Engineering and Technical Teaching Equipment

Computer Controlled **Hybrid and Electric Vehicles Application,** with SCADA

AEL-EHVC

Example configuration of "AEL-EHVC" application

Key features:

- **Advanced Real-Time SCADA.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON Control Software based on LabVIEW.**
- **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

POWERED BY NATIONAL INSTRUMENTS LabVIEW™

www.edibon.com
PRODUCTS
2.- ELECTRONICS, 4.- ELECTRICITY AND 5.- ENERGY

For more information about Key Features, click here

Certificate of Approval of the Quality Management System (LRQA CERTIFIED ISO 9001)

European Union Certificate (total safety)

UL and CSA Regulations (All our products are manufactured according to current UL and CSA regulations)

Certificate of Approval of the Environmental Management System (LRQA CERTIFIED ISO 14001)

Worlddidac Association Certificate of Membership

INTRODUCTION

Climate change and the depletion of fossil fuels are driving a major transformation in the transportation sector, positioning electric mobility as a key engine toward a sustainable future.

Manufacturers such as Tesla, Audi, BMW, Toyota, Nissan, and others have developed increasingly efficient electric and hybrid vehicles with greater driving ranges. However, limited charging infrastructure and long charging times remain significant challenges.

This technological evolution has led to a growing demand for specialized professionals, although there is still a shortage of training in the operation, diagnostics, and maintenance of electric traction systems.

To address this need, EDIBON presents a comprehensive technological solution that accurately emulates the operation of an electric vehicle, including battery management, motor control, and energy recovery systems. This unit is designed to support both technical training and the development of applied research projects in the field of electric mobility.

With this solution, EDIBON actively contributes to the training of new generations of engineers and technicians, while also providing experimental environments that foster innovation and scientific progress toward more sustainable and efficient mobility.

GENERAL DESCRIPTION

The Computer Controlled Hybrid and Electric Vehicles Application, "AEL-EHVC", hhas been developed by EDIBON to facilitate the understanding and analysis of key technologies used in electric and hybrid vehicles within the context of modern electric mobility.

Given the wide diversity of electric and hybrid vehicle configurations that can be studied, this application has been developed with a modular design, allowing users, students, or researchers to implement the desired vehicle topology. This feature offers a competitive advantage over other systems on the market by enabling real comparisons between different configurations in terms of operation, efficiency, and dynamic behavior.

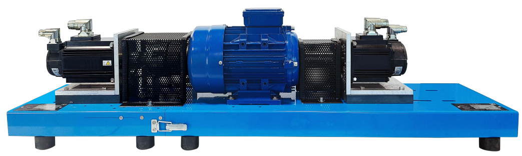
The "AEL-EHVC" application is structured into three main areas of study:

- **100% Electric Vehicle (included):** Comprising a set of modules that allow for the study of a fully electric vehicle's behavior, including the traction motor, terrain simulator, frequency inverter, and regenerative DC power source.
- **Hybrid Vehicle (recommended) (Not included):** Incorporates a servomotor with a magnetic clutch, capable of replicating the behavior of a gasoline engine interacting with the main electric motor.
- **Electric Vehicle Charging Station (recommended) (Not included):** A real charging system identical to those used at service stations, enabling the study of the electric vehicle charging process.

Given the high potential of this application, the following sections detail the two vehicle topologies that can be configured, along with the capabilities of the included SCADA supervision and control software:

Elements included:

The 100% Electric Vehicle Topology integrates all the elements necessary to simulate a real electric vehicle:



AEL-EHVC detail

- N-DCPWS/R. **Regenerative DC Power Supply Module:** Simulates the behavior of the traction battery.
- N-RGTR. **Regenerative Powertrain Module:** Regulates the speed and torque of the electric motor.
- EMT7B/1K-E. **3PH Squirrel-Cage Industrial Motor, 1 kW, 4 Poles:** Emulates the main traction system.
- **Terrain Simulation Servomotor:** Coupled to the motor shaft, allows the simulation of uphill, downhill, and flat terrain conditions.

By simulating different slopes, users can observe the principles of energy conversion between electrical and mechanical forms, both in traction (uphill) and regeneration (downhill) modes.

The system also includes a set of real automotive pedals (accelerator and brake), allowing practical management of acceleration, deceleration, and regenerative braking phases.

The powerful **SCADA software** stands out, enabling the modeling of different types of batteries by configuring key parameters such as:

- Capacity in ampere-hours (Ah).
- Charging voltages for bulk, absorption, and float stages.

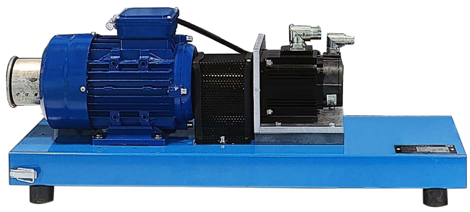
The user can analyze the power flow during charging and discharging in a virtual energy buffer, safely replicating the behavior of a real lithium battery across the different charging stages.

Additional recommended elements (Not included):

The hybrid vehicle topology extends the previous capabilities by incorporating an additional servomotor that simulates the behavior of a gasoline engine.

- N-ENGS. **Petrol Engine Simulation Module.**

  Thanks to a **magnetic clutch**, the thermal engine can be coupled or decoupled from the electric traction train in a controlled manner, depending on the vehicle's operating regime:



AEL-EHVC detail

  - At low revolutions, the vehicle operates purely in electric mode.
  - When exceeding a certain speed threshold, the gasoline engine smoothly couples to the electric motor, replicating a hybrid traction mode.

  In this phase, the electric motor acts as an assistant, providing extra power only when requested by the accelerator.

  The **SCADA system** plays a key role in dynamically configuring this topology, allowing users to:

  - Define the degree of assistance provided by the electric motor to the combustion engine.
  - Program the torque/speed curve of the gasoline engine by adjusting parameters such as starting torque, maximum torque, and torque at maximum speed.

  These advanced options allow users to experiment with different control strategies, as if reprogramming the ECU of a real hybrid vehicle, greatly varying the dynamic behavior of the system.

- EVCH. **Electric Vehicle Charger.**

  Optionally, the "AEL-EHVC" application can be complemented with a **real electric vehicle charging module**, identical to those used in service stations.

  This device enables users to:

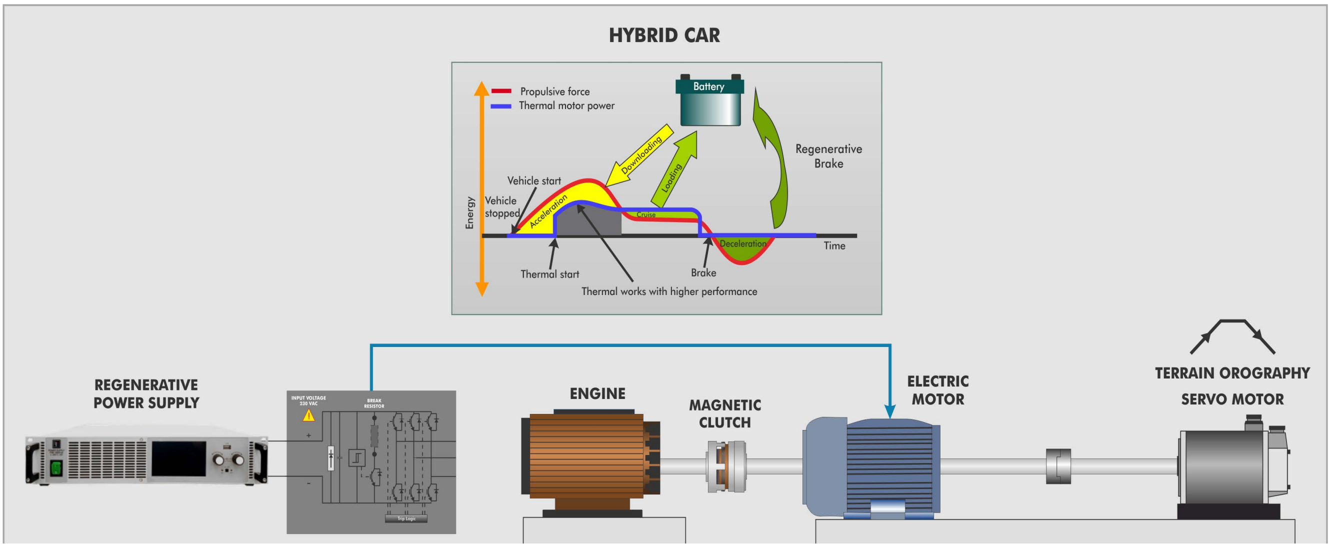
  - Familiarize themselves with electric vehicle charging protocols.
  - Monitor energy flows during the charging process.
  - Analyze the relationship between the previously defined battery capacity and the required charging time.

  From the **SCADA system**, users can:

  - Enable and disable battery charging remotely.
  - Monitor real-time electrical parameters (voltage, current, power).
  - Study how the battery's state of charge evolves throughout the charging cycle.

  This module provides a deep understanding of one of the critical factors in electric mobility: how battery size and charger type directly influence charging times.

The following reference diagrams illustrate some of the topologies that can be analyzed using this unit.



The “AEL-EHVC” application includes the following elements:

- EMT7B/1K-E. 3PH Squirrel-Cage Industrial Motor, 1 kW, 4 Poles.
- N-RGTR. Regenerative Powertrain Module.
- N-DYTS. Dynamic Ground Simulation Module.
- N-DCPWS/R. Regenerative DC Power Supply Module.

Additional recommended elements (Not included):

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

The application “AEL-EHVC” can be mounted on rack (option A) or on rail (option B):

Option A:

This application needs the following rack:

- N-RACK-M.
- N-RACK-B (2 units).

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.

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-EHVC. Application:

- EMT7B/1K-E. **3PH Squirrel-Cage Industrial Motor, 1 kW, 4 Poles.**
  Nominal power: 1000 W.
  Nominal voltage: 230 VAC / 400 VAC.
  Frequency: 50 / 60 Hz.
  Nominal load speed: 1500 rpm.
  Nominal current: 4.57 A / 2.64 A.

N-RGTR + EMT7B/1K-E

- N-RGTR. **Regenerative Powertrain Module.**
  Power supply: 230 VAC.
  ON / OFF switch.
  Internal frequency drive with speed and torque control.
  Safety key "Start/Stop".

- N-DYTS. **Dynamic Ground Simulation Module.**
  Power supply: 400 VAC+N.
  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 (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.
    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-ENGS

- 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.

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-EHVC/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.

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-EHVC/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 & Practices manuals.

*References 1 to 4 are the main items: AEL-EHVC + AEL-EHVC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

1.- Detailed study of the traction system in a 100% electric vehicle:

Analysis of the conversion of electrical energy into mechanical energy, evaluating the dynamic response of the three-phase motor based on acceleration and load demand.

2.- Comprehensive analysis of regenerative braking under different scenarios:

Evaluation of kinetic energy recovery during controlled braking events and its conversion into electrical energy, monitoring the power flow regenerated back into the virtual battery.

3.- Dynamic evaluation of an electric vehicle's behavior through simulated real driving cycles:

Simulation of acceleration, deceleration, and constant speed patterns, replicating urban, interurban, and highway routes, and analysis of energy efficiency in each case.

4.- Analysis of the torque-speed relationship under different operating conditions:

Study of how motor torque and speed vary according to load, acceleration, and terrain type, with graphical representation of the electric motor's characteristic curve.

5.- Simulation of ascending terrain to study the traction system's response:

Analysis of the additional torque demand required on uphill slopes and its impact on energy consumption, motor efficiency, and vehicle dynamics.

6.- Simulation of flat terrain for the analysis of stable traction behavior:

Study of energy performance under constant load conditions, evaluating motor efficiency during steady-state driving without terrain variations.

7.- Simulation of descending terrain and evaluation of its effect on the control and regeneration systems:

Analysis of kinetic energy utilization through regenerative braking and its impact on battery recharging, depending on the simulated slope.

8.- Real-time graphical representation of terrain profile and its influence on vehicle behavior:

Generation and monitoring of orographic profiles via SCADA, with dynamic updates of slope, speed, and power parameters.

9.- Analysis of power consumption under different conditions using a bidirectional battery simulator:

Study of energy flows in traction and regeneration modes, evaluating the efficiency of energy conversion depending on terrain and driving cycle.

10.- Real-time monitoring of all key operational parameters through interactive SCADA graphs:

Simultaneous visualization of critical variables such as current, voltage, power, speed, and motor torque, enabling an in-depth analysis of the vehicle's electrical system behavior.

Some practical exercises with the recommended additional element of the Petrol Engine Simulation Module (N-ENGS):

11.- Study of the combined operation of the electric and combustion engines in a hybrid vehicle:

Analysis of the dynamic coordination between both energy sources, evaluating power distribution and overall efficiency under various driving conditions.

12.- Visualization and analysis of the magnetic clutch coupling to the main traction system:

Observation of the controlled connection process between the combustion engine and the electric motor, assessing the real-time transition between operating modes.

13.- Graphical analysis of torque transmission during the coupling process:

Interactive graphical representation of the motor torque behavior at the moment the combustion engine couples to the traction system.

14.- Monitoring the automatic synchronization process between the combustion and electric motors:

Real-time monitoring of both motors' speed and torque during automatic synchronization, evaluating transition efficiency and smoothness.

15.- Evaluation of electric and combustion motor participation under different terrain conditions in automatic mode:

Study of the vehicle's adaptive behavior on ascending, flat, and descending terrains, with automatic management of the participation percentages of each motor.

16.- Study of motor coupling and clutch control in manual mode:

Manual configuration of motor coupling/decoupling, allowing experimentation and analysis of customized energy management strategies.

17.- Simulation of ascending terrain for parallel hybrid vehicles:

Analysis of the hybrid system's response to increasing slopes, evaluating the combined effort of both motors and the impact on energy consumption.

18.- Simulation of descending terrain for parallel hybrid vehicles:

Study of regenerative capacity and energy management during downhill conditions, analyzing the interaction between regenerative braking and combustion engine decoupling.

19.- Configuration and analysis of the electric motor's response to sudden accelerations:

Adjustment of accelerator pedal sensitivity parameters and evaluation of the electric motor's response during high instantaneous power demand.

20.- Study of in-motion battery recharging through electric motor drag by the combustion engine:

Analysis of electrical energy generation when the battery is at low charge levels, simulating the typical in-motion recharging mode of hybrid vehicles.

21.- Integration and comparative analysis of different combustion engine torque-speed maps:

Programming and evaluation of various combustion engine performance curves, assessing their effect on hybrid vehicle efficiency and dynamics.

22.- Modification of control parameters related to motor participation:

Adjustment of advanced functions such as generation mode activation at low battery levels and accelerator pedal sensitivity, optimizing the hybrid strategy.

23.- Comparison of energy efficiency between a 100% electric vehicle and a parallel hybrid vehicle:

Comparative analysis based on energy consumption, range, and dynamic behavior, evaluating the advantages and disadvantages of each technology under real operating conditions.

Some practical exercises with the recommended additional element of the with the Electric Vehicle Charger (EVCH):

24.- Simulation of a realistic charging process using a real electric vehicle charger:

Reproduction of a real-world charging cycle by connecting a commercial-type charger to the system, allowing the study of the initiation, continuous charging, and completion phases under realistic conditions.

25.- Physical connection and validation of the link between the charger and the traction system:

Execution of the physical connection of the electric charger to the equipment, verification of communication between devices, and monitoring of the automatic activation of the charging protocol.

26.- Measurement and analysis of electrical parameters during the charging process:

Real-time monitoring of voltage, charging current, and supplied power, evaluating the electrical behavior of the system throughout the different stages of the charging process.

27.- Evaluation of charging times based on the battery capacity set in SCADA:

Study of the time required to reach specific charge levels, analyzing how the defined battery capacity directly influences the total charging time.

28.- Analysis of the influence of C-Rate on charging process efficiency:

Evaluation of the impact of different C-Rates on the total charging time, assessing the relationship between charge rate, battery characteristics, and energy management efficiency.

Other possibilities to be done with this unit:

29.- Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

30.- Open Control, Multicontrol and Real Time Control.

This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.

31.- The Computer Control System with SCADA allows a real industrial simulation.

32.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.

33.- This unit can be used for doing applied research.

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

- 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-EHVC:

- 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-ENGS. Petrol Engine Simulation Module.
- EVCH. Electric Vehicle Charger.

SIMILAR UNITS AVAILABLE

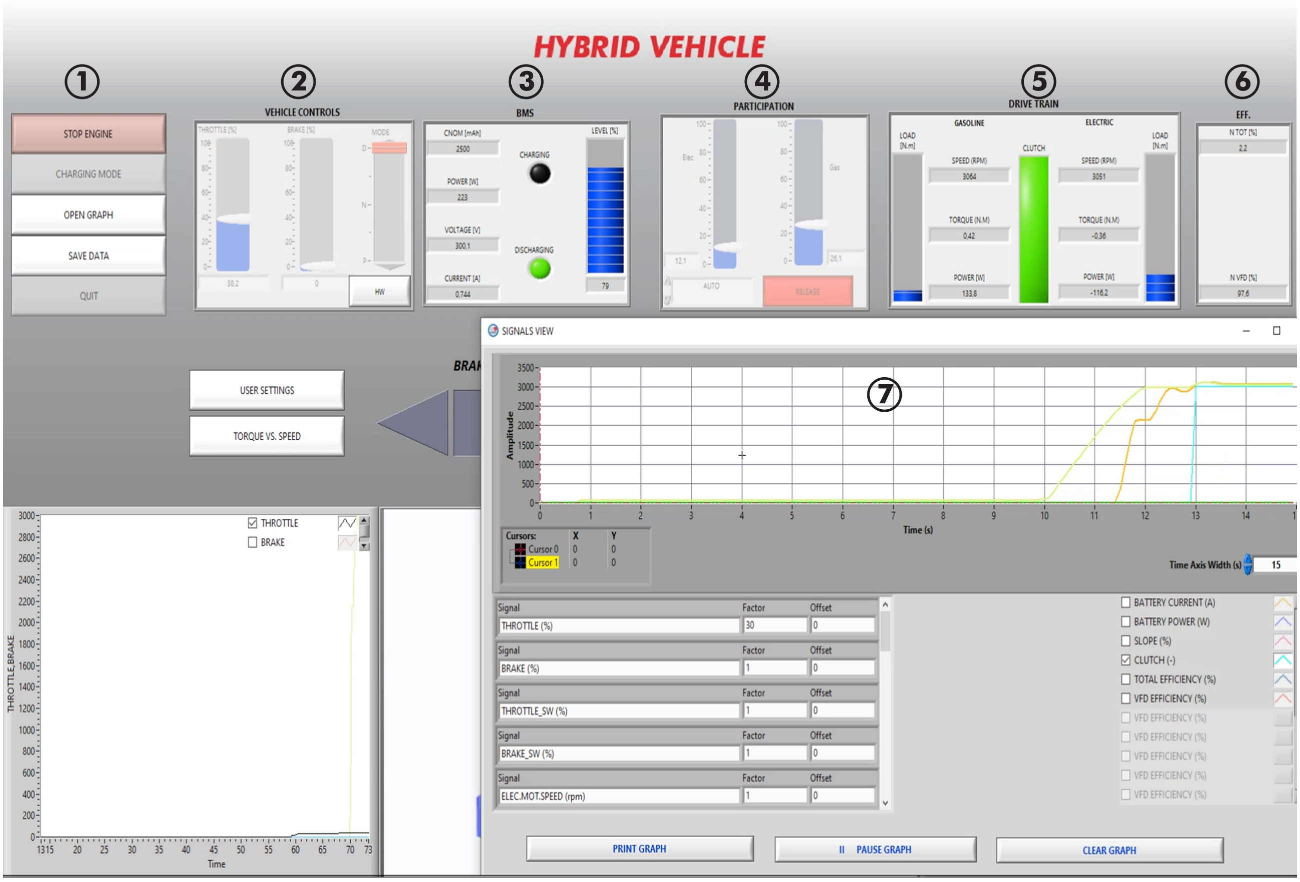
Offered in this catalog:

- AEL-EHVC. Computer Controlled Hybrid and Electric Vehicles Application.

Offered in other catalog:

- TBM/H. Comprehensive Testing and Diagnosis Bench for Hybrid Engine with Braking and Diagnostic Software.

Hybrid Vehicle Control Interface: Real-time visualization of the coordinated operation between the electric and thermal engines, with magnetic clutch in automatic engagement mode.



① **SCADA Control Panel:** Access to system startup functions, charge mode configuration, data storage, and historical log display.

② **Dynamic Vehicle Controls:** Management of acceleration and braking via the driving interface.

③ **Battery System Status:** Monitoring of charge level and electrical parameters.

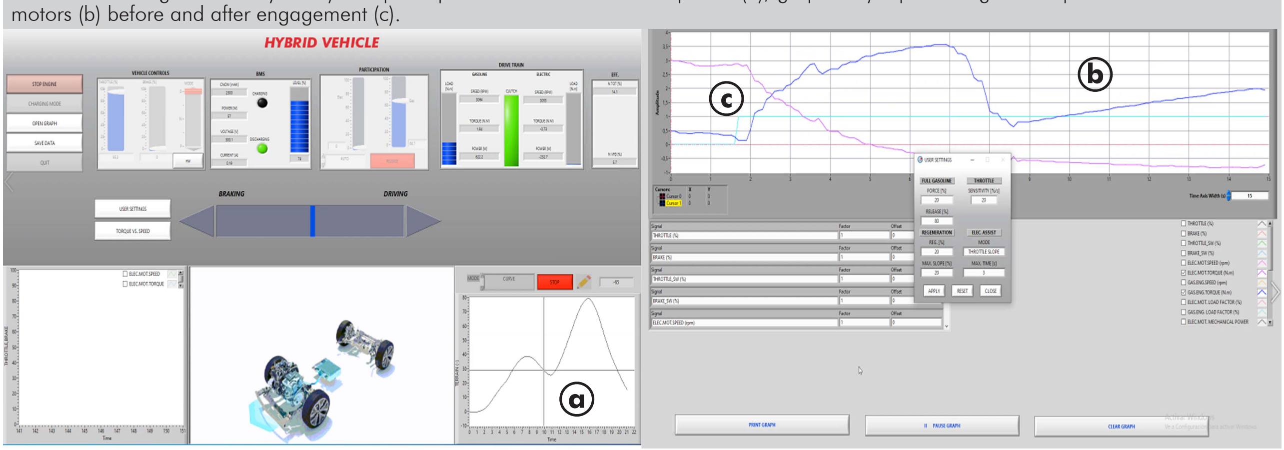
④ **Drive Participation Management:** Selection of operating modes and monitoring of the electromagnetic clutch.

⑤ **Drive Parameters Monitoring:** Display of speed, torque, and power of both engines, along with clutch status.

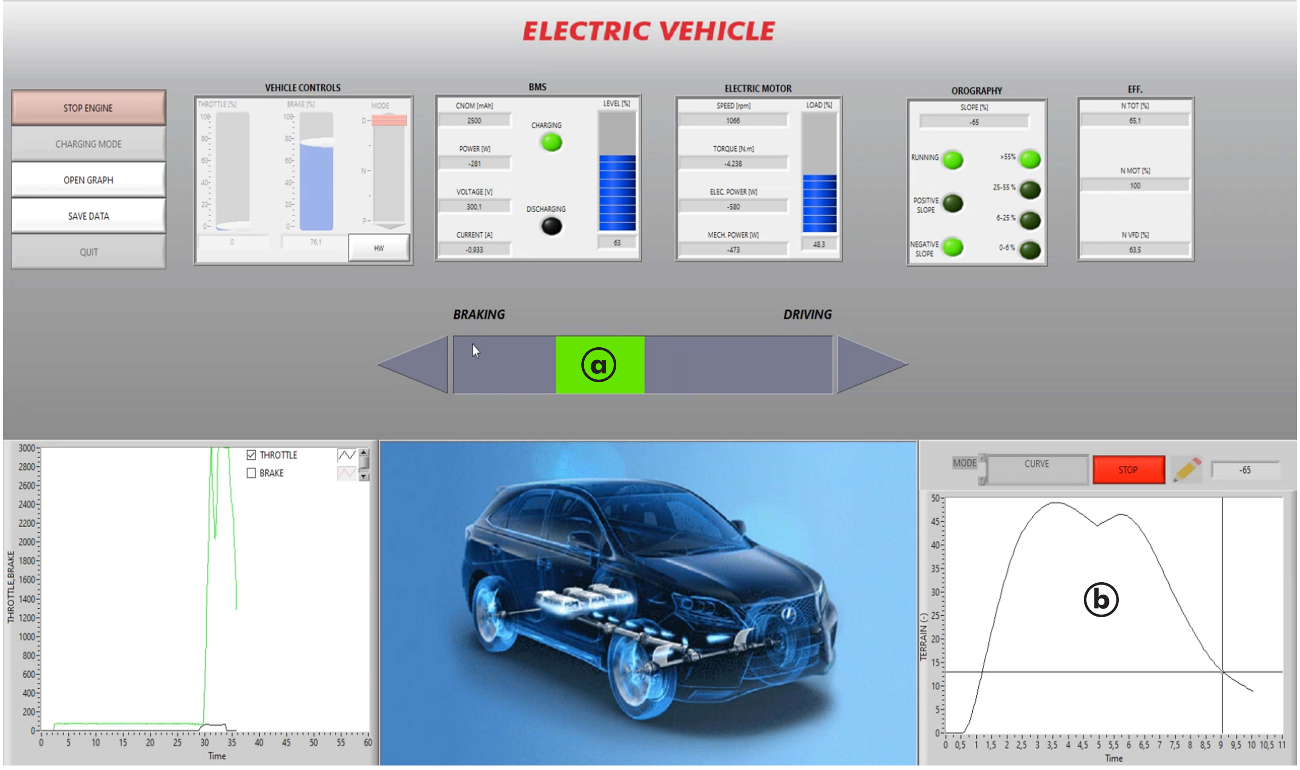
⑥ **Energy Performance Analysis:** Graphical monitoring of the traction system's efficient behavior.

⑦ **OPEN GRAPH Window:** Graphical representation tool for user-selected variables.

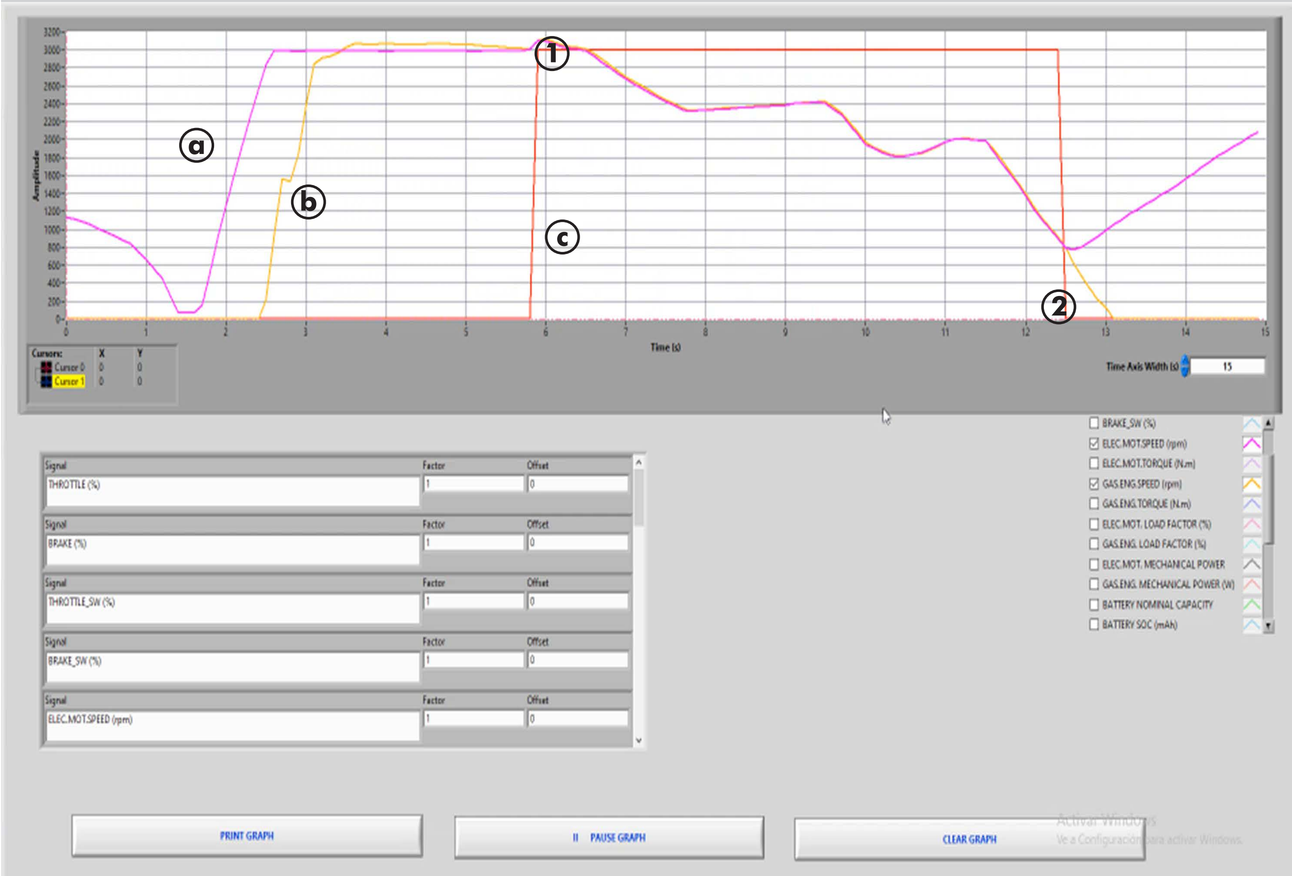
Automatic management of hybrid system participation level over a terrain profile (a), graphically representing the torque contribution of both motors (b) before and after engagement (c).



100% Electric Vehicle Interface: Vehicle response during an energy regeneration scenario (a) on a downhill terrain segment drawn by the user using the terrain profile editor (b).



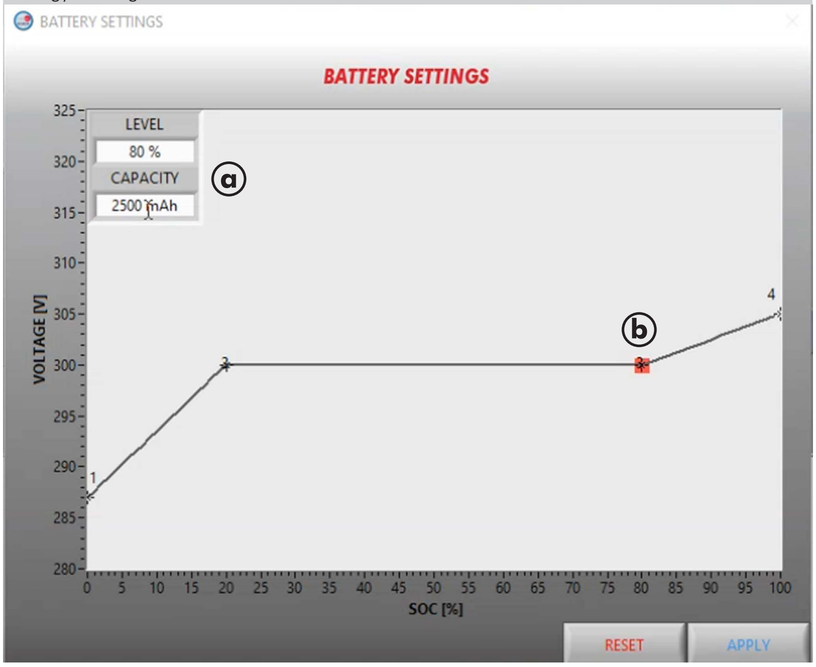
OPEN GRAPH Window: Electric motor speed (a), gasoline engine speed (b), and magnetic clutch engagement (c), allowing for a smooth transition. When the speed decreases, the gasoline engine disengages from the drive system.



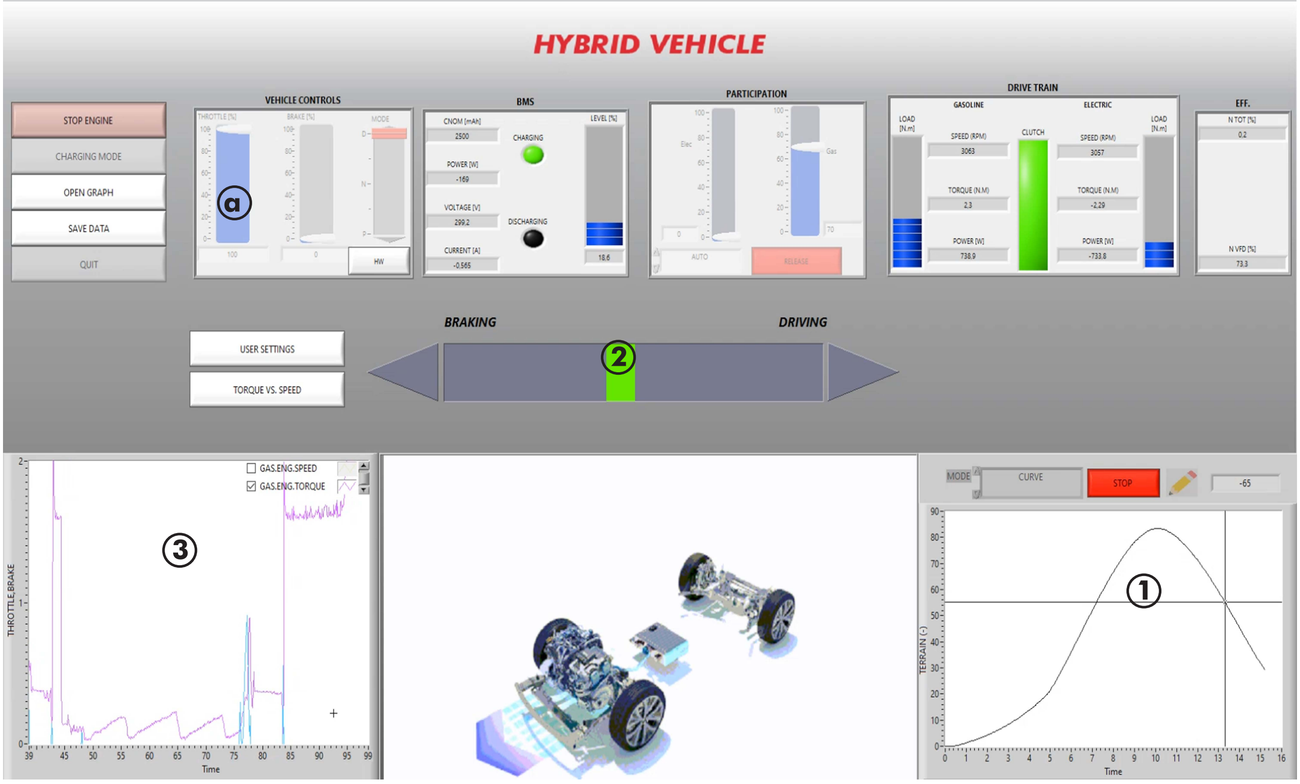
① Moment of traction system engagement when RPMs of both engines are synchronized.

② Moment of disengagement, when the speed is low enough that only the electric motor's power is needed.

Advanced Battery Configuration: This screen displays the Voltage–State of Charge (SOC) curve for a user-configured battery capacity, in this case 2500 mAh (a). It allows the adjustment of the initial charge percentage (b) to enable precise simulations and optimized energy management



Main Hybrid Vehicle Interface in Operation: This screen shows the adaptive behavior of the vehicle on ascending, flat, and descending terrain, with automatic management of each engine's participation percentage and energy regeneration through regenerative braking (a). Terrain profile editing: Manual creation of paths for dynamic simulations.

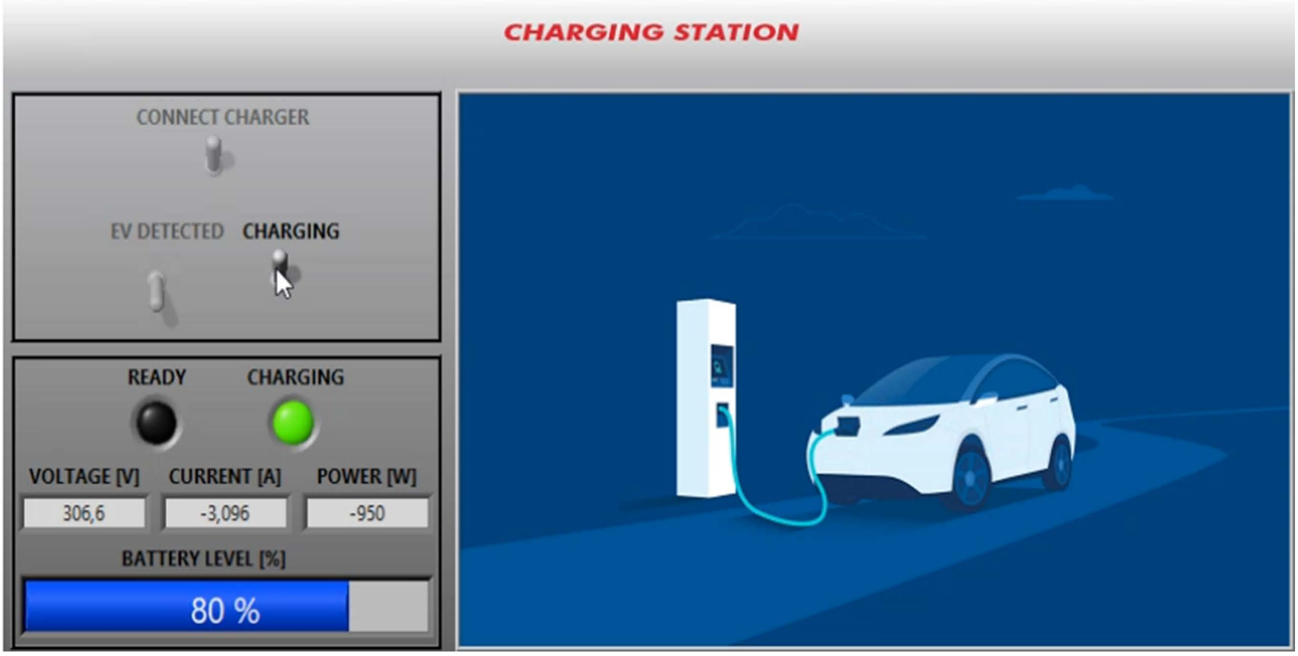


① **Terrain Profile Editing:** Manual creation of paths for dynamic simulations.

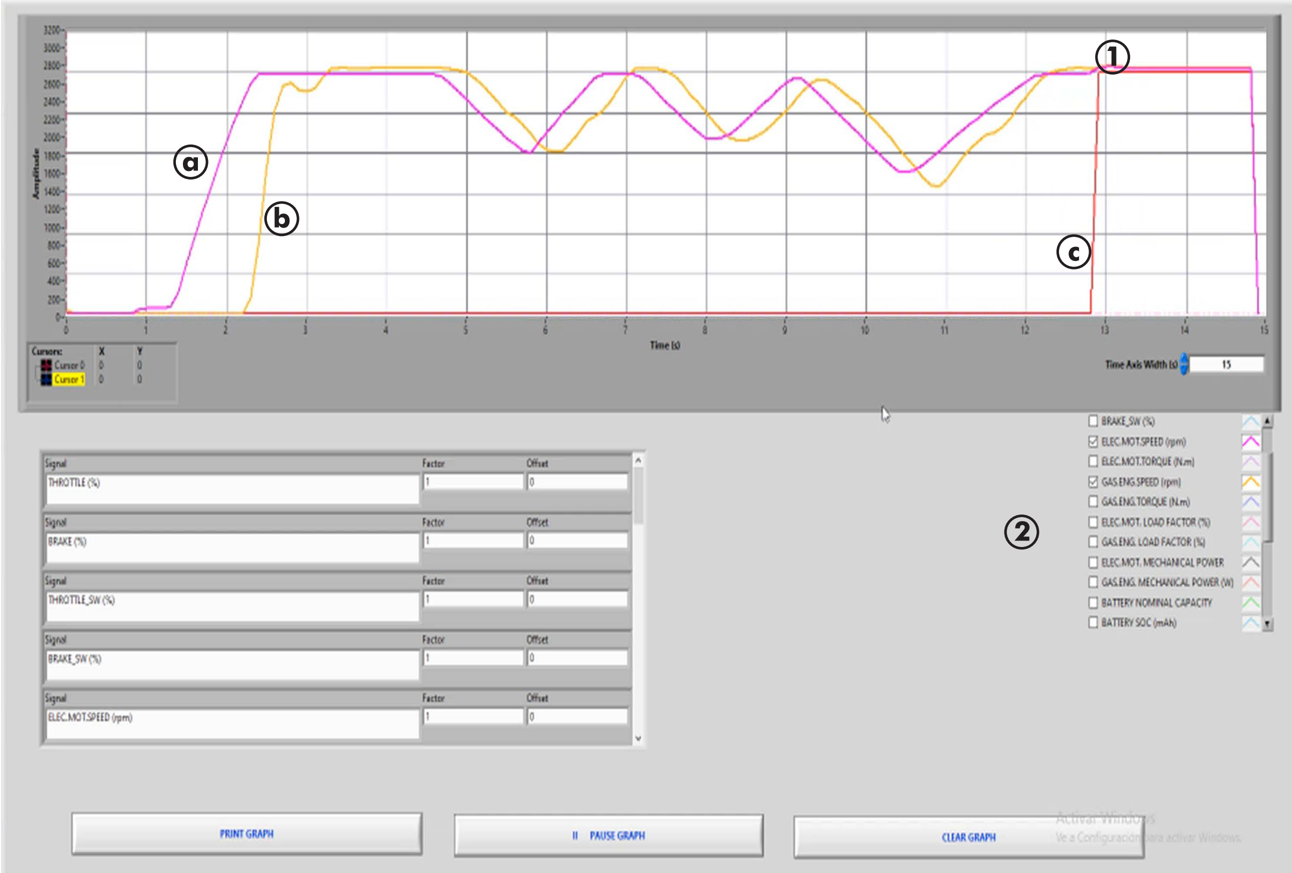
② **Activation of Regenerative Braking:** Recording of energy recovery during downhill segments.

③ **Torque Comparison Between Engines:** Graphical representation of torque distribution under variable conditions.

Charging Station: Simulation of a realistic charging process using the EVHC module, allowing the user to initiate the charging sequence and visualize real-time changes in parameters such as voltage, current, power, and battery state of charge



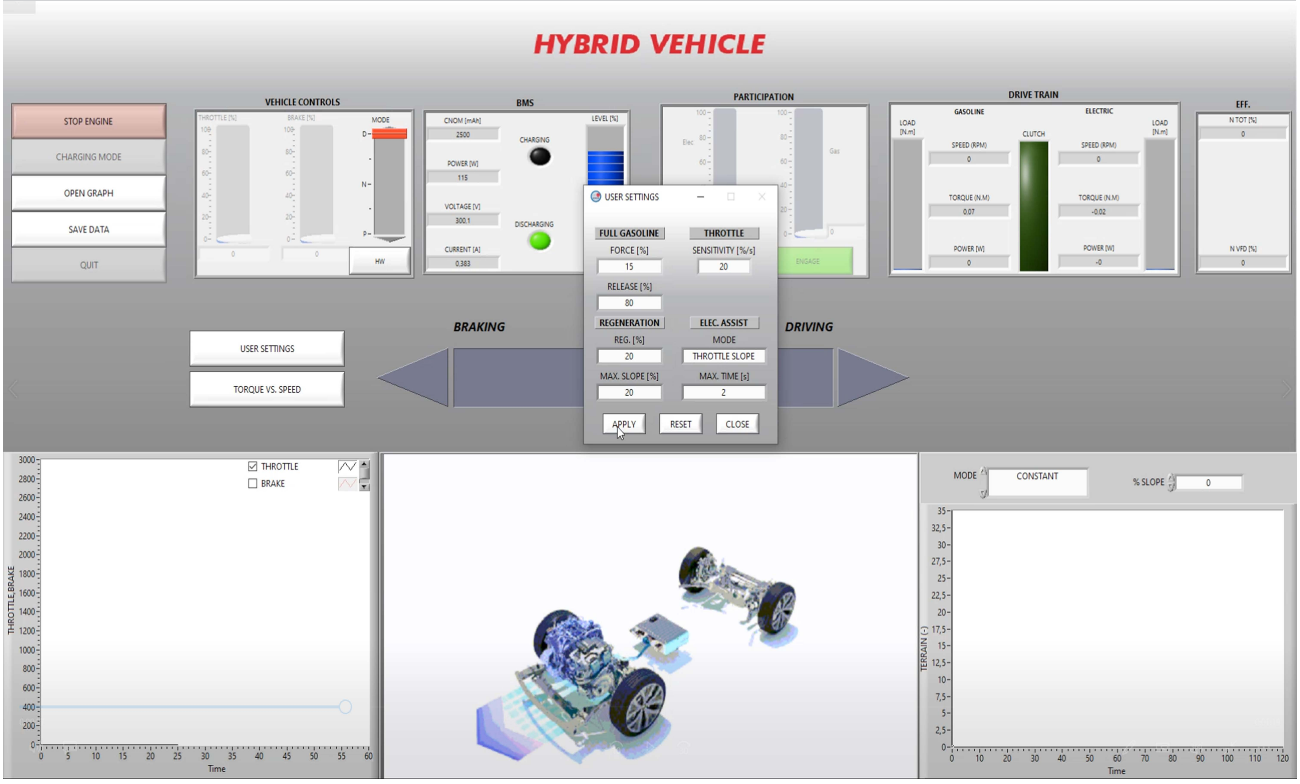
Speed Synchronization Between Engines: PID control process by which the speed of the thermal engine (b) is regulated based on encoder readings to match the speed of the electric motor (a), ultimately allowing the engagement of the magnetic clutch (c).



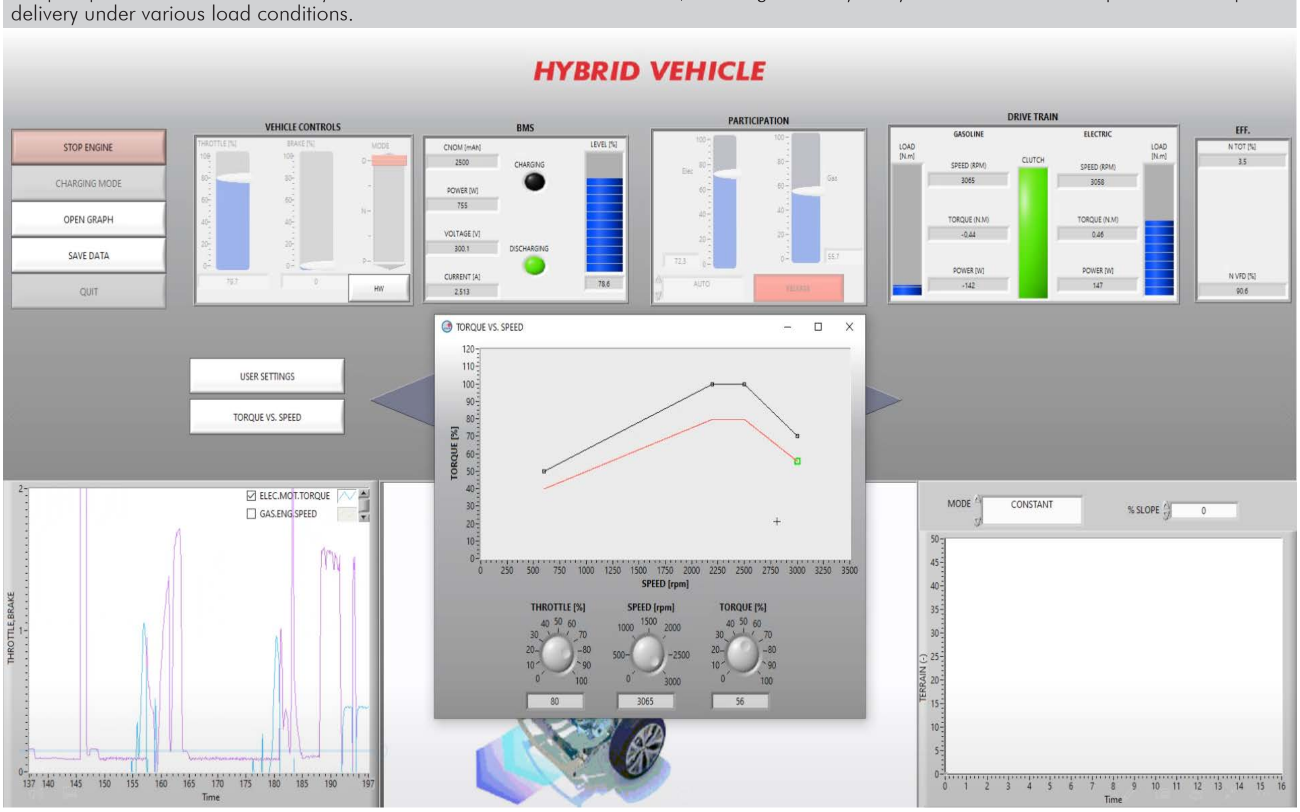
① **RPM Synchronization Point:** Identification of the precise engagement moment.

② **Graph Parameter Selector:** Configuration of variables shown on the dynamic chart.

User Settings: Adjustment of key parameters such as throttle sensitivity, the activation threshold of the electric motor in generator mode, and the assistance strategy of the electric motor to the combustion engine during sudden accelerations.



Torque-speed curves of the drive system under different acceleration levels, allowing the study of dynamic behavior and optimization of power delivery under various load conditions.



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-EHVC/ICAI. Interactive Computer Aided Instruction Software.

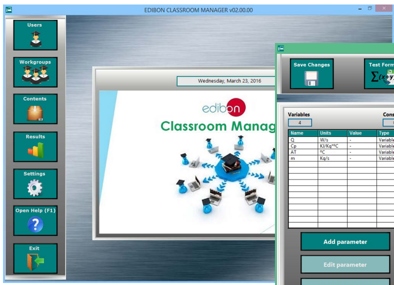
This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the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

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

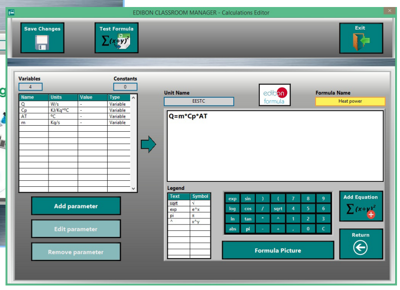
Instructor Software

- 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.



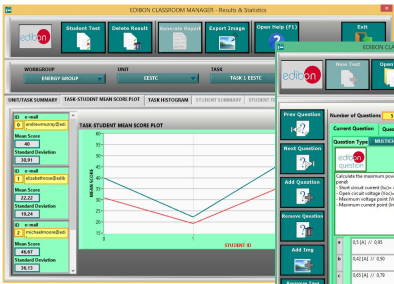
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



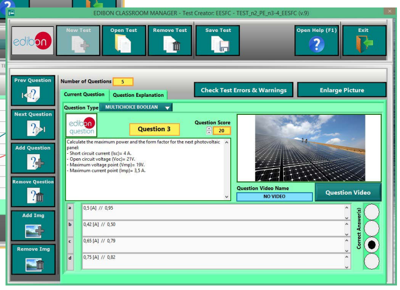
ECAL. EDIBON Calculations Program Package - Formula Editor Screen

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.**



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

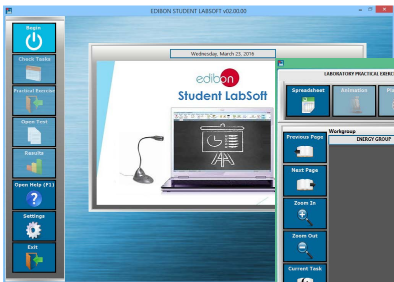


ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

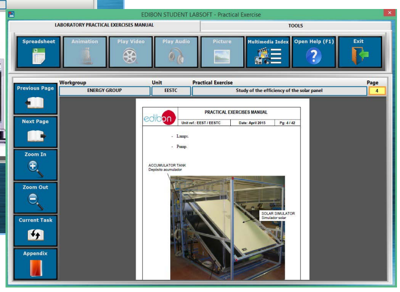
- ESL-SOF. EDIBON Student Labsoft (Student Software).

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.

Student Software



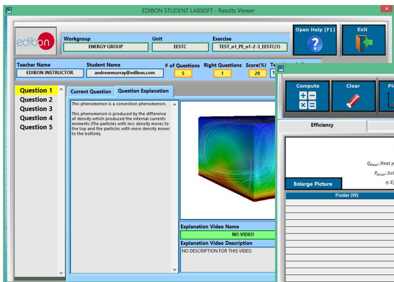
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



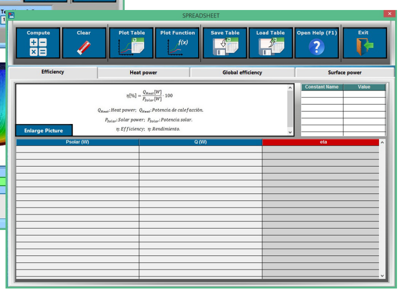
EPE. EDIBON Practical Exercise Program Package Main Screen

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.**



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

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.

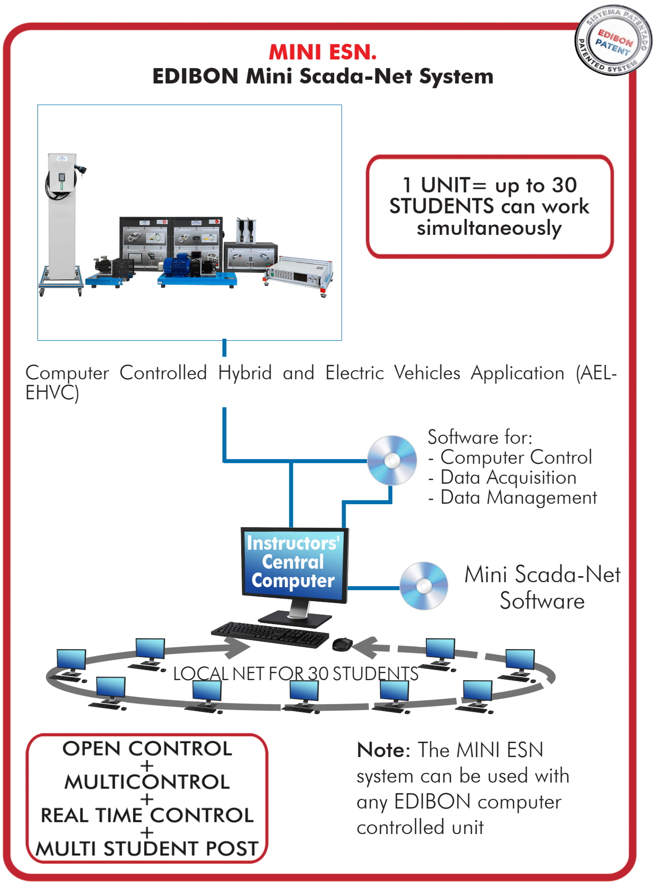
This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

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:
www.edibon.com/en/edibon-scada-net

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:
www.edibon.com/en/edibon-scada-net

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: AEL-EHVC. Computer Controlled Hybrid and Electric Vehicles Application.**

② **AEL-EHVC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**

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

④ **Manuals.**

*IMPORTANT: Under AEL-EHVC 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-EHVC/ICAI. 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.

①AEL-EHVC. Application:

- EMT7B/1K-E. 3PH Squirrel-Cage Industrial Motor, 1 kW, 4 Poles.
  - Nominal power: 1000 W.
  - Nominal voltage: 230 VAC / 400 VAC.
  - Frequency: 50 / 60 Hz.
  - Nominal load speed: 1500 rpm.
  - Nominal current: 4.57 A / 2.64 A.
- N-RGTR. Regenerative Powertrain Module.
  - Power supply: 230 VAC.
  - ON / OFF switch.
  - Internal frequency drive with speed and torque control.
  - Safety key "Start/Stop".
- N-DYTS. Dynamic Ground Simulation Module.
  - Power supply: 400 VAC+N.
  - 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 (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.
    - Speed and torque control.
    - Nominal power: 1 kW.
    - Maximum power: 3 kW.
    - Nominal torque: 3.18 Nm.
    - Maximum torque: 9.55 Nm.
    - Temperature control.
- 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.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on LabVIEW.

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.

②AEL-EHVC/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.

It allows the registration of the alarms state and the graphic representation in real time.

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.

③Cables and Accessories, for normal operation.

④Manuals:

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

Exercises and Practical Possibilities to be done with the Main Items

1.- Detailed study of the traction system in a 100% electric vehicle:

Analysis of the conversion of electrical energy into mechanical energy, evaluating the dynamic response of the three-phase motor based on acceleration and load demand.

2.- Comprehensive analysis of regenerative braking under different scenarios:

Evaluation of kinetic energy recovery during controlled braking events and its conversion into electrical energy, monitoring the power flow regenerated back into the virtual battery.

3.- Dynamic evaluation of an electric vehicle's behavior through simulated real driving cycles:

Simulation of acceleration, deceleration, and constant speed patterns, replicating urban, interurban, and highway routes, and analysis of energy efficiency in each case.

4.- Analysis of the torque-speed relationship under different operating conditions:

Study of how motor torque and speed vary according to load, acceleration, and terrain type, with graphical representation of the electric motor's characteristic curve.

5.- Simulation of ascending terrain to study the traction system's response:

Analysis of the additional torque demand required on uphill slopes and its impact on energy consumption, motor efficiency, and vehicle dynamics.

6.- Simulation of flat terrain for the analysis of stable traction behavior:

Study of energy performance under constant load conditions, evaluating motor efficiency during steady-state driving without terrain variations.

7.- Simulation of descending terrain and evaluation of its effect on the control and regeneration systems:

Analysis of kinetic energy utilization through regenerative braking and its impact on battery recharging, depending on the simulated slope.

8.- Real-time graphical representation of terrain profile and its influence on vehicle behavior:

Generation and monitoring of orographic profiles via SCADA, with dynamic updates of slope, speed, and power parameters.

9.- Analysis of power consumption under different conditions using a bidirectional battery simulator:

Study of energy flows in traction and regeneration modes, evaluating the efficiency of energy conversion depending on terrain and driving cycle.

10.- Real-time monitoring of all key operational parameters through interactive SCADA graphs:

Simultaneous visualization of critical variables such as current, voltage, power, speed, and motor torque, enabling an in-depth analysis of the vehicle's electrical system behavior.

Some practical exercises with the recommended additional element of the Petrol Engine Simulation Module (N-ENGS):

11.- Study of the combined operation of the electric and combustion engines in a hybrid vehicle:

Analysis of the dynamic coordination between both energy sources, evaluating power distribution and overall efficiency under various driving conditions.

12.- Visualization and analysis of the magnetic clutch coupling to the main traction system:

Observation of the controlled connection process between the combustion engine and the electric motor, assessing the real-time transition between operating modes.

13.- Graphical analysis of torque transmission during the coupling process:

Interactive graphical representation of the motor torque behavior at the moment the combustion engine couples to the traction system.

14.- Monitoring the automatic synchronization process between the combustion and electric motors:

Real-time monitoring of both motors' speed and torque during automatic synchronization, evaluating transition efficiency and smoothness.

15.- Evaluation of electric and combustion motor participation under different terrain conditions in automatic mode:

Study of the vehicle's adaptive behavior on ascending, flat, and descending terrains, with automatic management of the participation percentages of each motor.

16.- Study of motor coupling and clutch control in manual mode:

Manual configuration of motor coupling/decoupling, allowing experimentation and analysis of customized energy management strategies.

17.- Simulation of ascending terrain for parallel hybrid vehicles:

Analysis of the hybrid system's response to increasing slopes, evaluating the combined effort of both motors and the impact on energy consumption.

18.- Simulation of descending terrain for parallel hybrid vehicles:

Study of regenerative capacity and energy management during downhill conditions, analyzing the interaction between regenerative braking and combustion engine decoupling.

19.- Configuration and analysis of the electric motor's response to sudden accelerations:

Adjustment of accelerator pedal sensitivity parameters and evaluation of the electric motor's response during high instantaneous power demand.

20.- Study of in-motion battery recharging through electric motor drag by the combustion engine:

Analysis of electrical energy generation when the battery is at low charge levels, simulating the typical in-motion recharging mode of hybrid vehicles.

21.- Integration and comparative analysis of different combustion engine torque-speed maps:

Programming and evaluation of various combustion engine performance curves, assessing their effect on hybrid vehicle efficiency and dynamics.

22.- Modification of control parameters related to motor participation:

Adjustment of advanced functions such as generation mode activation at low battery levels and accelerator pedal sensitivity, optimizing the hybrid strategy.

23.- Comparison of energy efficiency between a 100% electric vehicle and a parallel hybrid vehicle:

Comparative analysis based on energy consumption, range, and dynamic behavior, evaluating the advantages and disadvantages of each technology under real operating conditions.

Some practical exercises with the recommended additional element of the with the Electric Vehicle Charger (EVCH):

24.- Simulation of a realistic charging process using a real electric vehicle charger:

Reproduction of a real-world charging cycle by connecting a commercial-type charger to the system, allowing the study of the initiation, continuous charging, and completion phases under realistic conditions.

25.- Physical connection and validation of the link between the charger and the traction system:

Execution of the physical connection of the electric charger to the equipment, verification of communication between devices, and monitoring of the automatic activation of the charging protocol.

26.- Measurement and analysis of electrical parameters during the charging process:

Real-time monitoring of voltage, charging current, and supplied power, evaluating the electrical behavior of the system throughout the different stages of the charging process.

27.- Evaluation of charging times based on the battery capacity set in SCADA:

Study of the time required to reach specific charge levels, analyzing how the defined battery capacity directly influences the total charging time.

28.- Analysis of the influence of C-Rate on charging process efficiency:

Evaluation of the impact of different C-Rates on the total charging time, assessing the relationship between charge rate, battery characteristics, and energy management efficiency.

Other possibilities to be done with this unit:

29.- Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

30.- Open Control, Multicontrol and Real Time Control.

This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.

31.- The Computer Control System with SCADA allows a real industrial simulation.

32.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.

33.- This unit can be used for doing applied research.

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

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

a) Technical and Vocational Education configuration

⑤ AEL-EHVC/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.

C/ Julio Cervera, 10. Móstoles Tecnológico.
28935 MÓSTOLES. (Madrid). ESPAÑA - SPAIN.
Tel.: 34-91-6199363 Fax: 34-91-6198647
E-mail: edibon@edibon.com Web: **www.edibon.com**

Edition: ED01/25
Date: April/2025