Computer Controlled **Process Control Plant with Industrial Instrumentation and Service Module** (Flow, Temperature, Level and Pressure), with SCADA and PID Control

CPIC

EDIBON PATENT

Main Unit →

Service Module ↓

EDIBON **SCADA** System and **PID CONTROL** included

Teaching Technique used

② Control Interface Box

③ Data Acquisition Board

④ Software for:
- Computer Control
- Data Acquisition
- Data Management

Computer (not included in the supply)

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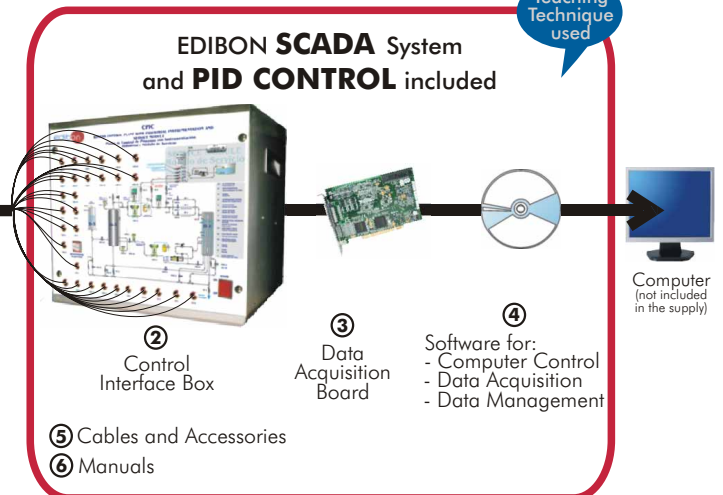
*Minimum supply always includes: 1 + 2 + 3 + 4 + 5 + 6
(Computer not included in the supply)

① Unit: CPIC. Process Control Plant with Industrial Instrumentation and Service Module. (Flow, Temperature, Level and Pressure).

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

Key features:

➤ **Advanced Real Time SCADA and PID Control.**

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

➤ **Own Control Software based on Labview.**

➤ **National Instruments Data Acquisition board (250 KS/s (kilo samples per second)).**

➤ **Calibration exercises included.**

➤ **Students multipost (an entire class) by using a projector.**

➤ **Ready for doing applied research, real industrial simulation, training courses possibilities, etc.**

➤ **Unit is totally safe (Mechanical, Electronic/Electrical and Software safety devices included).**

➤ **Results calculation and analysis software (CAL).**

➤ **Several future expansions, as ESN. EDIBON Scada-Net System (many students working simultaneously), and more.**

➤ **Designed and manufactured under several quality standards.**

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⤷Products
⤷Products range
⤷Units
⤷10.-Process Control

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

CE
European Union Certificate
(total safety)

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

Worlddidac Quality Charter Certificate
(Worlddidac Member)

GENERAL DESCRIPTION

CPIC is a "Computerized Industrial Process Control Plant", that offers, on a reasonable laboratory scale, the different process and elements that are commonly used by any kind the industry. It also shows the complexity that can take place while controlling in processes the same variable.
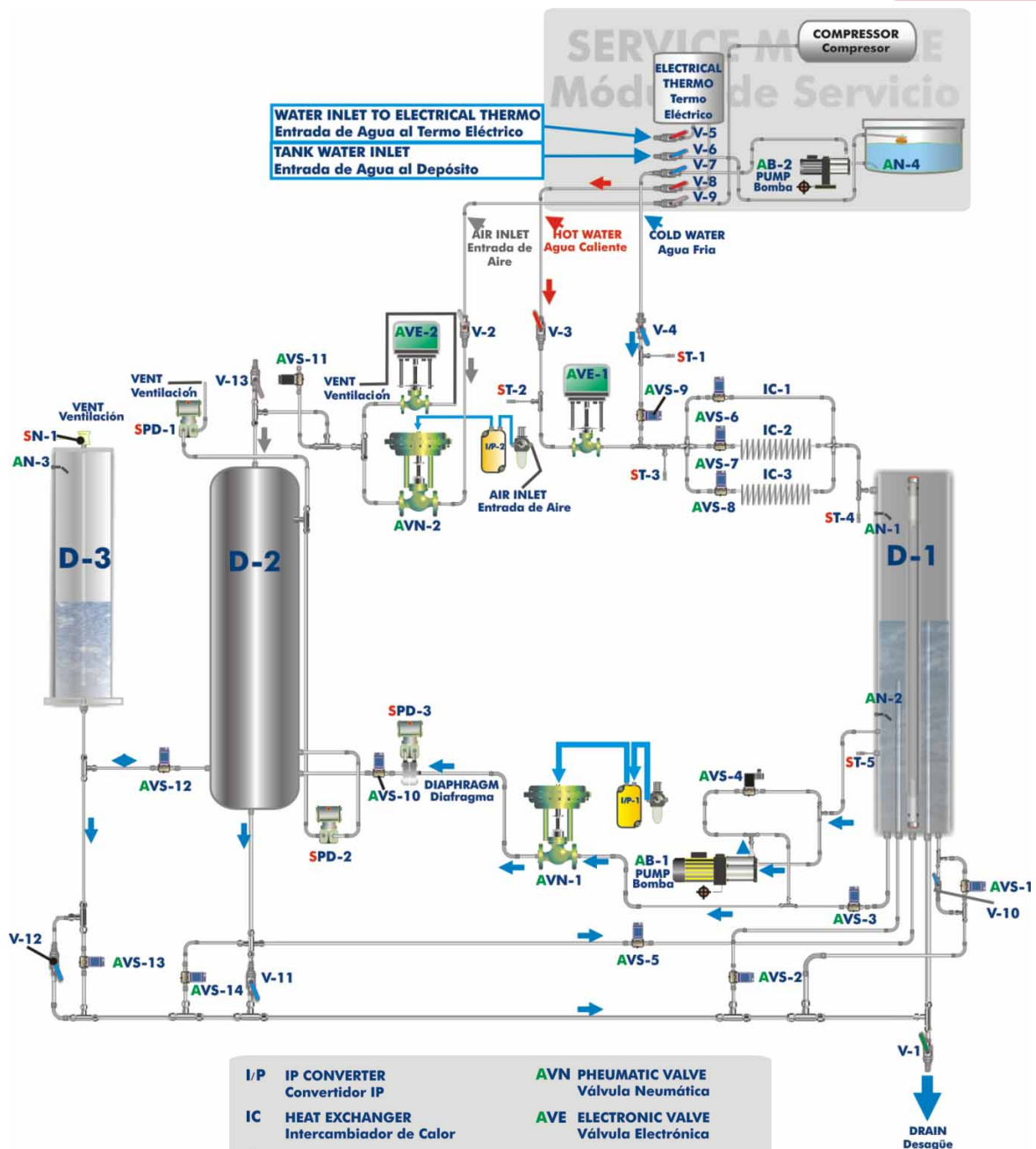
CPIC is made up of a main unit where the different elements are installed and a service module that provides cold and hot water, as well as compressed air, neccesary for the unit to work.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + 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.
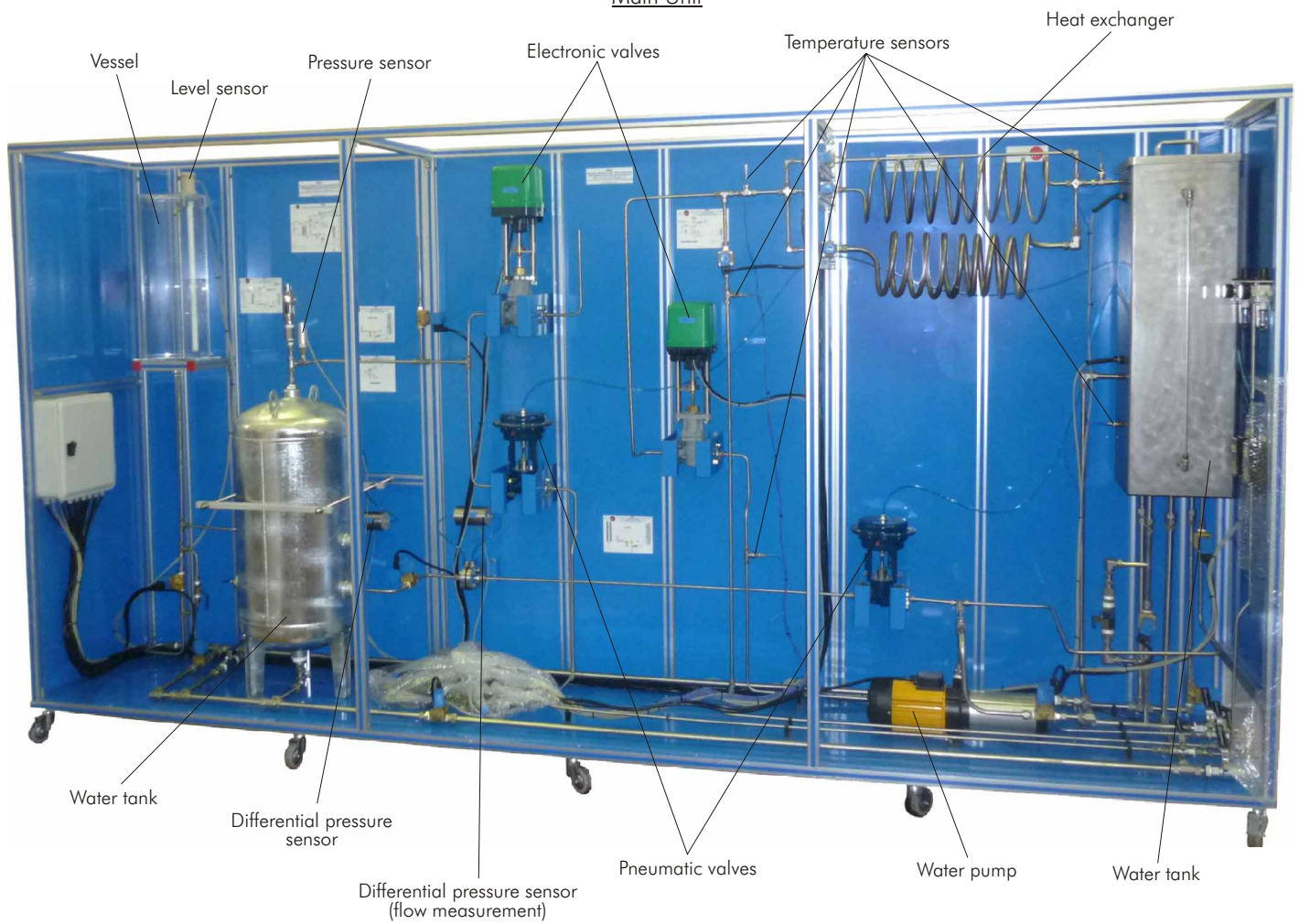
PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

26 actuators and 9 sensors controlled from any computer, and working simultaneously

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

I/P	IP CONVERTER Convertidor IP	**AVN**	PHEUMATIC VALVE Válvula Neumática
IC	HEAT EXCHANGER Intercambiador de Calor	**AVE**	ELECTRONIC VALVE Válvula Electrónica
D	VESSEL Depósito	**AVS**	SOLENOID VALVE Válvula Solenoide
ST	TEMPERATURE SENSOR Sensor de Temperatura	**AB**	PUMP Bomba
SN	LEVEL SENSOR Sensor de Nivel	**AN**	LEVEL SWITCH Interruptor de Nivel
SPD	DIFFERENTIAL PRESSURE SENSOR Sensor de Presión Diferencial	**V**	VALVE Válvula

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Main Unit

Vessel

Level sensor

Pressure sensor

Electronic valves

Temperature sensors

Heat exchanger

Water tank

Differential pressure sensor

Differential pressure sensor (flow measurement)

Pneumatic valves

Water pump

Water tank

Service Module

Compressor

Heater unit (tank with electrical resistance)

Water tank

Water pump

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 **CPIC. Unit:**

Metallic structure. Panels and main metallic elements in stainless steel.

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

Main Unit contains the following elements:

Two pneumatics valves with C_v: 0.25. Actuator (I/P) from 0.2 to 1.0 bar for electric signal from 4 to 20 mA.

Two electronic valves for electric signal from 4 to 20mA.

Twelve solenoid valves, normally closed.

Two solenoid valves, normally open, placed at the air loop and flow loop.

Three differential pressure sensors. They have a range from -100 to 100 psi.

Five temperature sensors, "J" type. These sensors are placed along the unit to control the temperature in different lines.

One level sensor (effective length: 300 mm.) (11.81 inches).

Four level switches.

Water pump: maximum water flow: 106 l./min. and maximum pressure: 7 bar.

Stainless steel water tank: maximum capacity: 100 l. It has five drains at its lower part. Two of them are placed at different height, middle and top of the tank.

Stainless steel tank:

Maximum capacity: 200 l.

Maximum pressure: 16 bar.

It has eight takings, but only six are used in this unit.

In the upper part, there is a safety valve that opens when the pressu

Two takings are used to measure the water height by the means of a differential pressure sensor. Other differential pressure sensor gives us the inner pressure.

Service Module contains the following elements:

Heater unit:

A tank with a maximum capacity of 80 litres and an electrical resistance of 1.2 kW as maximum electrical power. The temperature control is placed in the electrical resistance.

It has a safety valve and purge valve.

The lower part of the unit has an inlet pipe (cold water) and an outlet pipe (hot water).

Compressor unit:

Maximum pressure: 10 bar.

This unit has a regulating valve with a manometer to fix the outlet maximum pressure.

Water system:

Water tank, capacity: 400 l.

Water pump: 3.0 bar and 2500 l./h.

The inlet pipe of the tank has an automatic filling system.

Drain valve in the water tank.

