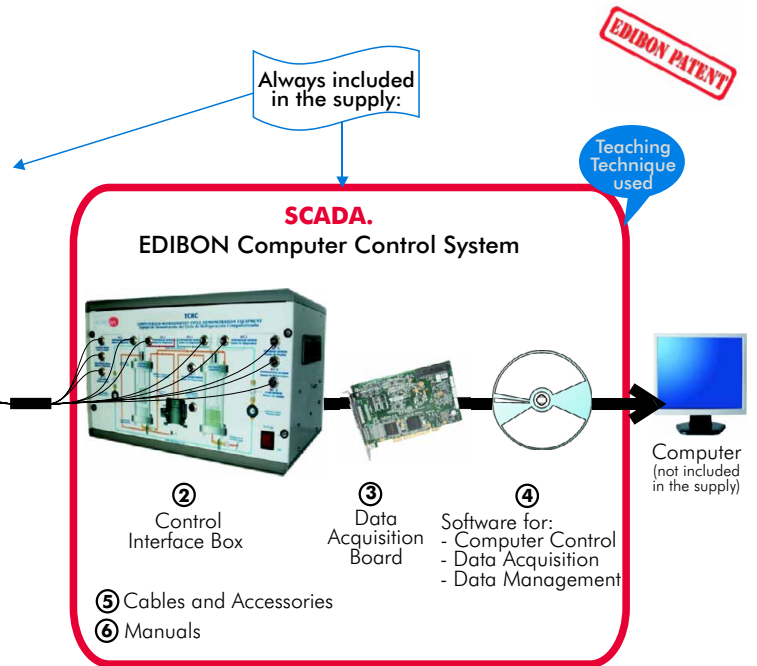
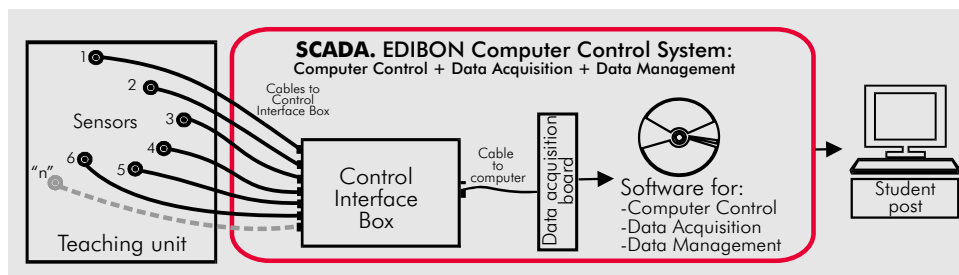




① Unit: TCRC. Refrigeration Cycle Demonstration Unit



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



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DESCRIPTION

The vapour compression refrigeration and heat pump cycle is very important in food and drug preservation, air conditioning and heat pumps, as well as other industrial and commercial process.

The TCRC unit allows the demonstration of vapour compression refrigeration and heat pump cycle with visual observation of all important processes.

Thanks by utilising a non-toxic refrigerant fluid with a low vapour pressure (SES36 refrigerant, environmental friendly), the evaporation and condensation processes are clearly visible in the glass cylinders (evaporator and condenser).

The evaporator is a vertical cylinder, made of glass, containing SES36, closed on both ends. Into the glass cylinder there is a nickel-plated copper coil.

An hermetic compressor draws vapour from the evaporator and compresses this before discharging it to the condenser. The low pressure of the evaporator causes the refrigerant to boil. The water flowing through the coil heats the refrigerant causing the vapours generation and the water temperature decreases.

From the compressor the high pressure vapour passes to the condenser.

The condenser, as the evaporator, is a glass recipient closed on both ends with a nickel-plated copper coil into it. Vapour condenses on the surface of the coil and falls to the bottom of the condenser. The liberated heat by the refrigerant phase change is transferred to the cooling water flowing through the coil.

The float valve located at the base of the condenser, that works as an expansion valve, controls the flow of high pressure refrigerant liquid returning to the evaporator. The refrigerant, after passing through the floating valve, expands to form a liquid vapour mixture at the same pressure as the evaporator and the cycle is repeated.

Besides, an insulating valve is installed in the condenser inferior part that can be closed for the demonstration of the technique used in the maintenance of refrigeration installations, whether commercial or industrial, where the refrigerant is collected and stored in the condenser. This technique is important for demonstrating how to prevent a possible refrigerant gas leak during the maintenance operations.

The unit has a high pressure switch that turns off the compressor when the pressure in the condenser reaches 2.3 bar. Besides, at the condenser upper part, the unit disposes of a relief valve that opens itself when the condenser pressure exceeds 2.4 bar.

By adjustment of the water flow to the evaporator and condenser coils, using control valves, the condensing and evaporating pressures can be varied.

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.

We can control the unit and know, at any time, the measure of:

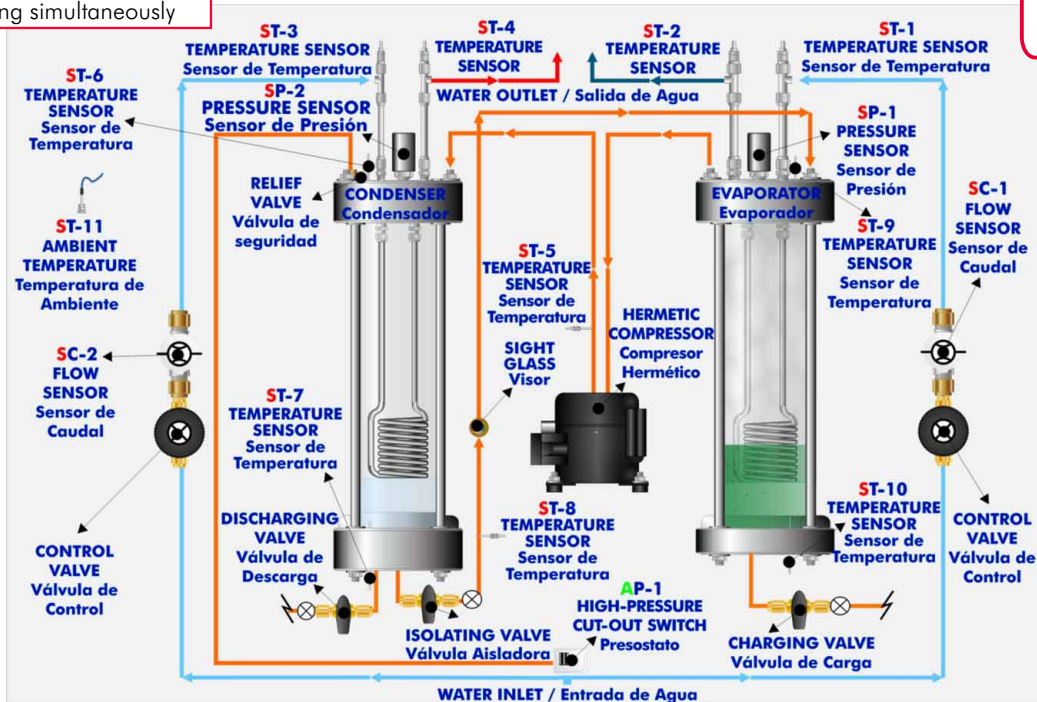
- The temperature and pressure of the refrigerant fluid in the evaporator and in the condenser.
- The temperature of the compression and expansion processes.
- The temperature of the water inlet and outlet at the coils of the evaporator and condenser.
- The water flow in the two coils.
- The room temperature.
- The electrical power used in the compression stage.

Etc.

PROCESS DIAGRAM AND ELEMENTS ALLOCATION

1 actuator and 16 sensors controlled from any computer, and working simultaneously

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



Items supplied as standard

① TCRC. Unit:

The TCRC unit allows the demonstration of vapour compression refrigeration and heat pump cycle with visual observation of all important processes.

TCRC is bench-top unit that is assembled in anodized aluminium structure and panels 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.

Compressor: hermetic compressor of 1/2CV, computer controlled (PC).

Condenser: vertical cylinder, made of glass, through which the coil can be seen where in its inside cooling water circulates. The cylinder is stabilised over special bristles that reduce the formation of tensions and turn it hermetic by using special viton joints. The heat transmission surface is formed by 9 nickel-plated copper spires of 1/4" diameter through which the water flows. The heat transmission area is approx. 0.032 m².

Evaporator: of similar structure to that of the condenser, and with a specially treated copper coil to promote the ebullition. Heat transmission area: 0.032 m² approx.

Expansion valve, float type, that is assembled on the condenser.

Sight glass: placed between the evaporator and the expansion valve, to show the formation of vapour bubbles after the expansion valve.

11 Temperature sensors ("J" type) that indicate the water output and input temperatures, both in the condenser and in the evaporator, and the evaporation, condensation, expansion and environmental temperatures.

Temperature sensors range: 0-100°C.

Maximum working temperature: 100°C.

2 Flow sensors to measure the water flow (condenser and evaporator), range: from 0 to 6.5 l/min.

2 Pressure sensors indicate the refrigerant fluid pressure in the condenser and in the evaporator:

Pressure sensor (condenser): from 0 to 6 bar.

Pressure sensor (evaporator): from -1 to 1,6 bar.

Power measurement from computer (PC). Measure range from 0 to 1000W.

There is a relief valve with a tare of 2.4 bar, so in case of overpressure in the condenser it will open.

High pressure cut-out, that stops the compressor if the condensation pressure exceeds 2.3 bar.

This unit has been designed for the use with the SES36 refrigerant gas, environmental friendly.

With the unit is supply following diagrams:

Mollier diagram of SES36 refrigerant.

Enthalpy diagram of SES36 refrigerant.

② TCRC/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 the sensors involved in the process.

Real time curves representation about system responses.

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

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

All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process. All the actuators and sensors values and their responses are placed in only one computer screen.

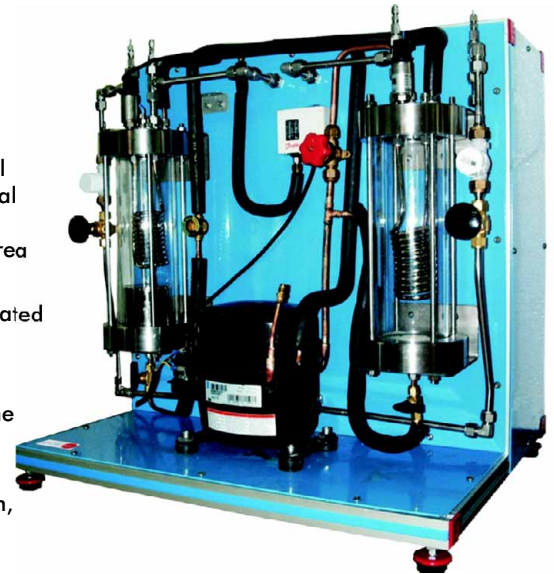
Shield and filtered signals to avoid external interferences.

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

Real time computer control for pumps, compressors, resistances, control valves, etc.

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

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



TCRC. Unit



TCRC/CIB

Continue...

Items supplied as standard (continuation)

③ DAB. Data Acquisition Board:

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)= $\pm 10V$.
- Data transfers=DMA, interrupts, programmed I/O.
- Number of DMA channels=6.

Analog output:

- Number of **channels=2**.
- Resolution= 16 bits**, 1 in 65536.
- Max. output rate up to: 833 KS/s.
- Output range(V)= $\pm 10V$.
- Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output:

- Channels=24 inputs/outputs.**
- D0 or DI Sample Clock frequency: 0 to 1 MHz.

Timing:

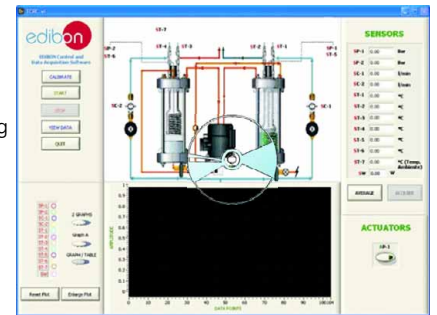
- Counter/timers=2.**
- Resolution:Counter/timers: 32 bits.



DAB

④ TCRC/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.**



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

Additional and optional 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.

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.

Free input AC voltage(100 to 240 V AC).

DC input: 16 (24 VDC).

Relay output: 14 (250 VA 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).

⑧ TCRC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.



PLC-PI

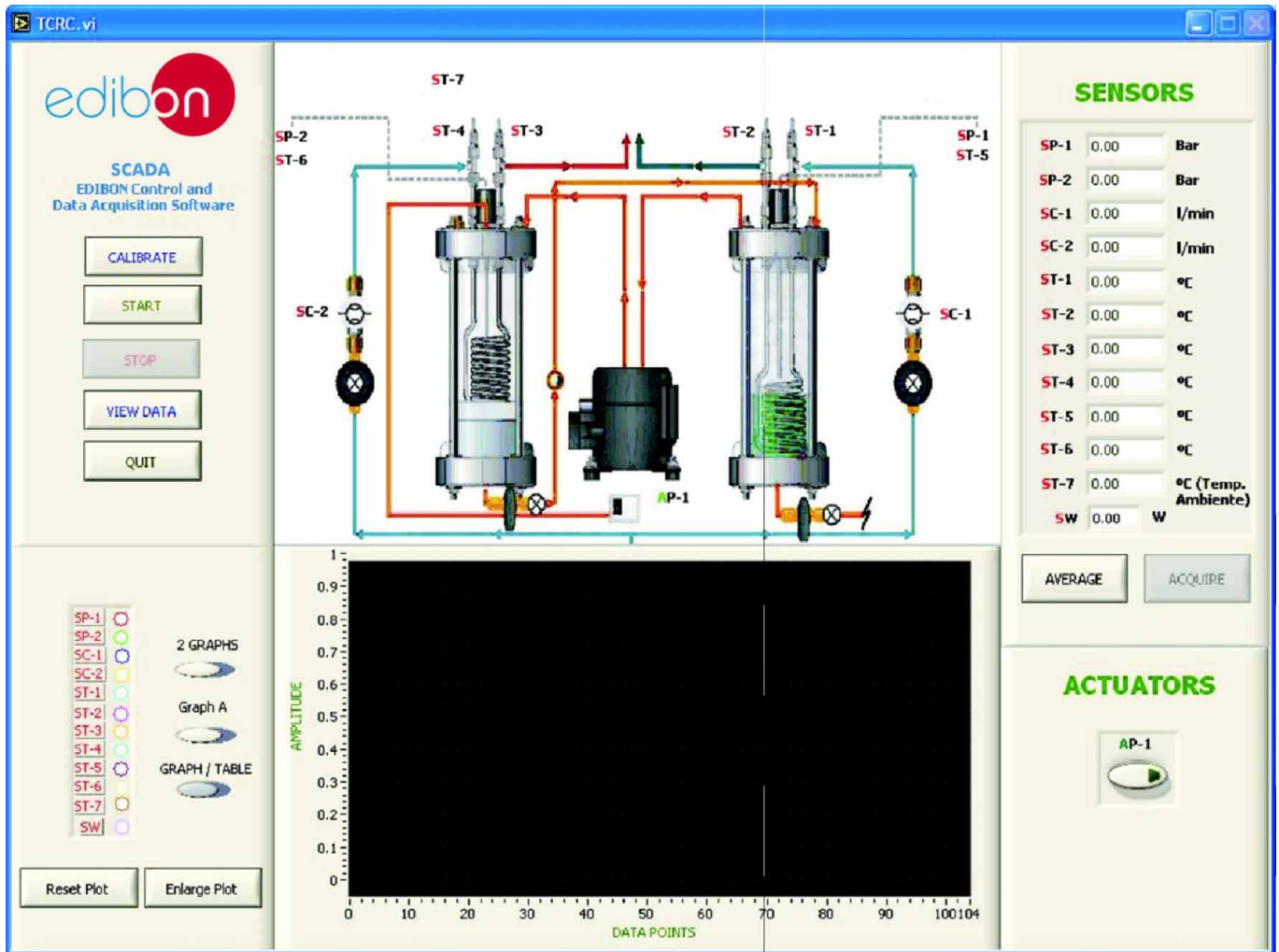
Items available on request

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

⑩ TCRC/FSS. Faults Simulation System.

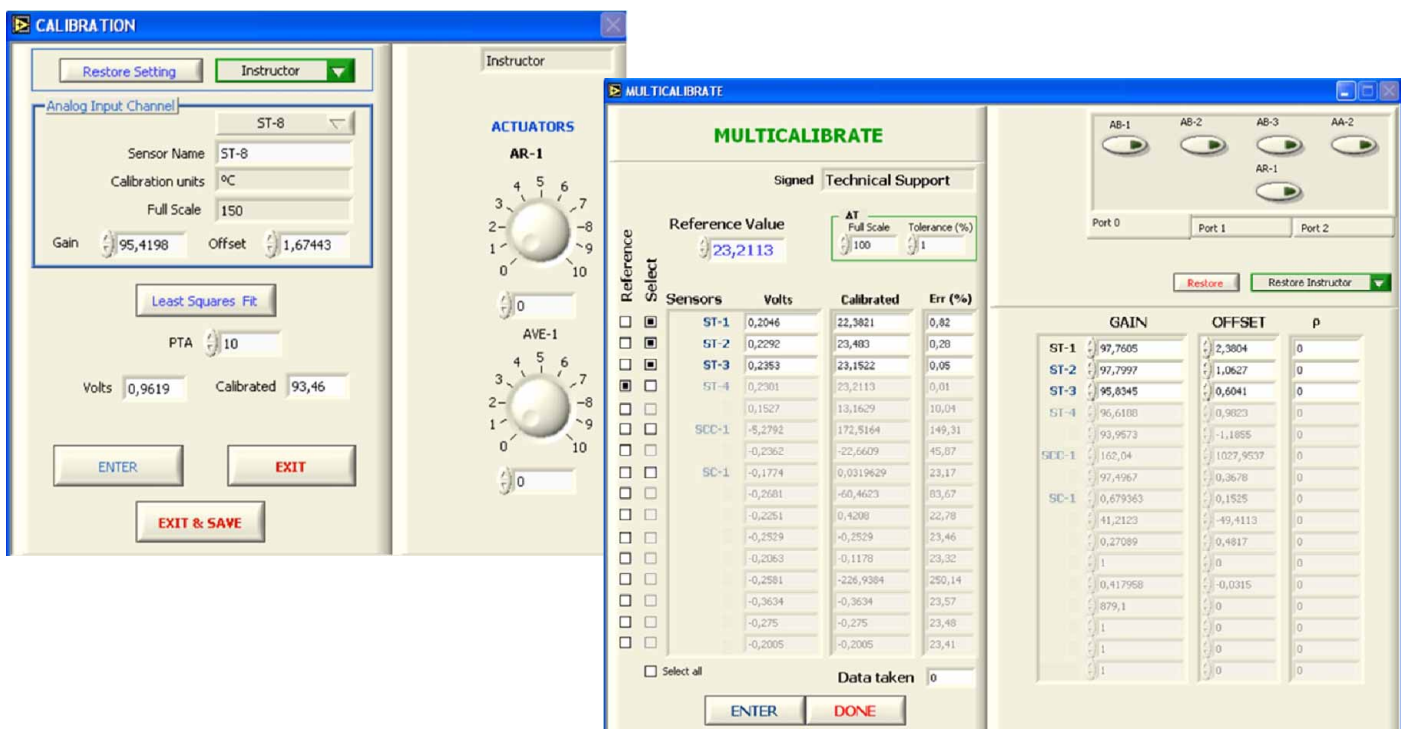
Software Main Screens

Main screen



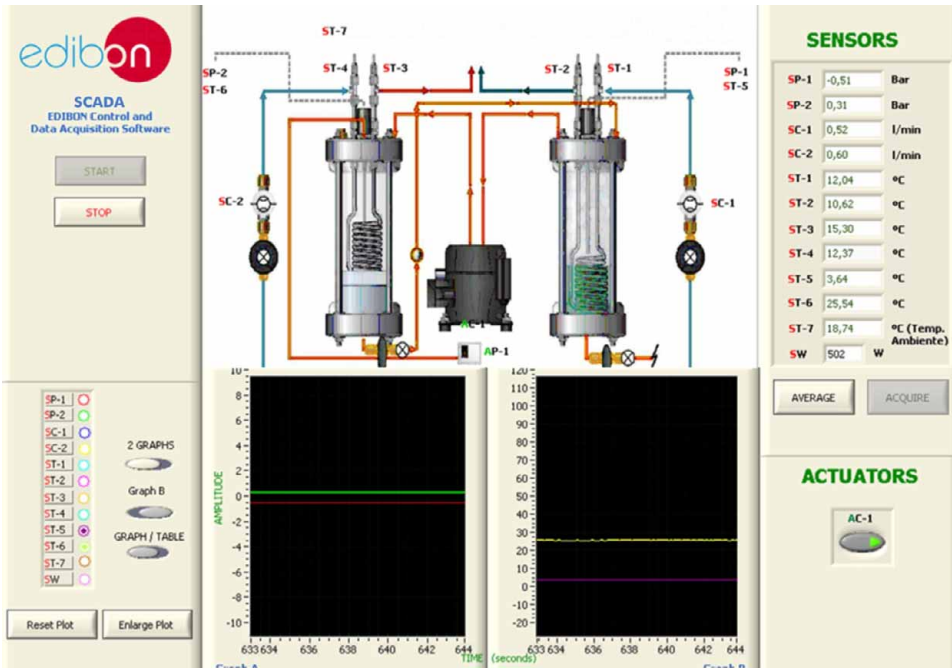
Note: ST= Temperature sensor SP=Pressure sensor SC=Flow sensor SW=Power measurement AP=Compressor

Examples of Sensors Calibration screens



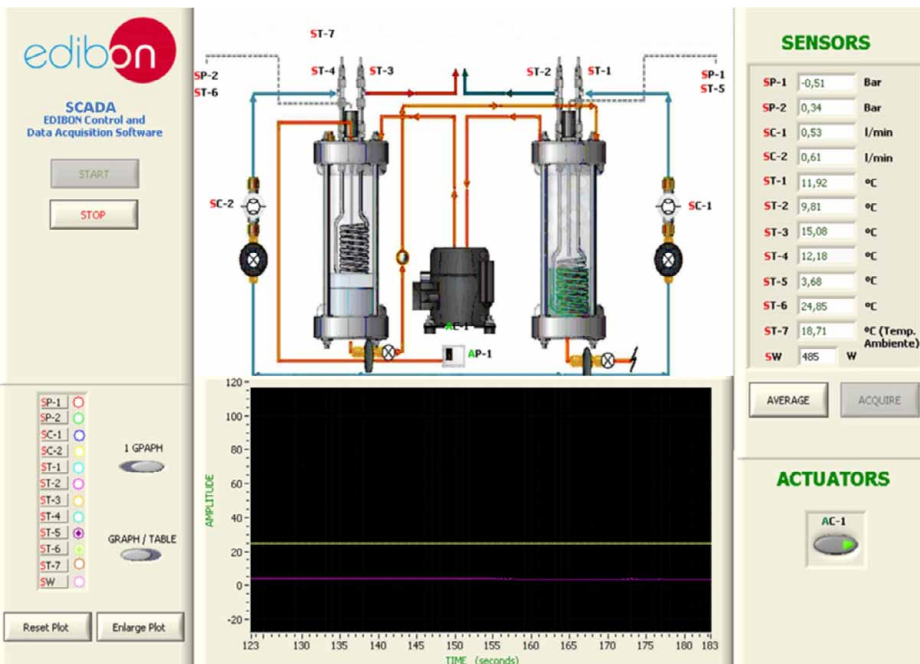
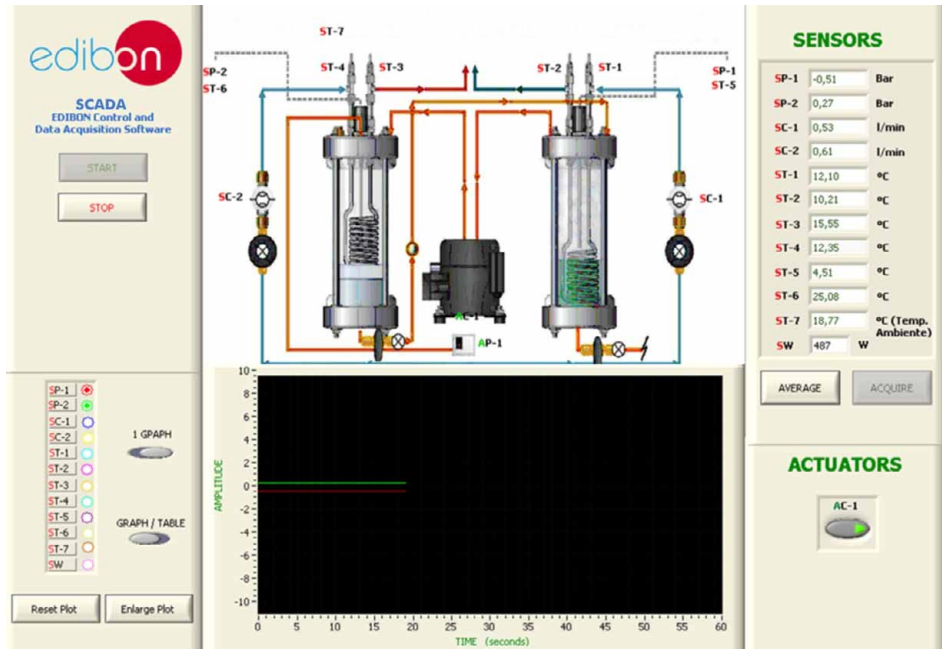
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Some typical exercises results



