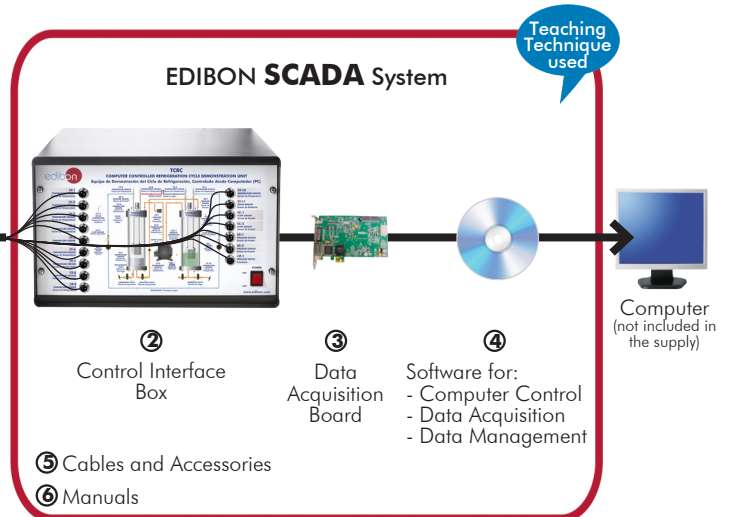


# Computer Controlled Refrigeration Cycle Demonstration Unit, with SCADA

TCRC



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

① Unit: TCRC. Computer Controlled Refrigeration Cycle Demonstration Unit

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 knowledge 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**



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↳ PRODUCTS  
↳ THERMODYNAMICS  
& THERMOTECHNICS

For more information about Key Features, click here



ISO 9001: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)



European Union Certificate (total safety)



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



"Worlddidac Quality Charter" and Platinum Member of Worlddidac

## INTRODUCTION

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.

Cooling is the process of reducing and maintaining the temperature of an object or space.

A very common refrigerating installation is the so-called compression cooling installation. It forces the flowing of a fluid inside a closed circuit mechanically, creating high and low pressure areas so that the fluid can absorb heat in one place and dissipate it in the other place.

In this installation, the coolant flows through four main elements: the compressor, the condenser, the expansion element and the evaporator. It is an advantage in a cooling installation the fact that the coolant has a lower boiling temperature at low pressure. For that reason, evaporation takes place at the low pressure side. During the coolant evaporation, heat is extracted from the air, that is to say, the environment cools down.

Condensation takes place at the high pressure side after the evaporator. In this case heat is emitted to the environment. A heat pump is the name given when not the cooling effect, but the emitted heat, is used.

The Computer Controlled Refrigeration Cycle Demonstration Unit, "TCRC", makes it possible to visualize clearly all the processes of a compression cooling system and the heat pump cycle, the analysis and demonstration of the pressure-temperature relationship during evaporation and condensation processes, the influence of diverse parameters on the process, etc.

## GENERAL DESCRIPTION

The Computer Controlled Refrigeration Cycle Demonstration Unit, "TCRC", 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.

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 allows a safe operation since it includes different safety elements, such as a high pressure switch that turns off the compressor when the pressure in the condenser and at the condenser upper part, the unit has a relief valve that opens itself when the condenser pressure is higher than the maximum valve allowed.

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

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

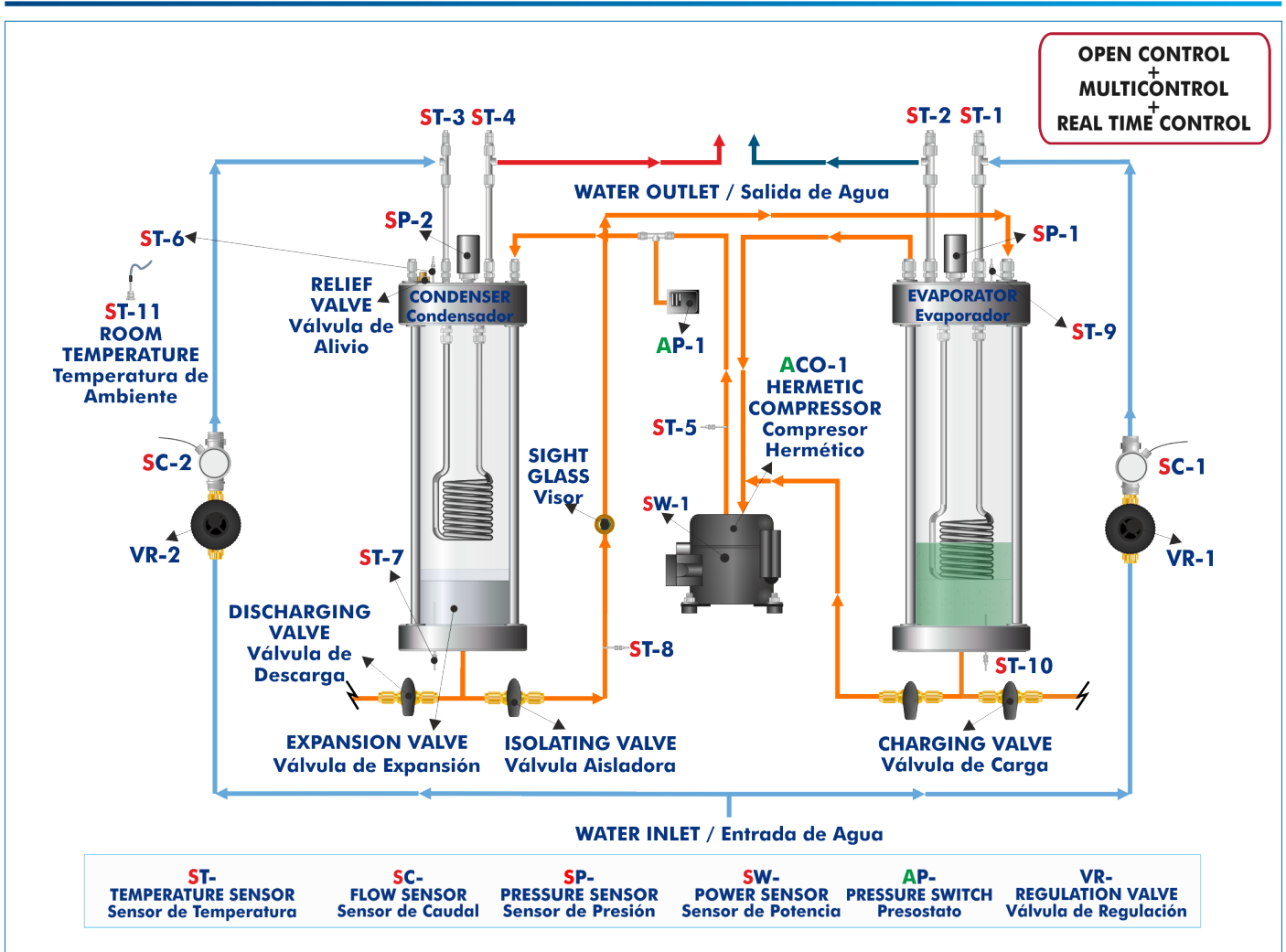
- The temperature and pressure of the refrigerant fluid in the evaporator and in the condenser.
- The temperature of the compression and expansion processes.
- The temperature of the water inlet and outlet at the coils of the evaporator and condenser.
- The water flow in the two coils.
- The room temperature.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

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.



TCRC detail

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



## COMPLETE TECHNICAL SPECIFICATIONS (for main items)

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 TCRC. Unit:

Bench-top unit.

Anodized aluminum structure and panels of painted steel.

Main metallic elements of stainless steel.

Diagram in the front panel with distribution of the elements similar to the real one.

#### Compressor:

Computer controlled hermetic compressor.

Power: 1/2 CV.

#### Condenser:

Vertical transparent cylinder, through which the coil of heat exchange can be seen.

Totally hermetic by viton joints.

It has a copper coil through which circulates cooling water inside:

Nine nickel-plated copper spires.

Diameter of coil: 1/4".

Heat transfer area: 0.032 m<sup>2</sup> approx.

#### Expansion:

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

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

#### Evaporator:

Vertical transparent cylinder, through which the coil of heat exchange can be seen.

Totally hermetic by viton joints.

It has a copper coil through which circulates water to promote the ebullition inside:

Nine nickel-plated copper spires.

Diameter of coil: 1/4".

Heat transfer area: 0.032 m<sup>2</sup> approx.

#### Instrumentation:

Eleven 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.

Two flow sensors to measure the water flow (condenser and evaporator), range: 0.25 – 6.5 l/min.

Two pressure sensors indicate the refrigerant fluid pressure in the condenser and in the evaporator:

Pressure sensor (condenser), range: 0 – 6 bar.

Pressure sensor (evaporator), range: -1 – 1.6 bar.

Power measurement from computer. Measure range: 0 – 1000 W.

The unit has all **necessary security measures** for safe work:

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.

Other valves:

Isolation valves to allow easy maintenance and modification.

Control valves.

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.

Entalpy diagram of SES36 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 knowledge 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: TCRC

**② TCRC/CIB. Control Interface Box:**

The Control Interface Box is part of the SCADA system.

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.

**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.**



TCRC/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/O. 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/O.

**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.

**The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.**



DAB

**④ TCRC/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).**

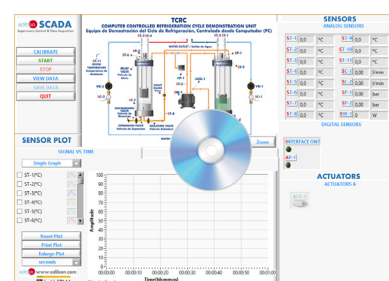
**Calibration system for the sensors involved in the process.**

**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.**



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 are the main items: TCRC + TCRC/CIB + DAB + TCRC/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

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1.- Demonstration of the vapour compression refrigeration and heat pump cycle and visualization of the most important processes.</li> <li>2.- Relation between pressure and temperature.</li> <li>3.- Demonstration of the refrigerant transfer from the evaporator to the condenser.</li> <li>4.- Charging demonstration.</li> <li>5.- Demonstration of the air effect in a refrigeration (cooling) system.</li> <li>6.- Evaporation and condensation temperatures effect in the refrigeration (cooling) rate and in the heat transfer at the condenser.</li> <li>7.- Analysis of the pressures relation effect in the system behaviour.</li> <li>8.- Determination of the system operation coefficients: coefficient of working as a refrigerator and as a heat pump.</li> <li>9.- Measurement of the electrical power.</li> <li>10.-Estimation of the heat transmission global coefficient between the SES36 refrigerant and the water.</li> </ol> <p>Additional practical possibilities:</p> <ol style="list-style-type: none"> <li>11.-Sensors calibration.</li> </ol> <p>Other possibilities to be done with this Unit:</p> <ol style="list-style-type: none"> <li>12.-Many students view results simultaneously.<br/>To view all results in real time in the classroom by means of a projector or an electronic whiteboard.</li> </ol> | <ol style="list-style-type: none"> <li>13.-Open Control, Multicontrol and Real Time Control.<br/>This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.</li> <li>14.-The Computer Control System with SCADA allows a real industrial simulation.</li> <li>15.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.</li> <li>16.-This unit can be used for doing applied research.</li> <li>17.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.</li> <li>18.-Control of the TCRC unit process through the control interface box without the computer.</li> <li>19.-Visualization of all the sensors values used in the TCRC unit process.<br/>- By using PLC-PI additional 19 more exercises can be done.<br/>- Several other exercises can be done and designed by the user.</li> </ol> |
|--|--|

### REQUIRED SERVICES

- |   |
|---|
| <ul style="list-style-type: none"> <li>- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.</li> <li>- Water supply and drain.</li> <li>- Computer.</li> </ul> |
|---|

### DIMENSIONS AND WEIGHTS

- |  |
|--|
| <p>TCRC:<br/>Unit:</p> <ul style="list-style-type: none"> <li>-Dimensions: 700 x 700 x 720 mm approx.<br/>(27.55 x 27.55 x 28.34 inches approx.)</li> <li>-Weight: 70 Kg approx.<br/>(154.32 pounds approx.)</li> </ul> <p>Control-Interface Box:</p> <ul style="list-style-type: none"> <li>-Dimensions: 490 x 330 x 310 mm approx.<br/>(19.29 x 12.99 x 12.20 inches approx.)</li> <li>-Weight: 10 Kg approx.<br/>(22 pounds approx.)</li> </ul> |
|--|

### SIMILAR UNITS AVAILABLE

- |  |
|--|
| <p style="text-align: center;"><u>Offered in this catalog:</u></p> <ul style="list-style-type: none"> <li>- TCRC. Computer Controlled Refrigeration Cycle Demonstration Unit.</li> </ul> <p style="text-align: center;"><u>Offered in other catalog:</u></p> <ul style="list-style-type: none"> <li>- TCRB. Refrigeration Cycle Demonstration Unit.</li> </ul> |
|--|

# SOFTWARE MAIN SCREENS

## SCADA Main screen

The SCADA Main screen displays a central schematic of the TCRC (Computer Controlled Refrigeration Cycle Demonstration Unit). The schematic includes components like the Condenser, Evaporator, Compressor (ACO-1), and various valves. It also shows a 'SENSORS ANALOG SENSORS' panel with real-time values for 11 temperature sensors (ST-1 to ST-11), two flow sensors (SC-1, SC-2), two pressure sensors (SP-1, SP-2), and one power sensor (SW-1). A 'DIGITAL SENSORS' panel shows the status of the compressor (ACO-1). A 'SIGNAL VS TIME' plot is visible, showing amplitude over time. A 'SENSORS PLOT' panel allows for channel selection and plot parameters. A 'Main software operation possibilities' panel includes buttons for CALIBRATE, START, STOP, VIEW DATA, SAVE DATA, and QUIT. A 'Real time graphics displays' panel shows a zoomed-in view of the plot.

- ① Main software operation possibilities.
- ② Sensors displays, real time values, and extra output parameters. Sensors: ST=Temperature sensor. SP=Pressure sensor. SC=Flow sensor. SW=Power sensor.
- ③ Actuators controls. Actuators: ACO=Compressor.
- ④ Channel selection and other plot parameters.
- ⑤ Real time graphics displays.

## Software for Sensors Calibration

Example of screen

The calibration interface consists of two main windows. The left window shows the 'Analog Input Channel' configuration for sensor SP-1, including calibration units (bar), current gain (0,221916), and current offset (-0,001878). It also has sections for 'Gain & Offset Settings' and 'Scaling Parameters' with a 'Least Square Fit' button. The right window shows a table of calibration data for multiple sensors and actuators.

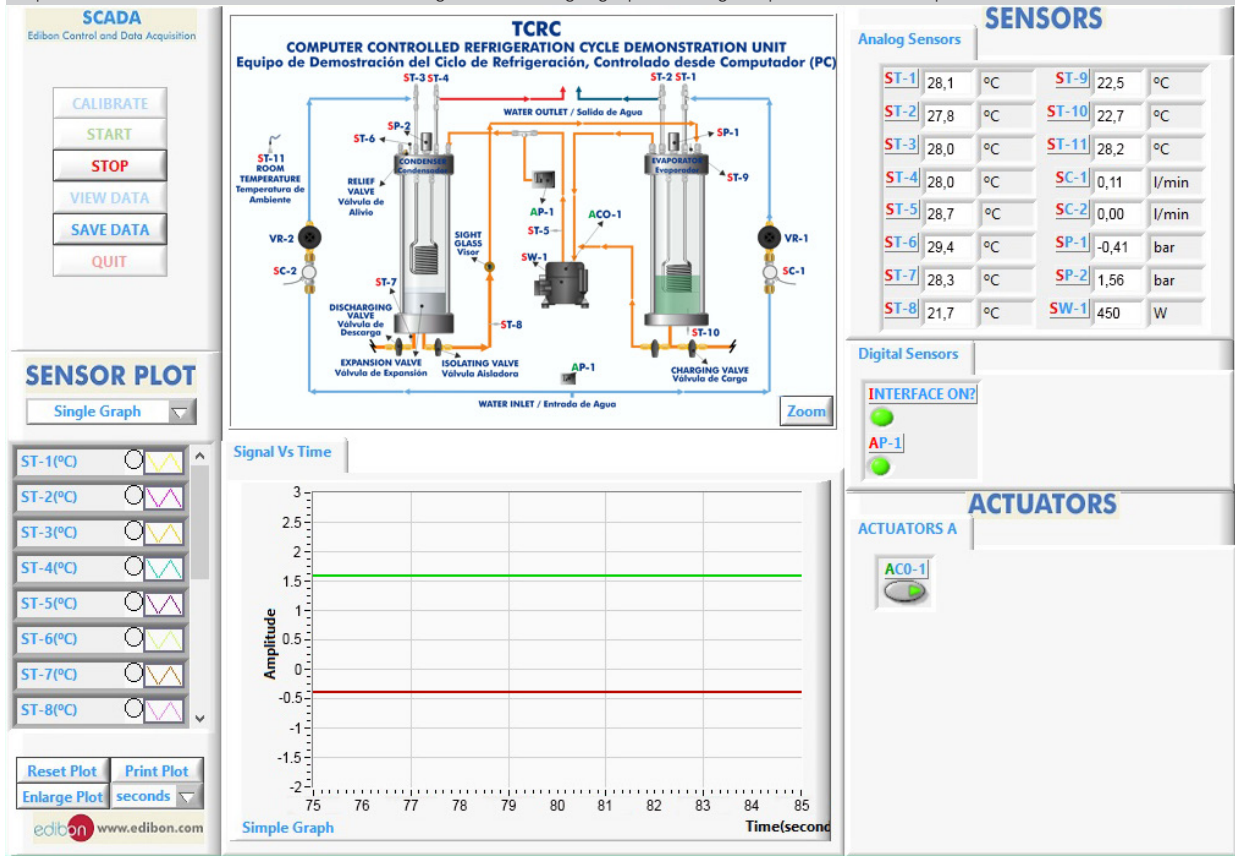
Sensors	Units	Volts	Calibrated	Err(%)	Current Gain	Current Offset
SP-1	bar	3,30668	0,731738	0,731738	0,221916	-0,001878
SP-2	bar	3,34534	4,05243	4,05243	1,21124	0,00146
SC-1	l/min	3,32428	1,79474	1,79474	0,554948	-0,049571
ST-1	°C	3,3573	315,797	315,797	93,2539	2,79439
SC-2	l/min	3,30089	1,75164	1,75164	0,545928	-0,049938
ST-2	°C	3,34753	311,898	311,898	92,6747	1,7456
ST-3	°C	3,32079	323,178	323,178	96,4974	2,8125

The right window also includes buttons for 'Restore factory Gains & Offsets', 'Set New Gain & Offset', 'Take Measurement', 'Get New Gain & Offset', and 'Taken Data'.

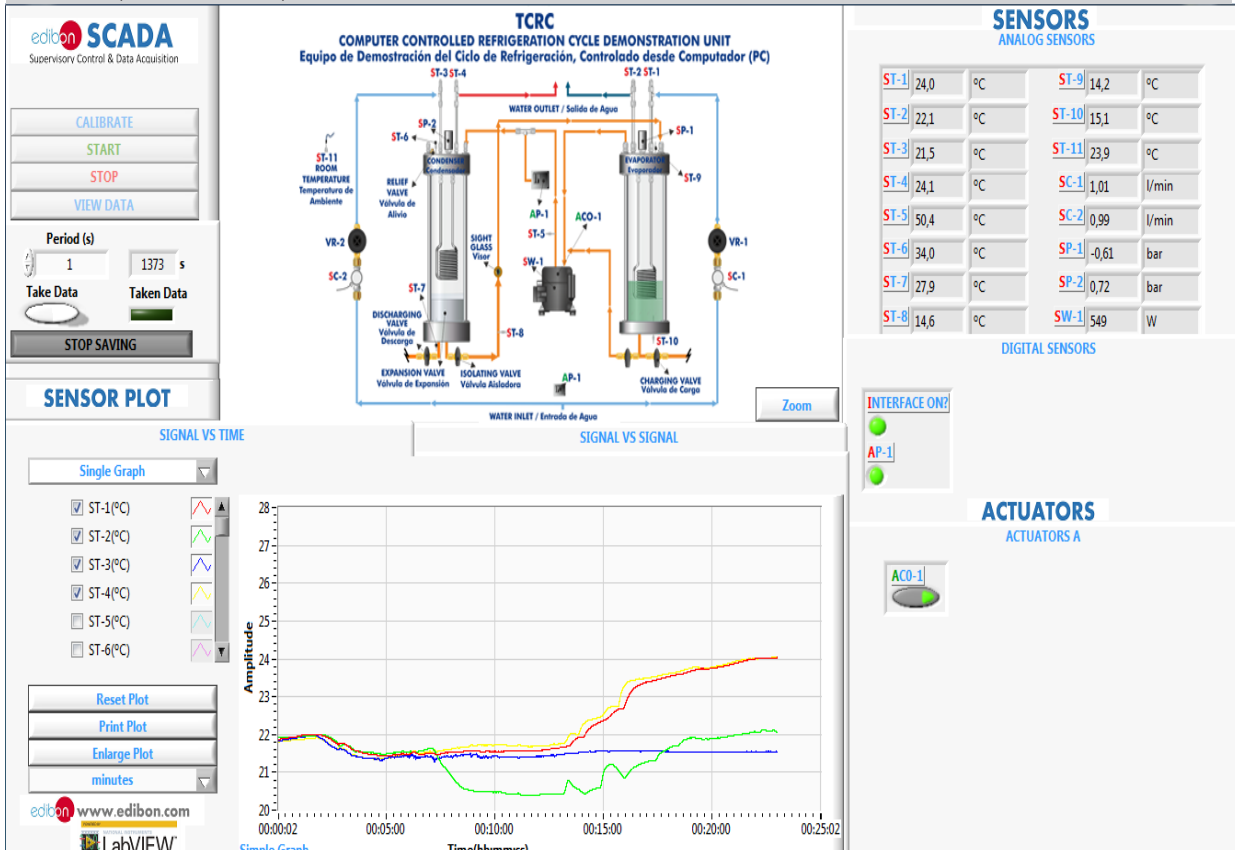
The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

## SOME REAL RESULTS OBTAINED FROM THIS UNIT

Representation in real time of the measured magnitudes. A single graph showing the pressure in the evaporator and condenser.



Real time representation of any measured variable.





Some **real** results obtained from this Unit

Real time representation of any measured variable.

**edibon SCADA**  
Supervisory Control & Data Acquisition

CALIBRATE  
START  
STOP  
VIEW DATA

Period (s)  
1 1559,2 s

Take Data Taken Data

STOP SAVING

**SENSOR PLOT**

SIGNAL VS TIME

Graph A

ST-11(°C)

SC-1(l/min)

SC-2(l/min)

SP-1(bar)

SP-2(bar)

SW-1(W)

Reset Plot  
Print Plot  
Enlarge Plot  
minutes

www.edibon.com  
LabVIEW

**TCRC**  
COMPUTER CONTROLLED REFRIGERATION CYCLE DEMONSTRATION UNIT  
Equipo de Demostración del Ciclo de Refrigeración, Controlado desde Computador (PC)

Zoom

**SENSORS**  
ANALOG SENSORS

ST-1	24,1	°C	ST-9	14,7	°C
ST-2	21,7	°C	ST-10	14,6	°C
ST-3	21,5	°C	ST-11	24,0	°C
ST-4	24,2	°C	SC-1	1,00	l/min
ST-5	51,2	°C	SC-2	1,00	l/min
ST-6	34,4	°C	SP-1	-0,63	bar
ST-7	28,1	°C	SP-2	0,73	bar
ST-8	13,9	°C	SW-1	555	W

DIGITAL SENSORS

INTERFACE ON?

AP-1

**ACTUATORS**  
ACTUATORS A

ACO-1

SIGNAL VS TIME

A Graph

SIGNAL VS SIGNAL

B Graph

Visualization and representation of saved data.

OPEN FILE

CLOSE

FILE NAME

Saved\_data\_ "TCRC" .xls

SIGNALS VS TIME

SIGNAL VS SIGNAL

- SC-1(l/min) 1
- ST-1(°C) 1
- SC-2(l/min) 1
- ST-2(°C) 1
- ST-3(°C) 1
- ST-4(°C) 1
- ST-5(°C) 1
- ST-6(°C) 1
- ST-7(°C) 1
- ST-8(°C) 1
- ST-9(°C) 1
- ST-10(°C) 1
- ST-11(°C) 1
- SW-1(W) 1

- SP-1(bar)
- SP-2(bar)
- SC-1(l/min)
- ST-1(°C)
- SC-2(l/min)
- ST-2(°C)
- ST-3(°C)
- ST-4(°C)
- ST-5(°C)
- ST-6(°C)
- ST-7(°C)
- ST-8(°C)
- ST-9(°C)
- ST-10(°C)
- ST-11(°C)
- SW-1(W)
- INTERFAC
- AP-1
- ACO-1

## COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

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  $\mu$ sec. 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.

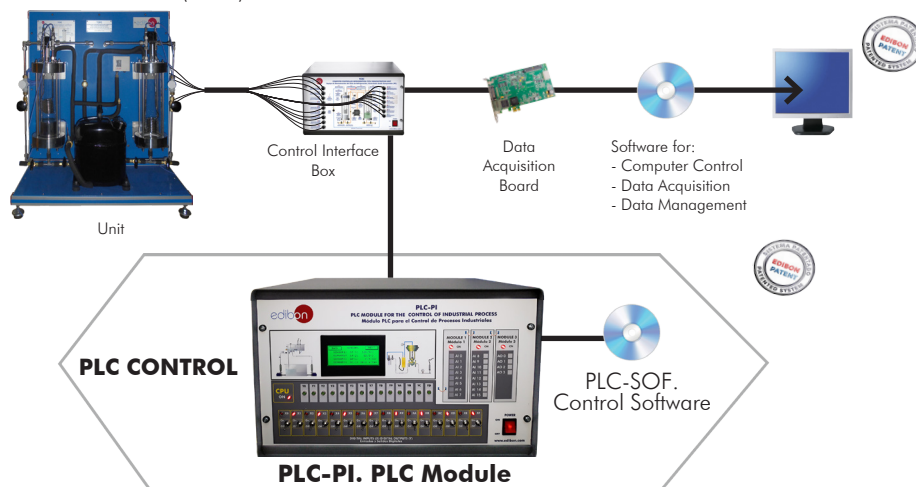
Communication RS232 wire to computer (PC).

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.).

##### -TCRC/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 Cycle Demonstration Unit (TCRC).



#### 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.

b) Technical and Vocational Education configuration

⑧ **TCRC/ICAI. Interactive Computer Aided Instruction Software.**

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.**

- **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.

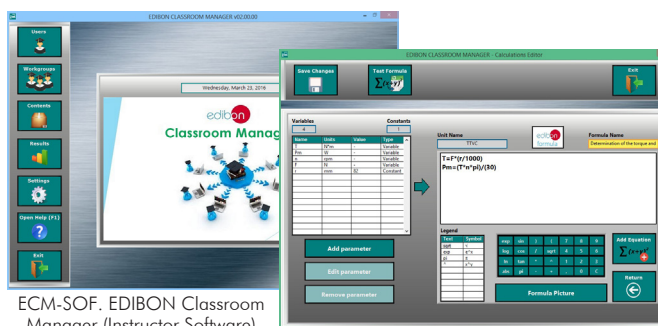
Innovative features:

- **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.**

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

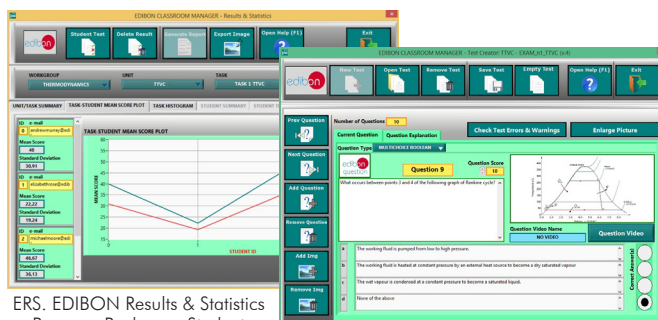
[www.edibon.com/en/files/expansion/ICAI/catalog](http://www.edibon.com/en/files/expansion/ICAI/catalog)

**Instructor Software**



ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen

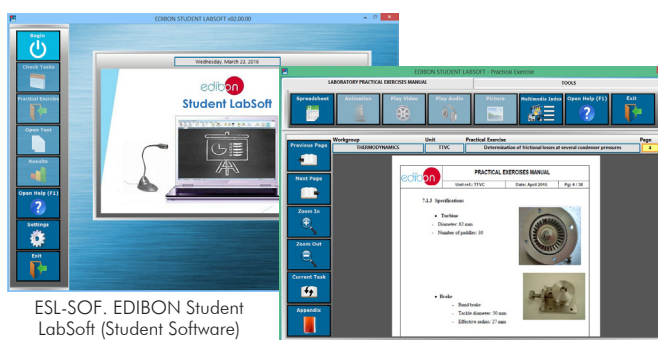
ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

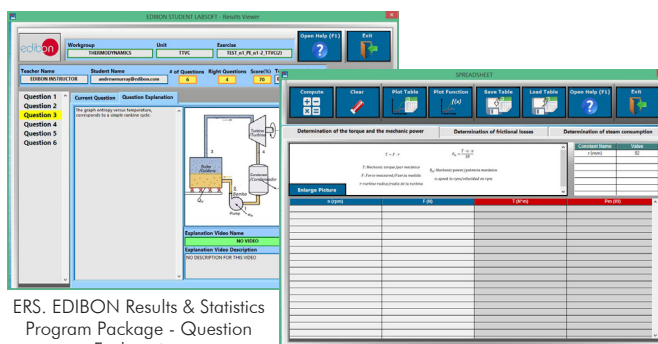
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

**Student Software**



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

EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation

ECAL. EDIBON Calculations Program Package Main Screen

9 **TCRC/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.

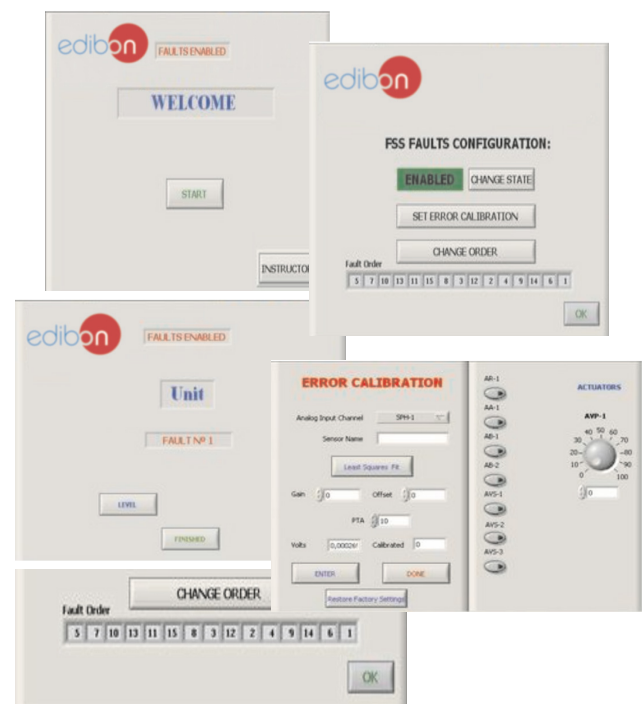
On/off faults:

- Several on/off faults can be included.

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

[www.edibon.com/en/files/expansion/FSS/catalog](http://www.edibon.com/en/files/expansion/FSS/catalog)

Example of some screens



c) Multipost Expansions options

10 **MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.**

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:

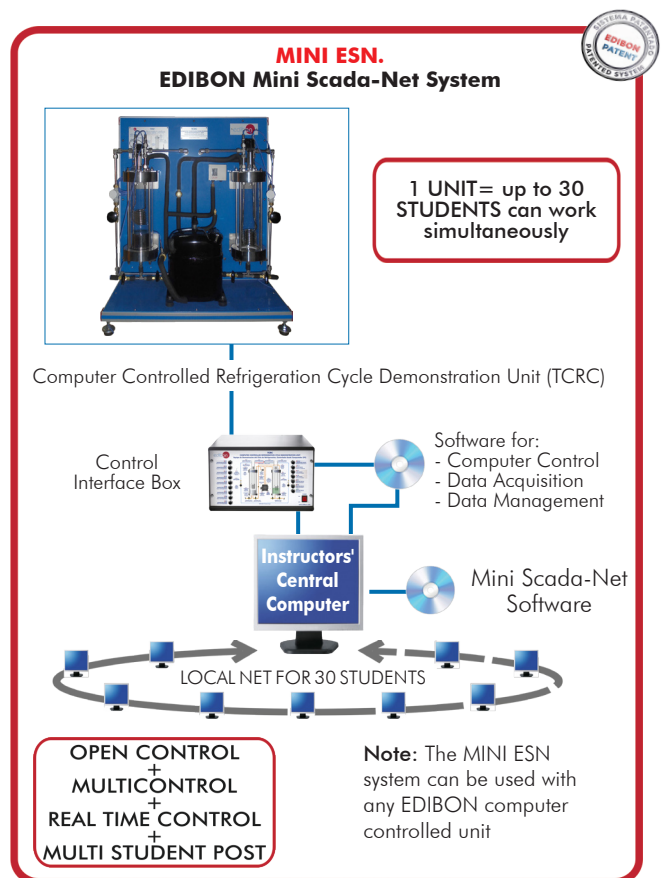
[www.edibon.com/en/files/expansion/MINI-ESN/catalog](http://www.edibon.com/en/files/expansion/MINI-ESN/catalog)

11 **ESN. EDIBON Scada-Net Systems.**

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/en/files/expansion/ESN/catalog](http://www.edibon.com/en/files/expansion/ESN/catalog)



## ORDER INFORMATION

### **Main items** (always included in the supply)

Minimum supply always includes:

- ① **Unit: TCRC. Computer Controlled 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.

### **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.
  - TCRC/PLC-SOF. PLC Control Software.

#### b) Technical and Vocational Education configuration

- ⑧ **TCRC/ICAL. Interactive Computer Aided Instruction Software.**
- ⑨ **TCRC/FSS. Faults Simulation System.**

#### c) Multipost Expansions options

- ⑩ **MINI ESN. EDIBON Mini Scada-Net System** for being used with EDIBON Teaching Units.
- ⑪ **ESN. EDIBON Scada-Net Systems.**

## TENDER SPECIFICATIONS (for main items)

### ① TCRC. Unit:

Bench-top unit.  
Anodized aluminum structure and panels of painted steel.  
Main metallic elements of stainless steel.  
Diagram in the front panel with distribution of the elements similar to the real one.

#### Compressor:

Computer controlled hermetic compressor.  
Power: 1/2 CV.

#### Condenser:

Vertical transparent cylinder, through which the coil of heat exchange can be seen.  
Totally hermetic by viton joints.  
It has a copper coil through which circulates cooling water inside:  
Nine nickel-plated copper spires.  
Diameter of coil: 1/4".  
Heat transfer area: 0.032 m<sup>2</sup> approx.

#### Expansion:

Expansion valve, float type, that is assembled on the condenser.  
Sight glass placed between the expansion valve and the evaporator, to show the formation of vapour bubbles after the expansion valve.

#### Evaporator:

Vertical transparent cylinder, through which the coil of heat exchange can be seen.  
Totally hermetic by viton joints.  
It has a copper coil through which circulates water to promote the ebullition inside:  
Nine nickel-plated copper spires.  
Diameter of coil: 1/4".  
Heat transfer area: 0.032 m<sup>2</sup> approx.

#### Instrumentation:

Eleven 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.  
Two flow sensors to measure the water flow (condenser and evaporator), range: 0.25 – 6.5 l/min.  
Two pressure sensors indicate the refrigerant fluid pressure in the condenser and in the evaporator:  
Pressure sensor (condenser), range: 0 – 6 bar.  
Pressure sensor (evaporator), range: -1 – 1.6 bar.  
Power measurement from computer. Measure range: 0 – 1000 W.  
The unit has all **necessary security measures** for safe work:  
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.

#### Other valves:

Isolation valves to allow easy maintenance and modification.  
Control valves.

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.  
Entalpy diagram of SES36 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 knowledge 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 TCRC/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.  
The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

### ④ TCRC/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.- Demonstration of the vapour compression refrigeration and heat pump cycle and visualization of the most important processes.
- 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: coefficient of working as a refrigerator and as a heat pump.
- 9.- Measurement of the electrical power.
- 10.-Estimation of the heat transmission global coefficient between the SES36 refrigerant and the water.

Additional practical possibilities:

- 11.-Sensors calibration.

Other possibilities to be done with this Unit:

- 12.-Many students view results simultaneously.

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

- 13.-Open Control, Multicontrol and Real Time Control.

This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.

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

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

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

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

- 18.-Control of the TCRC unit process through the control interface box without the computer.

- 19.-Visualization of all the sensors values used in the TCRC unit process.

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

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

## TENDER SPECIFICATIONS (for optional items)

### 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  $\mu$ sec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.

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

##### **-TCRC/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 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.

### b) Technical and Vocational Education configuration

#### **⑧ TCRC/ICAI. Interactive Computer Aided Instruction Software.**

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 TCRC/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.

c) Multipost Expansions options

**⑩ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.**

MINI ESN. 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.



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