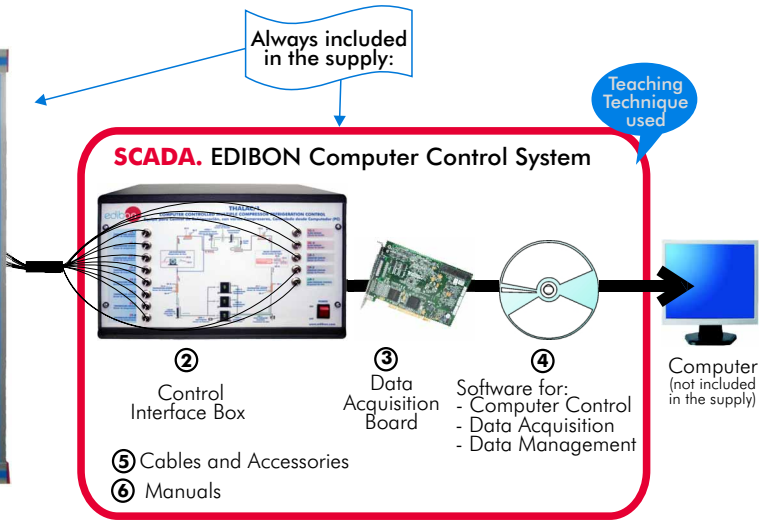
Technical Teaching Equipment

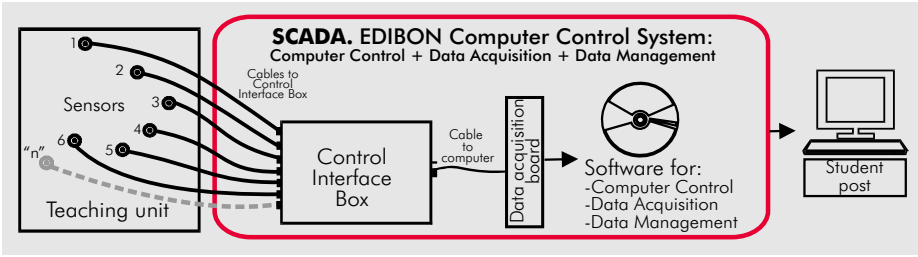
Computer Controlled
Multiple Compressor Refrigeration Control
THALAC/1

EDIBON PATENT



① Unit: THALAC/1. Multiple Compressor Refrigeration Control

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL



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Products
Products range
Units
9.-Thermodynamics & Thermotechnics

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

European Union Certificate
(total safety)

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

Worlddidac Quality Charter Certificate
(Worlddidac Member)

DESCRIPTION

Refrigeration unit for the demonstration of the combined operation of compressors.

The multiple compressor refrigeration control unit made by EDIBON has the goal of introducing the student into the complex world of installing heat pumps, as well as the study and calculation of the characteristic operating parameters of the unit in relation to the environmental demands (heat, temperature, refrigeration, etc.).

This unit is basically made up of a coolant circuit. All along it, there are a water condenser, an air evaporator and three compressors.

Moreover, the unit has been designed for the study of changes in the refrigerant conditions, water and air, that allow the study of the refrigeration circuit.

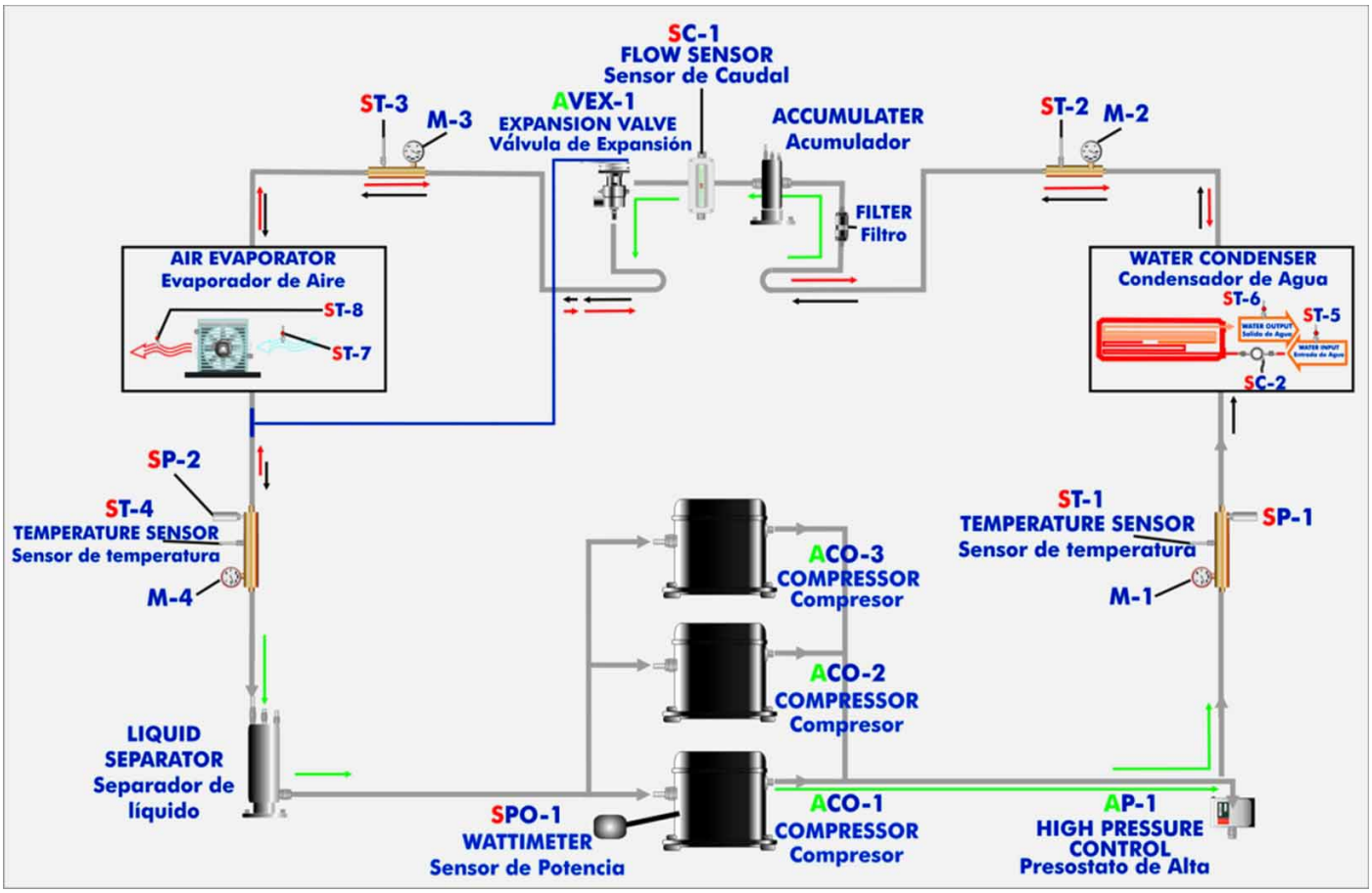
In the traditional refrigeration units the efficiency is controlled using several condensers to decrease the temperature of the refrigerant liquid. The problem with this system of control is the electric power. It is always the same, because the compressor is always switched on. Another way to control the efficiency of the unit is by including several compressors, in this way it is possible to connect only the compressors needed in each case. With this type of control the electric power is only produced when the compressor is switched on.

This Computer Controlled Steam Power Plant 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

4 actuators and 12 sensors controlled from any computer, and working simultaneously

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL



Items supplied as standard

①THALAC/1. Unit:

Bench-top unit.
Anodized aluminium structure and panels in painted steel. Main metallic elements in stainless steel.
Diagram in the front panel with similar distribution to the elements in the real unit.
3 Cooling compressors, computer controlled:
- Technical data of each compressor:
  - Power: 1/5 CV, 1.9A.
  - Fridge efficiency: 460W to 0° C.
  - Cylinder volume: 7.55 cm^3.

This compound system is controlled so that individual compressor can be switched depending on the performance.
Water condenser:
- Concentric pipes type. Capacity: 1580W. Consume DT=8K:170 l./h.

Coolant accumulation tank, capacity: 1.50 dm^3.
Cooling filter.
Expansion valve, capillar type.
Air evaporator, computer controlled. Air flow: 980m^3/h.
Tank of division of the cooling liquid.
2 Low pressure manometers.
2 High pressure manometers.
High pressure control: Pressure switch.
- The pressure switch disconnect the electric power to the compressor when the pressure in the circuit is higher than the fixed pressure.
- Type: Spring, with automatic restart.
- Switch off pressure: 14 Bar.
- Restart pressure: 9.5 Bar.

8 Temperature sensors "J" type:
- Refrigerant temperature in the compressor outlet.
- Refrigerant temperature in the condenser outlet.
- Refrigerant temperature in the evaporator inlet.
- Refrigerant temperature in the compressor inlet.
- Water temperature in the condenser inlet.
- Water temperature in the condenser outlet.
- Environmental temperature.
- Air temperature in the evaporator outlet.

2 Flow sensors:
- Cooling flow sensor, magnetic type, range: 0 to 60 l./h.
- Water flow sensor (condenser), turbine type, range: 0.2 to 6.5 l./min.

2 Pressure sensors:
- High pressure sensor, range: 0 to 25 bar.
- Low pressure sensor, range: 0 to 10 bar.

Power measurement form the computer (PC).
Enthalpy diagram of the refrigerant R134a.

THALAC/1. Unit

②THALAC/1/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 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.

THALAC/1/CIB

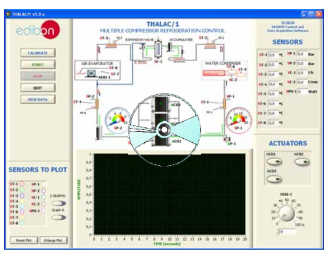
③DAB. Data Acquisition Board:

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)=±10V. 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)=±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.

DAB

④THALAC/1/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.



THALAC/1/CCSOF

⑤Cables and Accessories, for normal operation.
⑥Manuals: 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: THALAC/1 + THALAC/1/CIB + DAB + THALAC/1/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):

⑦PLC-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).

⑧THALAC/1/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

PLC-PI

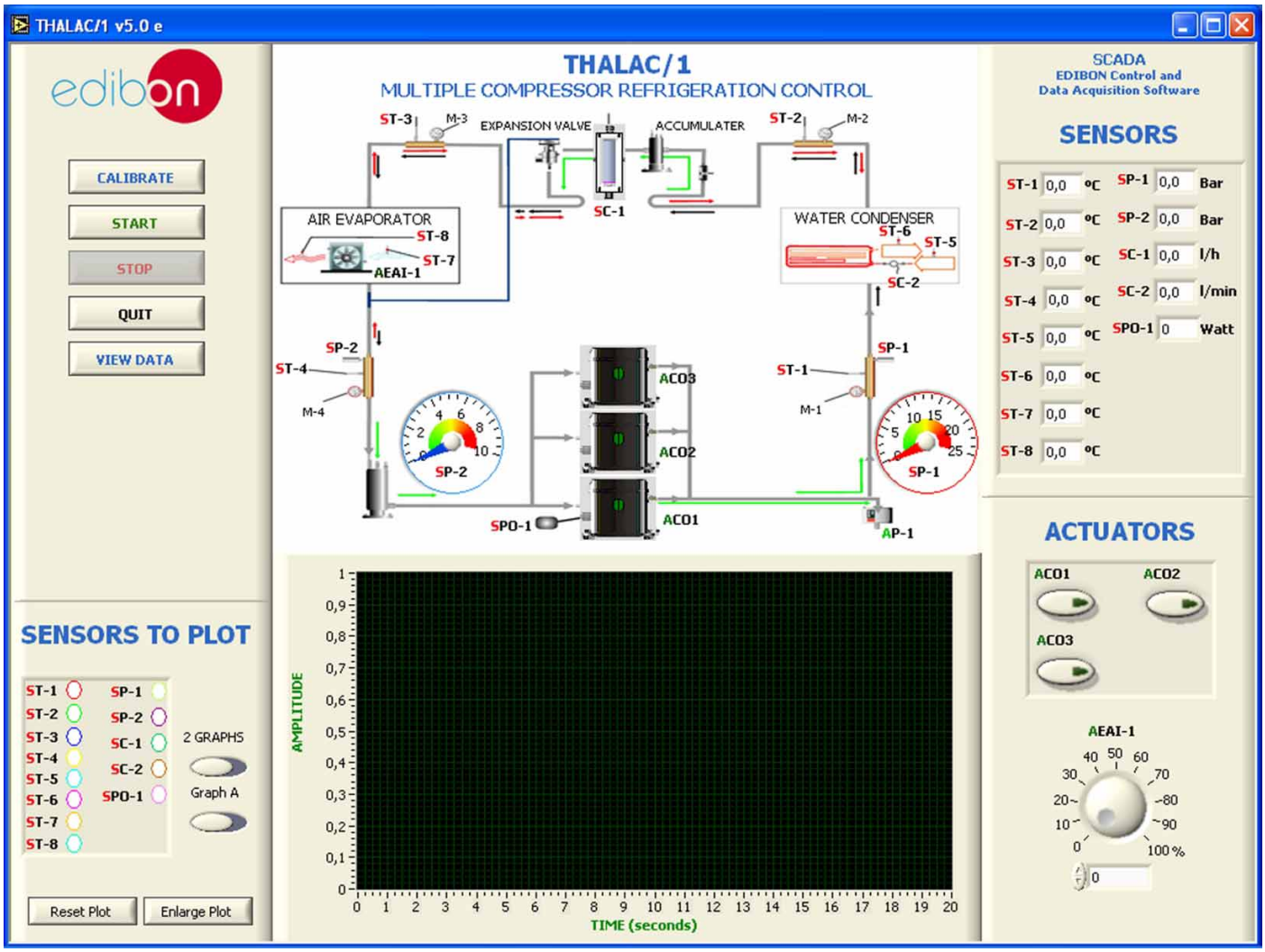
Items available on request

⑨THALAC/1/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

⑩THALAC/1/FSS. Faults Simulation System.

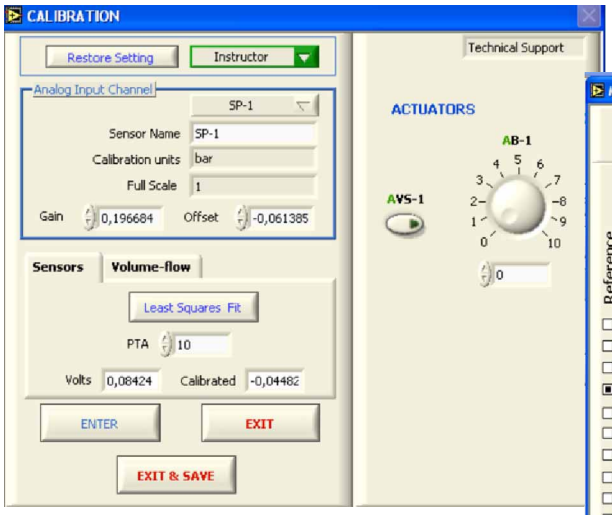
Software Main Screens

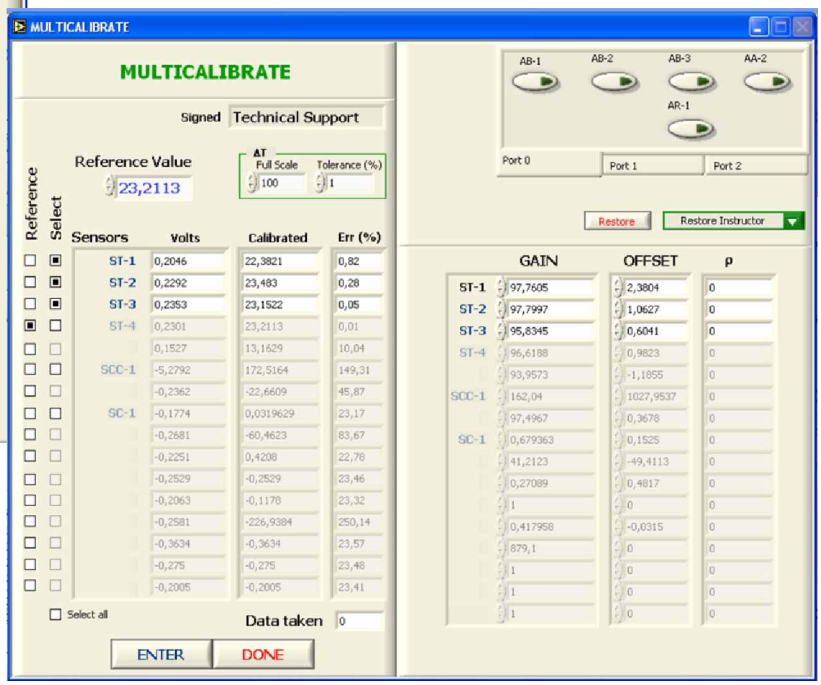
Main screen



Note: ST=Temperature sensor. SP=Pressure sensor. SC=Flow sensor. SPO=Power measurement. ACO=Compressor. AEAI=Air evaporator.

Examples of Sensors Calibration screens





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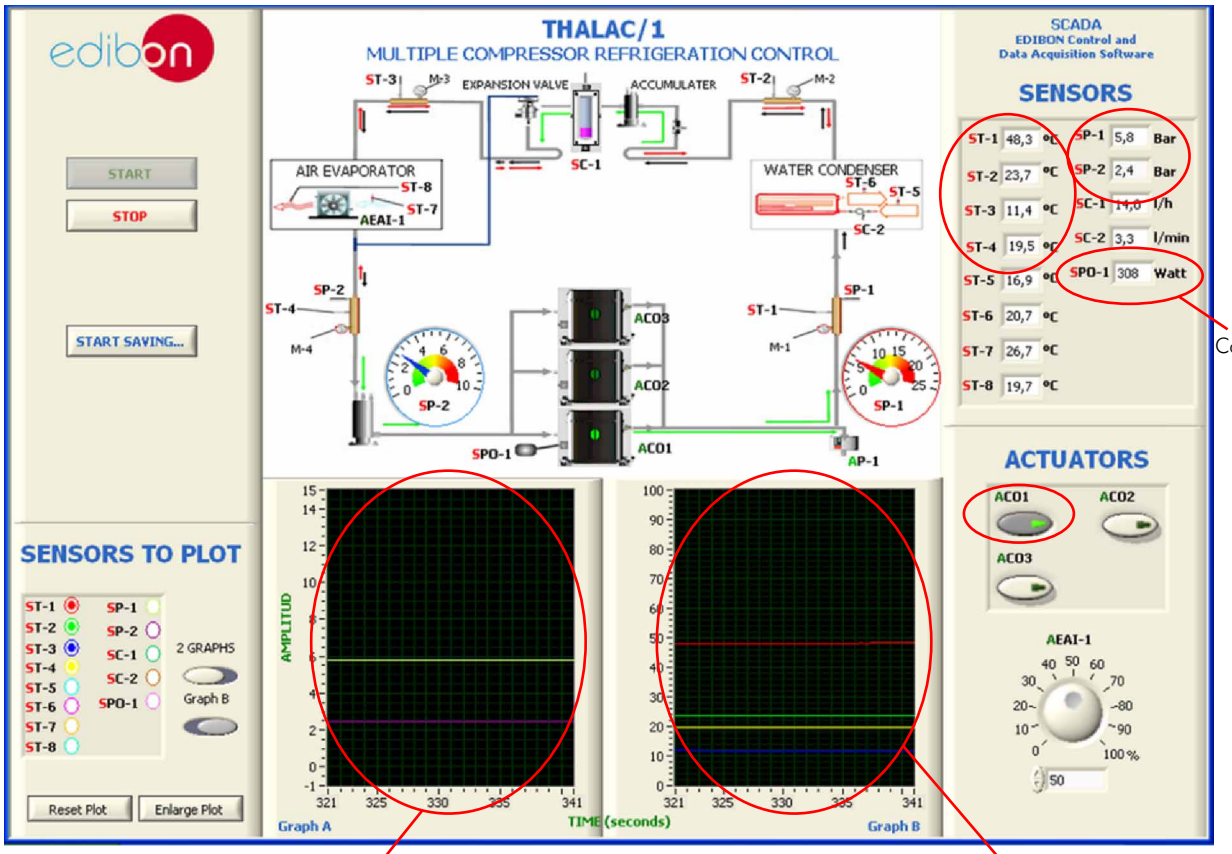
Some typical exercises results

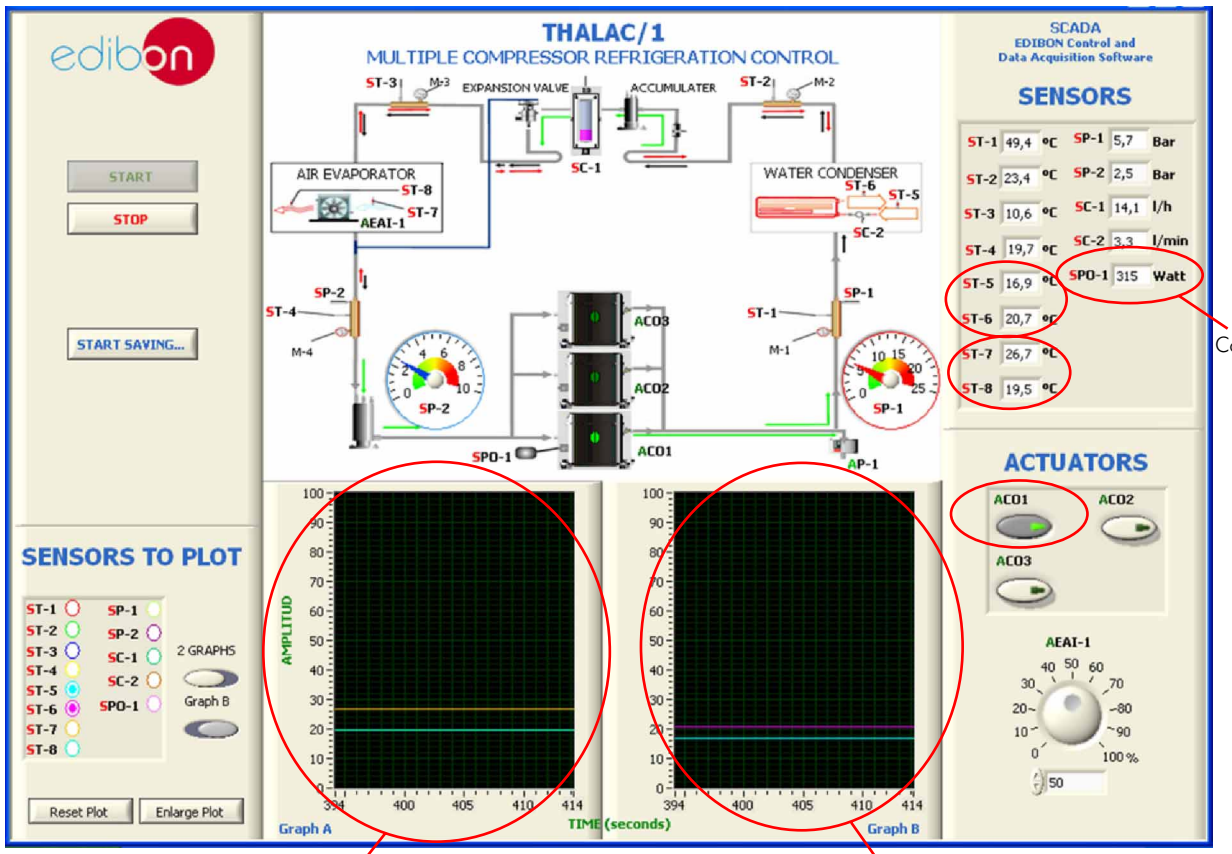
One compressor switched on:



Consumption

High and low pressures
(SP-1, SP-2)

Refrigeration circuit temperatures
(ST-1, ST-2, ST-3, ST-4)



Consumption

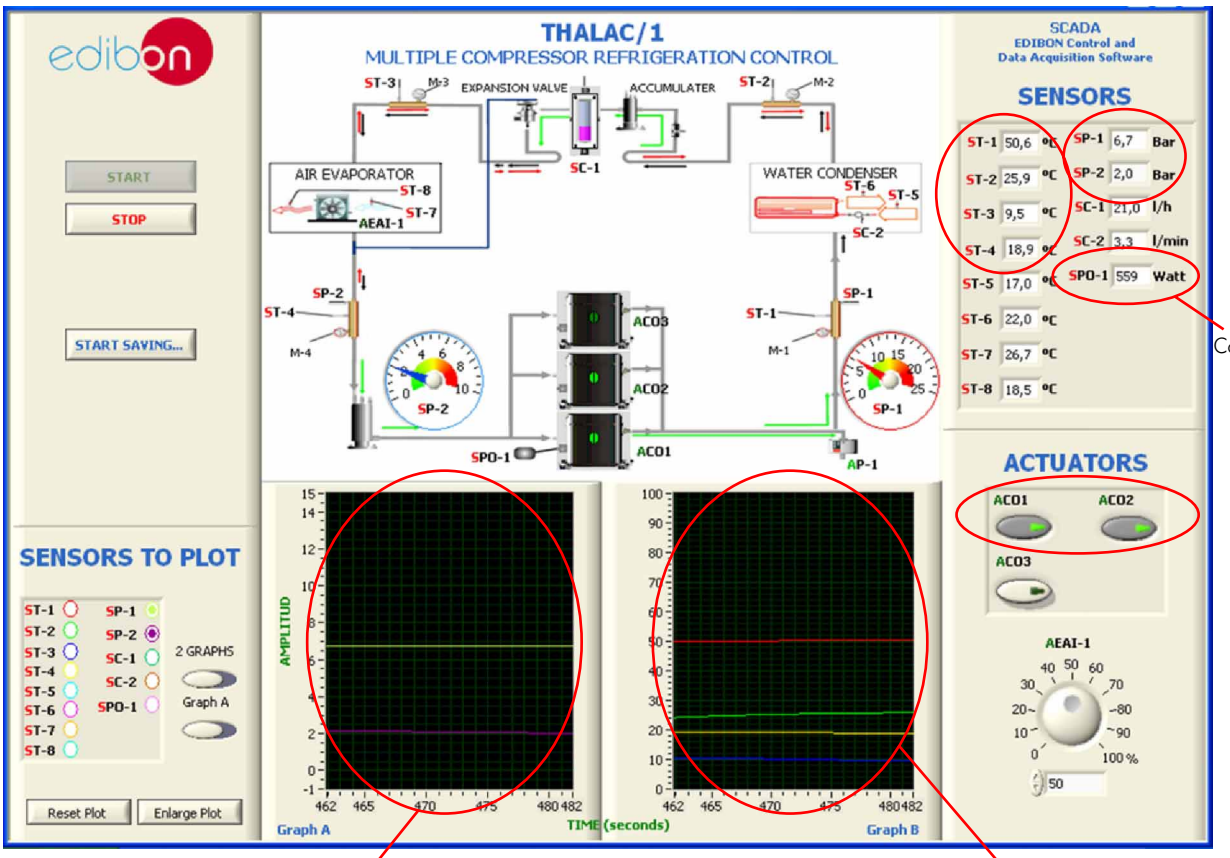
Air temperatures
(ST-7, ST-8)

Water temperatures
(ST-5, ST-6)

Continue...

Some typical exercises results

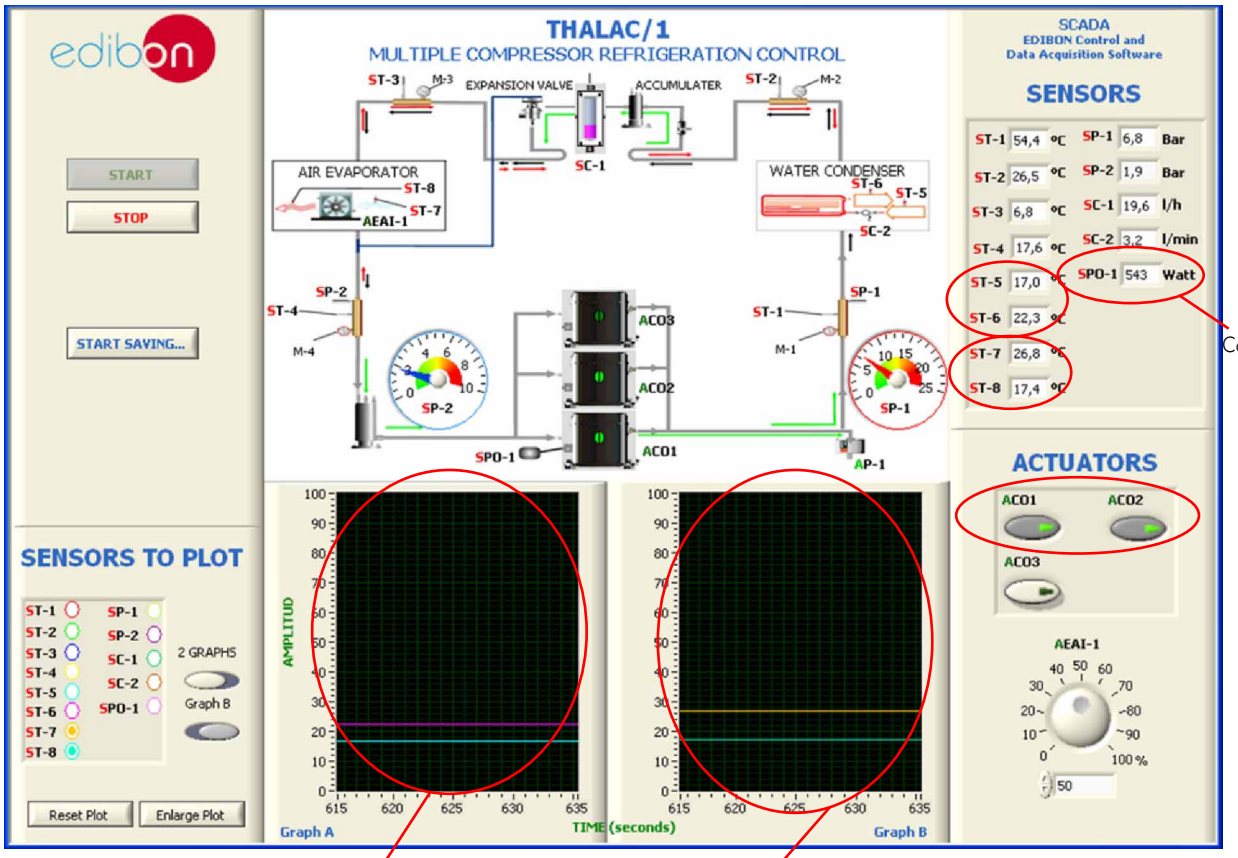
Two compressors switched on:



Consumption

Pressures
(SP-1, SP-2)

Refrigeration circuit temperatures
(ST-1, ST-2, ST-3, ST-4)



Consumption

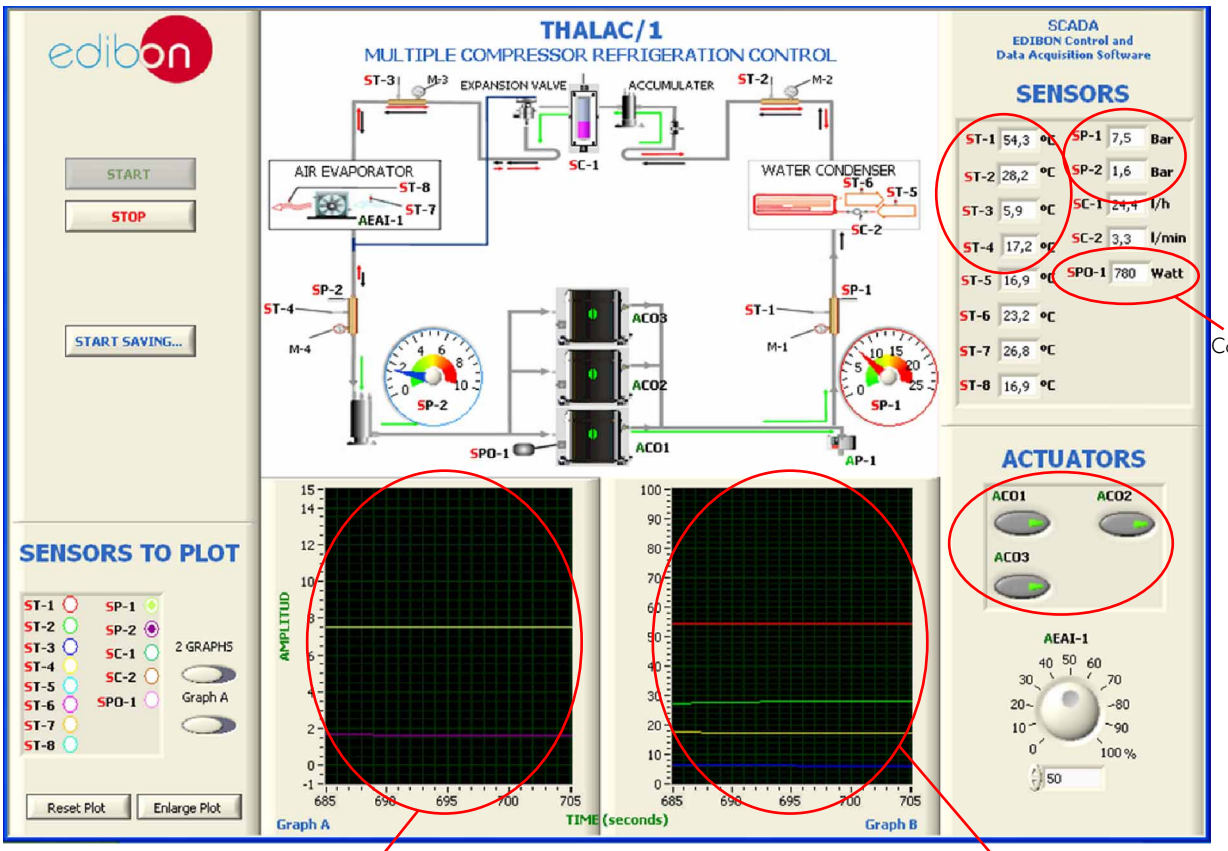
Water temperatures
(ST-5, ST-6)

Air temperatures
(ST-7, ST-8)

Continue...

Some typical exercises results

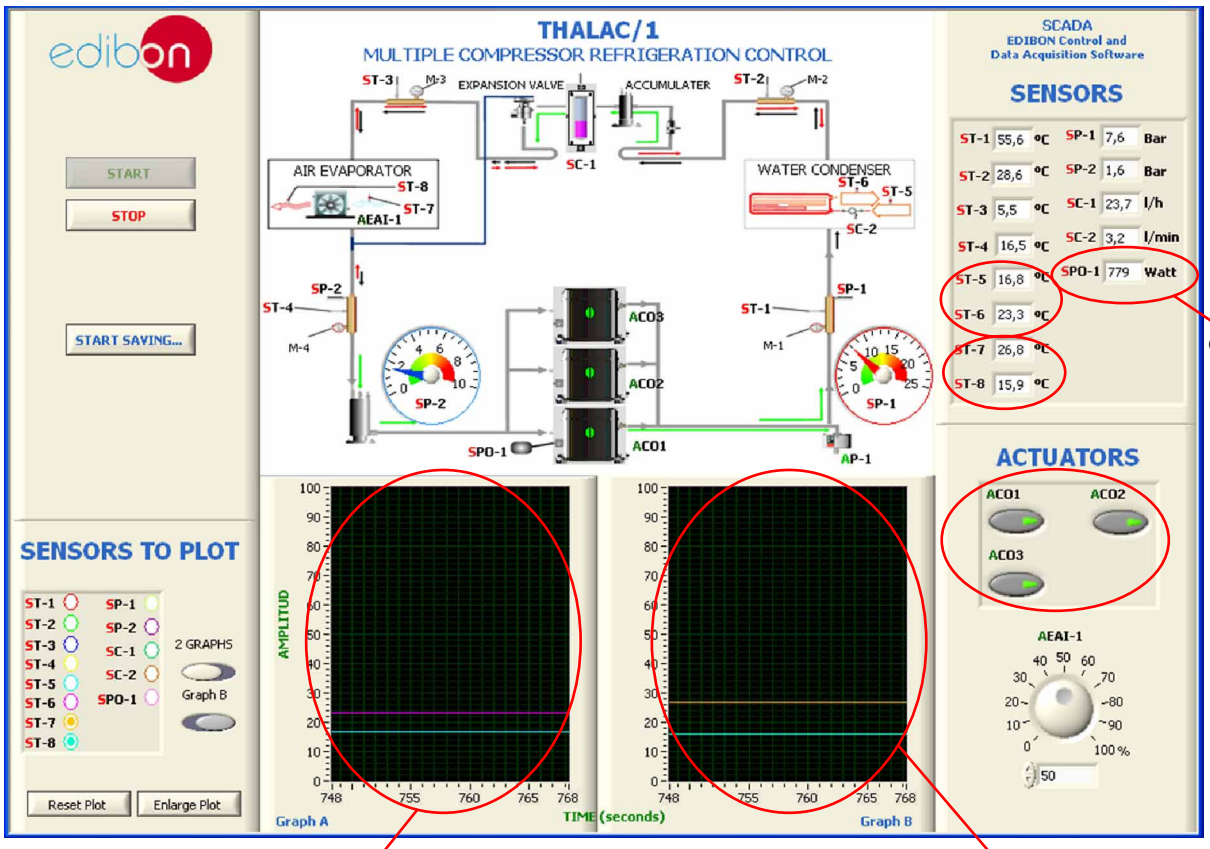
Three compressors switched on:



Consumption

Pressures
(SP-1, SP-2)

Refrigeration circuit temperatures
(ST-1, ST-2, ST-3, ST-4)



Consumption

Water temperatures
(ST-5, ST-6)

Air temperatures
(ST-7, ST-8)

EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Combined operation of compressors:

Power measurement.

Comparison of the energy for operating individual compressor and multiple compressors.

2.- Cyclic process on the p-h state diagram.

3.- Determination of the inlet power, heat produced and performance coefficient. Air as heat source.

4.- Preparation of performance curves of the unit with different inlet and outlet temperatures. Air as heat source.

5.- Lay out of the steam compression cycle in a diagram P-H and comparison with the ideal cycle. Air as heat source.

6.- Effect of refrigerant supercooling.

7.- Effect of the airflow rate on the condenser performance.

8.- Preparation of the performance curves of the unit based on the properties of the refrigerant and at different condensation and evaporation temperatures. Air as heat source.

9.- Energy balances.

Other possible practices:

10.- Temperature sensors calibration.

11.- Flow sensors calibration.

12.- Pressure sensors calibration.

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

13.- Control of the THALAC/1 unit process through the control interface box without computer.

14.- Visualization of all the sensors values used in THALAC/1 unit process.

15.- Calibration of all sensors included in THALAC/1 unit process.

16.- Hand on of all the actuators involved in the THALAC/1 unit process.

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

18.- 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).

19.- PLC hardware general use and manipulation.

20.- PLC process application for the THALAC/1 unit.

21.- PLC structure.

22.- PLC inputs and outputs configuration.

23.- PLC configuration possibilities.

24.- PLC program languages.

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

26.- New configuration and development of new process.

27.- Hand on an established process.

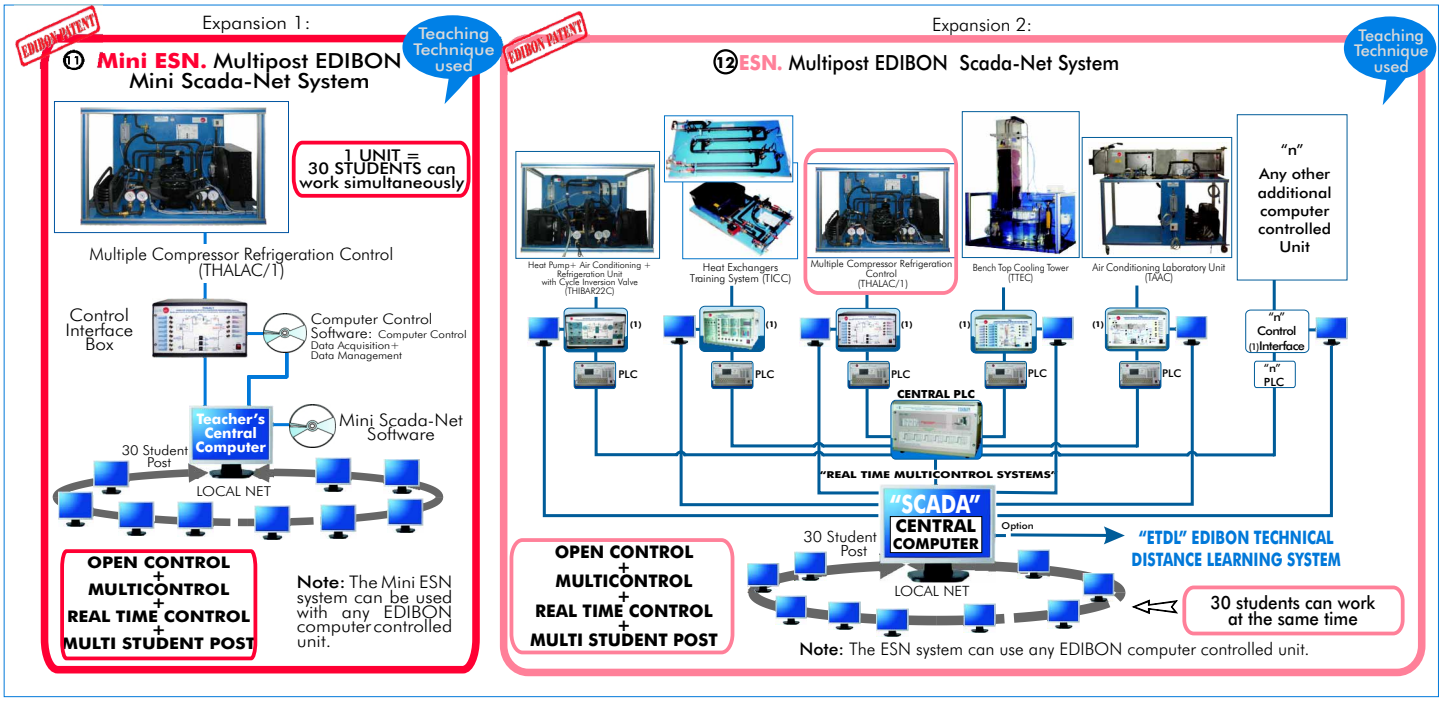
28.- To visualize and see the results and to make comparisons with the THALAC/1 unit process.

29.- Possibility of creating new process in relation with the THALAC/1 unit.

30.- PLC Programming Exercises.

31.- 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: THALAC/1. Multiple Compressor Refrigeration Control.**
- ② **THALAC/1/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **THALAC/1/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
- ⑤ **Cables and Accessories**, for normal operation.
- ⑥ **Manuals.**

* **IMPORTANT: Under THALAC/1 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 THALAC/1/PLC-SOF. PLC Control Software.
- ⑨ THALAC/1/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).
- ⑩ THALAC/1/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: 220V., 1-phase + neutral + ground, 50Hz ; or 110V., 1-phase + neutral + ground, 60Hz.; and 1CV max.

-Water supply and drainage.

-Computer (PC).

DIMENSIONS & WEIGHTS

THALAC/1 Unit:	-Dimensions: 1000 x 600 x 600 mm. approx.
	-Weight: 100 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.

RECOMMENDED ACCESSORIES

For refilling R134a refrigerant and maintenance, we recommend:

- T/KIT1. Maintenance Kit, containing: vacuum pump, hoses and manometers.
- T/KIT2. Maintenance Kit, containing: leakage detector.
- R134a refrigerant (to be acquired by the customer locally).

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

edibon INTERNATIONAL

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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