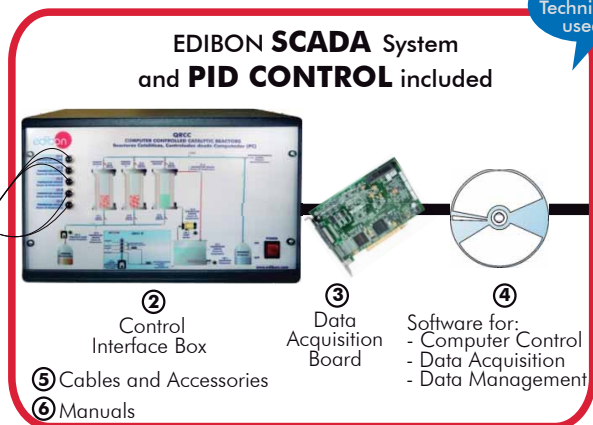




Teaching
Technique
used



① Unit: QRCC. Catalytic Reactors



Computer
(not included
in the supply)

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



Optional accessory:
QRCC-IF. Flow Injection
Analysis (FIA) Unit

Key features:

- **Advanced Real-Time SCADA and PID Control.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON 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 EDIBON 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 EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

**OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL**

For more information about Key Features, click here:



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)

INTRODUCTION

In a chemical reaction, the process of catalysis is the increase or decrease in the speed of the chemical reaction (reaction kinetics) caused by what we call a catalyst.

Nowadays, research and development of catalysts are extremely important in the chemical industry. It is thought that approximately 90% of industry-made chemical products involve some catalytic process in their processing.

One of the main characteristics of catalysts is that they are not consumed by the chemical reaction, although they may suffer some deterioration. This deterioration is due to the loss of their catalytic features. Besides, the student must understand the immobilization of catalysts in the reactors, a fact that prevents them from being dragged by the final product.

GENERAL DESCRIPTION

The QRCC is an unit designed to perform the saccharose hydrolysis reaction in a continuous way by using catalytic fixed-bed reactors.

Saccharose hydrolysis is the industrial process to obtain glucose and fructose from saccharose. It is a reversible chemical reaction.

The QRCC unit is composed of three fixed-bed reactors. Two of them are fixed-bed reactors for chemical catalysis with the same chemical catalyst, called ionic exchange resin but with different grain size. The third reactor is a fixed-bed reactor for biological (enzymic) catalysis with an immobilized enzyme. To start the hydrolysis process our product (saccharose) has to pass through this enzyme.

Saccharose hydrolysis is favoured with temperatures around 50°C - 60°C. For that end, the reactors have a jacket through which hot water will flow. The water temperature is controlled with the PID control through the control software.

Feeding saccharose to our reactors is done through a peristaltic pump which allows the regulation of speed through the control software.

The resulting solution is pumped to the final-product flask. From this point on it will be analysed with a spectrophotometer that is adapted to QRCC unit interface.

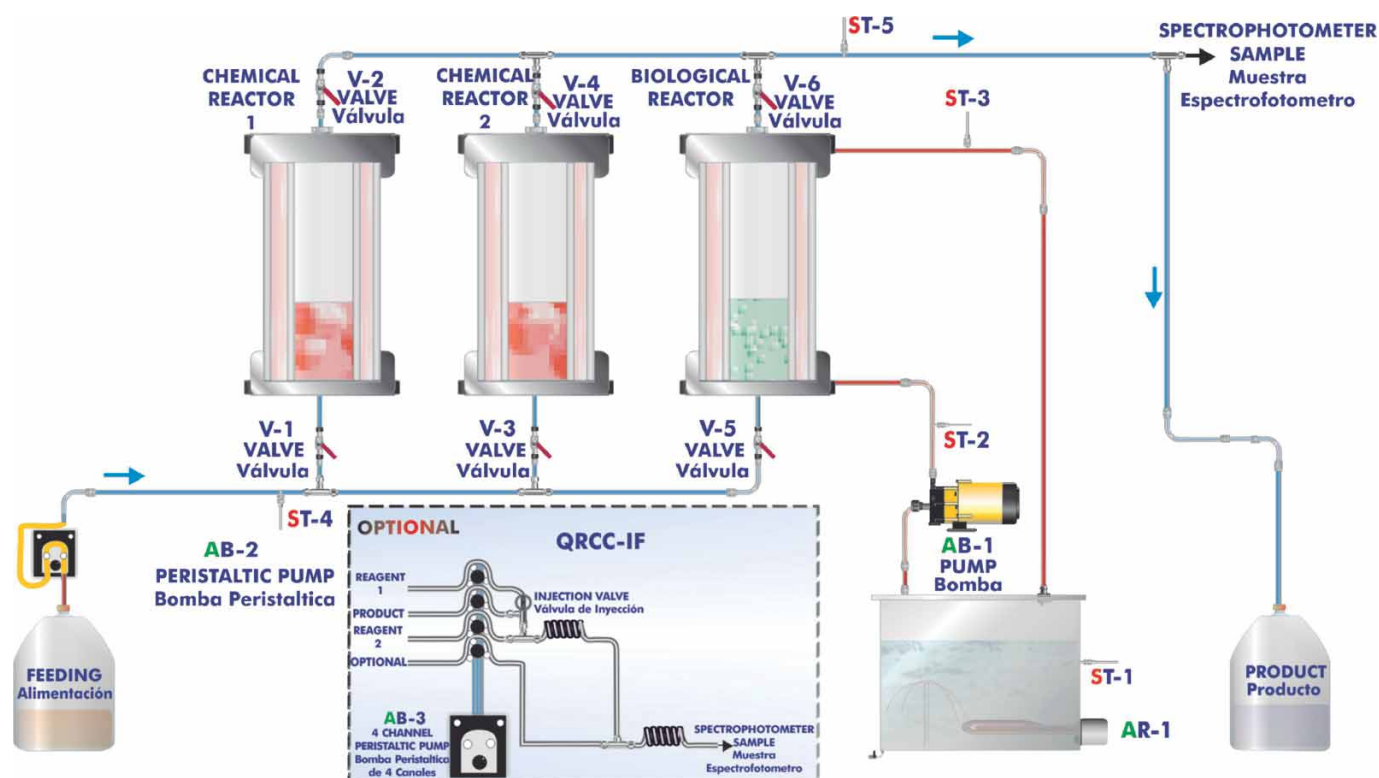
As an optional supply, there is the possibility of acquiring the QRCC-IF. Flow Injection Analysis (FIA) Unit. This unit is a Flow Injection Analysis system, which is used to measure the conversion degree of the reaction of the saccharose hydrolysis in a continuous way.

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

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

3 actuators and 5 sensors
controlled from any computer
and working simultaneously

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL



With this unit there are several options and possibilities:

- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8, 9, 10, 11 and 12.

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

① QRCC. Unit:

Bench-top unit.

Anodized aluminium structure and panels in painted steel.

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

2 Glass flasks of 2 litres of capacity, for the initial solution and the final product.

Reactors:

Two fixed-bed reactors for chemical catalysis, composed by acid ion exchange resins.

A fixed-bed reactor for biological (enzymic) catalysis. (Recommended use with an immobilized enzyme).

Reactors diameter: 50 mm. Reactors height: 160 mm.

Material: glass, with a methacrylate cover for protection.

Thermostatic bath, with heating resistance of 600W, controlled by a PID from the computer (PC).

A heated water supply to the reactors jackets allows the automatic control of reaction temperature to a set point value.

Peristaltic pump, with speed regulation, computer controlled (PC), that allows to regulate the feed flow from 0 to 32 ml/min.

5 Temperature sensors, "J" type, placed at key points of the system.

Spectrophotometer, computer controlled (PC), for the final product analysis and absorbance measures:

Wavelength range: 325-1000 nm. Band width: 5 nm.

All electrical circuits are protected by adequate protection devices.

The complete unit includes as well:

Advanced Real-Time SCADA and PID Control.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON 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 EDIBON 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 EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.



QRCC. Unit

Optional accessory (NOT included in the supply): (see section "optional accessory" in page 4)

- QRCC-IF. Flow Injection Analysis (FIA) Unit.

② QRCC/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.

Shield and filtered signals to avoid external interferences.

Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process. Real time PID and on/off control for pumps, compressors, resistances, control valves, etc. **Real time PID control for parameters involved in the process simultaneously.** Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).

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

Possibility of automatization of the actuators involved in the process.

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



QRCC/CIB

③ **DAB. Data Acquisition Board:**

The Data Acquisition board is part of the SCADA system.

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

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/O. DMA channels=6.

Analog output:

Number of channels=2. Resolution= 16 bits, 1 in 65536. Maximum output rate up to: 833 KS/s.

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

Digital Input/Output:

Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency: 0 to 1 MHz.

Timing: Number of Counter/timers=2. Resolution: Counter/timers: 32 bits.



DAB

④ **QRCC/CCSOF. PID 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.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

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

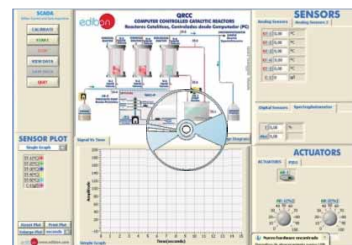
Calibration system for the sensors involved in the process.

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.

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.



QRCC/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 are the main items: QRCC + QRCC/CIB + DAB + QRCC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

Optional accessory

- QRCC-IF. Flow Injection Analysis (FIA) Unit.

This unit is a Flow Injection Analysis system, which we will use to measure the conversion degree of the reaction of the saccharose hydrolysis in a continuous way.

This unit provides an easy method for measuring the saccharose concentration of the final product in continuous way without the need of the measuring it manually. The unit can also be useful for the teaching of the FIA technique and the demonstration of the advantages of this measuring method in continuous processes.

It consists of a peristaltic pump with four channels that is used to impulse the right quantities of the final product together with reagents that colour it. Then the solution are put through coil reactor in order to complete the mixture. The last stage of the QRCC-IF involves passing the reaction through the spectrophotometer measuring cell.

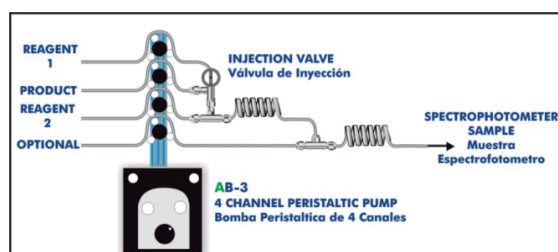
Specifications:

Four channels peristaltic pump, 0.01-35 ml/min. for each channel, computer controlled (PC).

6 Ports injection valve. Coil reactor.

Continuous measuring cell for spectrophotometer.

Dimensions: 500 x 500 x 350 mm. approx. Weight: 15 Kg. approx.



EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH MAIN ITEMS

- 1.- Study of the principles of catalytic fixed-bed reactors.
 - 2.- Effect of the variation in the particle's size in the effectiveness of a fixed-bed reactor.
 - 3.- Comparison of chemical and biological (enzymic) catalysis.
 - 4.- Checking the influence on different variables (feed flow, temperature of reaction, reagents concentration) on the obtained final product.
 - 5.- Spectrophotometer calibration.
 - 6.- Using the spectrophotometer and product analysis.
 - 7.- Study of the "FIA" Flow Injection Analysis technique and principles (with QRCC-IF optional accessory).
 - 8.- Examination of the reproducibility and sensitivity of the "FIA" analysis method as a function of the flow rate and sample concentration (with QRCC-IF optional accessory).
 - 16.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
 - 17.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
 - 18.- This unit can be used for doing applied research.
 - 19.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
 - 20.- Control of the QRCC unit process through the control interface box without the computer.
 - 21.- Visualization of all the sensors values used in the QRCC unit process.
- By using PLC-PI additional 19 more exercises can be done.
- Several other exercises can be done and designed by the user.

Additional practical possibilities to be done by the end customer:

- 9.- Sensors calibration.
- 10.- Studies of steady and unsteady state catalysis.
- 11.- Flow characterisation in a fixed-bed.
- 12.- Mass balances.
- 13.- Determination of steady state and unsteady state kinetics of a catalytic fixed-bed reactor.

Other possibilities to be done with this Unit:

- 14.- Many students view results simultaneously.

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

- 15.- 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.

REQUIRED SERVICES

- Electrical supply: single-phase, 220 V./50Hz. or 110V./60Hz.
- Water to fill the thermostatic bath.
- Computer (PC).

DIMENSIONS & WEIGHTS

QRCC:	
Unit :	-Dimensions: 650 x 700 x 800 mm. approx. (25.59 x 27.55 x 31.49 inches approx.)
	-Weight: 50 Kg. approx. (110.23 pounds approx.)
Spectrophotometer:	-Dimensions: 470 x 380 x 140 mm. approx. (18.50 x 14.96 x 5.51 inches approx.)
	-Weight: 10 Kg. approx. (22 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.)

OPTIONAL ACCESSORY

- QRCC-IF. Flow Injection Analysis (FIA) Unit.

AVAILABLE VERSIONS

Offered in this catalogue:

- QRCC. Computer Controlled Catalytic Reactors.

Offered in other catalogue:

- QRCB. Catalytic Reactors.

SCADA and PID Control

Main screen

The software interface is titled "edibon QRCC COMPUTER CONTROLLED CATALYTIC REACTORS Reactores Catalíticos, Controlados desde Computador (PC)". It features a central process diagram showing three reactors (Chemical, Chemical, Biological) with various valves (V-1 to V-6), pumps (AB-1, AB-2), and sensors (ST-1 to ST-5, C-1). The interface is divided into several functional areas:

- I. Control Panel:** Includes buttons for CALIBRATE, START, STOP, VIEW DATA, SAVE DATA, and QUIT.
- II. Sensors:** Displays real-time values for Analog Sensors (ST-1 to ST-5, C-1) and Digital Sensors (Abs). A "Spectrophotometer" section shows "Abs" and "Nuevo hardware encontrado".
- III. Actuators:** Shows PID1 control for actuators AB-1, AR-1, and AB-2 with graphical sliders.
- IV. Sensor Plot:** A "Signal Vs Time" graph showing Amplitude vs Time (seconds). It includes a "Single Graph" dropdown and a list of sensors to plot (ST-1 to ST-5, C-1).
- V. Real-time Graphics:** A large "Signal Vs Time" graph for real-time monitoring.

① Main software operation possibilities.

② Sensors displays, real time values, and extra output parameters. Sensors: ST= Temperature sensor. C= Concentration.

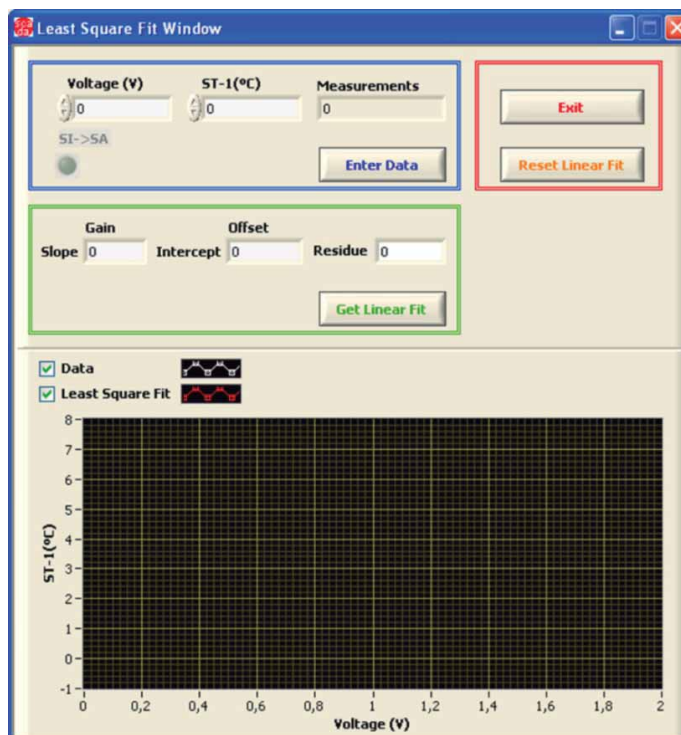
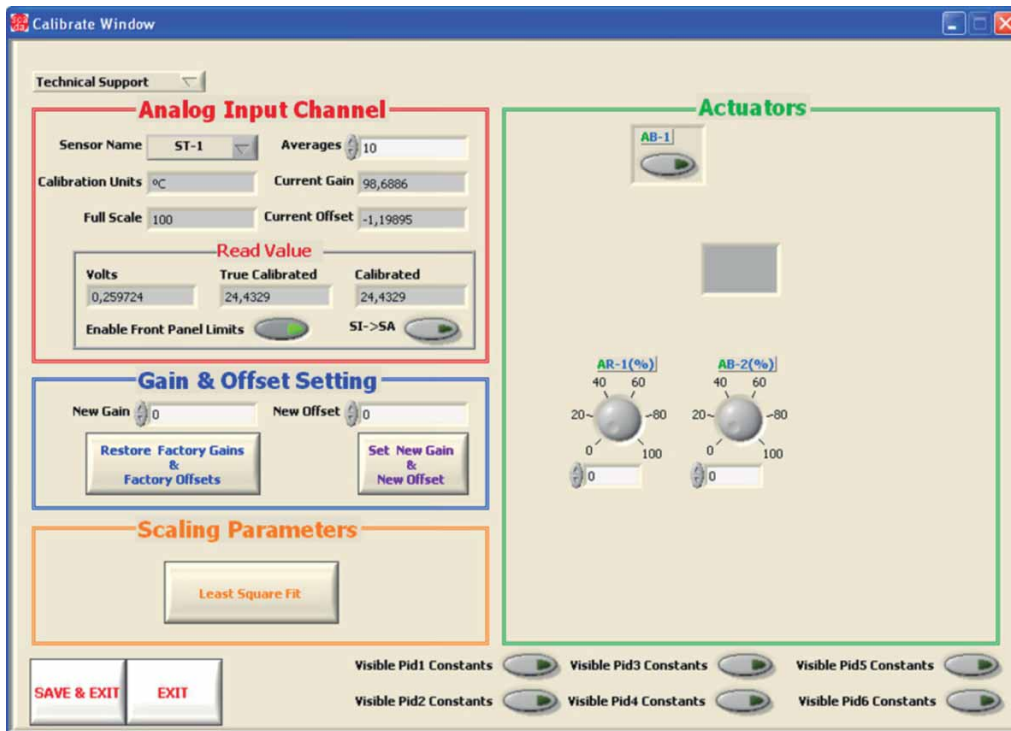
③ Actuators controls. Actuators: AR= Heating resistance. AB=Pump.

④ Channel selection and other plot parameters.

⑤ Real time graphics displays.

Continue...

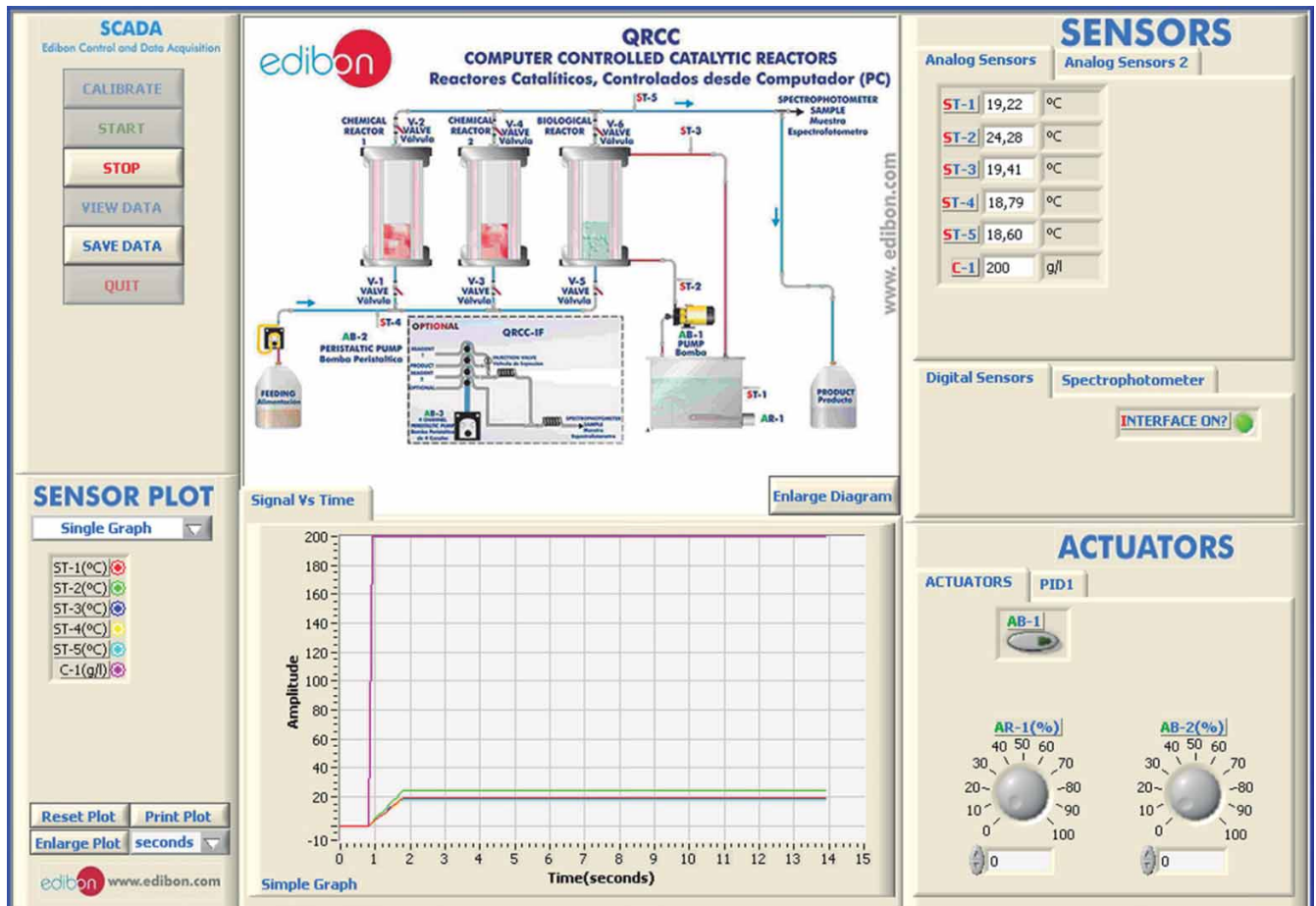
Software for Sensors Calibration



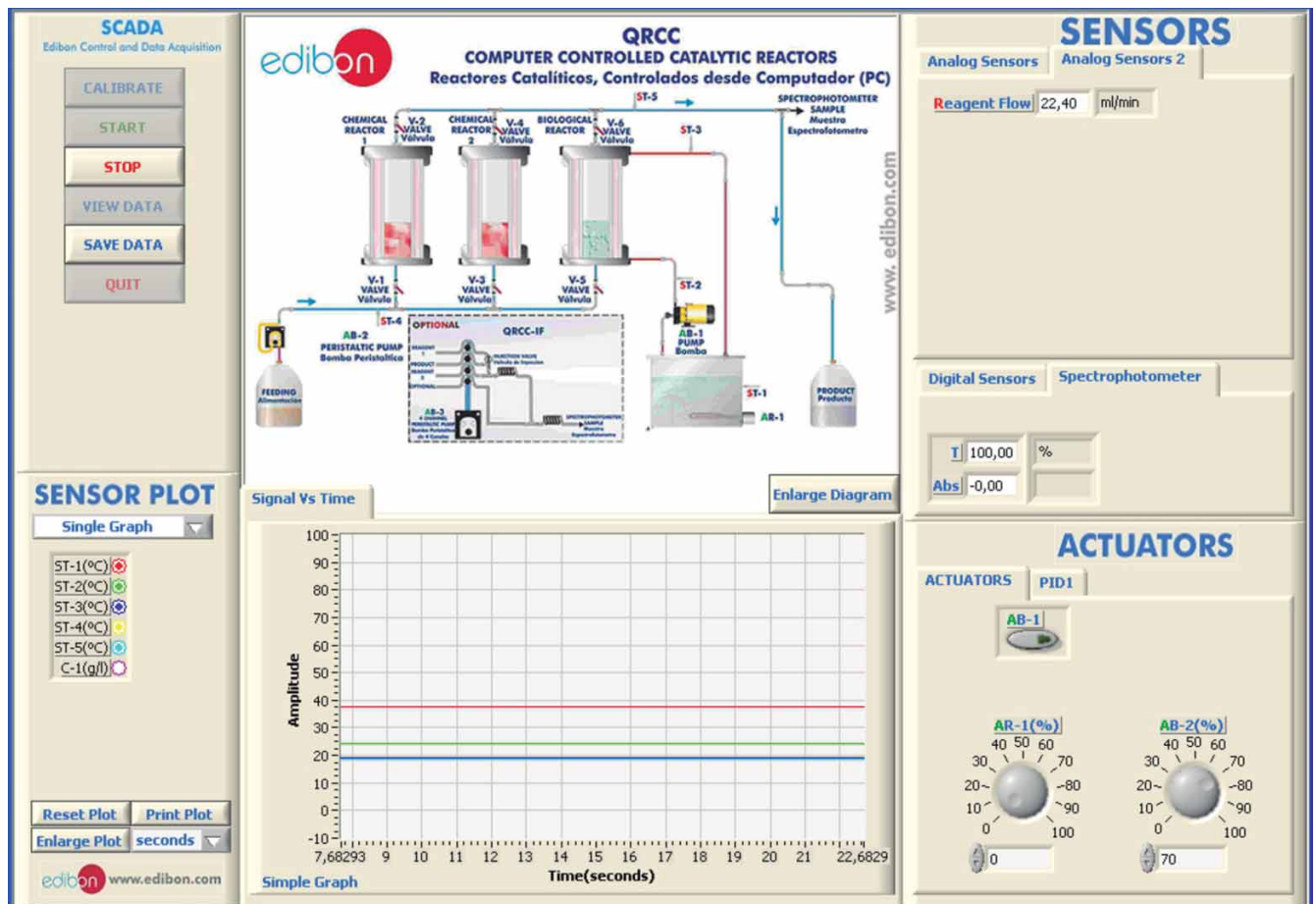
By using a free of charge code, the teacher and the students can calibrate the unit. The teacher can recover his/her own calibration by using the EDIBON code that we give free of charge.

SOME TYPICAL RESULTS

The different data collected by the sensors can be represented in function of time.



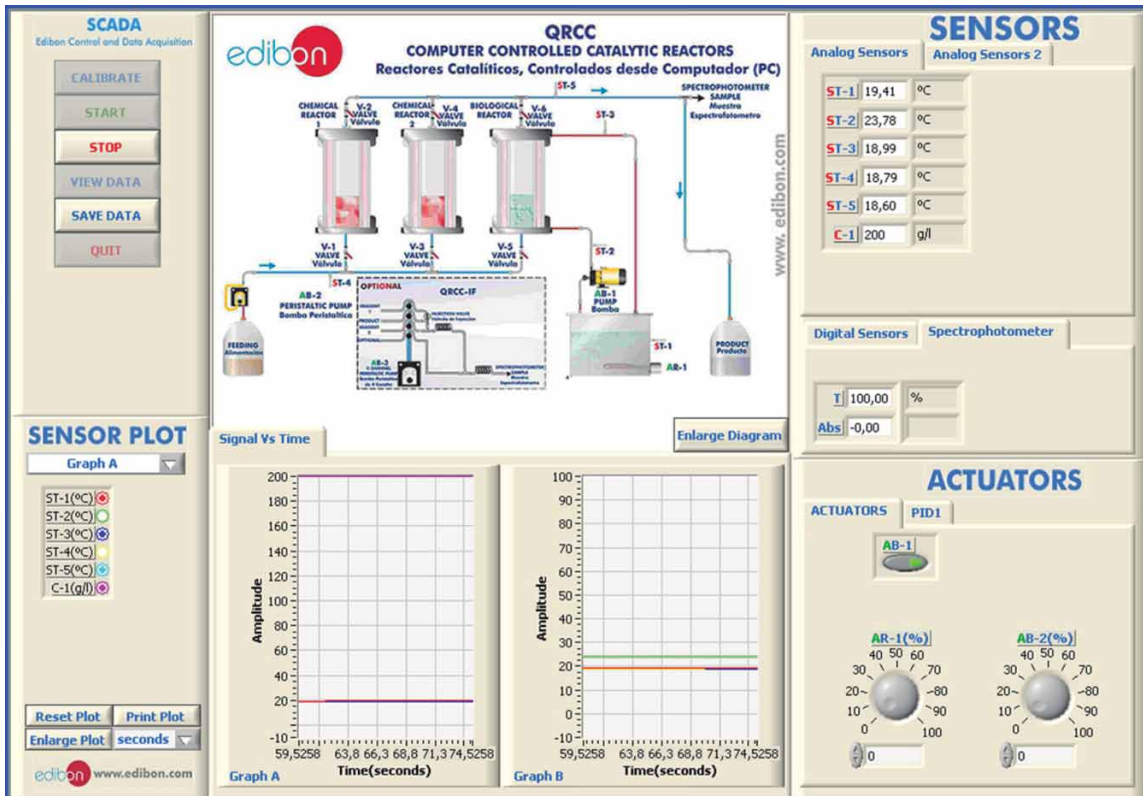
The reagent flow to be introduced into the different reactors (pump AB-2) can be controlled through a potentiometer. Such flow is visualized taking into account the pulses of the peristaltic pump.



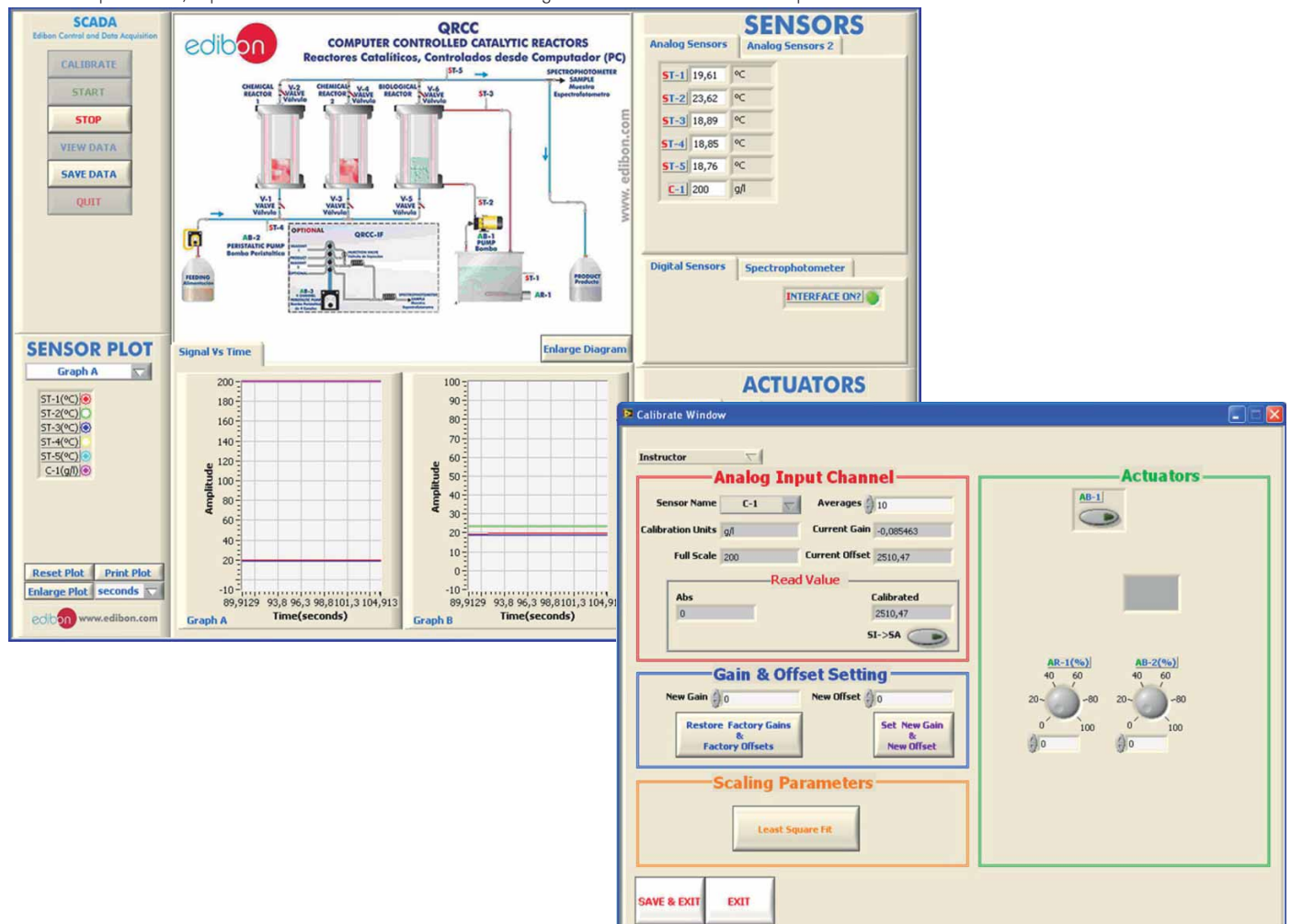
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Some typical results

The result of glucose concentration from the saccharose hydrolysis is obtained with a spectrophotometer. The absorbance and transmittance of such solution resulting from the reaction will be visualized through the software.

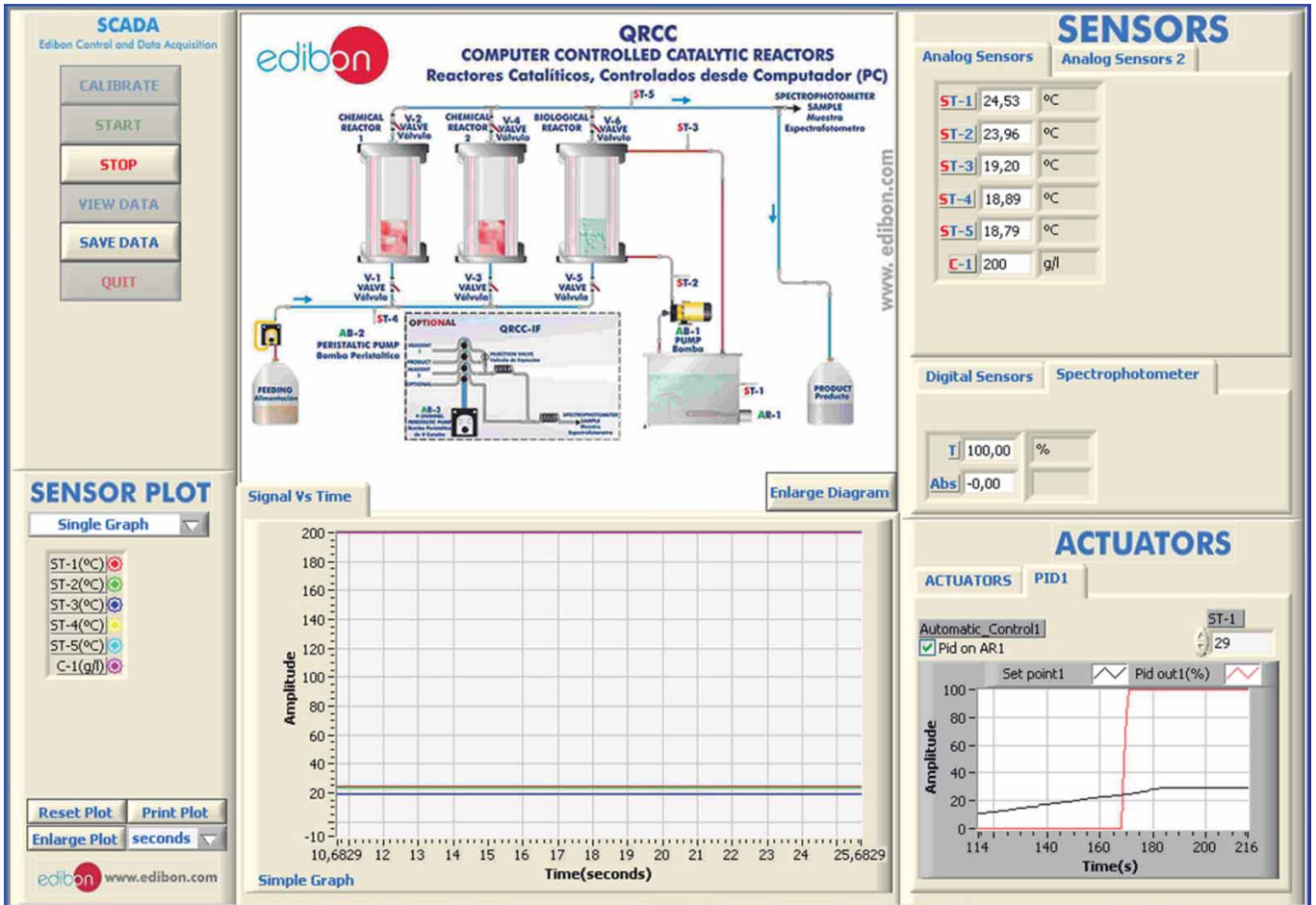


The result of glucose concentration from the saccharose hydrolysis can be obtained directly through the software. For that purpose, following the sensors calibration procedure, a prior calibration with solutions of known glucose concentration must be performed.



Continue...

The heating temperature of reactors is regulated through a PID control. When the target temperature is reached in temperature sensor (ST-1), the heating resistance switches off automatically. Thus, the influence of that heating temperature on the final result of the reaction can be studied. The evolution graph allows us to compare the PID response (AR-1 heating resistance) against the setpoint (ST-1 temperature sensor).



COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 12.

All these items try to give more possibilities for:

- a) Industrial configuration. (PLC)
- b) Technical and Vocational Education configuration. (CAI and FSS)
- c) Higher Education and/or Technical and Vocational Education configuration. (CAL)
- d) Multipost Expansions options. (Mini ESN and ESN)

a) Industrial configuration

⑦ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

Metallic box.

Circuit diagram in the module 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 (-10 V. to + 10 V.) (through SCSI connector).

Analog outputs block:

4 Analog outputs (-10 V. to + 10 V.) (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. USB 2.0 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.

Power supply input (100 to 240 V AC).

DC input: 16 (24 VDC).

Relay output: 14.

High-speed counter.

Multi-point PID control.

Digital inputs/outputs and analog inputs/outputs Panasonic modules.

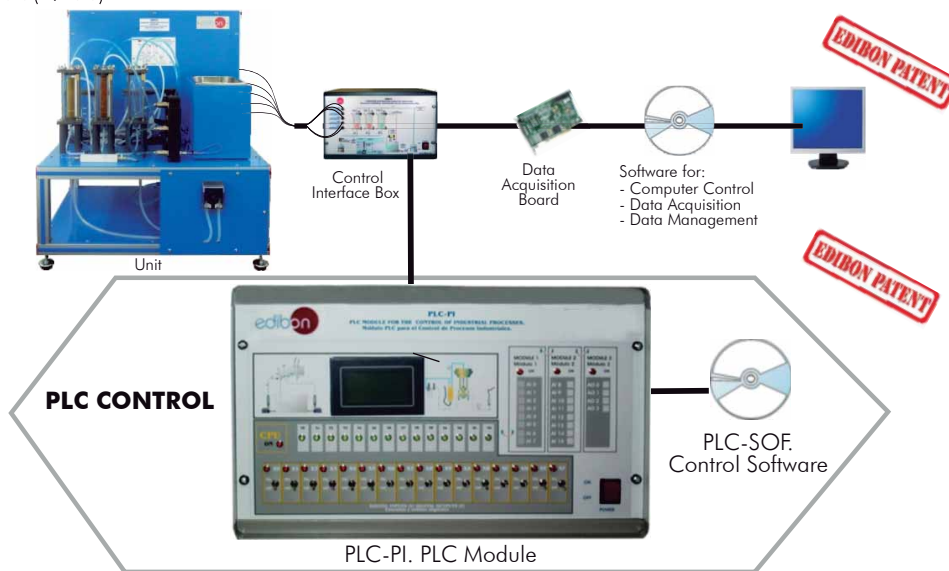
Communication RS232 wire to computer (PC).

Dimensions: 490 x 330 x 310 mm. approx. (19.29 x 12.99 x 12.20 inches approx.). Weight: 30 Kg. approx. (66 pounds approx.).

-QRCC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

The software has been designed using Labview and it follows the unit operation procedure and linked with the Control Interface Box used in the Computer Controlled Catalytic Reactors (QRCC).



Practices to be done with PLC-PI:

- 1.- Control of the QRCC unit process through the control interface box without the computer.
- 2.- Visualization of all the sensors values used in the QRCC unit process.
- 3.- Calibration of all sensors included in the QRCC unit process.
- 4.- Hand on of all the actuators involved in the QRCC unit process.
- 5.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
- 6.- Simulation of outside actions, in the cases hardware elements do not exist. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
- 7.- PLC hardware general use and manipulation.
- 8.- PLC process application for QRCC unit.
- 9.- PLC structure.
- 10.- PLC inputs and outputs configuration.
- 11.- PLC configuration possibilities.
- 12.- PLC programming languages.
- 13.- PLC different programming standard languages.
- 14.- New configuration and development of new process.
- 15.- Hand on an established process.
- 16.- To visualize and see the results and to make comparisons with the QRCC unit process.
- 17.- Possibility of creating new process in relation with the QRCC unit.
- 18.- PLC Programming exercises.
- 19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ **QRCC/CAI. Computer Aided Instruction Software System.**

This complete package includes two Softwares: the INS/SOF. Classroom Management Software (Instructor Software) and the QRCC/SOF. Computer Aided Instruction Software (Student Software).

This software is optional and can be used additionally to items (1 to 6).

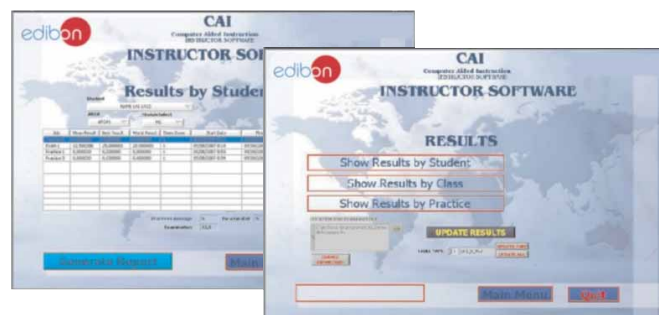
This complete package consists on an Instructor Software (INS/SOF) totally integrated with the Student Software (QRCC/SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students. These, on the other hand, get a virtual instructor who helps them to deal with all the information on the subject of study.

- INS/SOF. Classroom Management Software (Instructor Software):

The Instructor can:

- Organize Students by Classes and Groups.
- Create easily new entries or delete them.
- Create data bases with student information.
- Analyze results and make statistical comparisons.
- Print reports.
- Develop own examinations.
- Detect student's progress and difficulties.
- ...and many other facilities.

Instructor Software



- QRCC/SOF. Computer Aided Instruction Software (Student Software):

It explains how to use the unit, run the experiments and what to do at any moment.

This Software contains:

- Theory.
- Exercises.
- Guided Practices.
- Exams.

Student Software



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

www.edibon.com/products/catalogues/en/CAI.pdf

⑨ **QRCC/FSS. Faults Simulation System.**

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit. It is useful for Technical and Vocational level.

The "FAULTS" mode consists on causing several faults in the unit normal operation. The student must find them and solve them.

There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:

- Actuators channels interchange at any time during the program execution.
- Response reduction of an actuator.

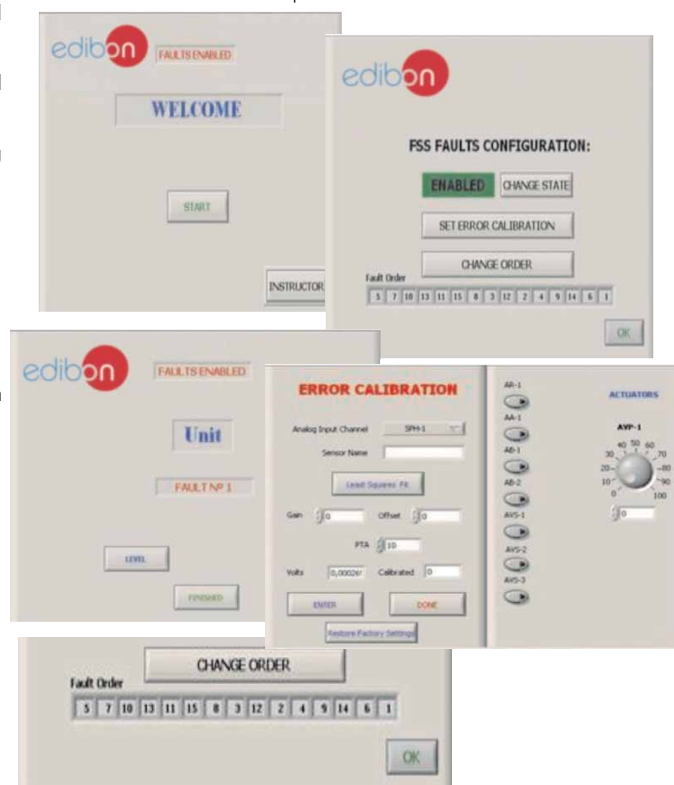
Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

On/off faults:

- Several on/off faults can be included.

Example of some screens



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

www.edibon.com/products/catalogues/en/FSS.pdf

c) Higher Education and/or Technical and Vocational Education configuration

⑩ **QRCC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).**

This Computer Aided Learning Software (CAL) is a Windows based software, simple and very easy to use, specifically developed by EDIBON. It is very useful for Higher Education level.

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.

CAL computes the value of all the variables involved.

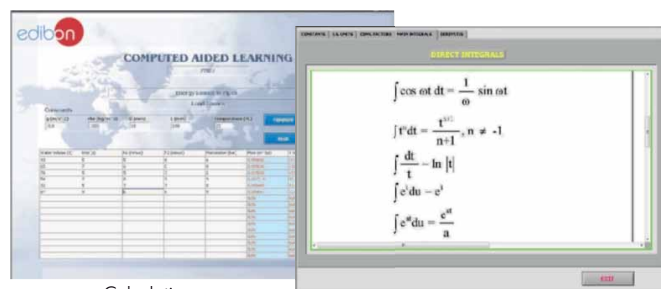
It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

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

www.edibon.com/products/catalogues/en/CAL.pdf



Calculations

Information of constant values, unit conversion factors and integral and derivative tables



Plotting options

d) Multipost Expansions options

⑪ **Mini ESN. EDIBON Mini Scada-Net System.**

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 on the adaptation of any EDIBON Computer Controlled Unit with SCADA and PID Control 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:

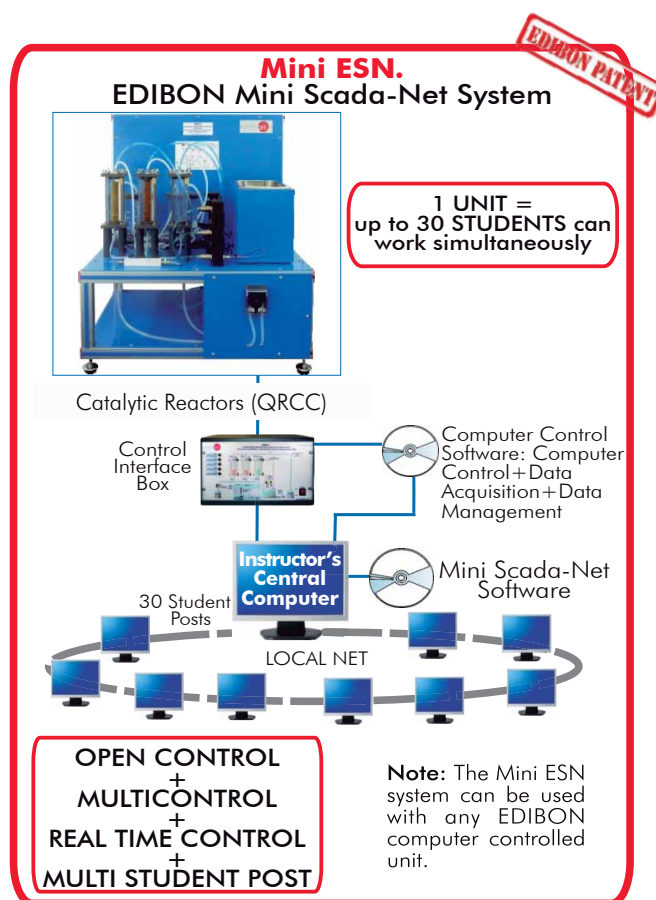
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA and PID Control, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student 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/products/catalogues/en/Mini-ESN.pdf



⑫ **ESN. EDIBON Scada-Net System.**

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

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

www.edibon.com/products/catalogues/en/units/chemicalengineering/esn-chemicalengineering/ESN-CHEMICAL_ENGINEERING.pdf

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

- ① **Unit: QRCC. Catalytic Reactors.**
- ② **QRCC/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **QRCC/CCSOF. PID Computer Control + Data Acquisition + Data Management Software.**
- ⑤ **Cables and Accessories**, for normal operation.
- ⑥ **Manuals.**

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

Optional items (supplied under specific order)

a) Industrial configuration

- ⑦ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):
 - PCL-PI. PLC Module.
 - QRCC/PLC-SOF. PLC Control Software.

b) Technical and Vocational configuration

- ⑧ QRCC/CAL. Computer Aided Instruction Software System.
- ⑨ QRCC/FSS. Faults Simulation System.

c) Higher Education and/or Technical and Vocational Education configuration

- ⑩ QRCC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

d) Multipost Expansions options

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

① QRCC. Unit:

Bench-top unit.

Anodized aluminium structure and panels in painted steel.

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

2 Glass flasks of 2 litres of capacity, for the initial solution and the final product.

Reactors:

Two fixed-bed reactors for chemical catalysis, composed by acid ionexchange resins.

A fixed-bed reactor for biological (enzymic) catalysis. (Recommended use with an immobilized enzyme).

Reactors diameter: 50 mm. Reactors height: 160 mm.

Material: glass, with a methacrylate cover for protection.

Thermostatic bath, with heating resistance of 600W, controlled by a PID from the computer (PC).

A heated water supply to the reactors jackets allows the automatic control of reaction temperature to a set point value.

Peristaltic pump, with speed regulation, computer controlled (PC), that allows to regulate the feed flow from 0 to 32 ml/min.

5 Temperature sensors, "J" type, placed at key points of the system.

Spectrophotometer, computer controlled (PC), for the final product analysis and absorbance measures:

Wavelength range: 325-1000 nm. Band width: 5 nm.

All electrical circuits are protected by adequate protection devices.

The complete unit includes as well:

Advanced Real-Time SCADA and PID Control.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON 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 EDIBON 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 EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

Optional accessory (NOT included in the supply):

- QRCC-IF. Flow Injection Analysis (FIA) Unit.

② QRCC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system. Control interface box with process diagram in the front panel.

The unit control elements are permanently computer controlled.

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.

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 PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process. Real time PID control for parameters involved in the process simultaneously. Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).

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 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 QRCC/CCSOF. PID 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.

Analog and digital PID control. PID menu and set point selection required in the whole work range.

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 Main Items

- 1.- Study of the principles of catalytic fixed-bed reactors.
- 2.- Effect of the variation in the particle 's size in the effectiveness of a fixed-bed reactor.
- 3.- Comparison of chemical and biological (enzymic) catalysis.
- 4.- Checking the influence on different variables (feed flow, temperature of reaction, reagents concentration) on the obtained final product.
- 5.- Spectrophotometer calibration.
- 6.- Using the spectrophotometer and product analysis.
- 7.- Study of the "FIA" Flow Injection Analysis technique and principles (with QRCC-IF optional accessory).
- 8.- Examination of the reproducibility and sensitivity of the "FIA" analysis method as a function of the flow rate and sample concentration (with QRCC-IF optional accessory).

Additional practical possibilities to be done by the end customer:

- 9.- Sensors calibration.
- 10.- Studies of steady and unsteady state catalysis.
- 11.- Flow characterisation in a fixed-bed.
- 12.- Mass balances.
- 13.- Determination of steady state and unsteady state kinetics of a catalytic fixed-bed reactor.

Other possibilities to be done with this Unit:

- 14.- Many students view results simultaneously.

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

- 15.- 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.

- 16.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
 - 17.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
 - 18.- This unit can be used for doing applied research.
 - 19.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
 - 20.- Control of the QRCC unit process through the control interface box without the computer.
 - 21.- Visualization of all the sensors values used in the QRCC unit process.
- By using PLC-PI additional 19 more exercises can be done.
- Several other exercises can be done and designed by the user.

a) Industrial configuration

⑦ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

Metallic box.
 Circuit diagram in the module front panel.
 Digital inputs(X) and Digital outputs (Y) block: 16 Digital inputs. 14 Digital outputs.
 Analog inputs block: 16 Analog inputs.
 Analog outputs block: 4 Analog outputs.
 Touch screen.
 Panasonic PLC:

High-speed scan of 0.32 μsec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.
 Digital inputs/outputs and analog inputs/outputs Panasonic modules.

-QRCC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

Practices to be done with PLC-PI:

- 1.- Control of the QRCC unit process through the control interface box without the computer.
- 2.- Visualization of all the sensors values used in the QRCC unit process.
- 3.- Calibration of all sensors included in the QRCC unit process.
- 4.- Hand on of all the actuators involved in the QRCC unit process.
- 5.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
- 6.- Simulation of outside actions, in the cases hardware elements do not exist. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
- 7.- PLC hardware general use and manipulation.
- 8.- PLC process application for QRCC unit.
- 9.- PLC structure.
- 10.- PLC inputs and outputs configuration.
- 11.- PLC configuration possibilities.
- 12.- PLC programming languages.
- 13.- PLC different programming standard languages.
- 14.- New configuration and development of new process.
- 15.- Hand on an established process.
- 16.- To visualize and see the results and to make comparisons with the QRCC unit process.
- 17.- Possibility of creating new process in relation with the QRCC unit.
- 18.- PLC Programming exercises.
- 19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ QRCC/CAI. Computer Aided Instruction Software System.

This complete package consists on an Instructor Software (INS/ SOF) totally integrated with the Student Software (QRCC/SOF).

-INS/SOF. Classroom Management Software (Instructor Software):

The Instructor can:

- Organize Students by Classes and Groups.
- Create easily new entries or delete them.
- Create data bases with student information.
- Analyze results and make statistical comparisons.
- Print reports.
- Develop own examinations.
- Detect student's progress and difficulties.

-QRCC/SOF. Computer Aided Instruction Software (Student Software):

It explains how to use the unit, run the experiments and what to do at any moment.

This Software contains:

- Theory.
- Exercises.
- Guided Practices.
- Exams.

⑨ QRCC/FSS. Faults Simulation System.

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit.

The "FAULTS" mode consists on causing several faults in the unit normal operation. The student must find them and solve them.

There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:

- Actuators channels interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

On/off faults:

- Several on/off faults can be included.

c) Higher Education and/or Technical and Vocational Education configuration

⑩ **QRCC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).**

This Computer Aided Learning Software (CAL) is a Windows based software, simple and very easy to use.

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.

CAL computes the value of all the variables involved.

It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

d) Multipost Expansions options

⑪ **Mini ESN. EDIBON 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 on the adaptation of any EDIBON Computer Controlled Unit with SCADA and PID Control 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 and PID Control, 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 improvements of the product.



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