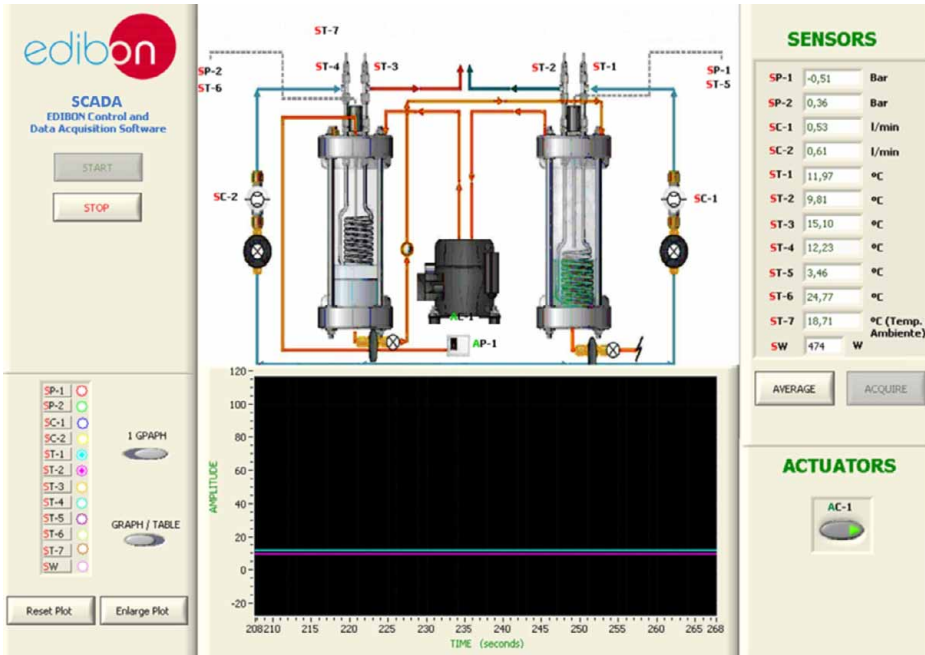
In the graphic "A" the pressures of high and low, condenser and evaporator, are represented.
In the graphic "B" the condenser and evaporator temperatures are represented.

Pressures in high (evaporator) and in low (condenser) are represented (SP-1 and SP-2) in the graphic. It can be seen that SP-1, evaporator pressure is -0,35 bar due to the expansion produced in the evaporator and to the compressor aspiration. SP-2 pressure in high condenser pressure is 0,5 bar approx.

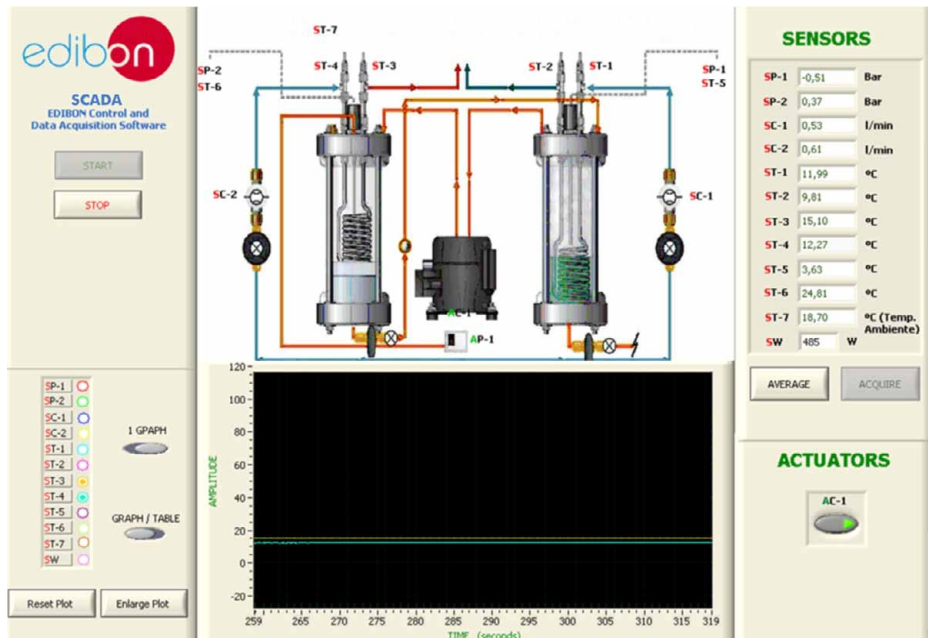


The temperature sensors ST-5 and ST-6 that characterize the evaporator and condenser temperatures are represented in the graphic. In the condenser we have high pressure and therefore high temperature, which correspond to the ST-6, and for the pressure of the experiment, it has a temperature of 25°C. In the evaporator there is an expansion making low pressure and low temperature, which correspond to the ST-7, that for the experiment conditions has a temperature of 5°C approx.

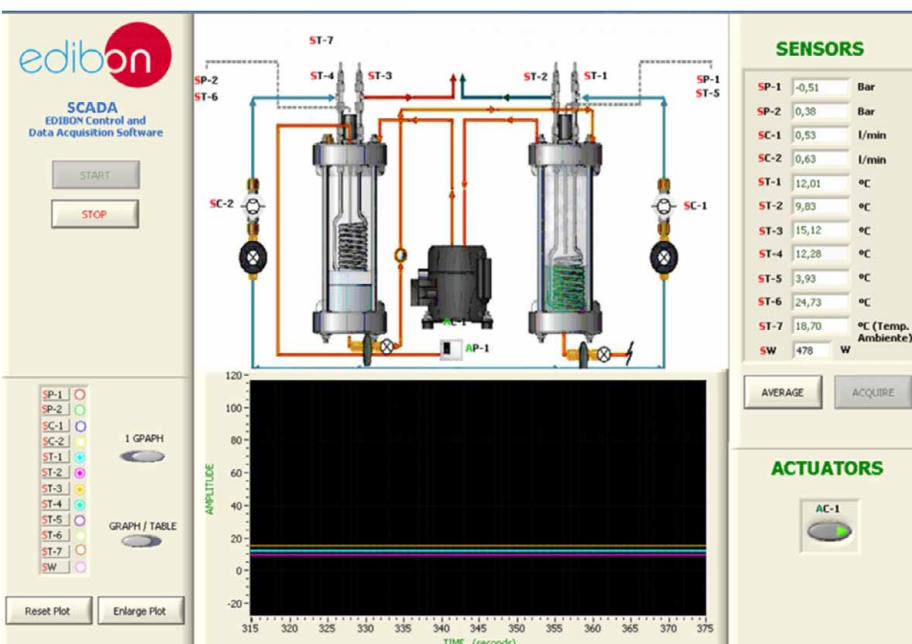
Some typical exercises results



Screen representing the water temperatures of the evaporator (ST-1 and ST-2). The water gets in at 12°C and gets out at 9°C due to the fact that it becomes colder in the evaporator.



Screen representing the water temperatures of the condenser (ST-3 and ST-4). The water gets in at 12°C and gets out at 16°C due to the fact that it becomes warmer in the



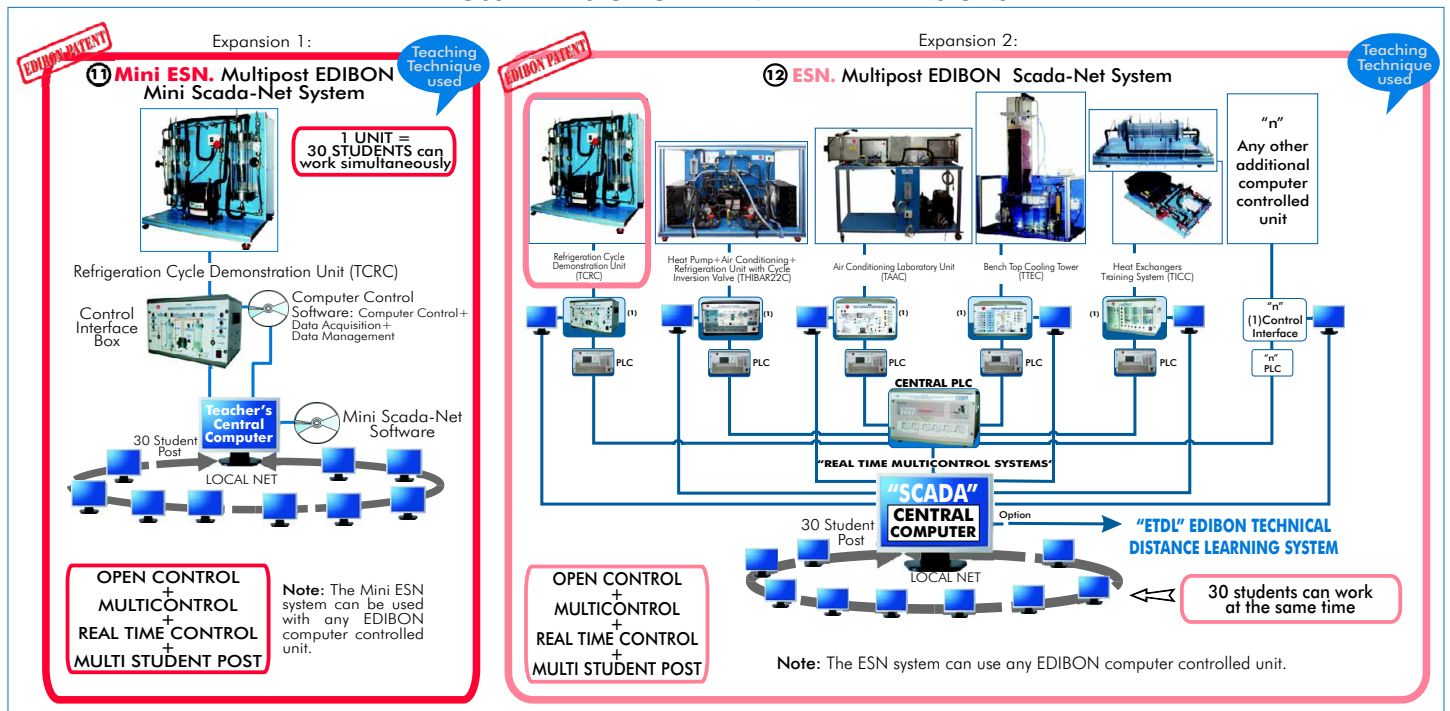
It represents the inlet and outlet water temperatures in the condenser and in the evaporator as well.

EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

- 1.- Demonstration of the vapour compression refrigeration and heat pump cycle.
- 2.- Relation between pressure and temperature.
- 3.- Demonstration of the refrigerant transfer from the evaporator to the condenser.
- 4.- Charging demonstration.
- 5.- Demonstration of the air effect in a refrigeration (cooling) system.
- 6.- Evaporation and condensation temperatures effect in the refrigeration (cooling) rate and in the heat transfer at the condenser.
- 7.- Analysis of the pressures relation effect in the system behaviour.
- 8.- Determination of the system operation coefficients.
- 9.- Measurement of the electrical power.
- 10.- Estimation of the heat transmission global coefficient between the SES36 refrigerant and the water.
- Other possible practices:
 - 11.- Sensors calibration.
- Practices to be done by PLC Module (PLC-PI) + PLC Control Software:
 - 12.- Control of the TCRC unit process through the control interface box without the computer.
 - 13.- Visualization of all the sensors values used in the TCRC unit process.
 - 14.- Calibration of all sensors included in the TCRC unit process.
 - 15.- Hand on of all the actuators involved in the TCRC unit process.
- 16.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
- 17.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
- 18.- PLC hardware general use and manipulation.
- 19.- PLC process application for TCRC unit.
- 20.- PLC structure.
- 21.- PLC inputs and outputs configuration.
- 22.- PLC configuration possibilities.
- 23.- PLC program languages.
- 24.- PLC different programming standard languages.
- 25.- New configuration and development of new process.
- 26.- Hand on an established process.
- 27.- To visualize and see the results and to make comparisons with the TCRC unit process.
- 28.- Possibility of creating new process in relation with the TCRC unit.
- 29.- PLC Programming Exercises.
- 30.- Own PLC applications in accordance with teacher and student requirements.

POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS



ORDER INFORMATION

Items supplied as standard

Minimum configuration for normal operation includes:

- ① Unit: TCRC. Refrigeration Cycle Demonstration Unit.
- ② TCRC/CIB. Control Interface Box.
- ③ DAB. Data Acquisition Board.
- ④ TCRC/CCSOF. Computer Control + Data Acquisition + Data Management Software.
- ⑤ Cables and Accessories, for normal operation.
- ⑥ Manuals.

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

Additional and optional items to the standard supply

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

- ⑦ PCL-PI. PLC Module.
- ⑧ TCRC/PLC-SOF. PLC Control Software.
- ⑨ TCRC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).
- ⑩ TCRC/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./50 Hz or 110V./60 Hz.
- Water supply.
- Computer (PC).

DIMENSIONS & WEIGHTS

- | | |
|------------------------|--|
| TCRC Unit: | -Dimensions: 700 x 700 x 720 mm. approx. |
| | -Weight: 70 Kg. approx. |
| Control Interface Box: | -Dimensions: 490 x 330 x 310 mm. approx. |
| | -Weight: 10 Kg. approx. |
| PLC Module (PLC-PI): | -Dimensions: 490 x 330 x 310 mm. approx. |
| | -Weight: 30 Kg. approx. |

AVAILABLE VERSIONS

Offered in this catalogue:

- **TCRC.** Computer Controlled **Refrigeration Cycle Demonstration Unit.**

Offered in other catalogue:

- **TCRB.** **Refrigeration Cycle Demonstration Unit.**

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



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