The complete unit includes as well:

Advanced Real Time SCADA and PID Control.

Open Control + Multicontrol + Real Time Control.

Own Control Software based on Labview.

National Instruments Data Acquisition board (250 KS/s (kilo samples per second)).

Calibration exercises included.

Students multipost (an entire class) by using a projector.

Ready for doing applied research, real industrial simulation, training courses possibilities, etc.

Unit is totally safe (Mechanical, Electronic/Electrical and Software safety devices included).

Results calculation and analysis software (CAL).

Several future expansions, as ESN. EDIBON Scada-Net System (many students working simultaneously), and more.

Designed and manufactured under several quality standards.

CPIC. Unit

Complete Technical Specifications (for main items)

② CPIC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.

<u>Control interface box with process diagram in the front panel</u> 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.

CPIC/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: <u>250 KS/s (kilo samples per second)</u>.

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: 833 KS/s.

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

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 CPIC/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 <u>250 KS/s (kilo samples per second)</u>.

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 blackboard.
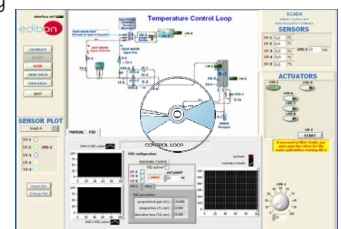
CPIC/CCSOF

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: CPIC + CPIC/CIB + DAB + CPIC/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 MAIN ITEMS

1.- Familiarisation with the different components of the system and their symbolic representation. Identification of components and description of their functions.

2.- The auxiliary systems: air and hot water supply.

3.- Flow sensors calibration.

4.- Temperature sensors calibration.

5.- Level sensor calibration.

6.- I/P converter calibration.

7.- Flow control loop (on/off).

8.- Flow control loop (proportional).

9.- Flow control loop (P+I).

10.- Flow control loop (P+D).

11.- Flow control loop (P+I+D).

12.- Adjust of the flow controller constants (Ziegler-Nichols).

13.- Adjust of the flow controller constants (reaction curves).

14.- Search of simple shortcomings in the loop of flow control.

15.- Temperature control loop (on/off).

16.- Temperature control loop (proportional).

17.- Temperature control loop (P+I).

18.- Temperature control loop (P+D).

19.- Temperature control loop (P+I+D).

20.- Adjust of the temperature controller constants (minimum area or reduction rate).

21.- Adjust of the temperature controller constants (minimum disturbance criterion).

22.- Adjust of the temperature controller constants (minimum width criterion).

23.- Study of the retards for speed/distance, exemplified through the temperature control loop.

24.- Study of the energy lost in the temperature control loop.

25.- Search of simple shortcomings in temperature control loop.

26.- Level control loop (on/off).

27.- Level control loop (proportional).

28.- Level control loop (P+I).

29.- Level control loop (P+D).

30.- Level control loop (P+I+D).

31.- Adjust of the level controller constants (minimum area or reduction rate).

32.- Adjust of the level controller constants (minimum disturbance criterion).

33.- Adjust of the level controller constants (minimum width criterion)

34.- Search of simple shortcomings in level control loop.

35.- Pressure control loop (on/off).

36.- Pressure control loop (proportional).

37.- Pressure control loop (P+I).

38.- Pressure control loop (P+D).

39.- Pressure control loop (P+I+D).

40.- Adjust of the pressure controller constants (minimum area or reduction rate).

41.- Adjust of the pressure controller constants (minimum disturbance criterion).

42.- Adjust of the pressure controller constants (minimum width criterion).

43.- Search of simple shortcomings in the pressure control loop.

44.- The use of the controllers in cascade, exemplified with the level/ flow control loop.

45.- Adjust of cascade control constants (minimum area or reduction rate).

46.- Adjust of cascade control constants (minimum disturbance criterion).

47.- Adjust of cascade control constants (minimum width criterion).

48.- Search of simple shortcomings in cascade control loop.

49.- Practical operation of the control plant to some wanted specific values: transfers without interferences.

50.- Calculation of the fluid flow in function of the differential pressure sensor.

Other possibilities to be done with this Unit:

51.- Many students view results simultaneously.

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

52.- 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.

53.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.

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

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

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

57.- Control of the CPIC unit process through the control interface box without the computer.

58.- Visualization of all the sensors values used in the CPIC unit process.

- By using PLC-PI additional 19 more exercises can be done.

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

REQUIRED SERVICES

- Electric supply: three-phase, 380 V/ 50Hz or 220 V/ 60Hz, 10KW.

- Water supply: 45 l./min. with 3 bar of minimum pressure.

- Computer (PC).

DIMENSIONS & WEIGHTS

CPIC. Unit:

-Main Unit:	-Dimensions:	5000 x 1500 x 2500 mm. approx. (196.85 x 59.05 x 98.42 inches approx.).
	-Weight:	1000 Kg. approx. (2200 pounds approx.).
-Service Module:	-Dimensions:	2000 x 1500 x 2000 mm. approx. (78.74 x 59.05 x 78.74 inches approx.).
	-Weight:	200 Kg. approx. (440 pounds approx.).
Control Interface Box:	-Dimensions:	490 x 450 x 470 mm. approx. (19.29 x 17.71 x 18.5 inches approx.).
	-Weight:	20 Kg. approx. (44 pounds approx.).

AVAILABLE VERSIONS

CPIC.   Computer Controlled Process Control Plant with Industrial Instrumentation and Service Module (Flow, Temperature, Level and Pressure).

CPIC-C. Computer Controlled Process Control Plant with Industrial Instrumentation and Service Module (only Flow).

CPIC-T. Computer Controlled Process Control Plant with Industrial Instrumentation and Service Module (only Temperature).

CPIC-N. Computer Controlled Process Control Plant with Industrial Instrumentation and Service Module (only Level).

CPIC-P. Computer Controlled Process Control Plant with Industrial Instrumentation and Service Module (only Pressure).

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SCADA and PID Control
Main screens
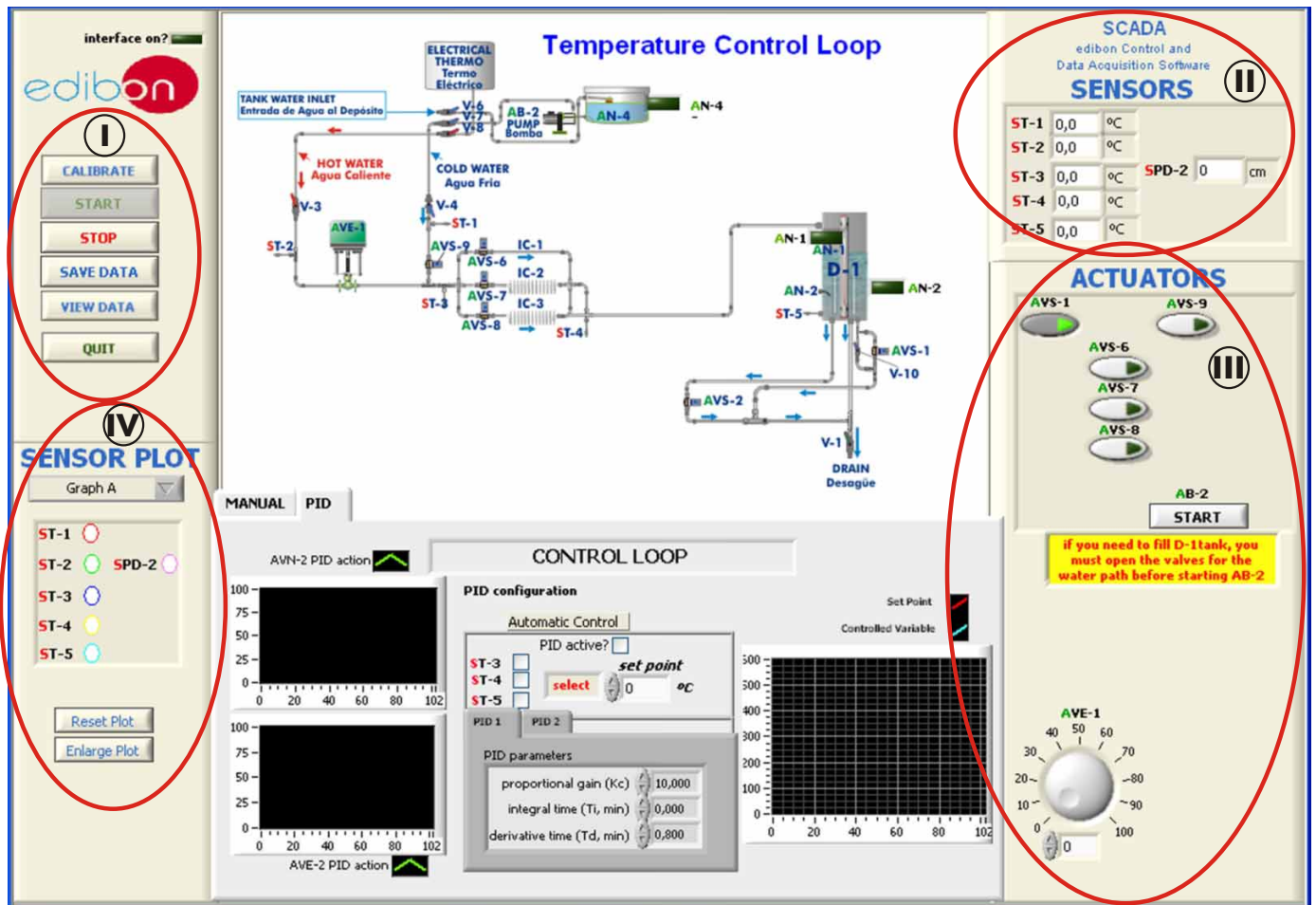
I Main Controls.
II Sensors displays and extra output parameters. Sensors: ST=Temperature sensor. SPD=Differential pressure sensor.
III Actuators controls. Actuators: AB=Pump. AVS=Solenoid valve. AVE=Electronic valve.
IV Channel selection and other plot parameters.

SCADA and PID Control
Main screens
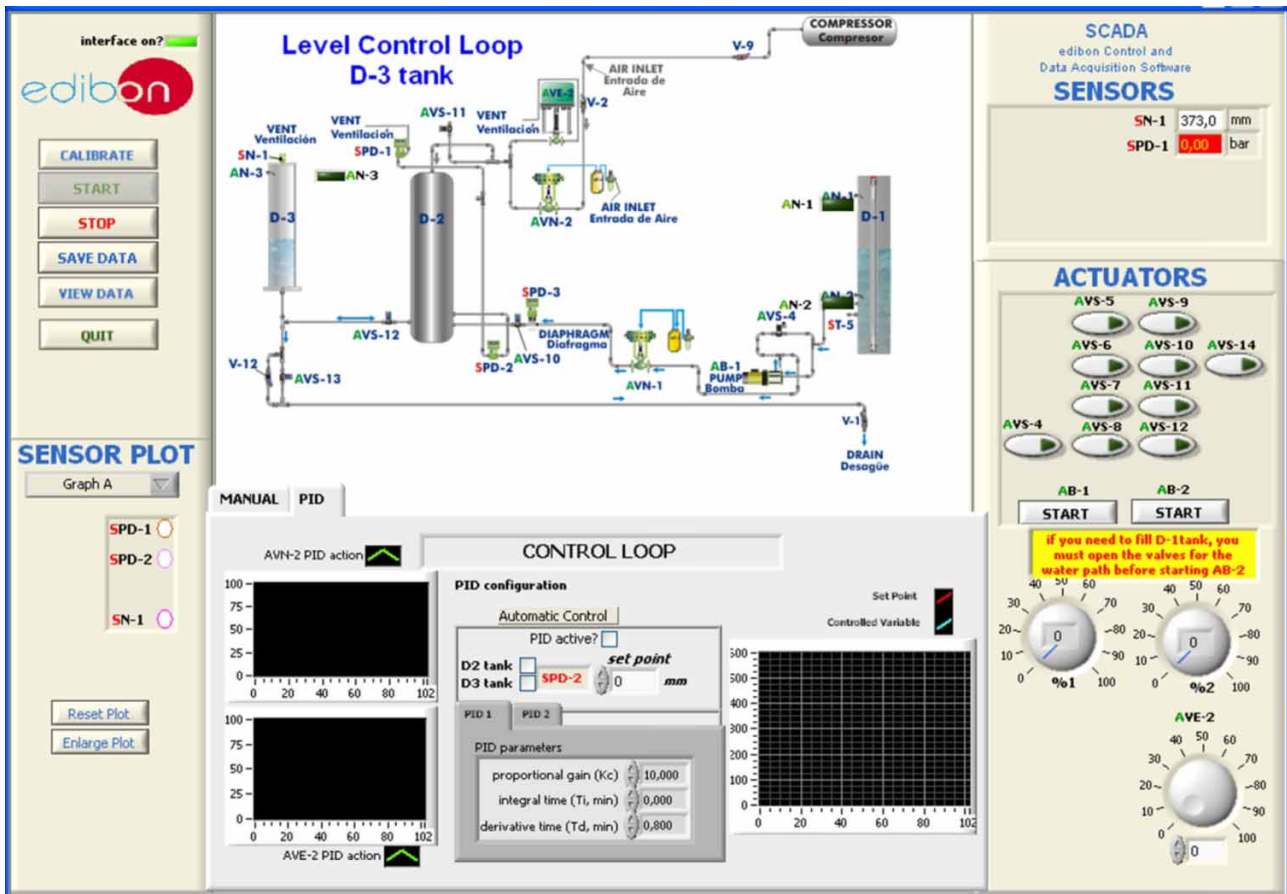
Sensors: SN=Level sensor.   SPD=Differential pressure sensor.

Actuators: AB=Pump.   AVS=Solenoid valve.   AVE=Electronic valve.   AVN=Pneumatic valve.
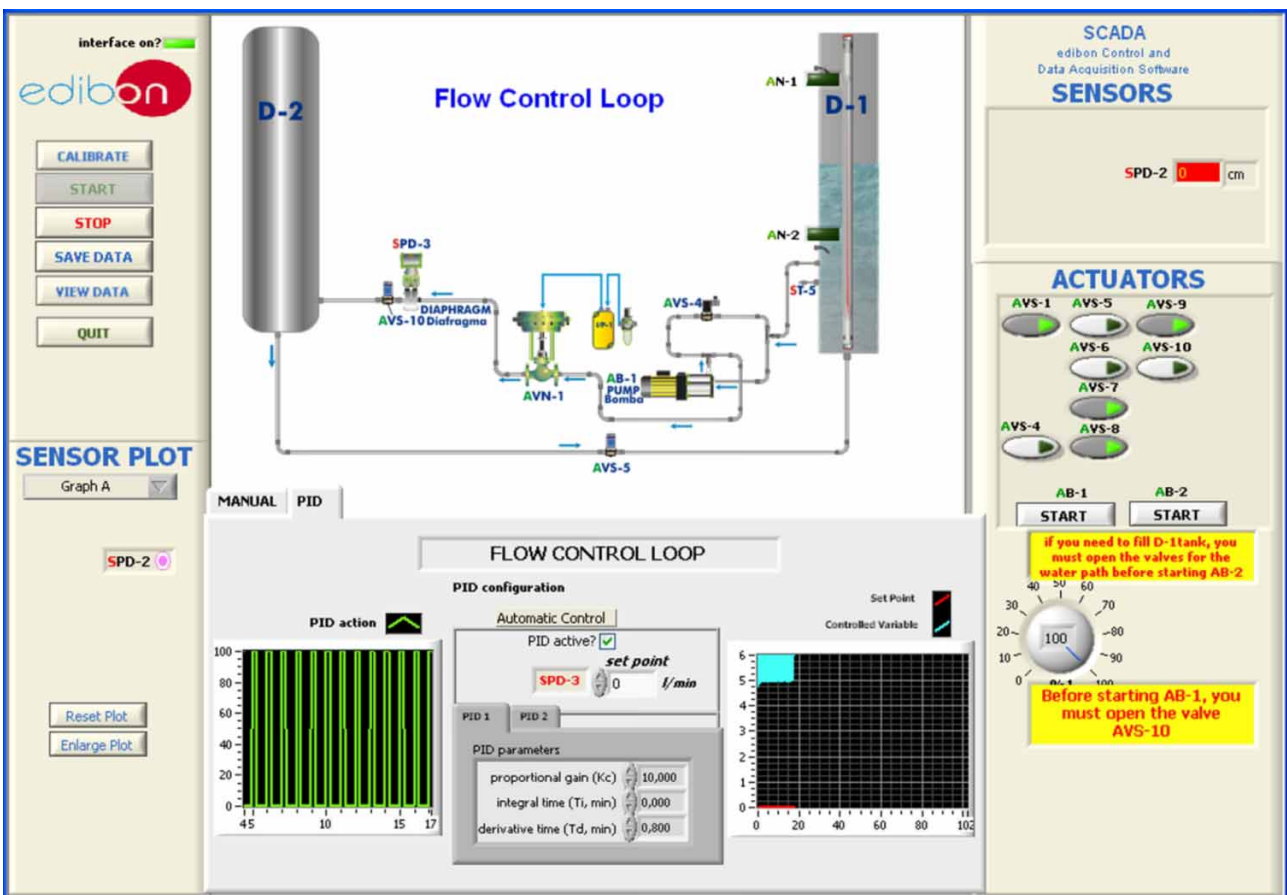
Sensors: SPD=Differential pressure sensor.

Actuators: AB=Pump.   AVS=Solenoid valve.   AVN=Pneumatic valve.

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SCADA and PID Control
Main screens
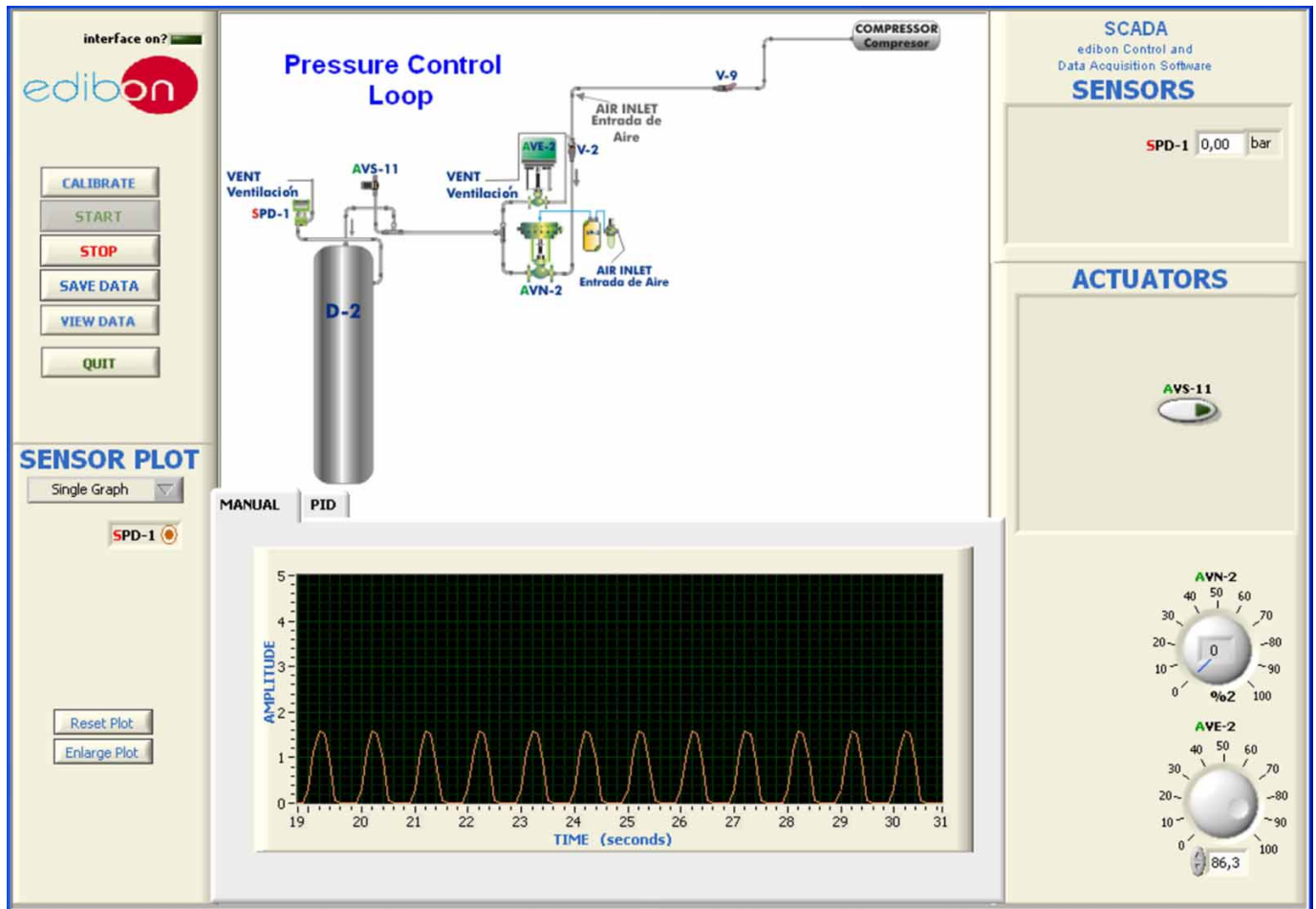
Sensors: SPD=Differential pressure sensor.

Actuators: AVS=Solenoid valve.   AVE=Electronic valve.   AVN=Pneumatic valve.

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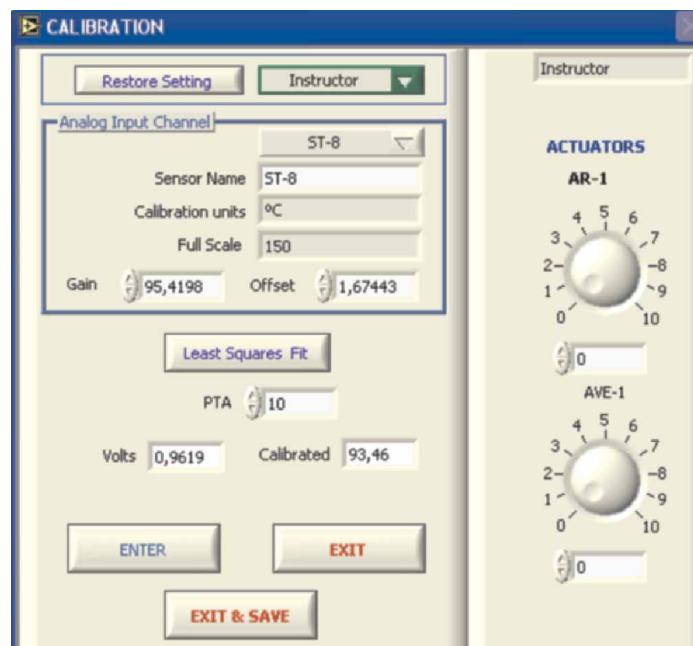
By using a free of charge code, the teacher and the students can calibrate the unit.
The teacher can recover his/her own calibration by using the EDIBON code that we give free of charge.

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 V DC).

      Relay output: 14.

      High-speed counter.

      Multi-point PID control.

    Digital inputs/outputs and analog inputs/outputs Panasonic modules.
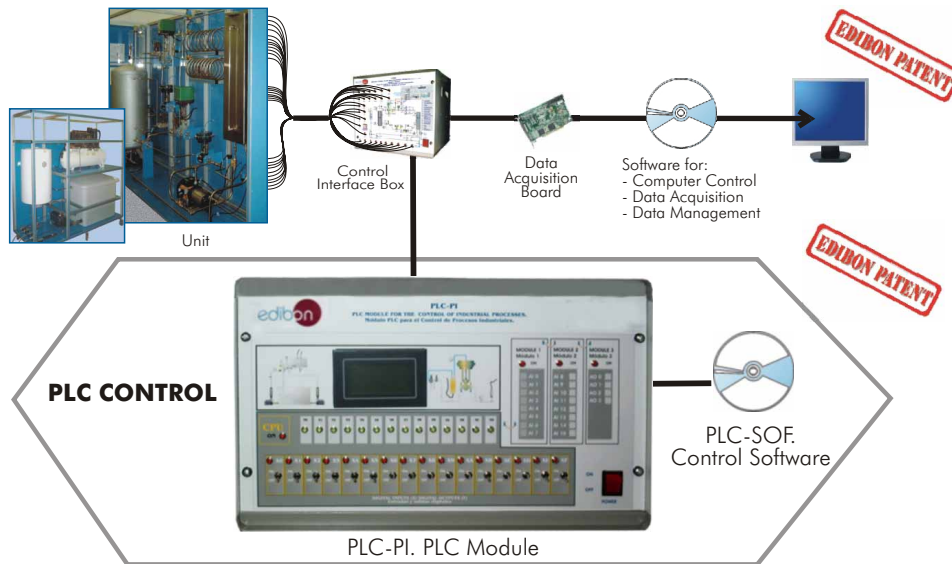
  Communication RS232 wire to computer (PC).

  Dimensions: 490 x 330 x 310 mm. approx. (19.3 x 13 x 12.2 inches approx.)   Weight: 30 Kg. approx. (66 pounds approx.)

  -**CPIC/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 Process Control Plant with Industrial Instrumentation and Service Module (Flow, Temperature, Level and Pressure) (CPIC).

Unit

Control Interface Box

Data Acquisition Board

Software for:
- Computer Control
- Data Acquisition
- Data Management

EDIBON PATENT

EDIBON PATENT

PLC CONTROL

PLC-SOF. Control Software

PLC-PI. PLC Module

Practices to be done with PLC-PI:

1.- Control of the CPIC unit process through the control interface box without the computer.

2.- Visualization of all the sensors values used in the CPIC unit process.

3.- Calibration of all sensors included in the CPIC unit process.

4.- Hand on of all the actuators involved in the CPIC 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 CPIC 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 CPIC unit process.

17.- Possibility of creating new process in relation with the CPIC unit.

18.- PLC Programming exercises.

19.- Own PLC applications in accordance with teacher and student requirements.

⑧ CPIC/CAI. Computer Aided Instruction Software System.

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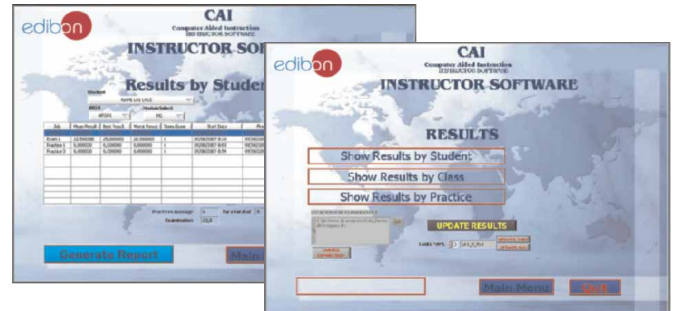
- CPIC/SOF. Computer Aided Instruction Software (Student Software):

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 CPIC/FSS. Faults Simulation System.

Example of some screens

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 canals interchange at any time during the program execution.

        - Response reduction of an actuator.
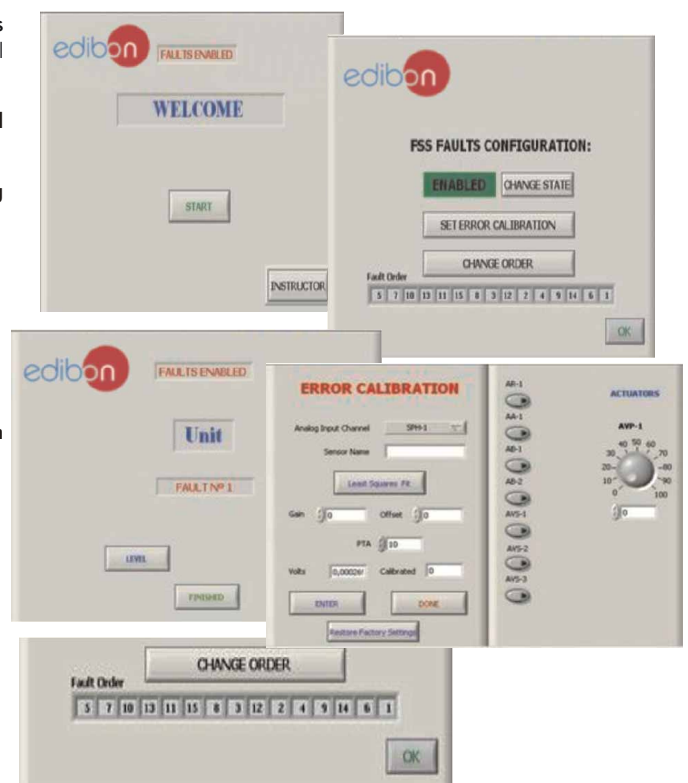
    Faults in the controls execution:

        - 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.

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 CPIC/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
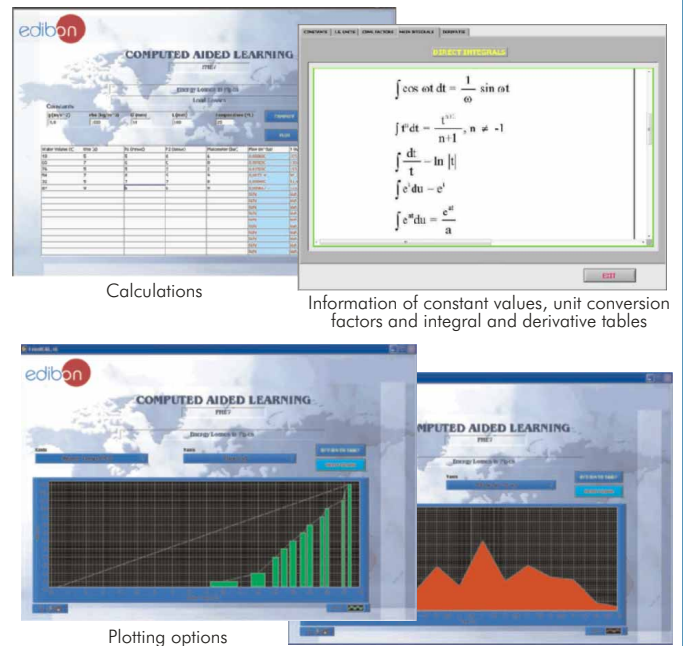
d) Multipost Expansions options

⑪ Mini ESN. EDIBON Mini Scada-Net System.

Mini ESN. EDIBON Mini Scada-Net System allows 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).
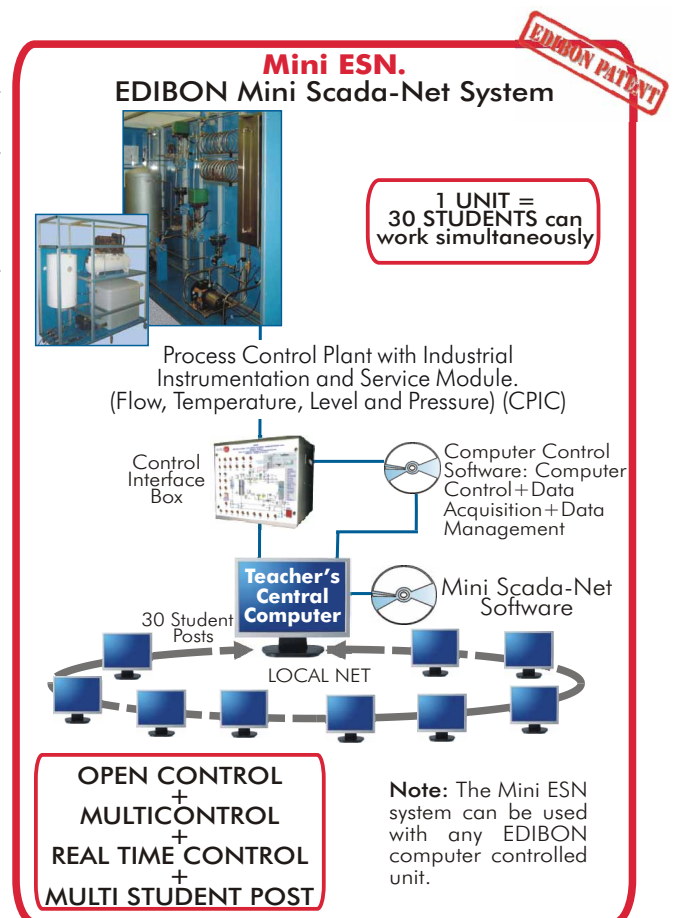
Main characteristics:

- It allows **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**.
- **Teacher controls and explains to all students at the same time**.
- **Any user/student can work doing "real time" control/multicontrol and visualisation**.
- **The manager/teacher can see in his/her computer what any user/ student is doing in the unit**.
- **Continuous communication between the manager and all the users/ students connected**.

Main advantages:

- **It allows an easier a quicker understanding**.
- **This system allows you can safe 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

Mini ESN.
EDIBON Mini Scada-Net System

EDIBON PATENT

1 UNIT =
30 STUDENTS can
work simultaneously

Process Control Plant with Industrial Instrumentation and Service Module. (Flow, Temperature, Level and Pressure) (CPIC)

Control Interface Box

Computer Control Software: Computer Control+Data Acquisition+Data Management

Teacher's Central Computer

Mini Scada-Net Software

30 Student Posts

LOCAL NET

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL
+
MULTI STUDENT POST

Note: The Mini ESN system can be used with any EDIBON computer controlled unit.

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/processcontrol/esn-processcontrol/ESN-PROCESS_CONTROL.pdf

Main items (always included in the supply)

Minimum supply always includes:

① Unit: CPIC. Process Control Plant with Industrial Instrumentation and Service Module (Flow, Temperature, Level and Pressure).

② CPIC/CIB. Control Interface Box.

③ DAB. Data Acquisition Board.

④ CPIC/CCSOF. PID Computer Control + Data Acquisition + Data Management Software.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals.

* IMPORTANT: Under CPIC 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.

  - CPIC/PLC-SOF. PLC Control Software.

b) Technical and Vocational configuration

⑧ CPIC/CAI. Computer Aided Instruction Software System.

⑨ CPIC/FSS. Faults Simulation System.

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

⑩ CPIC/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 **CPIC. Unit:**

Metallic structure. Panels and main metallic elements in stainless steel.

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

Main Unit contains the following elements:

Two pneumatics valves with C_v: 0.25. Actuator (I/P) from 0.2 to 1.0 bar for electric signal from 4 to 20 mA.

Two electronic valves for electric signal from 4 to 20mA.

Twelve solenoid valves, normally closed.

Two solenoid valves, normally open, placed at the air loop and flow loop.

Three differential pressure sensors. They have a range from -100 to 100 psi.

Five temperature sensors, "J" type. These sensors are placed along the unit to control the temperature in different lines.

One level sensor (effective length: 300 mm.) (11.81 inches).

Four level switches.

Water pump: maximum water flow: 106 l./min. and maximum pressure: 7 bar.

Stainless steel water tank: maximum capacity: 100 l. It has five drains at its lower part. Two of them are placed at different height, middle and top of the tank.

Stainless steel tank:

Maximum capacity: 200 l.

Maximum pressure:16 bar.

It has eight takings, but only six are used in this unit.

In the upper part, there is a safety valve that opens when the pressure exceeds 4 bar.

Two takings are used to measure the water height by the means of a differential pressure sensor. Other differential pressure sensor gives us the inner pressure.

Service Module contains the following elements:

Heater unit:

A tank with a maximum capacity of 80 litres and an electrical resistance of 1.2 kW as maximum electrical power. The temperature control is placed in the electrical resistance.

It has a safety valve and purge valve.

The lower part of the unit has an inlet pipe (cold water) and an outlet pipe (hot water).

Compressor unit:

Maximum pressure: 10 bar.

This unit has a regulating valve with a manometer to fix the outlet maximum pressure.

Water system:

Water tank, capacity: 400 l.

Water pump: 3.0 bar and 2500 l./h.

The inlet pipe of the tank has an automatic filling system.

Drain valve in the water tank.

The complete unit includes as well:

Advanced Real Time SCADA and PID Control.

Open Control + Multicontrol + Real Time Control.

Own Control Software based on Labview.

National Instruments Data Acquisition board (250 KS/s (kilo samples per second)).

Calibration exercises included.

Students multipost (an entire class) by using a projector.

Ready for doing applied research, real industrial simulation, training courses possibilities, etc.

Unit is totally safe (Mechanical, Electronic/Electrical and Software safety devices included).

Results calculation and analysis software (CAL).

Several future expansions, as ESN. EDIBON Scada-Net System (many students working simultaneously), and more.

Designed and manufactured under several quality standards.

② **CPIC/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 **CPIC/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 blackboard.

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.- Familiarisation with the different components of the system and their symbolic representation. Identification of components and description of their functions.

2.- The auxiliary systems: air and hot water supply.

3.- Flow sensors calibration.

4.- Temperature sensors calibration.

5.- Level sensor calibration.

6.- I/P converter calibration.

7.- Flow control loop (on/off).

8.- Flow control loop (proportional).

9.- Flow control loop (P+I).

10.- Flow control loop (P+D).

11.- Flow control loop (P+I+D).

12.- Adjust of the flow controller constants (Ziegler-Nichols).

13.- Adjust of the flow controller constants (reaction curves).

14.- Search of simple shortcomings in the loop of flow control.

15.- Temperature control loop (on/off).

16.- Temperature control loop (proportional).

17.- Temperature control loop (P+I).

18.- Temperature control loop (P+D).

19.- Temperature control loop (P+I+D).

20.- Adjust of the temperature controller constants (minimum area or reduction rate).

21.- Adjust of the temperature controller constants (minimum disturbance criterion).

22.- Adjust of the temperature controller constants (minimum width criterion).

23.- Study of the retards for speed/distance, exemplified through the temperature control loop.

24.- Study of the energy lost in the temperature control loop.

25.- Search of simple shortcomings in temperature control loop.

26.- Level control loop (on/off).

27.- Level control loop (proportional).

28.- Level control loop (P+I).

29.- Level control loop (P+D).

30.- Level control loop (P+I+D).

31.- Adjust of the level controller constants (minimum area or reduction rate).

32.- Adjust of the level controller constants (minimum disturbance criterion).

33.- Adjust of the level controller constants (minimum width criterion)

34.- Search of simple shortcomings in level control loop.

35.- Pressure control loop (on/off).

36.- Pressure control loop (proportional).

37.- Pressure control loop (P+I).

38.- Pressure control loop (P+D).

39.- Pressure control loop (P+I+D).

40.- Adjust of the pressure controller constants (minimum area or reduction rate).

41.- Adjust of the pressure controller constants (minimum disturbance criterion).

42.- Adjust of the pressure controller constants (minimum width criterion).

43.- Search of simple shortcomings in the pressure control loop.

44.- The use of the controllers in cascade, exemplified with the level/ flow control loop.

45.- Adjust of cascade control constants (minimum area or reduction rate).

46.- Adjust of cascade control constants (minimum disturbance criterion).

47.- Adjust of cascade control constants (minimum width criterion).

48.- Search of simple shortcomings in cascade control loop.

49.- Practical operation of the control plant to some wanted specific values: transfers without interferences.

50.- Calculation of the fluid flow in function of the differential pressure sensor.

Other possibilities to be done with this Unit:

51.- Many students view results simultaneously.

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

52.- 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.

53.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.

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

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

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

57.- Control of the CPIC unit process through the control interface box without the computer.

58.- Visualization of all the sensors values used in the CPIC 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) <u>Industrial configuration</u>

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.

-**CPIC/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 CPIC unit process through the control interface box without the computer.

2.- Visualization of all the sensors values used in the CPIC unit process.

3.- Calibration of all sensors included in the CPIC unit process.

4.- Hand on of all the actuators involved in the CPIC 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 CPIC 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 CPIC unit process.

17.- Possibility of creating new process in relation with the CPIC unit.

18.- PLC Programming exercises.

19.- Own PLC applications in accordance with teacher and student requirements.

b) <u>Technical and Vocational Education configuration</u>

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

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

-CPIC/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 **CPIC/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 canals 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 CPIC/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 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 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.

-Teacher controls and explains to all students at the same time.

-Any user/student can work doing "real time" control/multicontrol and visualisation.

-The manager/teacher can see in his/her computer what any user/student is doing in the unit.

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

Main advantages:

-It allows an easier a quicker understanding.

-This system allows you can safe time and cost.

-Future expansions with more EDIBON Units.

The system basically will consist of:

This system can be used with Computer Controlled Unit.

-Manager/Teacher computer.

-Computers in a local net.

-Mini SCADA-NET system (Manager/Instructor Software + User/Student Software + Unit Software adaptation + Unit-Control Interface adaptation + Webcam + cables and accessories required for a normal operation).

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

REPRESENTATIVE: