Computer Controlled **Refrigeration Unit with Refrigeration and Freezing Chamber,** with SCADA

Engineering and Technical Teaching Equipment

TRRC

EDIBON **SCADA** System

Teaching Technique used

EDIBON PATENT

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: TRRC. Computer Controlled Refrigeration Unit with Refrigeration and Freezing Chamber

Key features:

➤ **Advanced Real-Time SCADA.**

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

➤ **Specialized EDIBON Control Software based on LabVIEW.**

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

➤ **Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.**

➤ **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**

➤ **Capable of doing applied research, real industrial simulation, training courses, etc.**

➤ **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**

➤ **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**

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

➤ **Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc.**
 Apart from monitoring user's knowkledge and progress reached.

➤ **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

POWERED BY
NATIONAL INSTRUMENTS
LabVIEW

www.edibon.com
↳Products
 ↳Products range
  ↳Units
   ↳9.- Thermodynamics & Thermotechnics

For more information about Key Features, click here

INTRODUCTION

The objective of the Computer Controlled Refrigeration Unit with Refrigeration and Freezing Chamber "TRRC" designed by EDIBON is to introduce the student into the complex world of refrigeration systems, as well as to study and determine the characteristic operation parameters of the unit in function of the environmental demands (heat, temperature, refrigeration, etc.).

It is a unit designed to study a refrigeration system with two different chambers at different temperature. The refrigeration unit basically consists of a refrigeration circuit but, unlike usual circuits, it has two evaporators, one per chamber. Each evaporator has an evaporation pressure that enables to obtain different temperature conditions in the chambers.

Besides, this unit helps to acquire knowledge about design on purpose of the individual components.

GENERAL DESCRIPTION

This procedure performed by this unit consists of the following stages:

- **Compression:** This stage begins when the refrigerant enters the compressor. This refrigerant is compressed, increasing its pressure and temperature. The unit includes a pressure sensor, a manometer and a temperature sensor to measure those variables.

- **Condensation:** The refrigerant is driven to the condenser, where its temperature decreases, at constant pressure, and its state changes to liquid state. This change is explained because heat is given to the external air in the condenser. At the end of this stage, the pressure and temperature of the refrigerant are measured with a manometer and a temperature sensor. After leaving the condenser, the refrigerant goes to the accumulator, where it is stored to a greater or lesser extent in function of the chambers demand, and to a filter, to retain condensate particles. The flow is measured by a flow sensor. Before the expansion, it's possible to cool the refrigerant in a heat exchanger to get down the temperature (supercooling process), to increase the efficiency of the process.

- **Expansion:** From that point, with two solenoid valves, the circuit branches in two paths covered simultaneously, one per chamber. After the valve that defines the path, the pressure and temperature of the refrigerant decreases in the expansion valve and its states becomes a mixture of liquid and vapor. At the end of this stage the pressure and temperature of the refrigerant is measured by a pressure sensor, a manometer and a temperature sensor. Solenoid valves enable the individual or parallel operation of the evaporators in the two chambers.

- **Evaporation:** Finally, the refrigerant enters the evaporator, where it is gradually transformed in gas due to the heat absorbed coming from the inside of the chamber. This process is carried out in the refrigeration chamber at a pressure and temperature higher than in the freezing chamber thanks to a valve that regulates the evaporation pressure, which enables to evaporate at higher pressures and temperatures. In the freezing chamber there is an electric heating element to remove any possible layer of frost after finishing the process. The pressure and temperature of the refrigerant are measured at the outlet of each chamber with a manometer and a temperature sensor and the effect of the evaporation pressure controller on the overall process is examined.

  The flows coming from both chambers are mixed at the end of this stage and then they pass through a liquid separator to retain liquid particles before entering the compressor again. The inlet conditions to the compressor are measured by a pressure sensor, a manometer and a temperature sensor. There is a pressure switch located between the inlet and outlet of the compressor that stops the process when hazardous pressures are reached.
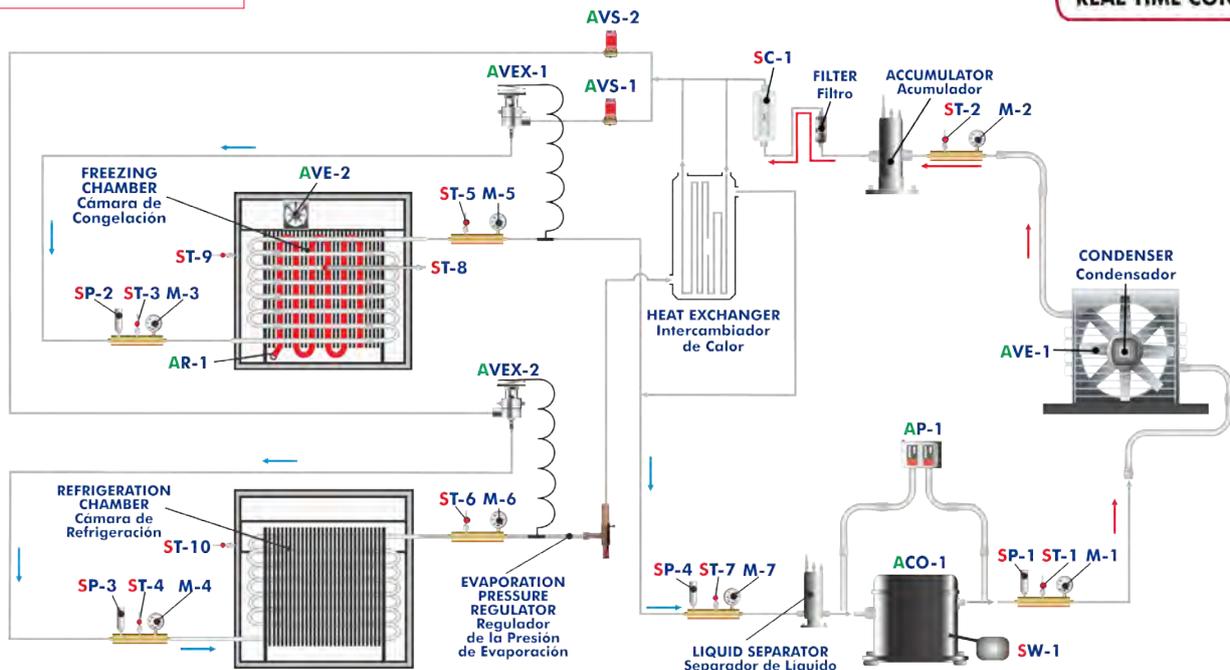
All the components are arranged clearly in the unit and a signal lamp in the process schematic indicate the operating state of the selected components.

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, Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

6 actuators and 16 sensors controlled from any computer, and working simultaneously

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

AVS-2
AVEX-1 AVS-1
SC-1
FILTER Filtro
ACCUMULATOR Acumulador
ST-2 M-2

FREEZING CHAMBER Cámara de Congelación
AVE-2
ST-5 M-5
ST-9
ST-8
SP-2 ST-3 M-3
AR-1

HEAT EXCHANGER Intercambiador de Calor

CONDENSER Condensador
AVE-1

AVEX-2

AP-1

REFRIGERATION CHAMBER Cámara de Refrigeración
ST-6 M-6
ST-10
SP-3 ST-4 M-4

EVAPORATION PRESSURE REGULATOR Regulador de la Presión de Evaporación

SP-4 ST-7 M-7
ACO-1
SP-1 ST-1 M-1

LIQUID SEPARATOR Separador de Líquido
SW-1

ST- TEMPERATURE SENSOR Sensor de Temperatura
SC- FLOW SENSOR Sensor de Caudal
SP- PRESSURE SENSOR Sensor de Presión
SW- WATTMETER Sensor de Potencia
AR- HEATING ELEMENT Resistencia
AVE- FAN Ventilador
AP- HIGH AND LOW PRESSURE CONTROL Presostato de Alta y Baja
AVS- SOLENOID VALVE Válvula Solenoide
AVEX- EXPANSION VALVE Válvula de Expansión
ACO- COMPRESSOR Compresor
M- MANOMETER Manómetro

With this unit there are several options and possibilities:
- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8, 9, 10 and 11.
Let us describe first the main items (1 to 6):

① **TRRC. Unit:**

Bench-top unit.

Anodized aluminum frame 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.

This unit is designed to investigate a refrigeration system with refrigeration and freezing chambers with 1125 W of power. This unit is used for the training of apprentices in the field of refrigeration.

High pressure area:

Hermetic compressor of 490 W, 5/40°C for refrigerant R-134a, computer controlled. Refrigerant capacity: 1100 W, 5/40°C.

Wattmeter to measure the compressor power.

Three pressure sensors located in the high pressure area, range: -1 to 24 bar.

High pressure manometer located at the outlet of the compressor.

Temperature sensor located at the outlet of the compressor, range: -50 to 120°C.

Double pressure switch of 32/7.5 bar.

Condensation area:

Air condenser, computer controlled, of 290 m³/h and 1.5 m² of area, with fan.

High pressure manometer located at the outlet of the condenser.

Temperature sensor located at the outlet of the condenser, range: -50 to 120°C.

Refrigerant receiver. Refrigerant filter to retain particles of condensate.

Flow sensor, range: 1.5 to 23.5 l./h. Heat exchanger for supercooling.

Low pressure area:

Two solenoid valves, computer controlled. Two expansion valves.

Three pressure sensors located after the expansion valves, range: -1 to 9 bar.

Two low pressure manometers located after the expansion valves.

Two temperature sensors located after the expansion valves, range: -50 to 120°C.

Compressor inlet:

Liquid separator to retain liquid particles before going on to the compressor.

Temperature sensor located at the inlet of the compressor, range: -50 to 120°C.

Low pressure manometer located at the compressor inlet.

Pressure sensor located at the compressor inlet, range: -1 to 15 bar.

Evaporation area:

Refrigeration:

Insulated refrigeration chamber with a capacity of 20 l., and with 1 m² of evaporator area.

Evaporator of the refrigeration chamber.

Evaporation pressure control valve, range: 0 - 5.5 bar.

Low pressure manometer located at the outlet of the refrigeration chamber evaporator.

Temperature sensor located at the outlet of the refrigeration chamber evaporator, range: -50 to 100°C.

Temperature sensor located at the refrigeration chamber, range: -50 to 100°C.

Freezing:

Insulated freezing chamber with a capacity of 20 l., and with 2.42 m² of evaporator area.

Evaporator of the freezing chamber with computer controlled fan with 135 m³/h of air flow rate.

Heating element of 150 W for defrosting, computer controlled.

Low pressure manometer located at the outlet of the freezing chamber evaporator.

Temperature sensor located at the outlet of the freezing chamber evaporator.

Temperature sensor located in the evaporator of the freezing chamber.

Temperature sensor located in the freezing chamber.

Complementary instrumentation:

Three thermocouple with range: -50 to 100°C.

This unit has been designed for the use with the refrigerant R134a, CFC-free, environmental friendly.

The unit includes a pressure-enthalpy chart of the R134a refrigerant.

The complete unit includes as well:

Advanced Real-Time SCADA.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on LabVIEW.

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

Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.

Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.

Capable of doing applied research, real industrial simulation, training courses, etc.

Remote operation and control by the user and remote control for EDIBON technical support, are always included.

Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).

Designed and manufactured under several quality standards.

Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc.

Apart from monitoring user's knowwledge and progress reached.

This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

Unit: TRRC

② **TRRC/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 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, heating elements, control valves, etc.

Real time computer control for parameters involved in the process simultaneously.

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.

TRRC/CIB

③ **DAB. Data Acquisition Board:**

The Data Acquisition board is part of the SCADA system.

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

Analog input:

Number of **channels= 16** single-ended or 8 differential. **Resolution=16 bits**, 1 in 65536.

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

Input range (V)=±10 V. Data transfers=DMA, interrupts, programmed I/0. DMA channels=6.

Analog output:

Number of **channels=2. Resolution=16 bits**, 1 in 65536.

Maximum output rate up to: 900 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 100 MHz.

Timing: Number of **Counter/timers=4.** Resolution: Counter/timers: 32 bits.

DAB

④ **TRRC/CCSOF. 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.

Management, processing, comparison and storage of data.

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

Calibration system for the sensors involved in the process.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.
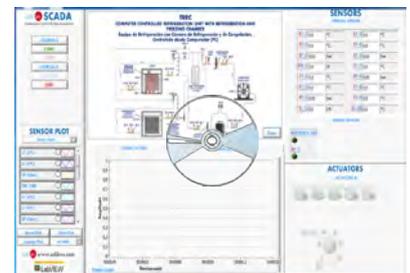
TRRC/CCSOF

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: TRRC + TRRC/CIB + DAB + TRRC/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 THE MAIN ITEMS

1.- Representation of the thermodynamic cycle in the p-h log diagram.

2.- Determination of the refrigeration capacity.

3.- Determination of the compressor work.

4.- Determination of the coefficient of performance (COP).

5.- Design and components of a refrigeration system with two evaporators.

Additional practical possibilities:

6.- Sensors calibration.

7.- Study of the refrigerant subcooling effect.

8.- Study of the compressor and its function.

9.- Study of the evaporators and their functions.

10.- Study of the condenser and its function.

11.- Study of the expansion valve and its function.

12.- Study of the evaporation pressure control valve.

13.- Study of the defrost heater and its function.

14.- Study of the pressure switches and their function.

15.- Study of the effect of air in a refrigeration system.

16.- Temperature control.

17.- Measurement of power.

18.- Determination of the electrical performance of the compressor.

19.- Study of the solenoid valve and its function.

20.- Analysis of the pressure ratio in the behavior of the system.

21.- Relation between pressure and temperature.

22.- Study of the structure and elements of a refrigeration system with two evaporators.

23.- Fault finding in refrigeration systems components.

Other possibilities to be done with this Unit:

24.- Many students view results simultaneously.

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

25.- 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.

26.- The Computer Control System with SCADA allows a real industrial simulation.

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

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

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

30.- Control of the TRRC unit process through the control interface box without the computer.

31.- Visualization of all the sensors values used in the TRRC 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

- Electrical supply: single-phase, 220 V./50 Hz. or 110 V./60 Hz.
- Computer.

RECOMMENDED ACCESSORIES (Not included)

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.

- T/KIT3. Maintenance Kit, containing: Recovery-Evacuating and Charging Module.

DIMENSIONS AND WEIGHTS

TRRC:
  Unit:
     -Dimensions: 650 x 900 x 1200 mm. approx.
                   (25.59 x 35.43 x 47.24 inches approx.)
     -Weight: 120 Kg. approx.
                   (264 pounds approx.)
  Control-Interface Box:
     -Dimensions: 490 x 330 x 310 mm. approx.
                   (19.29 x 12.99 x 12.20 inches approx.)
     -Weight: 10 Kg. approx.
                   (22 pounds approx.)

SCADA
Main screen

Ⓘ Main software operation possibilities.

Ⓘ Sensors displays, real time values, and extra output parameters. **Sensors:** ST= Temperature sensor. SC=Flow sensor. SP=Pressure sensor. SW=Wattmeter.

Ⓘ Actuators controls. **Actuators:** AVE=Fan. AR=Heating element. AP=High and low pressure control. AVS=Solenoid valve. ACO=Compressor.

Ⓘ Channel selection and other plot parameters.

Ⓥ Real time graphics displays.

Software for Sensors Calibration
Example of screen

The teacher and the students can calibrate the unit with a password provided by EDIBON.

The teacher can restore the factory calibration any time.

Representation in real time of the measured magnitudes. Two graphs with pressure, temperatures and power measures.
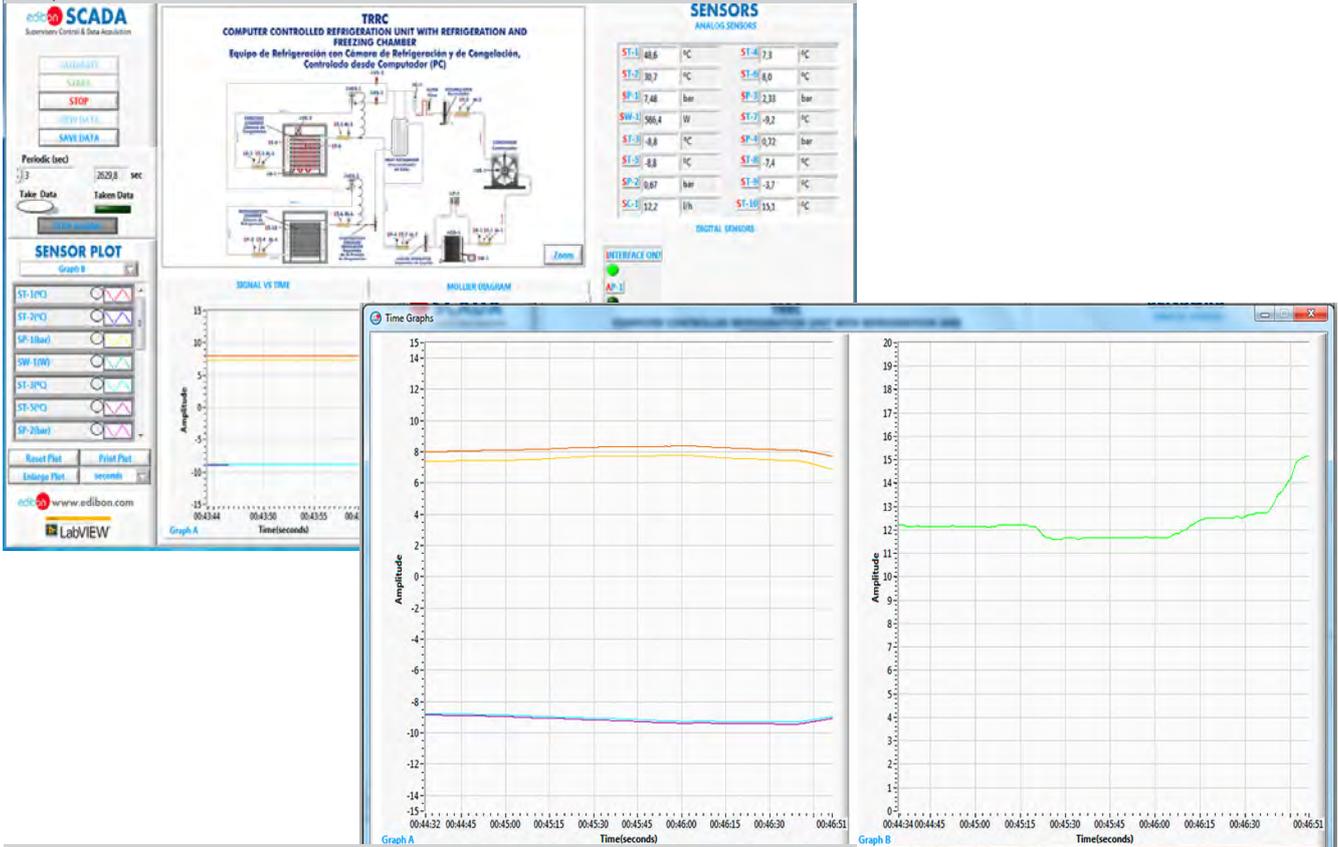
Representation in real time of carnot cycle in Mollier diagram with two different evaporation pressures.
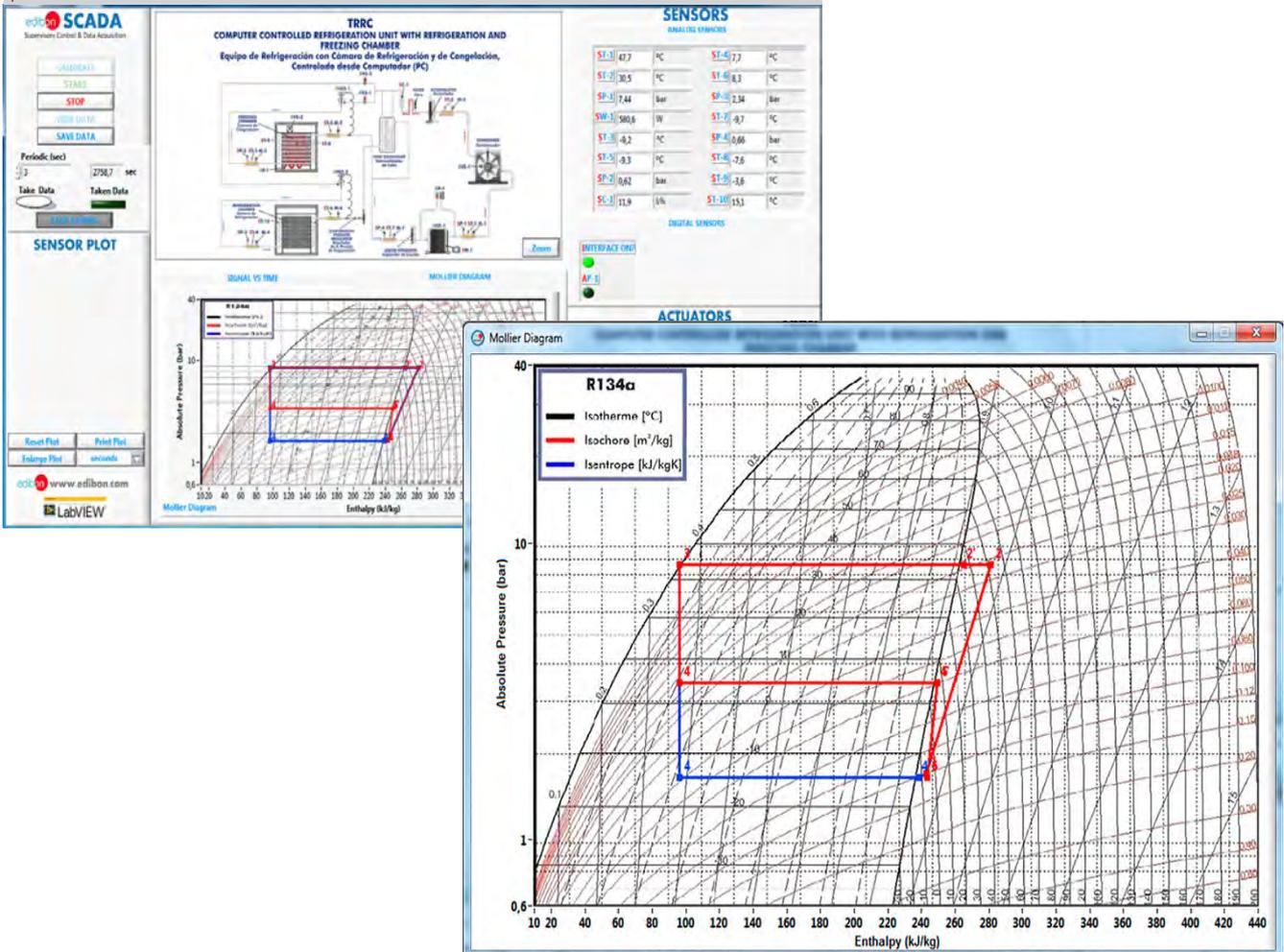
Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 11.

All these items try to give more possibilities for:

a) Industrial configuration. (PLC)

b) Technical and Vocational Education configuration. (ICAI and FSS)

c) 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.
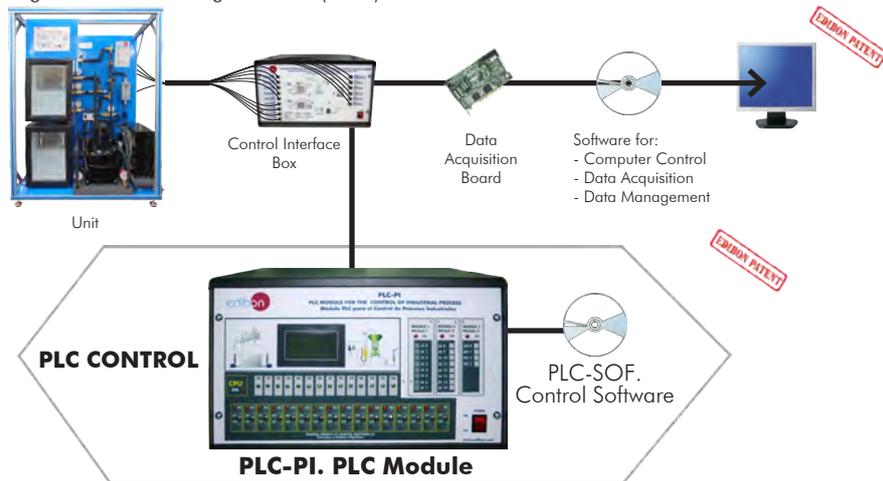
Communication RS232 wire to computer (PC).

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

-TRRC/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 Refrigeration Unit with Refrigeration and Freezing Chamber (TRRC).

Unit

Control Interface Box

Data Acquisition Board

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

PLC CONTROL

PLC-SOF. Control Software

PLC-PI. PLC Module

Practices to be done with PLC-PI:

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

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

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

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

5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).

6.- 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).

7.- PLC hardware general use.

8.- PLC process application for the particular unit.

9.- PLC structure.

10.-PLC inputs and outputs configuration.

11.-PLC configuration possibilities.

12.-PLC program languages.

13.-PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).

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 particular unit process.

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

18.-PLC Programming Exercises.

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

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

⑧ **TRRC/ICAI. Interactive Computer Aided Instruction Software System.**

This complete software package consists of an Instructor Software (EDIBON Classroom Manager -ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft -ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

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

-ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc... so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

User Data Base Management.

Administration and assignment of Workgroup, Task and Training sessions.

Creation and Integration of Practical Exercises and Multimedia Resources.
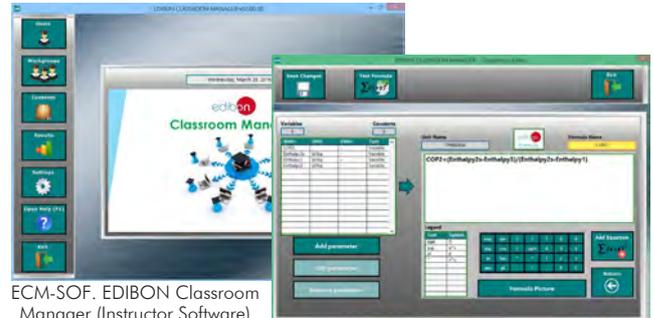
Custom Design of Evaluation Methods.

Creation and assignment of Formulas & Equations.

Equation System Solver Engine.

Updatable Contents.

Report generation, User Progression Monitoring and Statistics.

Instructor Software

ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application main screen

ECAL. EDIBON Calculations Program Package - Formula Editor Screen

ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram

ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

-ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

Student Log-In & Self-Registration.

Existing Tasks checking & Monitoring.

Default contents & scheduled tasks available to be used from the first session.

Practical Exercises accomplishment by following the Manual provided by EDIBON.

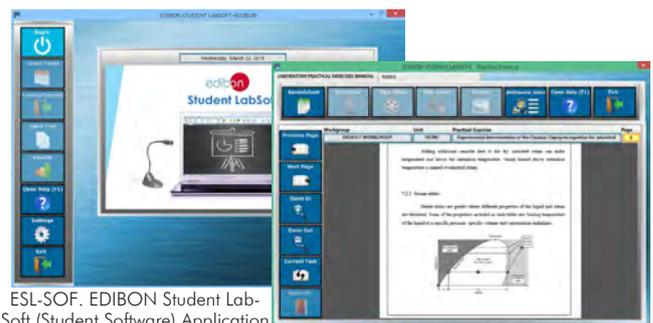**Evaluation Methods to prove your knowledge and progression.**

Test self-correction.

Calculations computing and plotting.

Equation System Solver Engine.

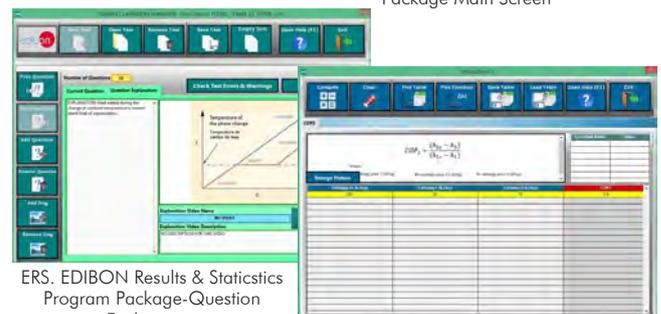**User Monitoring Learning & Printable Reports.**

Multimedia-Supported auxiliary resources.

Student Software

ESL-SOF. EDIBON Student Lab-Soft (Student Software) Application Main Screen

EPE. EDIBON Practical Exercise Program Package Main Screen

ERS. EDIBON Results & Staticstics Program Package-Question Explanation

ECAL. EDIBON Calculations ProgramPackage Main Screen

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

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

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

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

The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them. There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:

- An incorrect calibration is applied to them.

- Non-linearity.

Faults affecting the actuators:

- Actuators channels interchange at any time during the program execution.

- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.

- Reduction or increase of the calculated total response.

- The action of some controls is annulled.

On/off faults:

- Several on/off faults can be included.

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

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

Example of some screens

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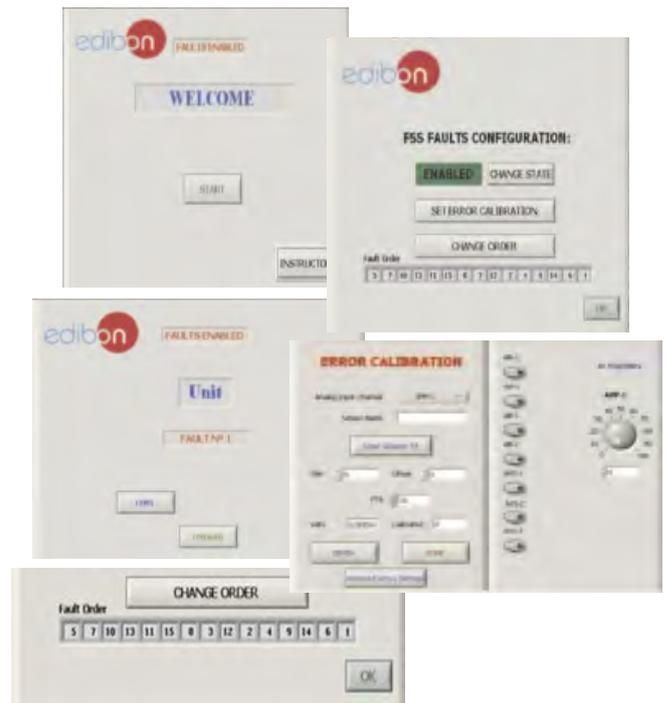
c) Multipost Expansions options

⑩ **Mini ESN. EDIBON Mini Scada-Net System.**

Mini ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously. It is useful for both, Higher Education and/or Technical and Vocational Education.

The Mini ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).
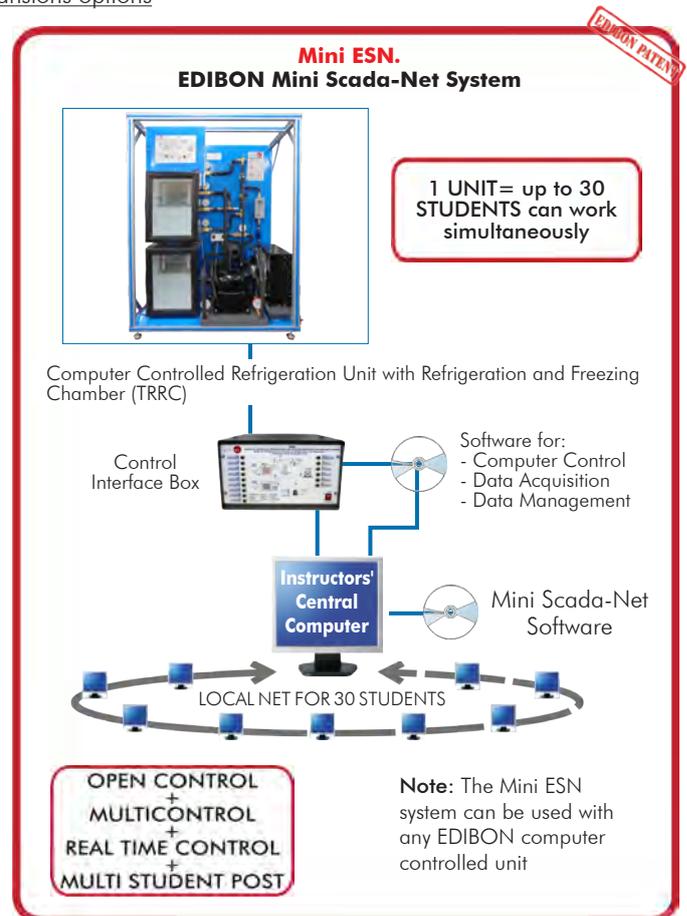
Main characteristics:

- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.

- Open Control + Multicontrol + Real Time Control + Multi Student Post.

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

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

- Instructor can see in the computer what any user/student is doing in the unit.

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

Main advantages:

- It allows an easier and quicker understanding.

- This system allows you can save time and cost.

- Future expansions with more EDIBON Units.

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

www.edibon.com/products/catalogues/en/Mini-ESN.pdf

Mini ESN.
EDIBON Mini Scada-Net System

1 UNIT= up to 30 STUDENTS can work simultaneously

Computer Controlled Refrigeration Unit with Refrigeration and Freezing Chamber (TRRC)

Control Interface Box

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

Instructors' Central Computer

Mini Scada-Net Software

LOCAL NET FOR 30 STUDENTS

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

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

⑪ **ESN. EDIBON Scada-Net System.**

This unit can be integrated, in the future, into 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/thermodynamicsthermotechnics/esn-thermodynamics/ESN-THERMODYNAMICS.pdf

Main items (always included in the supply)

Minimum supply always includes:

① Unit: TRRC. Computer Controlled Refrigeration Unit with Refrigeration and Freezing Chamber.

② TRRC/CIB. Control Interface Box.

③ DAB. Data Acquisition Board.

④ TRRC/CCSOF. Computer Control + Data Acquisition + Data Management Software.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals.

*IMPORTANT: Under TRRC 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.

   - TRRC/PLC-SOF. PLC Control Software.

b) Technical and Vocational Education configuration

⑧ TRRC/ICAI. Interactive Computer Aided Instruction Software System.

⑨ TRRC/FSS. Faults Simulation System.

c) Multipost Expansions options

⑩ Mini ESN. EDIBON Mini Scada-Net System.

⑪ ESN. EDIBON Scada-Net System.

① **TRRC. Unit:**
Bench-top unit.
Anodized aluminum frame 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.
This unit is designed to investigate a refrigeration system with refrigeration and freezing chambers with 1125 W of power. This unit is used for the training of apprentices in the field of refrigeration.

<u>High pressure area</u>:
    Hermetic compressor of 490 W, 5/40°C for refrigerant R-134a, computer controlled. Refrigerant capacity: 1100 W, 5/40°C.
    Wattmeter to measure the compressor power.
    Three pressure sensors located in the high pressure area, range: -1 to 24 bar.
    High pressure manometer located at the outlet of the compressor.
    Temperature sensor located at the outlet of the compressor, range: -50 to 120°C.
    Double pressure switch of 32/7.5 bar.

<u>Condensation area</u>:
    Air condenser, computer controlled, of 290 m³/h and 1.5 m² of area, with fan.
    High pressure manometer located at the outlet of the condenser.
    Temperature sensor located at the outlet of the condenser, range: -50 to 120°C.
    Refrigerant receiver. Refrigerant filter to retain particles of condensate.
    Flow sensor, range: 1.5 to 23.5 l./h. Heat exchanger for supercooling.

<u>Low pressure area</u>:
    Two solenoid valves, computer controlled. Two expansion valves.
    Three pressure sensors located after the expansion valves, range: -1 to 9 bar.
    Two low pressure manometers located after the expansion valves.
    Two temperature sensors located after the expansion valves, range: -50 to 120°C.
    Compressor inlet:
        Liquid separator to retain liquid particles before going on to the compressor.
        Temperature sensor located at the inlet of the compressor, range: -50 to 120°C.
        Low pressure manometer located at the compressor inlet.
        Pressure sensor located at the compressor inlet, range: -1 to 15 bar.

<u>Evaporation area</u>:
    Refrigeration:
        Insulated refrigeration chamber with a capacity of 20 l., and with 1 m² of evaporator area.
        Evaporator of the refrigeration chamber.
        Evaporation pressure control valve, range: 0 - 5.5 bar.
        Low pressure manometer located at the outlet of the refrigeration chamber evaporator.
        Temperature sensor located at the outlet of the refrigeration chamber evaporator, range: -50 to 100°C.
        Temperature sensor located at the refrigeration chamber, range: -50 to 100°C.
    Freezing:
        Insulated freezing chamber with a capacity of 20 l., and with 2.42 m² of evaporator area.
        Evaporator of the freezing chamber with computer controlled fan with 135 m³/h of air flow rate.
        Heating element of 150 W for defrosting, computer controlled.
        Low pressure manometer located at the outlet of the freezing chamber evaporator.
        Temperature sensor located at the outlet of the freezing chamber evaporator.
        Temperature sensor located in the evaporator of the freezing chamber.
        Temperature sensor located in the freezing chamber.

<u>Complementary instrumentation</u>:
    Three thermocouple with range: -50 to 100°C.
This unit has been designed for the use with the refrigerant R134a, CFC-free, environmental friendly.
The unit includes a pressure-enthalpy chart of the R134a refrigerant.
The complete unit includes as well:
    Advanced Real-Time SCADA.
    Open Control + Multicontrol + Real-Time Control.
    Specialized EDIBON Control Software based on LabVIEW.
    National Instruments Data Acquisition board (250 KS/s, kilo samples per second).
    Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.
    Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
    Capable of doing applied research, real industrial simulation, training courses, etc.
    Remote operation and control by the user and remote control for EDIBON technical support, are always included.
    Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
    Designed and manufactured under several quality standards.
    Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc.
    Apart from monitoring user's knowwledge and progress reached.
    This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② **TRRC/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 computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.
Real time computer control for parameters involved in the process simultaneously.
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 Express 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 **TRRC/CCSOF. 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.
Management, processing, comparison and storage of data.
Sampling velocity up to 250 KS/s (kilo samples per second).
Calibration system for the sensors involved in the process.
It allows the registration of the alarms state and the graphic representation in real time.
Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.
This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

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

⑥ **Manuals:**
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Exercises and Practical Possibilities to be done with the Main Items

1.- Representation of the thermodynamic cycle in the p-h log diagram.

2.- Determination of the refrigeration capacity.

3.- Determination of the compressor work.

4.- Determination of the coefficient of performance (COP).

5.- Design and components of a refrigeration system with two evaporators.

Additional practical possibilities:

6.- Sensors calibration.

7.- Study of the refrigerant subcooling effect.

8.- Study of the compressor and its function.

9.- Study of the evaporators and their functions.

10.-Study of the condenser and its function.

11.-Study of the expansion valve and its function.

12.-Study of the evaporation pressure control valve.

13.-Study of the defrost heater and its function.

14.-Study of the pressure switches and their function.

15.-Study of the effect of air in a refrigeration system.

16.-Temperature control.

17.-Measurement of power.

18.-Determination of the electrical performance of the compressor.

19.-Study of the solenoid valve and its function.

20.-Analysis of the pressure ratio in the behavior of the system.

21.-Relation between pressure and temperature.

22.-Study of the structure and elements of a refrigeration system with two evaporators.

23.-Fault finding in refrigeration systems components.

Other possibilities to be done with this Unit:

24.-Many students view results simultaneously.

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

25.-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.

26.-The Computer Control System with SCADA allows a real industrial simulation.

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

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

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

30.-Control of the TRRC unit process through the control interface box without the computer.

31.-Visualization of all the sensors values used in the TRRC unit process.

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

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

a) Industrial configuration

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

-PLC-PI. PLC Module:

Metallic box.

Circuit diagram in the module front panel.

Digital inputs (X) and Digital outputs (Y) block: 16 Digital inputs. 14 Digital outputs.

Analog inputs block: 16 Analog inputs.

Analog outputs block: 4 Analog outputs.

Touch screen.

Panasonic PLC:

High-speed scan of 0.32 μsec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.

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

-TRRC/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 particular unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the particular unit process.
3.- Calibration of all sensors included in the particular unit process.
4.- Hand on of all the actuators involved in the particular unit process.
5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrialenvironment to the process to be studied, etc).
7.- PLC hardware general use.
8.- PLC process application for the particular unit.
9.- PLC structure.
10.-PLC inputs and outputs configuration.
11.-PLC configuration possibilities.
12.-PLC program languages.
13.-PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).
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 particular unit process.
17.-Possibility of creating new process in relation with the particular unit.
18.-PLC Programming Exercises.
19.-Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ **TRRC/ICAI. Interactive Computer Aided Instruction Software System.**

This complete software package consists of an Instructor Software (EDIBON Classroom Manager -ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft -ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

-ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc...so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

User Data Base Management.

Administration and assignment of Workgroup, Task and Training sessions.

Creation and Integration of Practical Exercises and Multimedia Resources.

Custom Design of Evaluation Methods.

Creation and assignment of Formulas & Equations.

Equation System Solver Engine.

Updatable Contents.

Report generation, User Progression Monitoring and Statistics.

-ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

Student Log-In & Self-Registration.

Existing Tasks checking & Monitoring.

Default contents & scheduled tasks available to be used from the first session.

Practical Exercises accomplishment by following the Manual provided by EDIBON.

Evaluation Methods to prove your knowledge and progression.

Test self-correction.

Calculations computing and plotting.

Equation System Solver Engine.

User Monitoring Learning & Printable Reports.

Multimedia-Supported auxiliary resources.

⑨ TRRC/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 in causing several faults in the unit normal operation. The student must find them and solve them.

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

    Faults affecting the sensors measurement:
- An incorrect calibration is applied to them.
- Non-linearity.

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

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

    On/off faults:
- Several on/off faults can be included.

⑩ Mini ESN. EDIBON Mini Scada-Net System.

EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously.

The Mini ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit.

Main characteristics:
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing "real time" control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:
- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

The system basically will consist of:

  This system is used with a Computer Controlled Unit.
- Instructor's computer.
- Students' computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- Mini ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

✳ Specifications subject to change without previous notice, due to the convenience of improvement of the product.

REPRESENTATIVE: