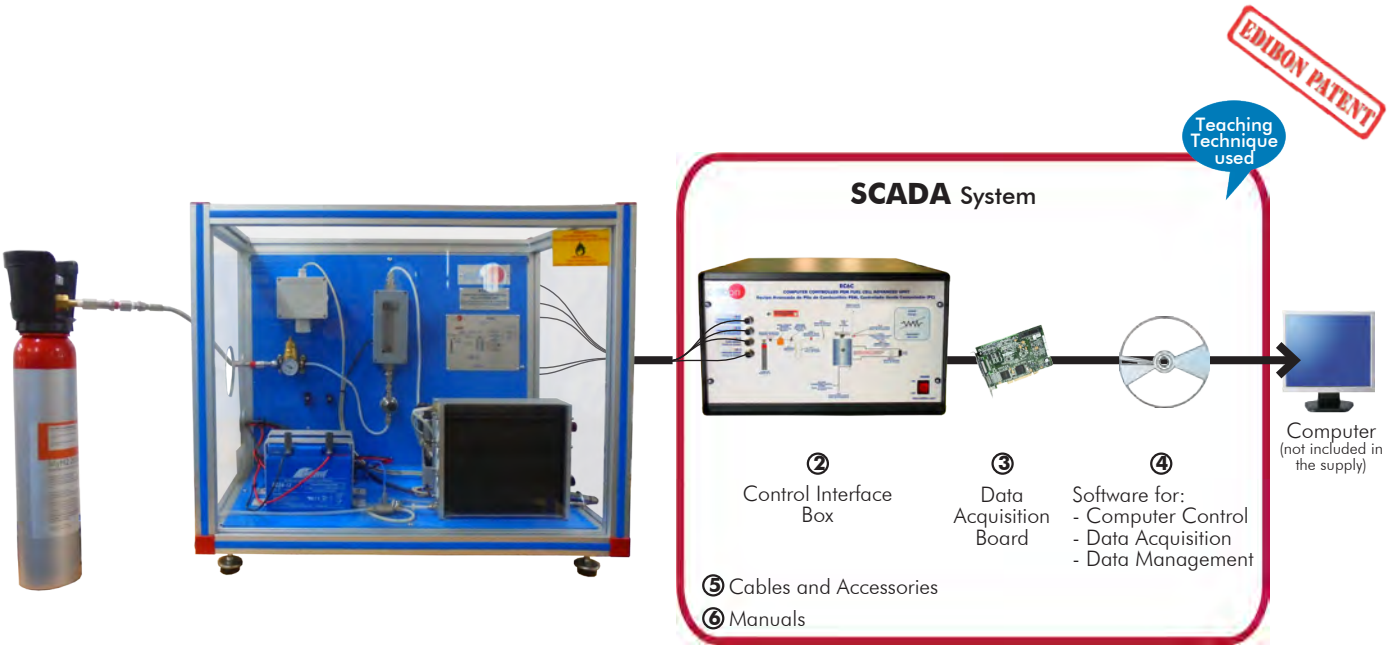
solarica
Energy Saving Technologies

Computer Controlled **PEM Fuel Cell Advanced Unit,** with SCADA

EC6C



* Minimum supply always includes: 1 + 2 + 3 + 4 + 5 + 6
(Computer not included in the supply)

① Unit: EC6C Computer Controlled PEM Fuel Cell Advanced Unit

Key features:

- **Advanced Real-Time SCADA.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized Control Software based on Labview.**
- **National Instruments Data Acquisition board (250 KS/s, kilo samples per second).**
- **Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.**
- **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**
- **Capable of doing applied research, real industrial simulation, training courses, etc.**
- **Remote operation and control by the user and remote control for technical support, are always included.**
- **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**
- **Designed and manufactured under several quality standards.**
- **Optional CAL software helps the user perform calculations and comprehend the results.**
- **This unit has been designed for future expansion and integration. A common expansion is the Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

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 Certificate and Worlddidac Member

INTRODUCTION

The current energetic situation is based on an unsustainable model from the economic and environmental points of view. Fuel cells technology offers the possibility of having energy in an efficient, clean and abundant manner, since hydrogen used for their operation is obtained from different sources.

A fuel cell is an electrochemical device that transforms chemical energy from a reaction directly into electrical energy.

Although there are several types of fuel cells, each one with advantages, disadvantages and ideal applications, the PEM fuel cell is nowadays the one which offers the best characteristics for portable and automobile applications. This type of device can generate electricity from hydrogen coming from different sources and oxigen from the atmosphere, generating only heat and water as a residue.

The main operation principles of a fuel cell PEM type (proton exchange membrane) can be studied with the Computer Controlled PEM Fuel Cell Advanced Unit "EC6C". It also enables to calculate several fundamental parameters of a PEM type fuel cell, such as power density, polarization curves, efficiency, etc., and the variation of some of these parameters in function of the consumption of reagents and the developed power.

GENERAL DESCRIPTION

The Computer Controlled PEM Fuel Cell Advanced Unit "EC6C" has been designed to allow the students to understand the fuel cells technology; especially that of a proton exchange membrane fuel cell (PEM).

The unit is supplied with a stack of proton exchange membrane fuel cells (PEM) with a rated power of 1000 W. The stack is composed of 72 cells with channelled plate shape that allow the air flow through the membrane. The membrane facilitates the hydrogen flow, generating the electrons release. There are separate plates which conduct electricity, allowing that electrons flow, between each pair of cells.

Cells are self-humidifying and do not require any type of external humidification.

The stack has an integrated fan that is able to provide the required air for proper operation and to maintain a suitable temperature.

Hydrogen storage represents one of the essential points regarding the hydrogen economy. For that purpose, a cylinder of metal hydride (2000NL) is included. Thanks to the absorption of the hydrogen inside, hydrogen is stored in a safe and certified way. Since the discharge pressure of the metal hydride cylinder is 15-20 bars., the "EC6C" unit also includes two pressure regulators: one of them is prepared to be installed in the H_2 cylinder in order to regulate the outlet pressure at 5-50 bars.; the other is placed at the outlet of the metal hydride cylinder in order to regulate the inlet pressure to the stack in a range from 0.50 to 0.55 bars.

In addition, the unit includes two solenoid valves. One of them is located before the stack and controls the hydrogen inlet, and when the unit is switched off, the valve is closed to avoid any possible hydrogen leakage. This valve is automatically shutted when the temperature of the stack exceeds 65°C. The other valve, placed at the stack outlet, purges the excess of water and hydrogen outside for a proper operation.

The unit also has a load regulation system. It enables the study of the generated electrical energy, the representation of the characteristic operation curves and their comparison with the theoretical curves.

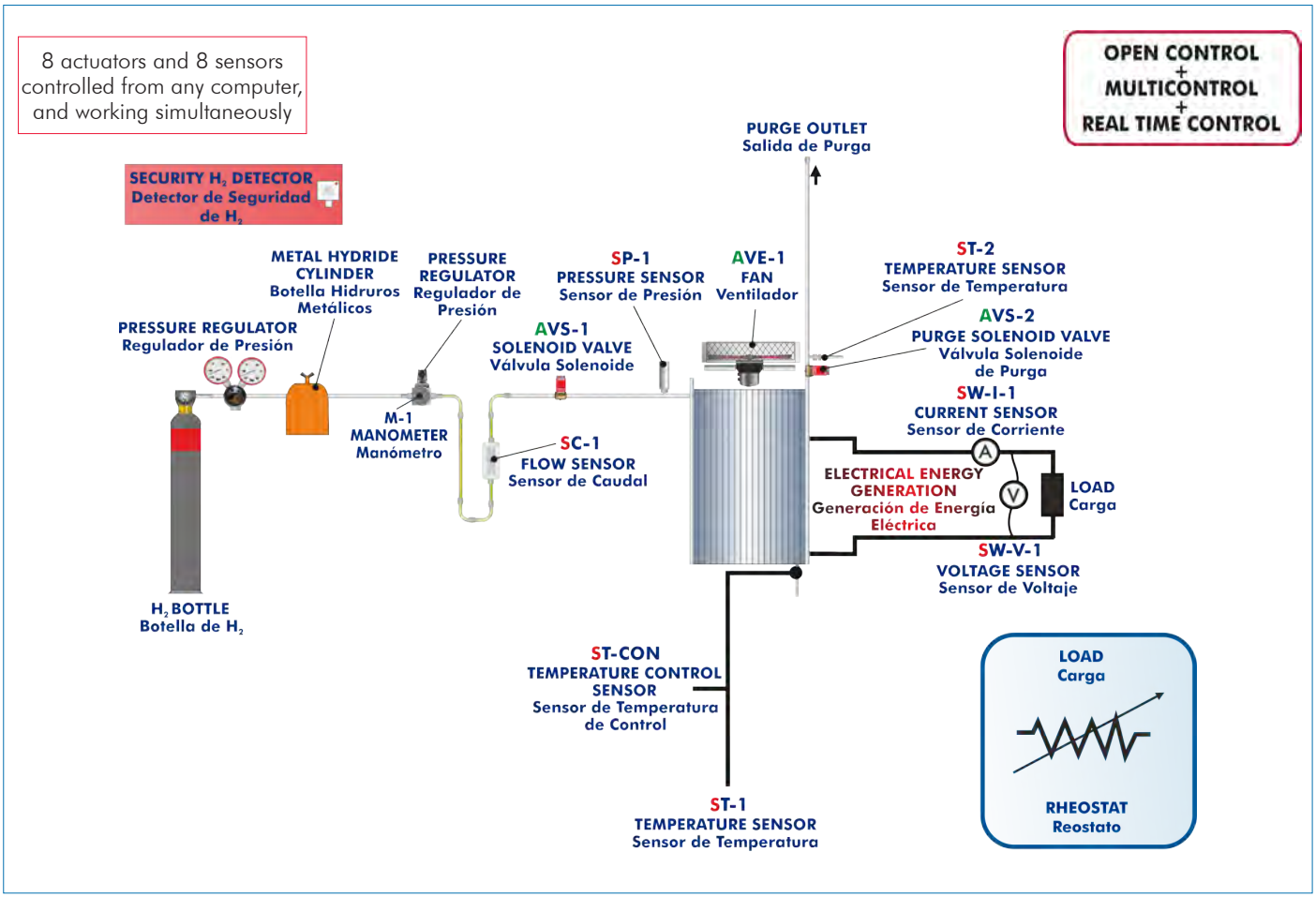
The whole electrical circuit of the stack is protected by a short-circuit unit in case of an overcurrent (30A) and low voltage shut down (36V). In the event of one of these problems, the hydrogen inlet solenoid valve is automatically closed.

The unit's connections and hoses are made of materials which are suitable for their use with H_2.

It includes a hydrogen leak detector with a detection range from 0 to 2% Vol. and from 0 to 100% L.E.L. (Lower Explosive Limit) respectively.

This Computer Controlled Unit is supplied with the Computer Control System (SCADA), and includes: The unit itself + a Control Interface Box + a Data Acquisition Board + Computer Control, Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



With this unit there are several options and possibilities:

- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8, 9, 10 and 11.

Let us describe first the main items (1 to 6):

① EC6C. Unit:

Bench-top unit.

Anodized aluminum structure and panels in painted steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Metal hydride cylinder with a capacity of 2000NL for the storage of H_2.

Fuel cell stack with 72 cells and a rated power of 1000W. Cells are self-humidifying and do not require any type of external humidification.

Fan incorporated in the stack.

Solenoid valve to supply H_2.

Pressure regulator for the H_2 bottle. Inlet at 200 bars. and outlet at 5-50 bars.

Pressure regulator for the hydrogen inlet at the PEM fuel cell, range: 0-1 bar.

Suitable hose for use with H_2 with a high safety factor: up to 210 bars.

Purge solenoid valve.

Load module: Rheostat (22R-760W) + 4 wirewound resistors (10R-300W).

Hydrogen leakage detector (4-20 mA; IP65) and software warning.

Battery and charger (12V).

Failure protection with solenoid valve at the stack inlet:

- Over current shut down (30A).
- Low voltage shut down (36V).
- Over temperature shut down in the stack.

Flow sensor to measure the inlet H_2 flow to the stack, range: 1-15 l./min.

Control temperature sensor placed between two bipolar plates of the cell.

Temperature sensor for the purging flow.

Pressure sensor to measure the H_2 pressure at the stack inlet, range: 0-1 bar.

Current, voltage and power sensors.

The complete unit includes as well:

Advanced Real-Time SCADA.
Open Control + Multicontrol + Real-Time Control.
Specialized Control Software based on Labview.
National Instruments Data Acquisition board (250 KS/s, kilo samples per second).
Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.
Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
Capable of doing applied research, real industrial simulation, training courses, etc. Remote operation and control by the user and remote control for technical support, are always included.
Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
Designed and manufactured under several quality standards.
Optional CAL software helps the user perform calculations and comprehend the results.
This unit has been designed for future expansion and integration. A common expansion is the Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

Unit: EC6C

Detail of the pressure regulator of the H_2 bottle and hose

② EC6C/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.

Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.

All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output.

Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.

Single cable between the control interface box and computer.

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

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

Calibration of all sensors involved in the process.

Real time curves representation about system responses.

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

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

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

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

EC6C/CIB

Shield and filtered signals to avoid external interferences.

Real time computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.

Real time computer control for pumps, compressors, heating elements, control valves, etc.

Real time computer control for parameters involved in the process simultaneously.

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

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

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

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

Bus PCI Express.

Analog input:

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

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

Input range (V)= ±10 V. Data transfers=DMA, interrupts, programmed I/0. DMA channels=6.

Analog output:

Number of **channels=2**. **Resolution=16 bits**, 1 in 65536. Maximum output rate up to: 900 KS/s.

Output range(V)= ±10 V. Data transfers=DMA, interrupts, programmed I/0.

DAB

Digital Input/Output:

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

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

④ EC6C/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.

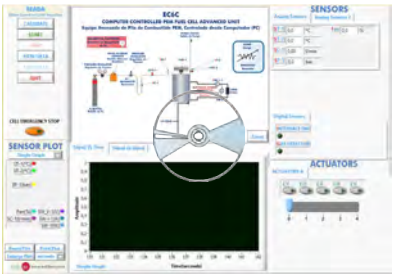
Management, processing, comparison and storage of data.

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

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.



EC6C/CCSOF

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.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:

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

∗References 1 to 6 are the main items: EC6C + EC6C/CIB + DAB + EC6C/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 main principles of a proton exchange fuel cell (PEM) operation.

2.- Study of the structure and main principles of a metal hydride cylinder.

3.- Calculation of the efficiency of a PEM fuel cell.

4.- Study of the influence of air consumption and hydrogen consumption in the efficiency of a PEM fuel cell.

5.- Study of the power density of a PEM fuel cell.

6.- Representation of the polarization curve of a PEM fuel cell.

7.- Determination of the voltage and current density characteristics of a PEM fuel cell.

8.- Influence of hydrogen consumption in the electric power generation.

9.- Study of the influence of the generated power in the efficiency of a PEM fuel cell.

10.-Study of the influence of the reagents' flows in the generation of electrical power.

11.-Study of the use of reagents and transport phenomena.

Additional practical possibilities:

12.-Sensors calibration.

Other possibilities to be done with this Unit:

13.-Many students view results simultaneously.

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

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

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

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

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

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

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

19.-Control of the EC6C unit process through the control interface box without the computer.

20.-Visualization of all the sensors values used in the EC6C unit process.

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

REQUIRED SERVICES

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

REQUIRED ACCESSORIES

- Bottle of compressed hydrogen of degree 4.0 (purity of 99.995%) at a pressure of 150-200 bars.

RECOMMENDED ACCESSORIES

- Edilab-Elec 2: Electrolyzer with a hydrogen production of 60 NL/h.

DIMENSIONS AND WEIGHTS

EC6C:

Unit:

-Dimensions: 700 x 400 x 550 mm. approx.
(27.55 x 15.75 x 21.65 inches approx.)

-Weight: 25 Kg. approx.
(55 pounds approx.).

Load module:

-Dimensions: 490 x 450 x 470 mm. approx.
(19.29 x 17.71 x 18.50 inches approx.)

-Weight: 12 Kg. approx.
(26.4 pounds approx.).

Control Interface Box:

-Dimensions: 490 x 330 x 310 mm. approx.
(19.29 x 12.99 x 12.20 inches approx.)

-Weight: 10 Kg. approx.
(22 pounds approx.).

AVAILABLE VERSIONS

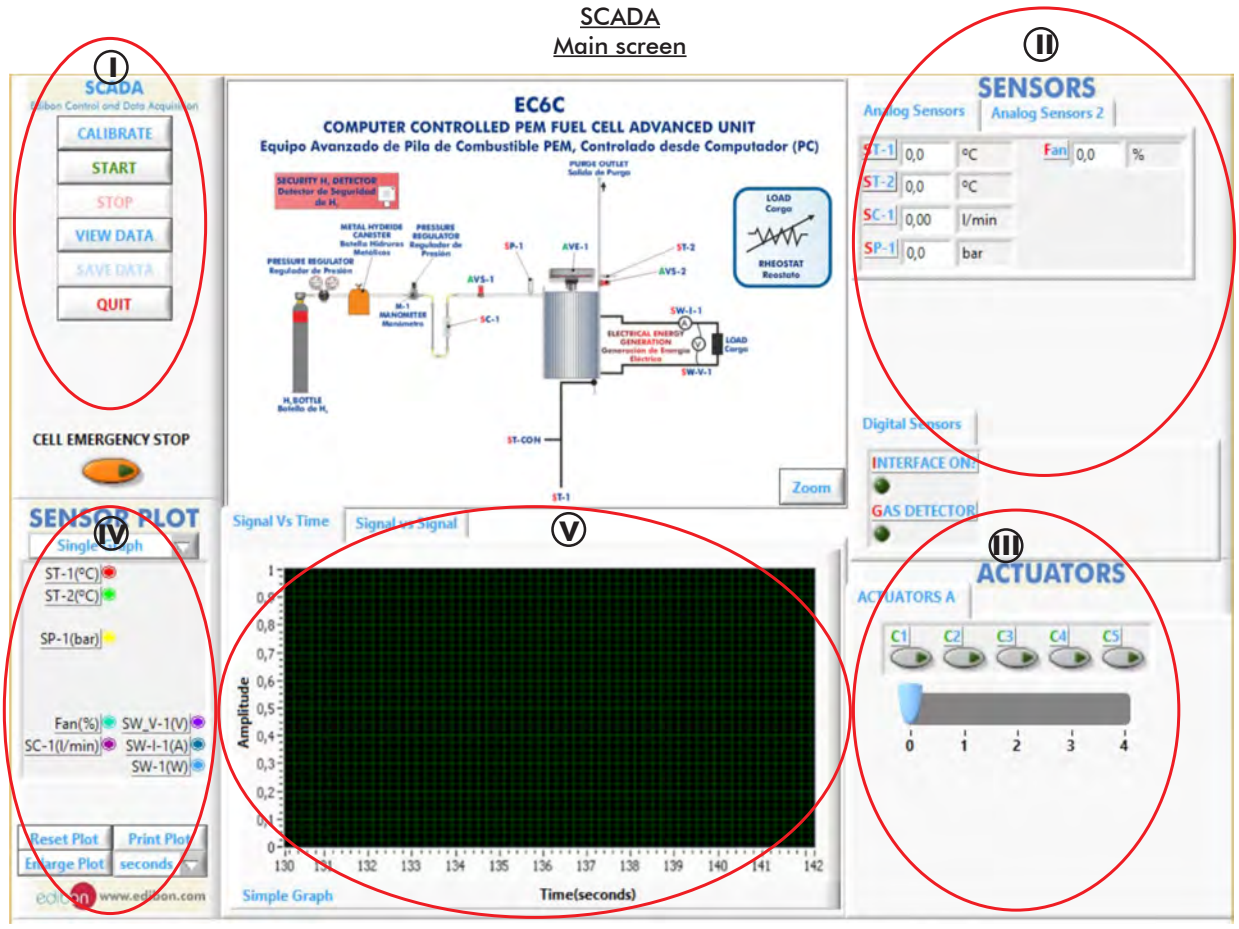
Offered in this catalogue:

-EC6C. Computer Controlled PEM Fuel Cell Advanced Unit.

Offered in other catalogue:

-EC6B. PEM Fuel Cell Advanced Unit.

SCADA
Main screen



(I) Main software operation possibilities.

(II) Sensors displays, real time values, and extra output parameters. Sensors: ST=Temperature sensor. SC=Flow sensor. SP=Pressure sensor. SW-A=Current sensor. FAN=Percentaje of air suppled by the fan. SW=Power sensor. SW-V=Voltage sensor.

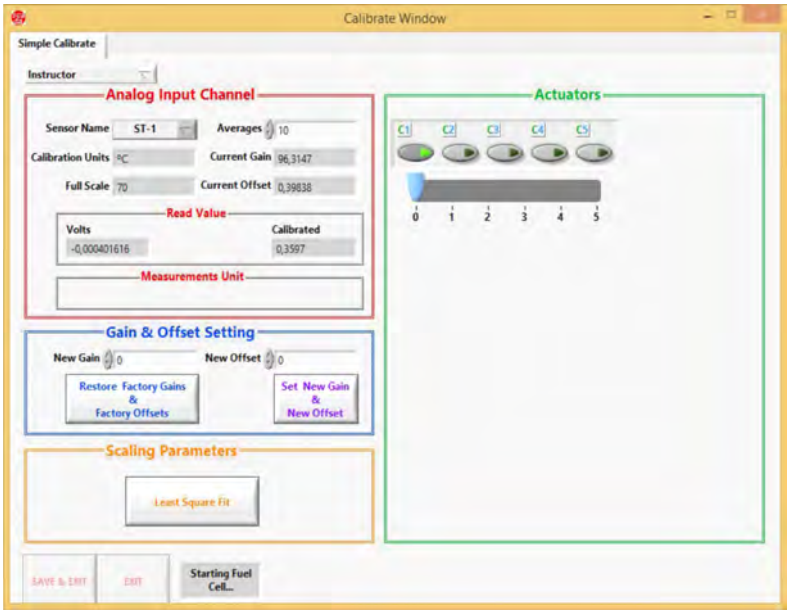
(III) Actuators controls. Actuators: WC1-C5= Load regulation.

(IV) Channel selection and other plot parameters.

(V) Real time graphics displays.

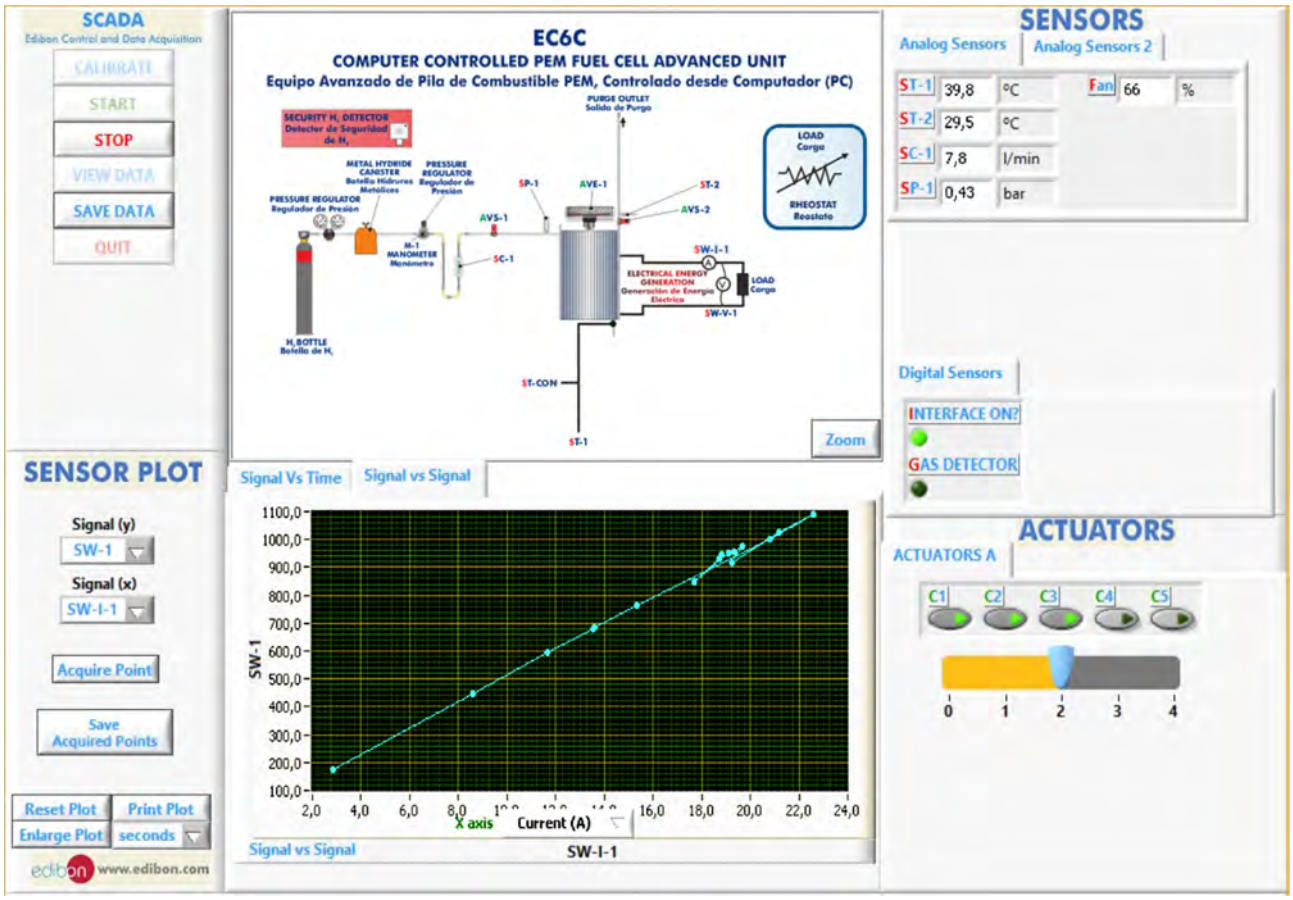
Software for Sensors Calibration

Example of screen

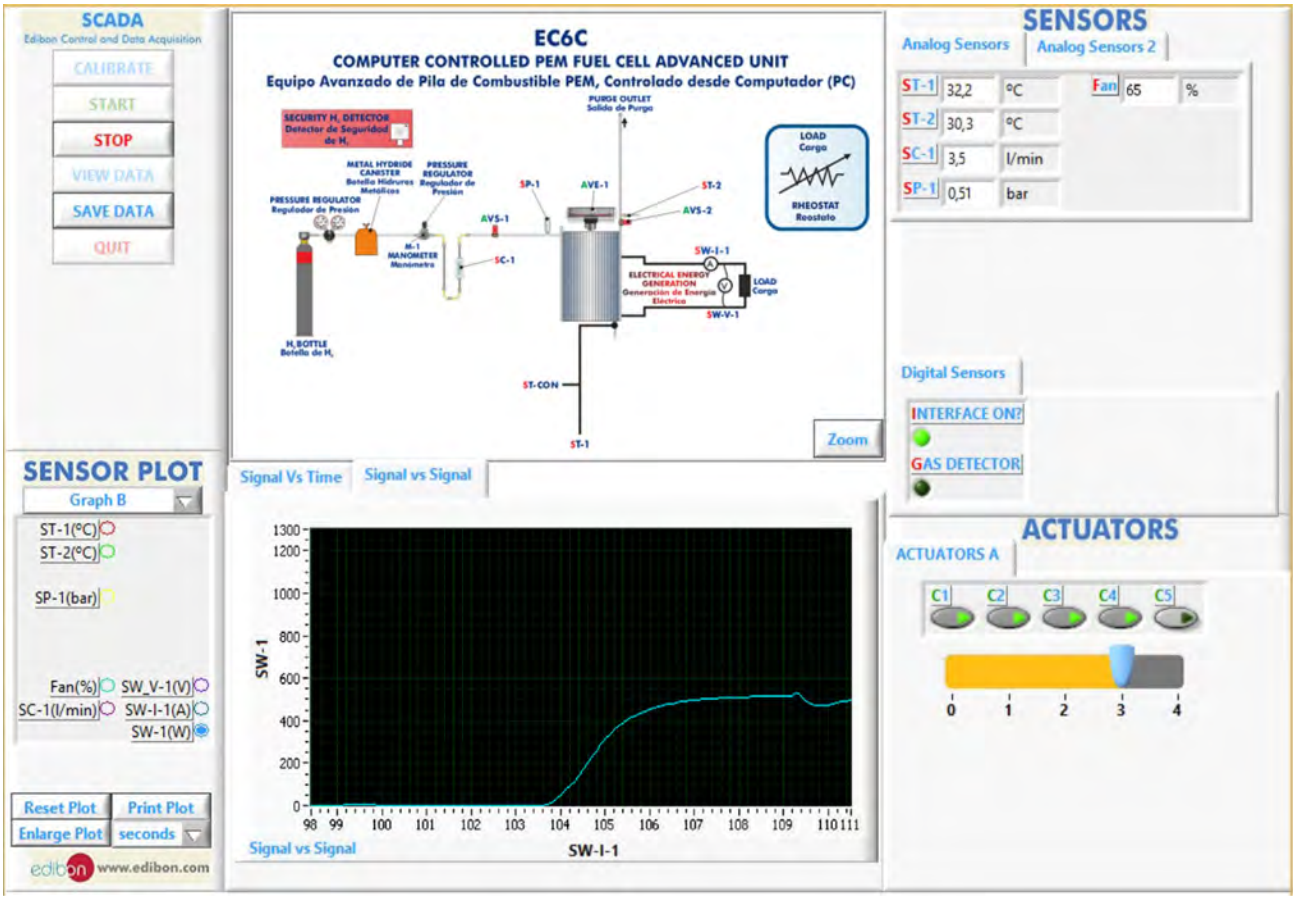


By using a free of charge code, the teacher and the students can calibrate the unit. The teacher can recover his/her own calibration by using the code that we give free of charge.

The software enables to plot the value of one signal versus another signal.

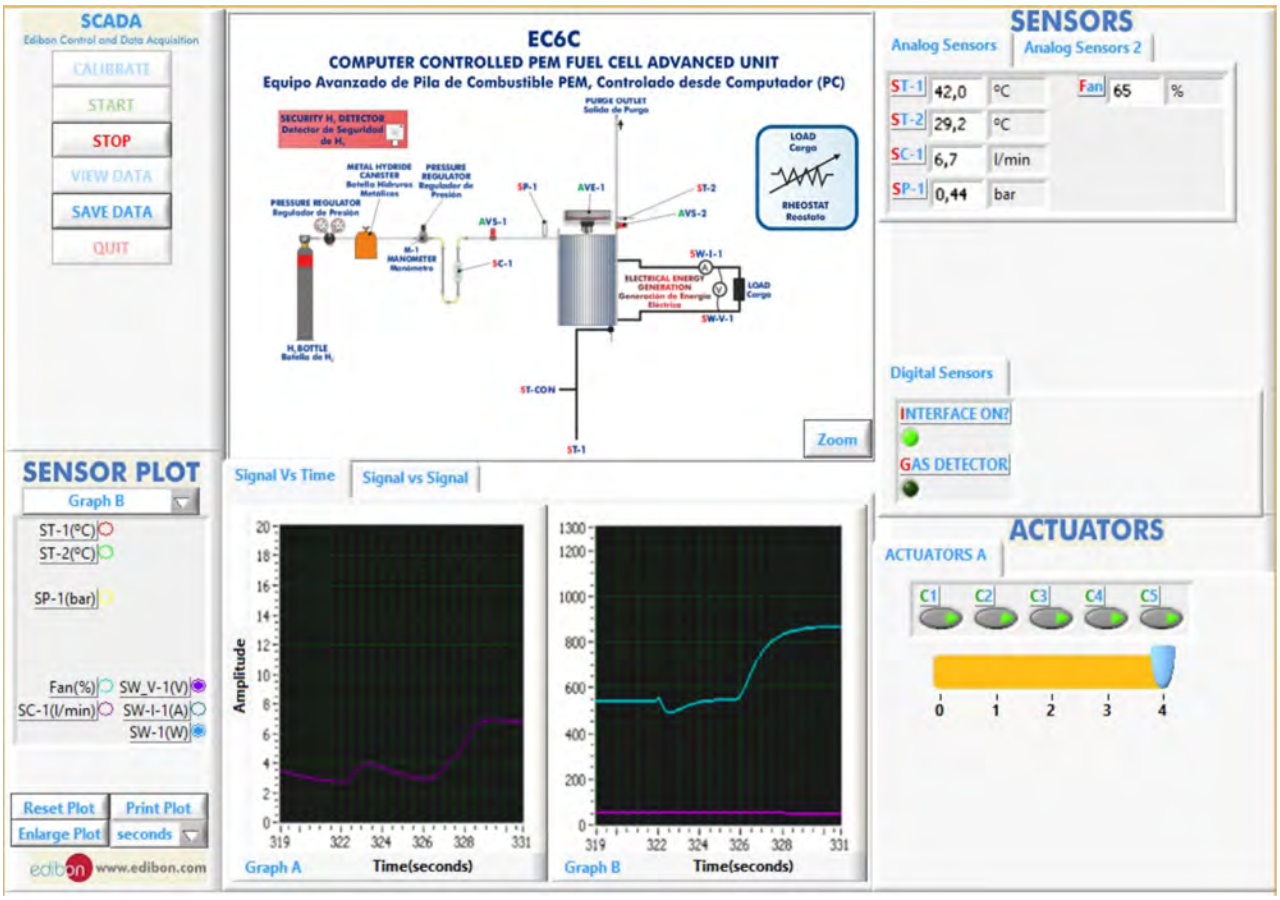


Data collected by the sensors can be represented vs. time. The evolution of the PEM type fuel cell power (SW-1 sensor) vs. time is observed in this graph.

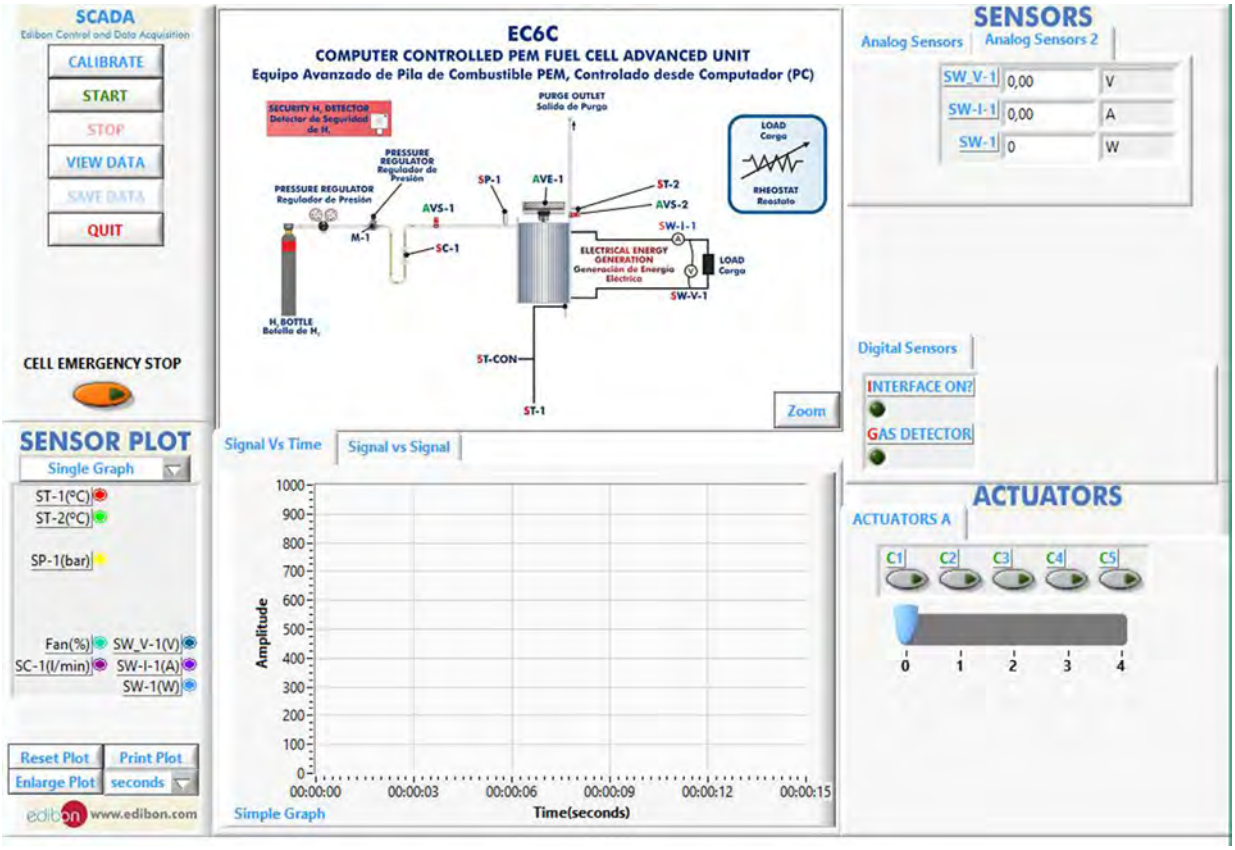


Some **real** results obtained from this Unit

The right side graph shows the evolution of power and voltage vs. time, and the left side graph shows the evolution of the required hydrogen flow vs. time depending on the consumed load. Thus, the influence of various parameters can be easily studied.



The software allows the plotting of the characteristic curves of the PEM fuel cell and their comparison with the theoretical working curves.
In this representation the points that determine the characteristic power curve (SW1) current (SW1-A) can be observed.



Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 9.
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

⑦ EC6C/ICAI. Interactive Computer Aided Instruction Software System.

This complete software package consists of an Instructor Software (Classroom Manager -ECM) totally integrated with the Student Software (Student Labsoft -ESL). 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 6).

-ECM. Classroom Manager (Instructor Software).

ECM 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.

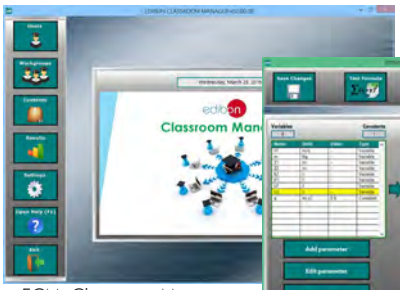
Creation and assignment of Formulas & Equations.

Equation System Solver Engine.

Updatable Contents.

Report generation, User Progression Monitoring and Statistics.

Instructor Software



ECM. Classroom Manager (Instructor Software) Application main screen

ECAL. Calculations Program Package - Formula Editor Screen

ERS. Results & Statistics Program Package - Student Scores Histogram

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

-ESL. Student Labsoft (Student Software).

ESL 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 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 us.

Evaluation Methods to prove your knowledge and progression.

Test self-correction.

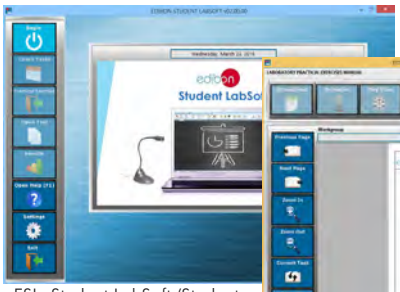
Calculations computing and plotting.

Equation System Solver Engine.

User Monitoring Learning & Printable Reports.

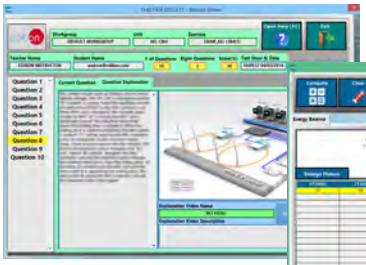
Multimedia-Supported auxiliary resources.

Student Software

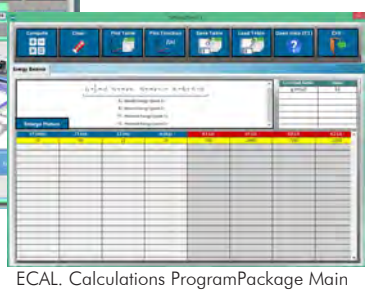


ESL. Student LabSoft (Student Software) Application Main Screen

EPE. Practical Exercise Program Package Main Screen



ERS. Results & Staticstics Program Package-Question Explanation



ECAL. Calculations ProgramPackage Main Screen

b) Multipost Expansions options

⑧ Mini ESN. Mini Scada-Net System.

Mini ESN. 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 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 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.

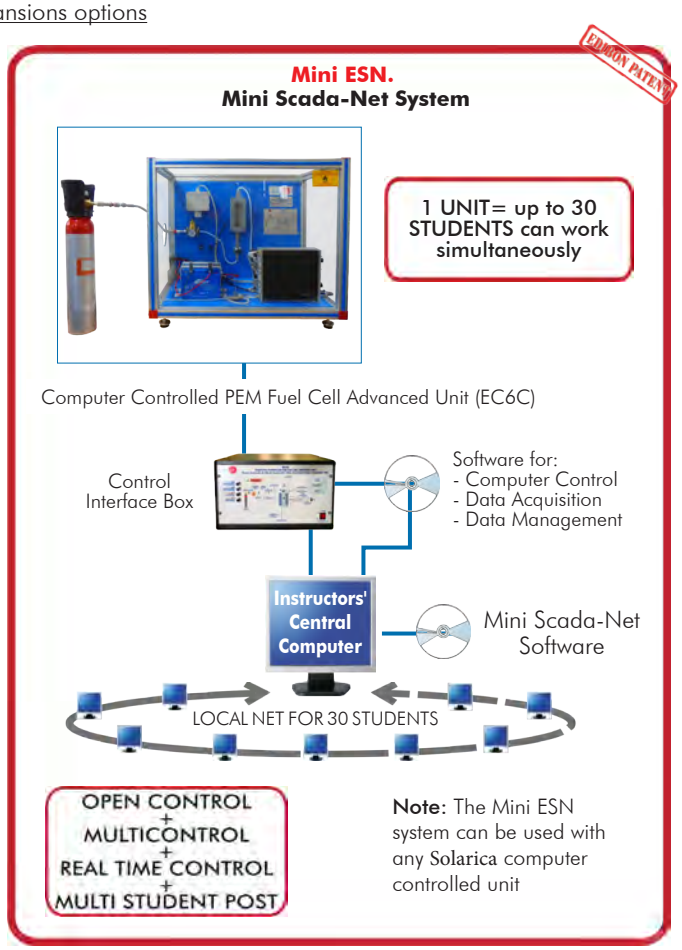
-Continuous communication between the instructor and all the users/students connected.

Main advantages:

-It allows an easier and quicker understanding.

-This system allows you can save time and cost.

-Future expansions with more Units.



⑨ ESN. Scada-Net System.

This unit can be integrated, in the future, into a Complete Laboratory with many Units and many Students.

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: EC6C. Computer Controlled PEM Fuel Cell Advanced Unit.**

② **EC6C/CIB. Control Interface Box.**

③ **DAB. Data Acquisition Board.**

④ **EC6C/CCSOF. Computer Control + Data Acquisition + Data Management Software.**

⑤ **Cables and Accessories**, for normal operation.

⑥ **Manuals.**

*IMPORTANT: Under EC6C we always supply all the elements for immediate running as 1, 2, 3, 4, 5 and 6.

Optional items (supplied under specific order)

a) Technical and Vocational configuration

⑦ EC6C/ICAI. Interactive Computer Aided Instruction Software System.

b) Multipost Expansions options

⑧ Mini ESN. Mini Scada-Net System. ESN.

⑨ Scada-Net System.

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Fuel cell stack with 72 cells and a rated power of 1000W. Cells are self-humidifying and do not require any type of external humidification.
Fan incorporated in the stack.
Solenoid valve to supply H_2.
Pressure regulator for the H_2 bottle. Inlet at 200 bars. and outlet at 5-50 bars.
Pressure regulator for the hydrogen inlet at the PEM fuel cell, range: 0-1 bar.
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Purge solenoid valve.
Load module: Rheostat (22R-760W) + 4 wirewound resistors (10R-300W).
Hydrogen leakage detector (4-20 mA; IP65) and software warning.
Battery and charger (12V).
Failure protection with solenoid valve at the stack inlet:
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- Optional CAL software helps the user perform calculations and comprehend the results.
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Calibration of all sensors involved in the process.
Real time curves representation about system responses.
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.
Shield and filtered signals to avoid external interferences.
Real time computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.
Real time computer control for parameters involved in the process simultaneously.
Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.
Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.
PCI Express Data acquisition board (National Instruments) to be placed in a computer slot.
Analog input: Channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).
Analog output: Channels=2. Resolution=16 bits, 1 in 65536.
Digital Input/Output: Channels=24 inputs/outputs.

④ EC6C/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.
Sampling velocity up to 250 KS/s (kilo samples per second).
Calibration system for the sensors involved in the process.
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.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:

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

Exercises and Practical Possibilities to be done with the Main Items

1.- Study of the main principles of a proton exchange fuel cell (PEM) operation.

2.- Study of the structure and main principles of a metal hydride cylinder.

3.- Calculation of the efficiency of a PEM fuel cell.

4.- Study of the influence of air consumption and hydrogen consumption in the efficiency of a PEM fuel cell.

5.- Study of the power density of a PEM fuel cell.

6.- Representation of the polarization curve of a PEM fuel cell.

7.- Determination of the voltage and current density characteristics of a PEM fuel cell.

8.- Influence of hydrogen consumption in the electric power generation.

9.- Study of the influence of the generated power in the efficiency of a PEM fuel cell.

10.-Study of the influence of the reagents' flows in the generation of electrical power.

11.-Study of the use of reagents and transport phenomena.

Additional practical possibilities:

12.-Sensors calibration.

Other possibilities to be done with this Unit:

13.-Many students view results simultaneously.

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

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

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

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

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

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

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

19.-Control of the EC6C unit process through the control interface box without the computer.

20.-Visualization of all the sensors values used in the EC6C unit process.

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

a) Technical and Vocational Education configuration

⑦ EC6C/ICAI. Interactive Computer Aided Instruction Software System.

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

-ECM. EDIBON Classroom Manager (Instructor Software).

ECM 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. EDIBON Student Labsoft (Student Software).

ESL 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

⑧ Mini ESN. Mini Scada-Net System.

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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