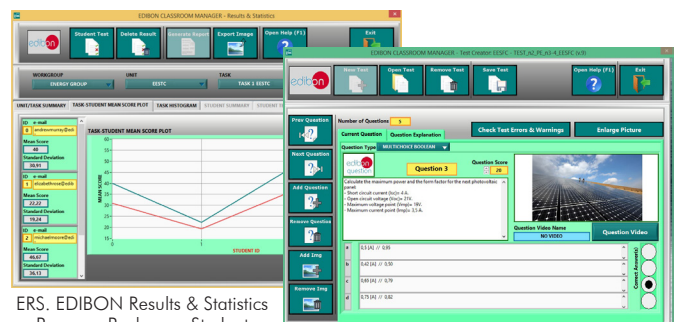
Innovative features:

- 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



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

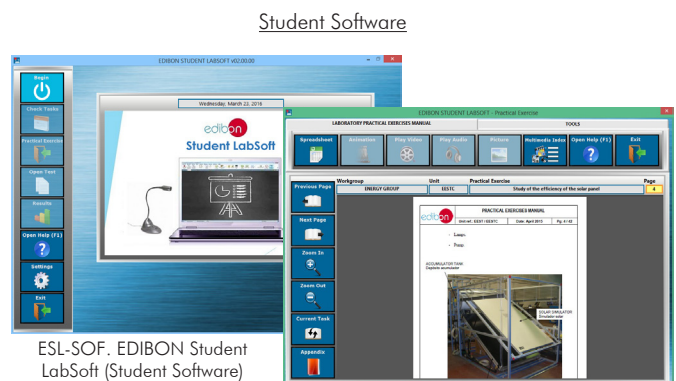
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

#### - 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.

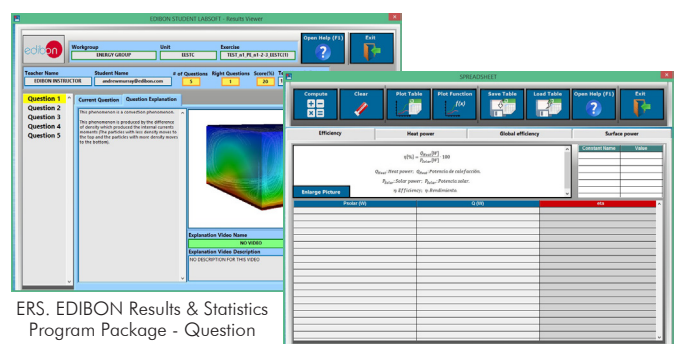
Innovative features:

- 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

EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation

ECAL. EDIBON Calculations Program Package Main Screen

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

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

b) Multipost Expansions options

⑥ **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:

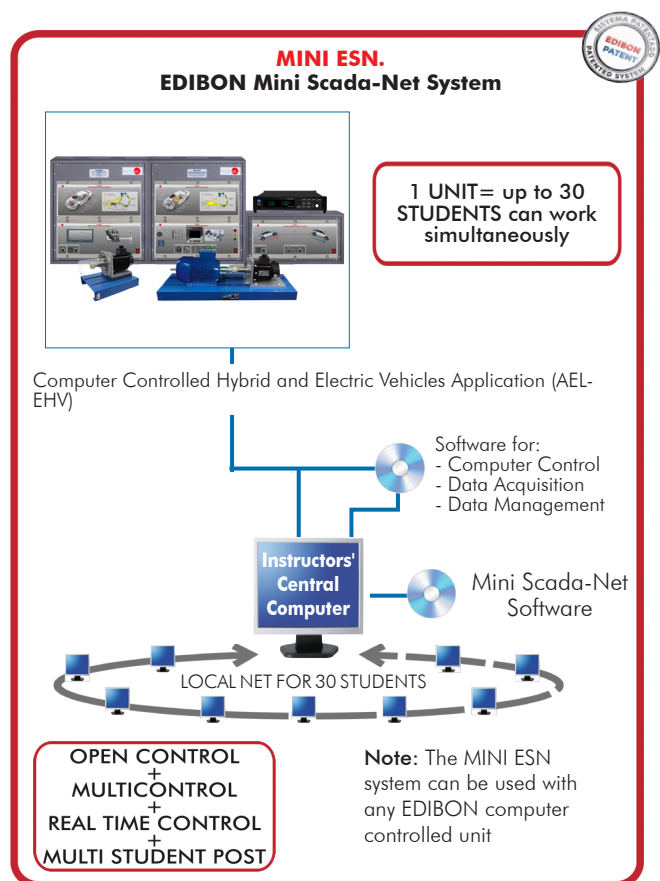
<https://www.edibon.com/en/edibon-scada-net/catalog>

⑦ **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:

<https://www.edibon.com/en/edibon-scada-net/catalog>



## ORDER INFORMATION

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

Minimum supply always includes:

- ① **Unit: AEL-EHV. Computer Controlled Hybrid and Electric Vehicles Application.**
- ② **AEL-EHV/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
- ③ **Cables and Accessories**, for normal operation.
- ④ **Manuals.**

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

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

a) Technical and Vocational Education configuration

- ⑤ AEL-EHV/ICAL. Interactive Computer Aided Instruction Software.

b) Multipost Expansions options

- ⑥ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.
- ⑦ ESN. EDIBON Scada-Net Systems.

**① AEL-EHV. Application:**

- EMT7. 3PH Squirrel-Cage Motor.

Nominal power: 370 W.

Nominal voltage: 3 x 230/400 VAC Δ/Y.

Frequency: 50/60 Hz.

Poles number: 2.

RPM: 2730 rpm.

Shaft height: 71 mm.

- N-RGTR. Regenerative Powertrain Module.

Power supply: 230 VAC.

ON/OFF switch.

Internal frequency drive with speed and torque control.

Safety key "Start/Stop".

Power analyzer:

The network analyzer module allows fulfilling measurements, displaying and analyzing all the parameters of the AC electrical networks. It has an LCD screen and push-buttons for the navigation through the different menus. It includes specific software for monitoring current and voltage curves, harmonics display, tariffs programming, alarms programming and electrical parameters storage.

Features:

Multifunctional three-phase power meter:

Single and three-phase voltage. Up to 690 VAC L-L.

Line and neutral nominal current: 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.

Voltage and current THD, TDD & 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, four types of days.

Automatic daily report of energy consumption maximums and minimums.

Communications:

RS-495 communications port.

Speed/brake control potentiometer.

DC battery input terminals.

AC motor output terminals.

- N-DYTS. Dynamic Ground Simulation Module.

Power supply: 400 VAC+N+GND.

Frequency: 50/60 Hz.

ON/OFF switch.

Servo motor and driver:

Dynamic and static operating regime in four quadrants.

Speed and torque control.

Nominal power: 1 kW.

Maximum power: 3 kW.

Nominal torque: 3.18 Nm.

Maximum torque: 9.55 Nm.

Temperature control.

Slope selector: uphill/flat terrain/downhill.

% slope control potentiometer.

- N-DCPWS/R. Regenerative DC Power Supply Module.

ON/OFF switch.

Voltage range: 0 - 350 VDC

Current range: 0 - 6 A.

Power: 800 W.

Control panel for battery mode configuration:

Source mode.

Charging mode.

Integrated overcurrent protections.

Integrated overvoltage protections.

Additional recommended elements to study the hybrid vehicle (Not included):

- N-ENGS. Petrol Engine Simulation Module.
  - Power supply: 230 VAC.
  - ON/OFF switch.
  - Internal frequency drive with speed and torque control.
  - Starter motor input signal.
  - Magnetic clutch.
  - Magnetic clutch control signal.
  - Servo motor and driver:
    - Dynamic and static operating regime.
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    - Nominal power: 1 kW.
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Additional recommended electric vehicle charger (Not included):

- EVCH. Electric Vehicle Charger.
  - Basic recharge box.
  - IP54 enclosure.
  - Single-phase Schuko socket (230 V, 16 A, 3.6 kW).
  - Single-phase energy meter (kWh).
- All necessary cables to realize the practical exercises are included.

The complete unit includes as well:

Advanced Real-Time SCADA.  
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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 AEL-EHV/CCSOF. Computer Control + Data Acquisition + Data Management Software:**

The three softwares are part of the SCADA system.  
Compatible with the industry standards.  
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.  
Management, processing, comparison and storage of data.  
Calibration system for the sensors involved in the process.  
It allows the registration of the alarms state and the graphic representation in real time.  
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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.

**③ Cables and Accessories**, for normal operation.

**④ Manuals:**

This unit is supplied with 7 manuals: Required Services, Assembly and Installation, Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

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

- 1.- Study of the 100% electric vehicle, torque-speed relationship, regenerative braking, operation of a driving cycle simulating different situations. Current and voltage measurements at different points of the circuits.
- 2.- Configuration of the terrain orography in uphill mode to study the response of the 100% electric vehicle system.
- 3.- Configuration of the terrain orography in horizontal mode to study the response of the 100% electric vehicle system.
- 4.- Configuration of the terrain orography in downhill mode for the study of the response of the 100% electric vehicle system.

Some practical exercises with the recommended additional hybrid vehicle element (N-ENGs):

- 5.- Study of the hybrid-parallel vehicle, torque-speed relationship, regenerative braking, operation of a driving cycle simulating different situations. Current and voltage measurements at different points of the circuits.
- 6.- Configuration of the terrain orography in uphill mode to study the response of the parallel hybrid vehicle system.
- 7.- Configuration of the terrain orography in horizontal mode for the study of the response of the parallel hybrid vehicle system.
- 8.- Configuration of the terrain orography in downhill mode for the study of the response of the parallel hybrid vehicle system.
- 9.- Integration of different maps of the torque-speed curves of the combustion engine.
- 10.- Comparison of the 100% gasoline vehicle with the hybrid vehicle.

Some practical exercises with the electric vehicle charger (EVCH):

- 11.- Connection to the vehicle network for charging. Voltage and charging current measurements.
- 12.- Theoretical analysis of the different existing charging levels: level 1, level 2 and level 3.
- 13.- Study of the different charging times according to the capacity of the battery and the existing types of connection.
- 14.- Study of the importance of the C-rate for the charging of the batteries of electric vehicles.

Other possibilities to be done with this unit:

- 15.- Many students view results simultaneously.  
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
  - 16.- The Computer Control System with SCADA allows a real industrial simulation.
  - 17.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
  - 18.- This unit can be used for doing applied research.
  - 19.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
  - 20.- Visualization of all the sensors values used in the AEL-EHV unit process.
- Several other exercises can be done and designed by the user.



## TENDER SPECIFICATIONS (for optional items)

### a) Technical and Vocational Education configuration

#### ⑤ AEL-EHV/ICAI. Interactive Computer Aided Instruction Software.

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.

### b) Multipost Expansions options

#### ⑥ 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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