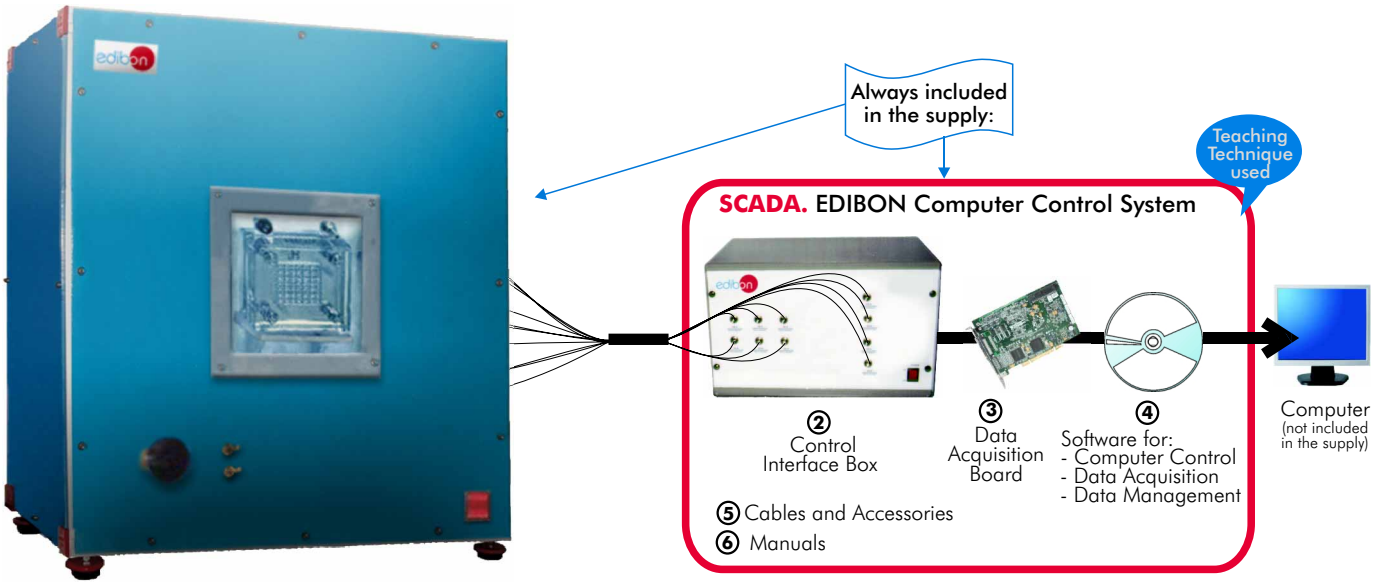
Computer Controlled **PEM Fuel Cell Advanced Unit**

EC6C

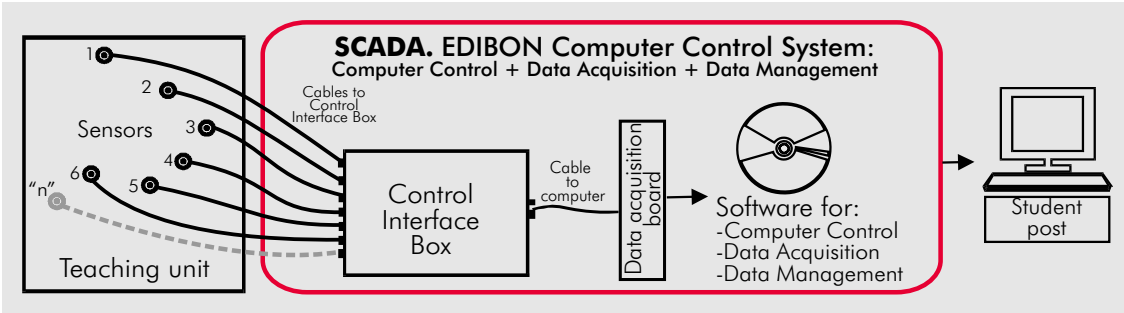
Technical Teaching Equipment

EDIBON PATENT



①Unit: EC6C. PEM Fuel Cell Advanced Unit

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL



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Products
Products range
Units
5.- Energy

ISO 9000: Quality Management
(for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate
(total safety)

Certificates ISO 14000 and **ECO-Management and Audit Scheme**
(environmental management)

Worlddidac Quality Charter Certificate
(Worlddidac Member)

DESCRIPTION

This unit demonstrates a high watt density PEM (Proton Exchange Membrane) Fuel Cell, generating electrical power directly from hydrogen. It allows a complete analysis of internal fuel cell phenomena and to experiment the performance in different conditions.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), including: Control Interface Box, Data Acquisition Board Computer Control Software, for controlling the process, and the parameters involved.

SPECIFICATIONS

Items supplied as standard

① EC6C. Unit:

Bench-top unit.
Anodized aluminium structure and metallic panel with transparent window as working elements visualization.
Main metallic elements in stainless steel.
Diagram in the front panel with similar distribution to the elements in the real unit.
Fuel cell module. The stack will produce up to 1.5 kW at approximately 10V dc. Each cell is water cooled. This also allows measurement of the heat losses from the cell arising from the exothermic chemical reaction.
Hydrogen and compressed air supply pressures are controlled by adjustable regulators and computer controlled electronic valves admit the gases to the stack.
Heat generated in the chemical reaction is collected by the internal water cooling and it is dissipated by an air cooled radiator.
Dual permeable membrane humidifiers control the humidity of the hydrogen and air supplied to the stack. Water management in the stack is aided by the all carbon based design, and purging of water generated by the chemical reaction is also computer controlled.
Variable electrical load.
Air flow sensor.
Temperature sensors.
Pressure sensors.
Power, current and voltage measurement from the computer.
The unit is provided with an integral flammable gas sensor that activates an external hydrogen solenoid valve.
Start up and shut down to a safe condition is controlled by the computer control.
The computer control monitors temperature, pressure and power for unsafe conditions and measurements and automatically shuts down the system in the event of safe limits being exceeded.
Electrical circuits are protected by circuit breakers.

EC6C. Unit

② EC6C/CIB. Control Interface Box:

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 connections during the whole process test procedure.
Simultaneously 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 placed in only one computer screen.
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, resistances, control valves, etc.
Open control allowing modifications, at any time and in a real time, of parameters involved in the process simultaneously.
Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.

EC6C/CIB

③ DAB. Data Acquisition Board:

PCI Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI.
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). Input range (V)=±10V.
Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.
Analog output: **Channels=2**. **Resolution=16 bits**, 1 in 65536. Maximum output rate up to: 833 KS/s.
Output range(V)=±10V. Data transfers=DMA, interrupts, programmed I/0.
Digital Input/Output: Channels=24 inputs/outputs. D0 or DI Sample Clock frequency: 0 to 1 MHz.
Timing: **Counter/timers=2**. Resolution: Counter/timers: 32 bits.

DAB

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

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 simultaneously 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 250,000 data per second guaranteed. 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 to the teacher to modify texts, instructions. Teacher's as student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.
This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.

EC6C/CCSOF

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: EC6C + EC6C/CIB + DAB + EC6C/CCSOF + Cables and Accessories + Manuals are included in the minimum supply, enabling a normal operation.

Continue...

Complementary items to the standard supply

PLC. Industrial Control using PLC (7 and 8):

⑦ PLC-PI. PLC Module:

Circuit diagram in the front panel.

Front panel:

Digital inputs(X) and Digital outputs (Y) block:

16 Digital inputs, activated by switches and 16 LEDs for confirmation (red).

14 Digital outputs (through SCSI connector) with 14 LEDs for message (green).

Analog inputs block:

16 Analog inputs (-10V. to + 10V.)(through SCSI connector).

Analog outputs block:

4 Analog outputs (-10V. to + 10V.)(through SCSI connector).

Touch screen:

High visibility and multiple functions.
Display of a highly visible status.
Recipe function.
Bar graph function.
Flow display function.
Alarm list.
Multi language function.
True type fonts.

Back panel:

Power supply connector.
Fuse 2A.
RS-232 connector to PC.

Inside:

Power supply outputs: 24 Vdc, 12 Vdc, -12 Vdc, 12 Vdc variable.

Panasonic PLC:

High-speed scan of 0.32 μsec. for a basic instruction.
Program capacity of 32 Ksteps, with a sufficient comment area.
Free input AC voltage(100 to 240 V AC).
DC input:16 (24 V DC).
Relay output: 14 (250 V A AC/2 A).
High-speed counter.
Multi-point PID control.
Digital inputs/outputs and analog inputs/outputs Panasonic modules.

Communication RS232 wire, to computer (PC).

PLC-PI

⑧ EC6C/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

Items available on request

⑨ EC6C/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

⑩ EC6C/FSS. Faults Simulation System.

EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Study of the fundamental principles of how the PEM based fuel cell operates.
2.- Power density from a single cell and a stack of cells.
3.- Measurement of power density from a fuel cell.
4.- Measurement of the current density and voltage-current characteristics of a fuel cell.
5.- Measurement and investigation of fuel cell efficiency with reference to fuel and air consumption, power output and heat losses.
6.- Measurement and display of temperatures and pressures in the gas and cooling circuits.
7.- Measurement and investigation of reactant utilisation and transport phenomena.
8.- Tests at constant current value and at variable current values.
9.- Variation of different operative parameters and their influence on stack performance:
- effect of temperature.
- effect of reactant flows.
- effect of pressure.
- effect of humidification.

Other possible practices:

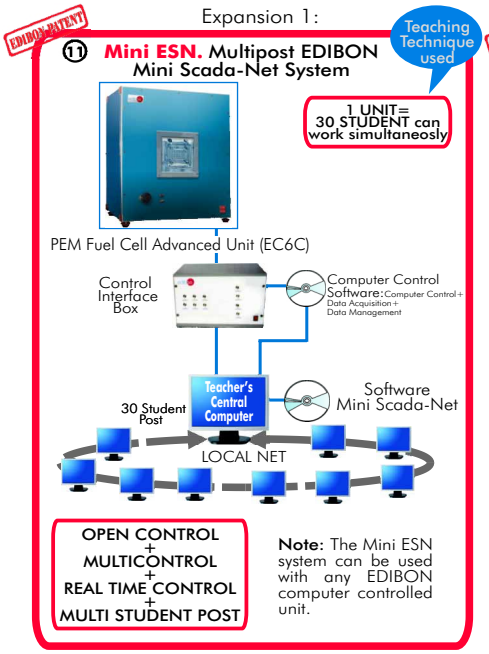
10.- Sensors calibration.

Practices to be done by PLC Module (PLC-PI) + PLC Control Software:

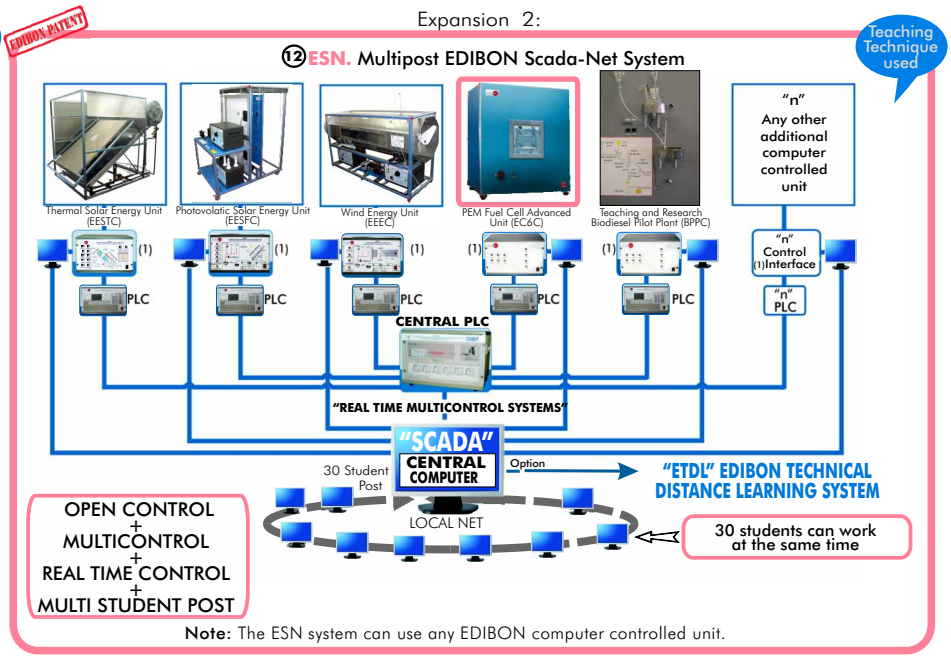
11.- Control of the EC6C unit process through the control interface box without computer.
12.- Visualization of all the sensors values used in EC6C unit process.
13.- Calibration of all sensors included in EC6C unit process.
14.- Hand on of all the actuators involved in the EC6C process.
15.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
16.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
17.- PLC hardware general use and manipulation.
18.- PLC process application for the EC6C unit.
19.- PLC structure.
20.- PLC inputs and outputs configuration.
21.- PLC configuration possibilities.
22.- PLC program languages.
23.- PLC different programming standard languages (literal structured, graphic, etc.).
24.- New configuration and development of new process.
25.- Hand on an established process.
26.- To visualize and see the results and to make comparisons with the EC6C unit process.
27.- Possibility of creating new process in relation with the EC6C unit.
28.- PLC Programming Exercises.
29.- Own PLC applications in accordance with teacher and student requirements.

POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS

Expansion 1:



Expansion 2:



ORDER INFORMATION

Items supplied as standard:

Minimum configuration for normal operation includes:

① **Unit: EC6C. 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.**

Complementary items to the standard supply:

PLC. Industrial Control using PLC. (7 and 8):

⑦PCL-PI. PLC Module.
⑧EC6C/PLC-SOF. PLC Control Software.
⑨EC6C/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).
⑩EC6C/FSS. Faults Simulation System. (Available on request).

Expansions

⑪Mini ESN. Multipost EDIBON Mini Scada-Net System.
⑫ESN. Multipost EDIBON Scada-Net System.

REQUIRED SERVICES

Electrical supply: Single-phase 220V./50 Hz. or 110 V./60 Hz. (with earth/ground).

Compressed air supply.

Computer (PC).

DIMENSIONS & WEIGHTS

EC6C. Unit:	-Dimensions: 1000 x 500 x 1000 mm. approx.
	-Weight: 70 Kg. approx.
Control Interface Box:	-Dimensions: 490 x 330 x 310 mm. approx.
	-Weight: 10 Kg. approx.
PLC Module (PLC-PI):	-Dimensions: 490 x 330 x 310 mm. approx.
	-Weight: 30 Kg. approx.

CONSUMABLES REQUIRED

- Hydrogen gas.
- Air.
- Water.

✱ Specifications subject to change without previous notice, due to the convenience of improvements of the product.

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Issue: ED01/10
Date: September/2010

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