Computer Controlled **Recycle Loops Unit**

TRLC

Technical Teaching Equipment

EDIBON PATENT

Always included in the supply:

Teaching Technique used

SCADA. EDIBON Computer Control System

① Unit: TRLC. Recycle Loops Unit

② Control Interface Box

③ Data Acquisition Board

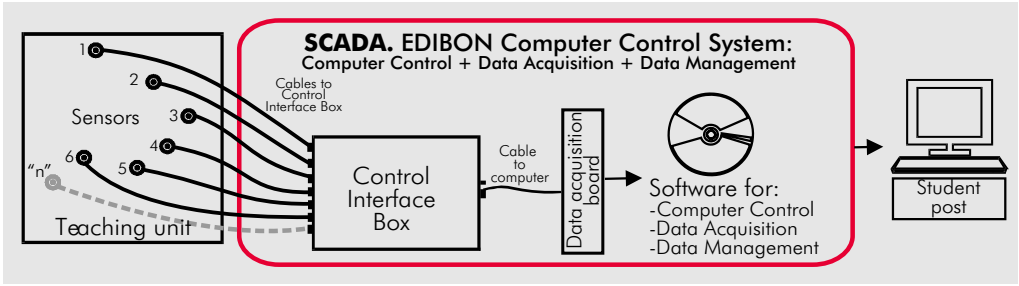
④ Software for:
- Computer Control
- Data Acquisition
- Data Management

⑤ Cables and Accessories

⑥ Manuals

Computer (not included in the supply)

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL



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ISO 9001:2000 Certificate of Approval

European Union Certificate

Certificates ISO 14001: 2004 and ECO-Management and Audit Scheme (environmental management)

Worlddidac Quality Charter Certificate
Worlddidac Member

DESCRIPTION

TRLC unit developed by EDIBON has been designed to demonstrate, both visually and experimentally, how a recycle loop works. It has a lot of teaching applications of which the carried out of mass and energy balances under steady and unsteady state conditions is emphasized.

In this unit an inlet water flow is thermally conditioned through a recycle loop to obtain an outlet water flow in the desired terms.

The hot water recycle loop is a type of application used in several chemical and industrial installations, to control the outlet temperature from the variations inside the loop.

The unit consists of a through pipe conveying water from a cold water supply to a suitable drain with a loop of pipework connected between the supply and drain connections. This recycle loop incorporates a circulating pump and a heater (heating resistance) to raise the temperature of the water in the loop. Every pipe and connection are made in stainless steel.

Different volumes in the recycle loop can be simply selected by opening the appropriate valve. With this, the residence time of each configuration can be studied. The loop flow variation has significant teaching properties. By means of this variation the recycle loop is regulated.

Water temperatures at the inlet, outlet and within the recycle loop are measured using temperature sensors. Water flowrates at the corresponding points are measured using flow sensors.

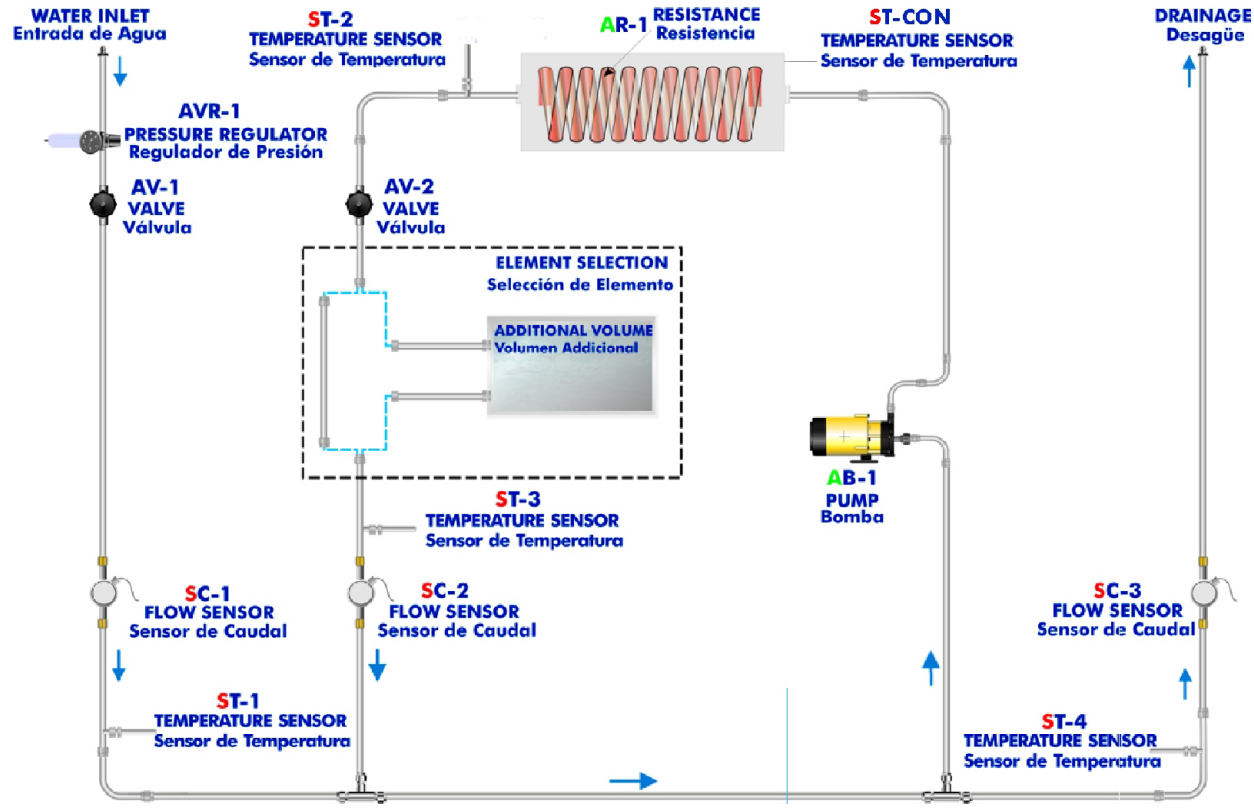
With the obtained data it could be possible to determine a mass balance and a energy balance in several points of our circuit. The experimental results are compared with theoretical by the software.

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

PROCESS DIAGRAM AND ELEMENTS ALLOCATION

2 actuators and 8 sensors controlled from any computer, and working simultaneously

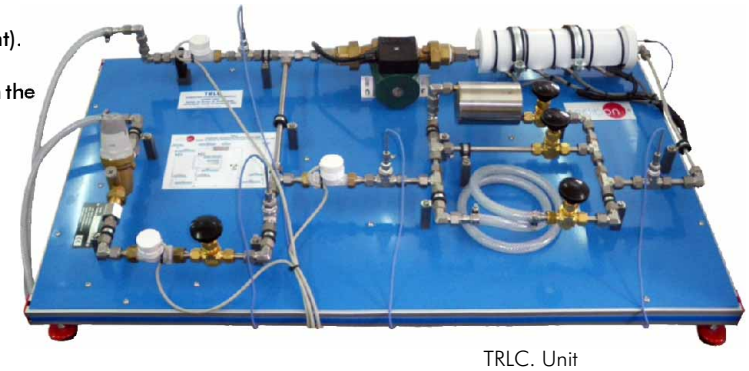
OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL



Items supplied as stardard

①TRLC. Unit:

Bench-top unit.
Anodized aluminium structure and panel in painted steel (epoxy paint).
Main metallic elements in stainless steel.
Diagram in the front panel with similar distribution to the elements in the real unit.
Water inlet pipe, which incorporates a temperature sensor "J" type and a flow sensor (0 to 6.5 l./min).
Water inlet flow regulation valve to the circuit (pressure: 0-3 bar).
Pressure regulation valve, which avoids producing overpressures along all the circuit.
Recycle loop, composed of:
Recirculation pump, computer controlled:
hot water impulsion centrifugal pump, with frequency variator to control the speed.
Heating resistance (2000 W). It works with a PID control over the temperature sensor from the computer.
Protection thermostat for the heating resistance.
Water control valve, located in a recirculating line. It is useful to regulate the water flow inside the loop.
3 Temperature sensors "J" type.
Flow sensor (0 to 6.5 l./min).
Water outlet pipe, which incorporates a temperature sensor "J" type and a flow sensor (0 to 6.5 l./min).
Different volumes of recycle loop, usable without having to be dismounted.
With the different temperature and flow sensors we can know the unit thermal and mass balances and also the heat transfers.



TRLC. Unit

②TRLC/CIB. Control Interface Box:

Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.
All sensors, with their respective signals, are properly manipulated from -10V. to +10V computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors. Single cable between the control interface box and computer.
The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure. **Simultaneously visualization in the computer of all parameters involved in the process. Calibration of all sensors involved in the process.**
Real time curves representation about system responses. Storage of all the process data and results in a file. Graphic representation, in real time, of all the process/system responses.
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process. All the actuators and sensors values and their responses are placed in only one computer screen.
Shield and filtered signals to avoid external interferences.
Real time 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 time and in a 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, other electronic in control interface and the third one in the control software.

TRLC/CIB

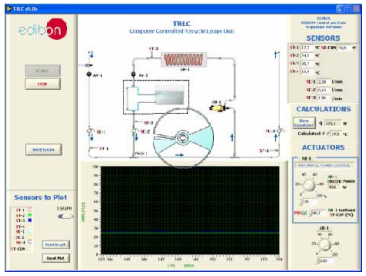
③DAB. Data Acquisition Board:

PCI Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI.
Analog input: **Channels= 16** single-ended or 8 differential. **Resolution=16 bits,** 1 in 65536.
Sampling rate up to: 250 KS/s (Kilo samples per second).
Input range (V)=±10V. Data transfers=DMA, interrupts, programmed I/0. DMA channels=6.
Analog output: **Channels=2. Resolution=16 bits,** 1 in 65536. Max. output rate up to: 833 KS/s.
Output range(V)=±10V. Data transfers=DMA, interrupts, programmed I/0.
Digital Input/Output: Channels=24 inputs/outputs. D0 or DI Sample Clock frequency: 0 to 1 MHz.
Timing: **Counter/timers=2**. Resolution: Counter/timers: 32 bits.

DAB

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

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.
Compatible with the industry standards.
Registration and visualization of all process variables in an automatic and simultaneously way.
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters. **Management, processing, comparison and storage of data.**
Sampling velocity up to 250,000 data per second guaranteed.
Calibration system for the sensors involved in the process.
It allows the registration of the alarms state and the graphic representation in real time.
Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.
This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.



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

Continue...

Complementary items to the standard supply

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

⑦ PLC-PI. PLC Module:

Circuit diagram in the front panel.

Front panel:

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

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

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

Analog inputs block:

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

Analog outputs block:

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

Touch screen:

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

Back panel:

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

Inside:

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

Panasonic PLC:

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

Communication RS232 wire, to computer (PC).

PLC-PI

⑧ TRLC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

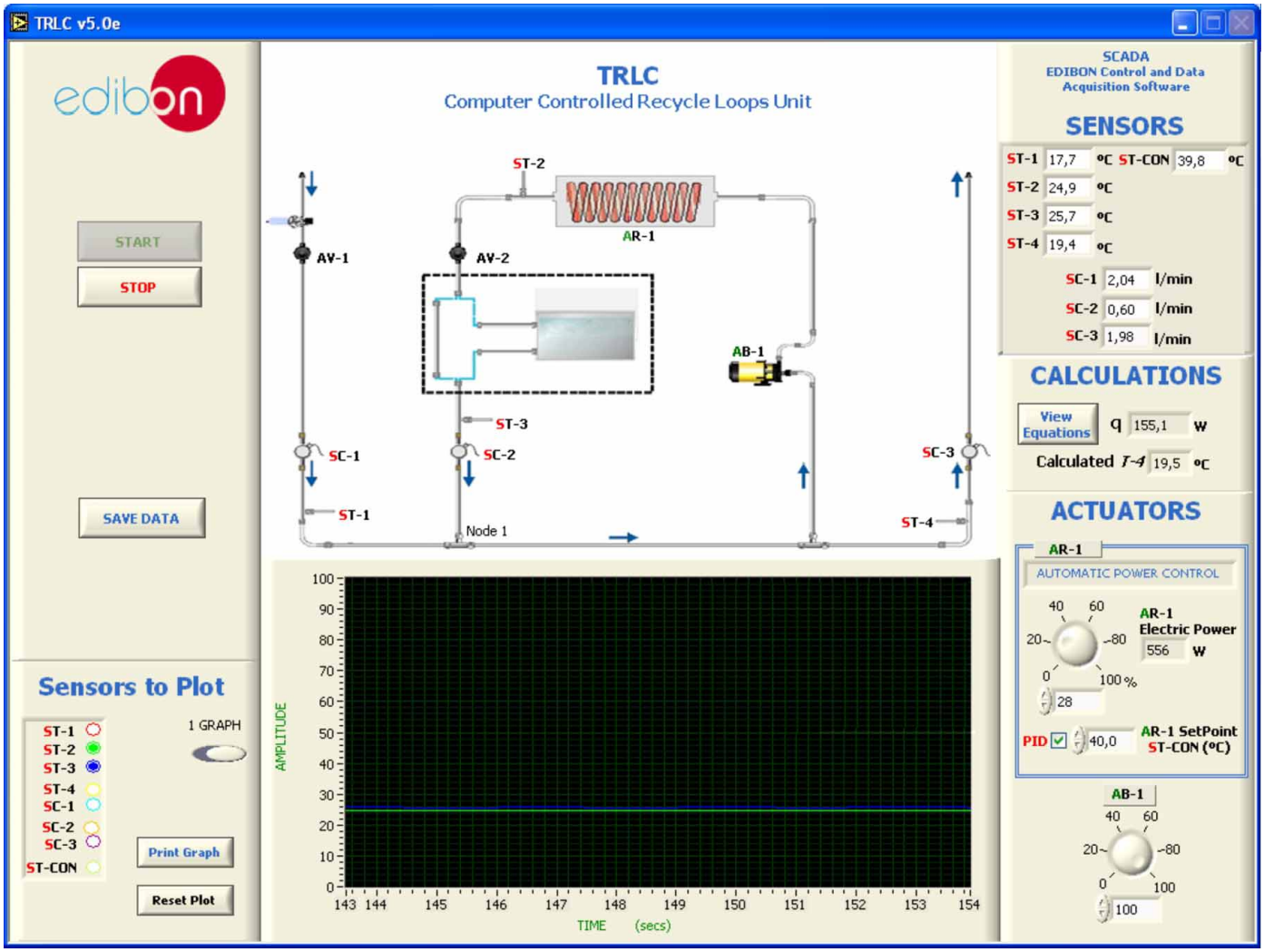
Items available on request

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

⑩ TRLC/FSS. Faults Simulation System.

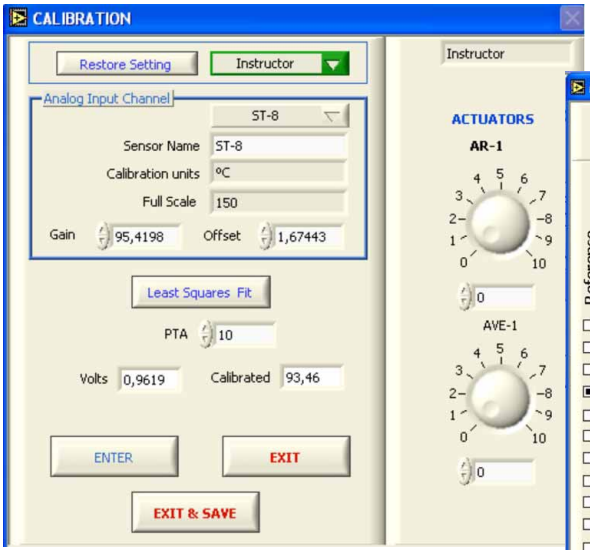
Software Main Screens

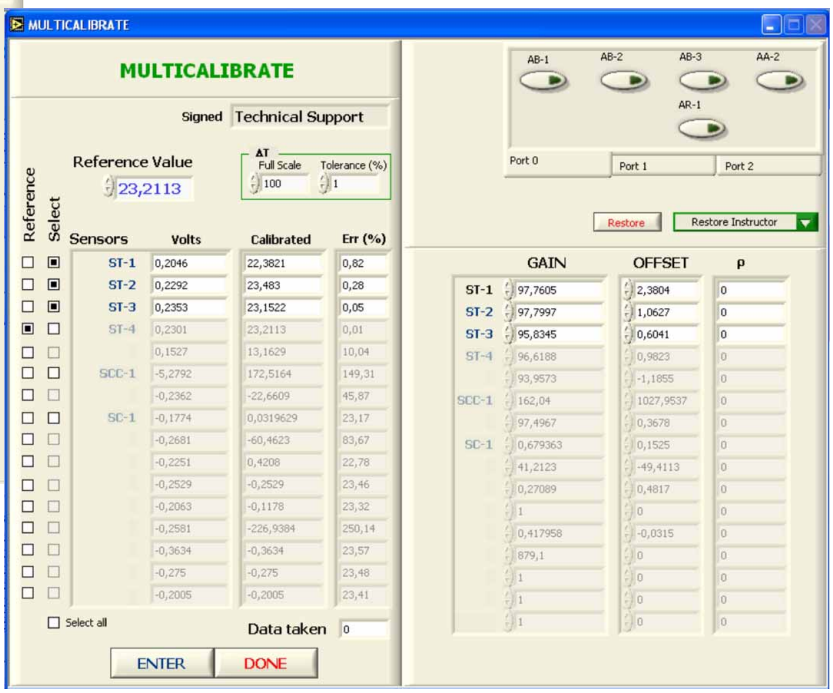
Main screen



Note: ST= Temperature sensor. SC= Flow sensor. AR= Heating resistance. AB= Pump.

Examples of Sensors Calibration screens





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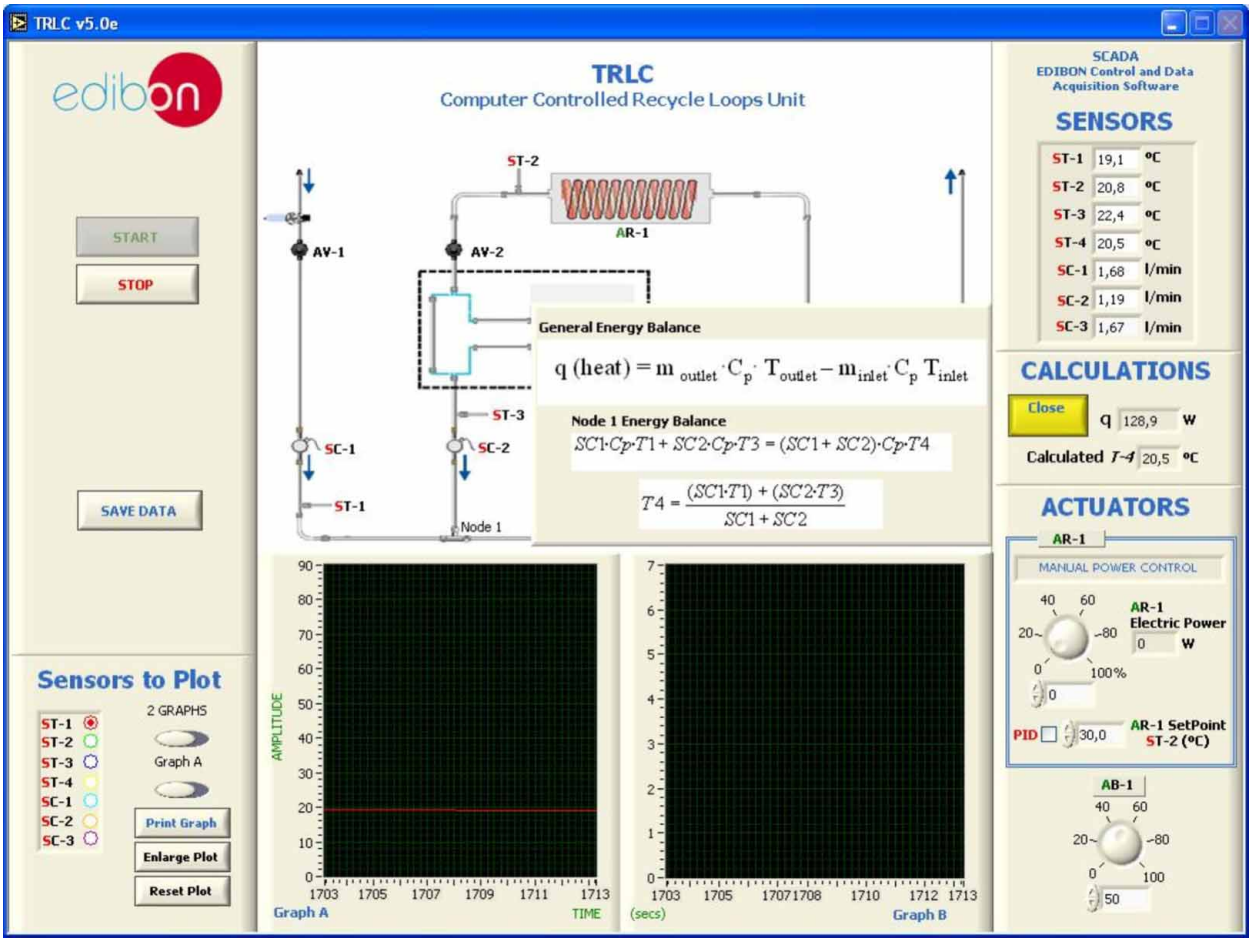
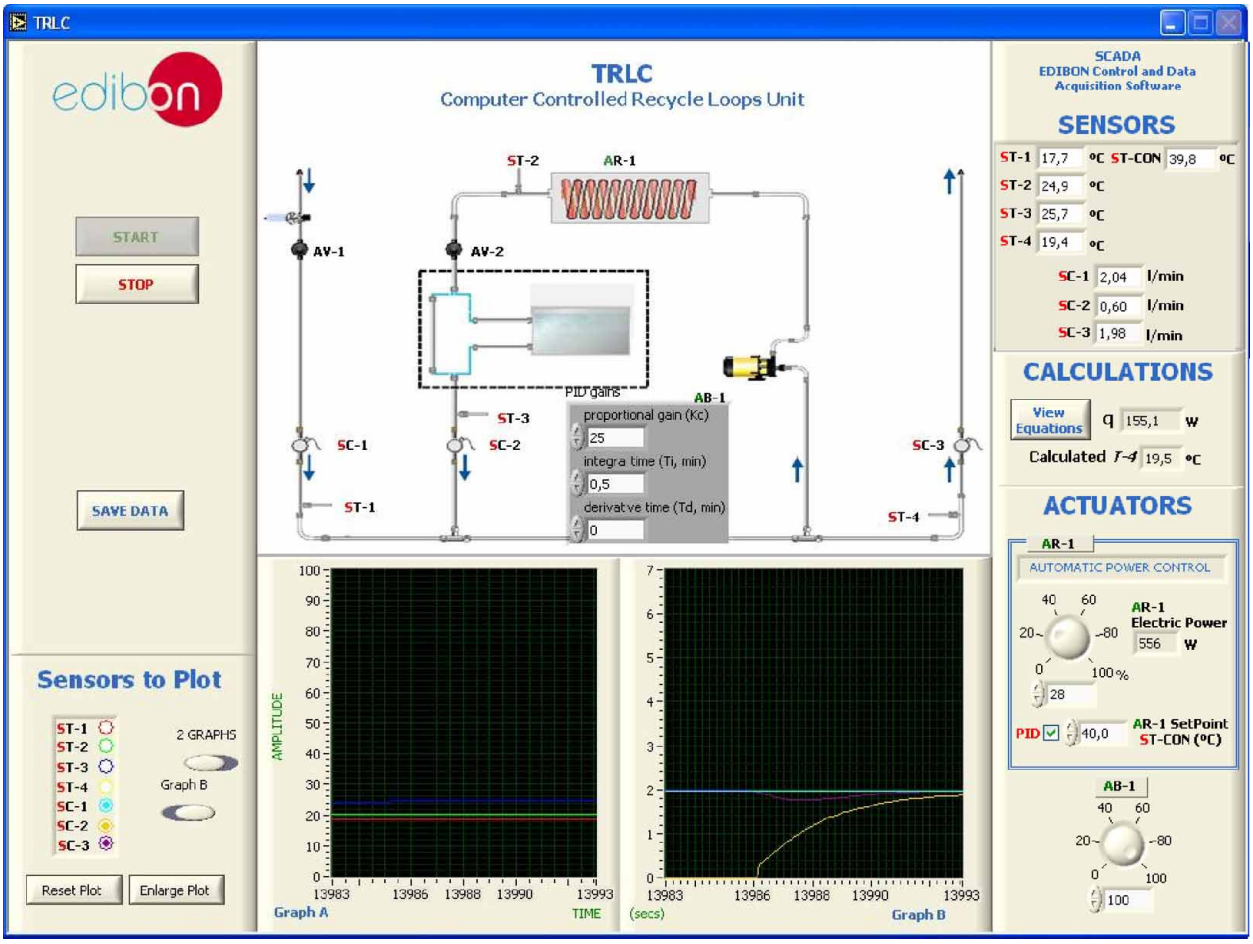
Some typical exercises results

Calculations section:
The equations involved in the Calculation Process are shown. In real time the software calculates General Energy Balance and Energy Balance in Nodes.



Representation of the different flows involved in the exercise. The transients in loop pump startings are shown.



EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Understanding the meaning of recycle.

Steady state mass balances: (2)

2.- Demonstrating that whatever the recycle rate, the inlet flow rate always equals the outlet flow rate.

Unsteady state heat balances: (3-6)

3.- Determining the unit response when the electrical heater is switched on at different through flow rates.

4.- Determining the effect of a changes in the inlet flow.

5.- Determining the response when the electrical heater is switched off at different through flow rates.

6.- Determining the effect of recycle with no through flow.

Steady state heat balances: (7-8)

7.- With the electrical heater switched on and at a fixed water flow rate at the inlet we can check that different reclycled flow incites a variation in the outlet temperature.

8.- With the electrical heater switched on, the difference between inlet temperature and outlet temperature can be used to determine the heat quantity absorbed in the recycle loop.

9.- Use of the steady flow energy equation for the overall system.

10.- Use of the steady flow energy equation for the mixing process.

11.- Effects on response rates to parameter changes in recycle flow.

12.- Effects on response rates to parameter changes in through flow.

13.- Effects on response rates to parameter changes in loop volume.

14.- Effects on response rates to parameter changes in heater power.

Other possible practices:

15.- Sensors calibration.

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

16.- Control of the TRLC unit process through the control interface box without computer.

17.- Visualization of all the sensors values used in TRLC unit process.

18.- Calibration of all sensors included in TRLC unit process.

19.- Hand on of all the actuators involved in the TRLC unit process.

20.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).

21.- Simulation of outside actions, in the cases do not exist hardware elements (Example: test of complementary tanks, complementary industria environment to the process to be studied, etc).

22.- PLC hardware general use and manipulation.

23.- PLC process application for the TRLC unit.

24.- PLC structure.

25.- PLC inputs and outputs configuration.

26.- PLC configuration possibilities.

27.- PLC program languages.

28.- PLC different programming standard languages (literal structured, graphic, etc.).

29.- New configuration and development of new process.

30.- Hand on an established process.

31.- To visualize and see the results and to make comparisons with the TRLC unit process.

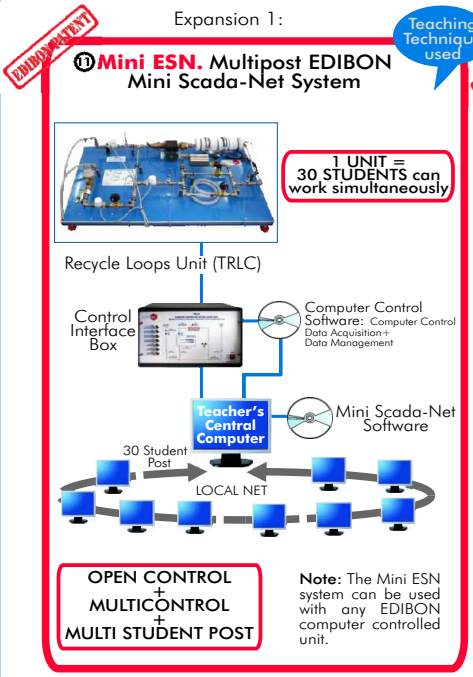
32.- Possibility of creating new process in relation with the TRLC unit.

33.- PLC Programming Exercises.

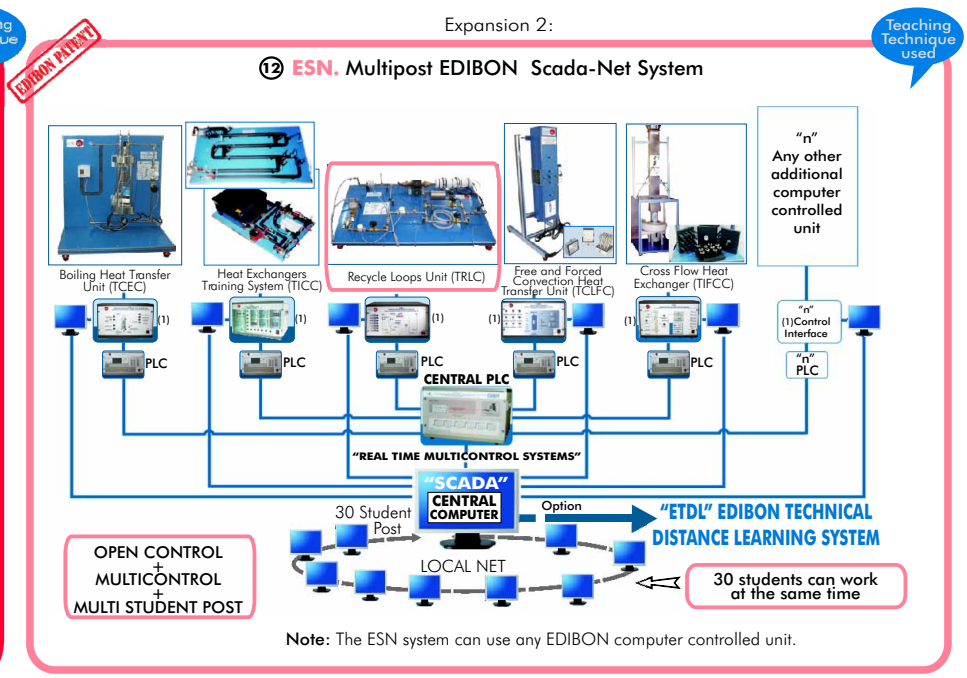
34.- Own PLC applications in accordance with teacher and student requirements.

POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS

Expansion 1:



Expansion 2:



ORDER INFORMATION

Items supplied as standard

Minimum configuration for normal operation includes:

① **Unit: TRLC. Recycle Loops Unit.**

② **TRLC/CIB.Control Interface Box.**

③ **DAB.Data Acquisition Board.**

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

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

⑥ **Manuals.**

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

Complementary items to the standard supply

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

⑦ PCL-PI.PLC Module.

⑧ TRLC/PLC-SOF. PLC Control Software.

⑨ TRLC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).

⑩ TRLC/FSS. Faults Simulation System. (Available on request).

Expansions

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

⑫ ESN. Multipost EDIBON Scada-Net System.

REQUIRED SERVICES

Electrical supply: single-phase, 220V./50Hz or 110V./60Hz.
Water supply and drainage.
Computer (PC).

DIMENSIONS & WEIGHTS

TRLC Unit:	-Dimensions: 1110 x 630 x 300 mm. approx.
	-Weight: 40 Kg. approx.
Control Interface Box:	-Dimensions: 490 x 330 x 310 mm. approx.
	-Weight: 10 Kg. approx.
PLC Module (PLC-PI):	-Dimensions: 490 x 330 x 310 mm. approx.
	-Weight: 30 Kg. approx.

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

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C/ Del Agua, 14. Polígono Industrial San José de Valderas.
28918 LEGANÉS (Madrid). SPAIN.
Phone: 34-91-6199363 FAX: 34-91-6198647
E-mail: edibon@edibon.com WEB site: www.edibon.com

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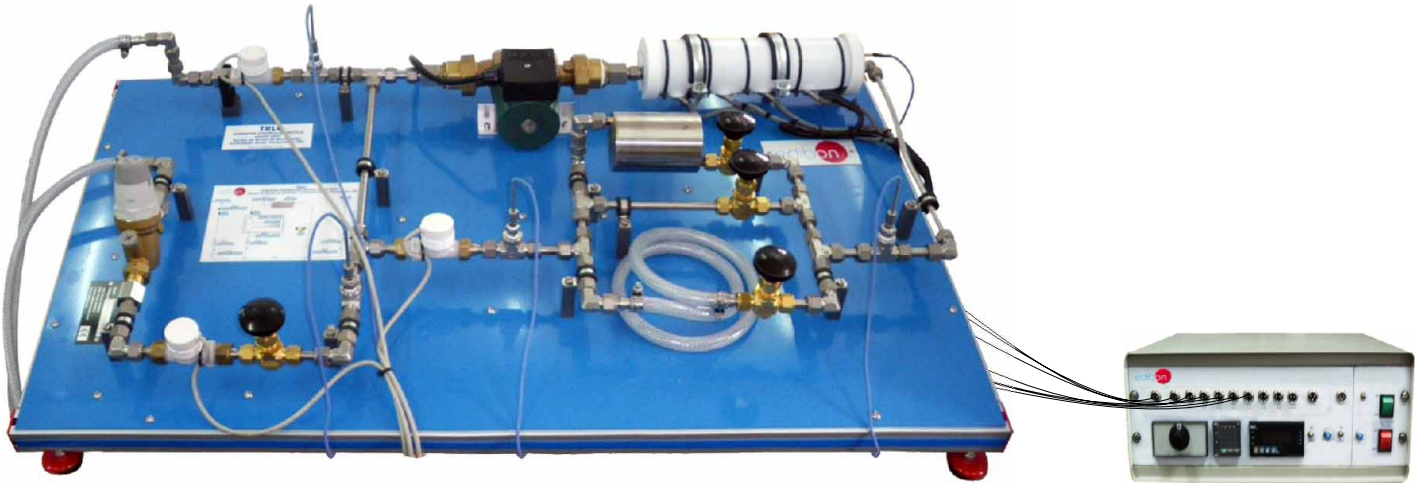

Electronic Console

DESCRIPTION

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In this unit an inlet water flow is thermally conditioned through a recycle loop to obtain an outlet water flow in the desired terms.

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SPECIFICATIONS

Bench-top unit.
Anodized aluminium structure and panel in painted steel (epoxy paint).
Main metallic elements in stainless steel.
Diagram in the front panel with similar distribution to the elements in the real unit.
Water inlet pipe, which incorporates a temperature sensor "J" type and a flow sensor (0 to 6.5 l./min).
Water inlet flow regulation valve to the circuit (pressure: 0-3 bar).
Pressure regulation valve, which avoids producing overpressures along all the circuit.
Recycle loop, composed of:
- Recirculation pump:
  - hot water impulsion centrifugal pump, with speed regulation.
- Heating resistance (2000 W).
- Protection thermostat for the heating resistance.
- Water control valve, located in a recirculating line. It is useful to regulate the water flow inside the loop.
- 3 Temperature sensors "J" type.
- Flow sensor (0 to 6.5 l./min).

Water outlet pipe, which incorporates a temperature sensor "J" type and a flow sensor (0 to 6.5 l./min).
Different volumes of recycle loop, usable without having to be dismounted.
With the different temperature and flow sensors we can know the unit thermal and mass balances and also the heat transfers.
Electronic Console:
- Metallic box.
- Temperature sensors connections.
- Digital display for the temperature sensors.
- Selector for temperature sensors.
- Pump controller.
- Heating resistance controller, with PID over the heating resistance temperature.
- Digital display for the flow sensors.

Cables and Accessories, for normal operation.
Manuals: This unit is **supplied with following manuals:** Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

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28918 LEGANÉS (Madrid). SPAIN.
Phone: 34-91-6199363 FAX: 34-91-6198647
E-mail: edibon@edibon.com WEB site: www.edibon.com

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REPRESENTATIVE: