edibon

Engineering and Technical Teaching Equipment

Computer Controlled **Refrigeration and Air Conditioning Modular Unit,** with SCADA and PID Control

TRAMC

Key features:

- **Advanced Real-Time SCADA and PID Control.**
- **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

POWERED BY NATIONAL INSTRUMENTS LabVIEW

www.edibon.com
PRODUCTS
9.- 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

Refrigeration is a process that involves lowering or maintaining the heat level of a body or a space.

The main devices where this process takes place are: cold rooms, refrigerated meat cases and blast chillers.

There are several types of refrigeration, among the most common ones:

Absorption refrigeration: based on the ability to absorb heat that some substances have.

Vapor-compression refrigeration: based on the ability of some substances to absorb heat when changing from a liquid to a gaseous state. This case is the most common at domestic and industrial level.

The compression refrigeration is based on mechanically forcing the circulation of a refrigerant through a closed circuit divided into two zones (high and low pressure), so that the fluid absorbs heat from the environment in a heat exchanger called evaporator (low pressure zone) and transfers heat in another exchanger called condenser (high pressure zone).

The absorption of heat from the environment in the evaporator may increase depending on the operating conditions of the refrigeration (pressure and temperature), so refrigeration or freezing processes can be distinguished depending on that heat.

The Computer Controlled Refrigeration and Air Conditioning Modular Unit, "TRAMC", designed by EDIBON, is a modular unit consisting on the TRAMC Unit Base, "TRAMC-UB", that can be complemented with different optional models to form different complete compression refrigeration circuits.

GENERAL DESCRIPTION

The minimum supply consists of two main elements: the TRAMC Unit Base, "TRAMC-UB", and at least one of the required elements described below.

The models are interconnected by special refrigerant hoses.

The main components of the TRAMC Unit Base, "TRAMC-UB", are compressor, condenser, refrigerant receiver and accessories to complement the refrigeration cycle. They are arranged in a clear and visible way to facilitate the understanding of the thermodynamic cycle.

The SCADA software, developed by EDIBON, has a data acquisition and control system that enables to automate the unit and to perform and assess all the practical exercises quickly, as well as to represent all the measured and calculated magnitudes in real time.

The measurements of the experiment are recorded in function of time and the generation of file compatible with spreadsheet applications via software. The temperatures and pressures existing in the system are recorded by sensors. Besides, the thermodynamic cycle can be represented in p-H and H- X diagrams.

Required elements (at least one) (Not included):

TRAMC/1. Home refrigeration model.

It consists of a refrigeration chamber with heater as refrigeration load, evaporator, fan and two expansion elements, capillary tube or expansion valve, selected by a solenoid valve.

TRAMC/2. Refrigeration system with refrigeration and freezing stage model.

It consists of two separated refrigeration chambers, each one with an evaporator that can work in series or in parallel. Two fans are included in the refrigeration chambers and heater to simulate the refrigeration loads. One of the refrigeration chambers can be alternatively used with an expansion valve or with a capillary tube as expansion element.

TRAMC/2 detail

TRAMC/3. Simple air conditioning system model for room cooling.

The TRAMC/3 model is part of the "TRAMC" training system for refrigeration and air conditioning engineering. The model, attached to the base unit by refrigeration hoses and fastened to the frame by bolts, is a simple air conditioning system that allows for the explanation of the basis of room refrigeration as well as the components of an air conditioning system. It contains an air duct with transparent front part, fan, an evaporator with air refrigerator and an expansion valve. All the components are clearly mounted on a panel.

The air volumetric flow is determined through a differential pressure measurement. The temperatures before and after the evaporator are recorded with sensors.

TRAMC/4. Complete air conditioning system model.

The TRAMC/4 model is part of the "TRAMC" training system for refrigeration and air conditioning engineering. The model, attached to the base unit by refrigeration hoses and fastened to the frame by bolts, is a full air conditioning system is created for the air cooler that allows for the explanation of the operation of an air conditioning system, the principals components and the recirculating air and outer air operating mode.

The purpose of room air conditioning is to shape the room climate in accordance with the requirements of people or sensitive goods.

It contains a fan with transparent front part, that recirculates the air between the two air ducts . The top air duct serves as climatic chamber whilst the bottom air duct contains the air cooler, two electric air heaters and a steam humidifier. A motorized butterfly valve in the top air duct allows a change between outer air and recirculating operation.

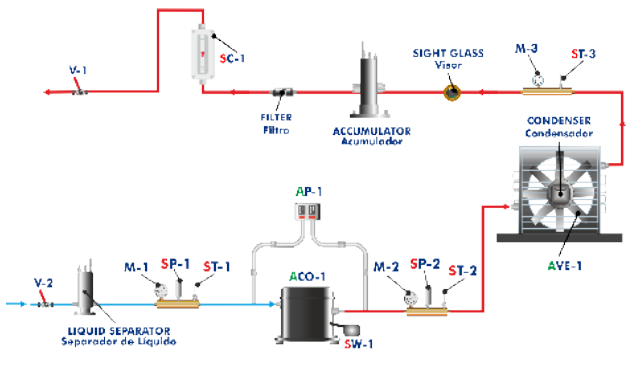
Depending on the combination of the different elements, the air can be cooled, heated, humidified or dehumidified.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The TRAMC Unit Base (TRAMC-UB) + 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.

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

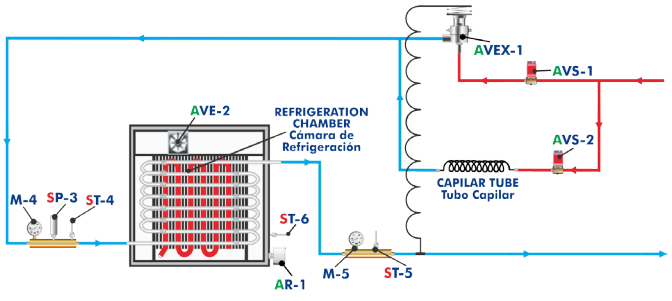
TRAMC-UB

TRAMC UNIT BASE
Unidad Base de TRAMC



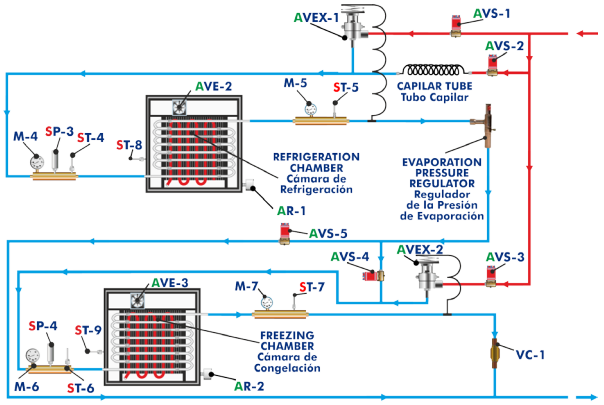
TRAMC/1

HOME REFRIGERATION MODEL
Modelo de Refrigerador Doméstico



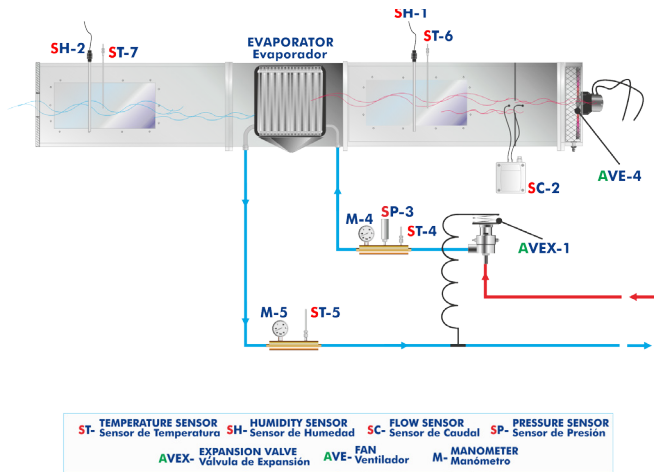
TRAMC/2

REFRIGERATION SYSTEM WITH REFRIGERATION AND FREEZING STAGE MODEL
Modelo de Instalación Frigorífica con Etapa de Refrigeración y Congelación



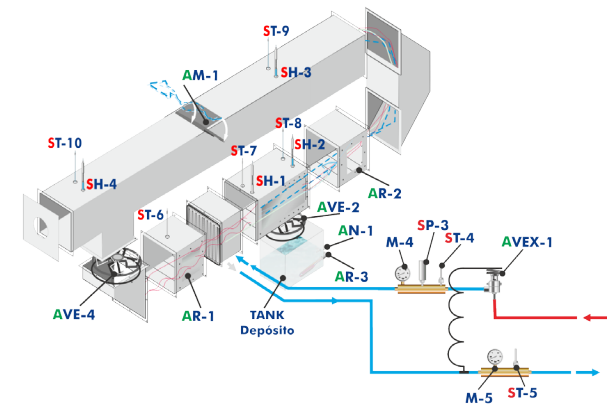
TRAMC/3

SIMPLE AIR CONDITIONING SYSTEM MODEL FOR ROOM COOLING
Modelo de Instalación de Aire Acondicionado Simple para Refrigeración de Espacios



TRAMC/4

COMPLETE AIR CONDITIONING SYSTEM MODEL
Modelo de Climatización Completo



With this unit there are several options and possibilities:
- Main items: 1, 2, 3, 4 and 5.
- Optional items: 6, 7, 8, 9 and 10.

Let us describe first the main items (1 to 5):

① TRAMC-UB. TRAMC Unit Base:

TRAMC-UB

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Base unit that allows, together with the models, the performance of experiments for the study of the operation of refrigeration and air conditioning systems.

Models safely coupled through refrigerant hoses with shut-off valves.

Computer controlled hermetic compressor. Power: 3/8 HP.

Condenser. Finned tube heat exchanger with computer controlled fan. Air flow: 580 m^3/h.

Storage vessel to prevent a wrong operation of the compressor, capacity: 0.5 l.

Filter for the refrigerant.

Sight glass for the refrigerant.

Liquid separator to prevent liquid from entering the compressor, capacity: 0.73 l.

High and low pressure switch, range: 0.7 – 4 bar for low pressure and 8 – 32 bar for high pressure.

Two pressure sensors:

Pressure measurement before the compressor. Low pressure range: 0 – 10 bar.

Pressure measurement after the compressor. High pressure range: 0 – 25 bar.

Flow sensor for the refrigerant, range: 5 – 60 l/h.

Three "J" type temperature sensors.

Power sensor for the compressor.

Low pressure manometer at the intake side (before the compressor), range: from -1 to 10 bar/from -50 – 40 °C.

Two high pressure manometers in the delivery side (after the compressor and after the condenser), range: from -1 to 30 bar/from -40 – 80 °C.

Enthalpy diagram of the R134a refrigerant.

The unit has been designed to be used with the CFC-free and environmentally friendly R134a refrigerant.

The complete unit includes as well:

Advanced Real-Time SCADA and PID Control.

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.

Required elements (at least one) (Not included):
- TRAMC/1. Home refrigeration model.
- TRAMC/2. Refrigeration System with Refrigeration and Freezing Stage Model.
- TRAMC/3. Simple Air Conditioning System Model for Room Cooling.
- TRAMC/4. Complete Air Conditioning System Model.

Additional recommended elements (Not included):
-T/KIT1. Maintenance Kit containing Vacuum Pump, Hoses and Manometers.
-T/KIT2. Maintenance Kit containing Leakage Detector.
-T/KIT3. Maintenance Kit containing Refrigerant Filling and Evacuation module.

② TRAMC/CIB. Control Interface Box:

This control interface is common for the required elements (at least one) (Not included)

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.

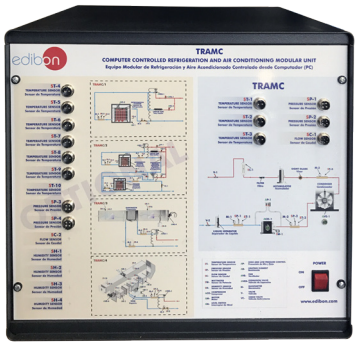
Real time curves representation about system responses.

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.



TRAMC/CIB

Shield and filtered signals to avoid external interferences.

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

Real time PID and on/off control for pumps, compressors, heating elements, control valves, etc.

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

Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).

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

Possibility of automatization of the actuators involved in the process.

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

③ DAB. Data Acquisition Board:

Common for the modules type "TXC".

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

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

④ Cables and Accessories, for normal operation.

⑤ Manuals:

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

Required elements (at least one) (Not included):

TRAMC/1. Home Refrigeration Model:

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Insulated refrigeration chamber with transparent front side and capacity of 35 l. The chamber includes:

Finned tube evaporator with fan. Air flow: 50 m^3/h.

Computer controlled finned heating element, power: 100 W.

Two computer controlled solenoid valves to select the circuits.

Thermal expansion valve.

Capillary tube made of copper with a length of 6 m.

Pressure sensor. Low pressure range: 0 – 10 bar.

Three "J" type temperature sensors.

Two low pressure manometers, range: from -1 – 10 bar/from -50 – 40 °C.

Easy connection to the TRAMC Unit Base, "TRAMC-UB".

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

TRAMC/1

(+)**TRAMC/1/CCSOF. PID 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.

Analog and digital PID control.

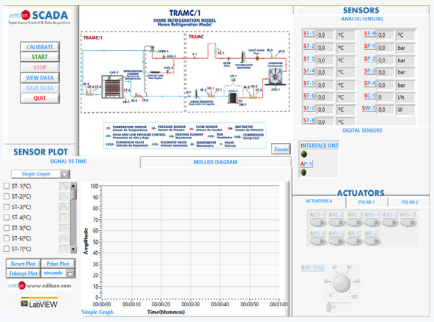
PID menu and set point selection required in the whole work range.

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.

Required elements (at least one) (Not included):

TRAMC/2. Refrigeration System with Refrigeration and Freezing Stage Model

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Insulated refrigeration chamber with transparent front side and capacity of 35 l. The chamber includes:

- Finned tube evaporator with fan. Air flow: 50 m^3/h.
- Computer controlled finned heating element, power: 100 W.

Insulated freezing chamber with transparent front side and capacity of 35 l. The chamber includes:

- Finned tube evaporator with fan. Air flow: 50 m^3/h.
- Computer controlled finned heating element, power: 100 W.

Five computer controlled solenoid valves to select the circuits. The evaporators can operate in series or in parallel.

Thermal expansion valve for the refrigeration chamber.

Capillary tube made of copper for the refrigeration chamber with a length of 6 m.

Thermal expansion valve for the freezing chamber.

Adjustable evaporation pressure regulator.

Non-return valve.

Two pressure sensors. Low pressure range: 0 – 10 bar.

Six "J" type temperature sensors.

Four low pressure manometers, range: from -1 – 10 bar/from -50 – 40 °C.

Easy connection to the TRAMC Unit Base, "TRAMC-UB".

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

TRAMC/2

(+)**TRAMC/2/CCSOF. PID 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.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

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

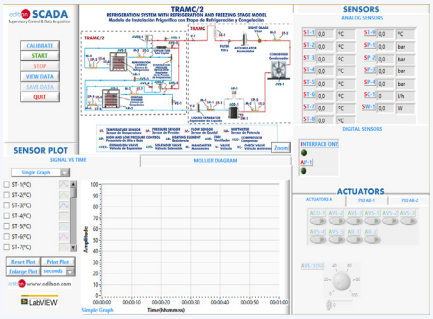
Calibration system for the sensors involved in the process.

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.



Required elements (at least one) (Not included):

TRAMC/3. Simple Air Conditioning System Model for Room Cooling

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Air tunnel with windows to look inside.

Fan with computer controlled speed.

Evaporator: radiator to cool air.

"J" type temperature sensor and humidity sensor in the tunnel, before and after the evaporator.

Differential pressure sensor to measure air flow.

Refrigeration circuit:

- Thermal expansion valve.
- Pressure sensor. Low pressure range: 0 – 10 bar.
- Two "J" type temperature sensors.
- Two low pressure manometers, range: from -1 – 10 bar/from -50 – 40 °C.

Easy connection to the TRAMC Unit Base, "TRAMC-UB".

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

TRAMC/3

(+)TRAMC/3/CCSOF. PID 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.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

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

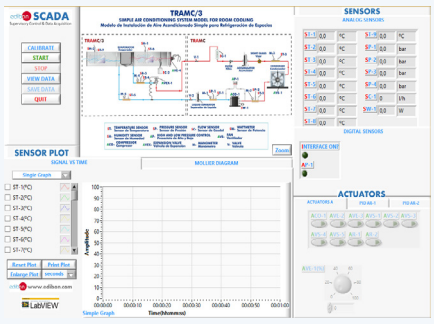
Calibration system for the sensors involved in the process.

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.



Required elements (at least one) (Not included):

TRAMC/4. Complete Air Conditioning System Model

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Air tunnel with windows to look inside the tunnel.

Motor driven trapdoor enables the mixture of outside air and flowing air.

Fan with computer controlled speed.

Evaporator: radiator to cool air.

Two heating elements: a preheating one at the inlet of the evaporator and a reheating one at the outlet of the evaporator.

Air humidifier with level switch, fan and heating element.

Four humidity sensors and five "J" type temperature sensors at key points of the tunnel.

Refrigeration circuit:

- Thermal expansion valve.
- Pressure sensor. Low pressure range: 0 – 10 bar.
- Two "J" type temperature sensors.
- Two low pressure manometers. Range: from -1 – 10 bar/from -50 – 40 °C.

Easy connection to the TRAMC Unit Base, "TRAMC-UB".

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

TRAMC/4

(+)**TRAMC/4/CCSOF. PID 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.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

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

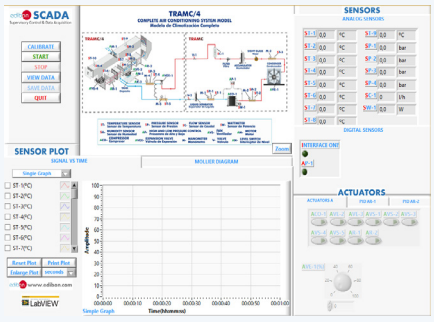
Calibration system for the sensors involved in the process.

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.



Practices to be done with the Home Refrigeration Model (TRAMC/1):

1.- Function and behavior of the refrigeration circuit components.

2.- Study and comparation of work with different expansion elements:

Expansion valve.

Capillary tube.

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

Additional practical possibilities:

4.- Sensors calibration.

5.- Properties of the refrigerant R134a.

6.- Enthalpy-pressure diagram for the refrigerant R134a.

Practices to be done with the Refrigeration System with Refrigeration and Freezing Stage Model (TRAMC/2):

7.- Function and behavior of the refrigeration circuit components.

8.- Study and comparation of work with different expansion elements:

Expansion valve.

Capillary tube.

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

10.- Study of a refrigeration system with two evaporators in series and in parallel.

11.-Study of a refrigeration system with two evaporators in series and in parallel.

Additional practical possibilities:

12.-Sensors calibration.

13.-Properties of the refrigerant R134a.

14.-Enthalpy-pressure diagram for the refrigerant R134a.

Practices to be done with the Simple Air Conditioning System Model for Room Cooling (TRAMC/3):

15.-Study of the function and behavior of an air conditioning system.

16.-Study of the room air conditioning.

17.-Study of the operation of an evaporator as air cooler.

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

Additional practical possibilities:

19.-Sensors calibration.

20.-Properties of the refrigerant R134a.

21.-Enthalpy-pressure diagram for the refrigerant R134a.

Practices to be done with the Complete Air Conditioning System Model (TRAMC/4):

22.-Study of the components of an air conditioning system for room cooling and a complete air conditioning system.

23.- Demonstration of air heating, cooling, humidifying and de-humidifying processes.

24.-Representation in the h-x diagram for humid air: heating and cooling, humidifying and de-humidifying.

25.-Recirculation and outer air operation modes.

Additional practical possibilities:

26.-Sensors calibration.

27.-Properties of the refrigerant R134a.

28.-Enthalpy-pressure diagram for the refrigerant R134a.

Other possibilities to be done with this System:

29.- Many students view results simultaneously.

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

30.- 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.

31.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.

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

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

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

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

36.- Visualization of all the sensors values used in the 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 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Water supply and drain.
- Computer.

DIMENSIONS AND WEIGHTS

TRAMC:

TRAMC-UB. TRAMC Unit Base:

-Dimensions: 1100 x 630 x 500 mm approx.
(43.30 x 24.80 x 19.68 inches approx.)

-Weight: 50 kg approx.
(110.2 pounds approx.)

TRAMC/1. Unit:

-Dimensions: 1100 x 630 x 320 mm approx.
(43.30 x 24.80 x 12.60 inches approx.)

-Weight: 20 kg approx.
(44.09 pounds approx.)

TRAMC/2. Unit:

-Dimensions: 1500 x 700 x 320 mm approx.
(59.05 x 27.55 x 12.60 inches approx.)

-Weight: 30 kg approx.
(66.13 pounds approx.)

TRAMC/3. Unit:

-Dimensions: 1100 x 630 x 320 mm approx.
(43.30 x 24.80 x 12.60 inches approx.)

-Weight: 20 kg approx.
(44.09 pounds approx.)

TRAMC/4. Unit:

-Dimensions: 1200 x 700 x 320 mm approx.
(47.24 x 27.55 x 12.60 inches approx.)

-Weight: 25 kg approx.
(55.11 pounds approx.)

Control Interface Box:

-Dimensions: 490 x 450 x 470 mm approx.
(19.29 x 17.71 x 18.50 inches approx.)

-Weight: 20 kg approx.
(44 pounds approx.)

REQUIRED ELEMENTS (Not included)

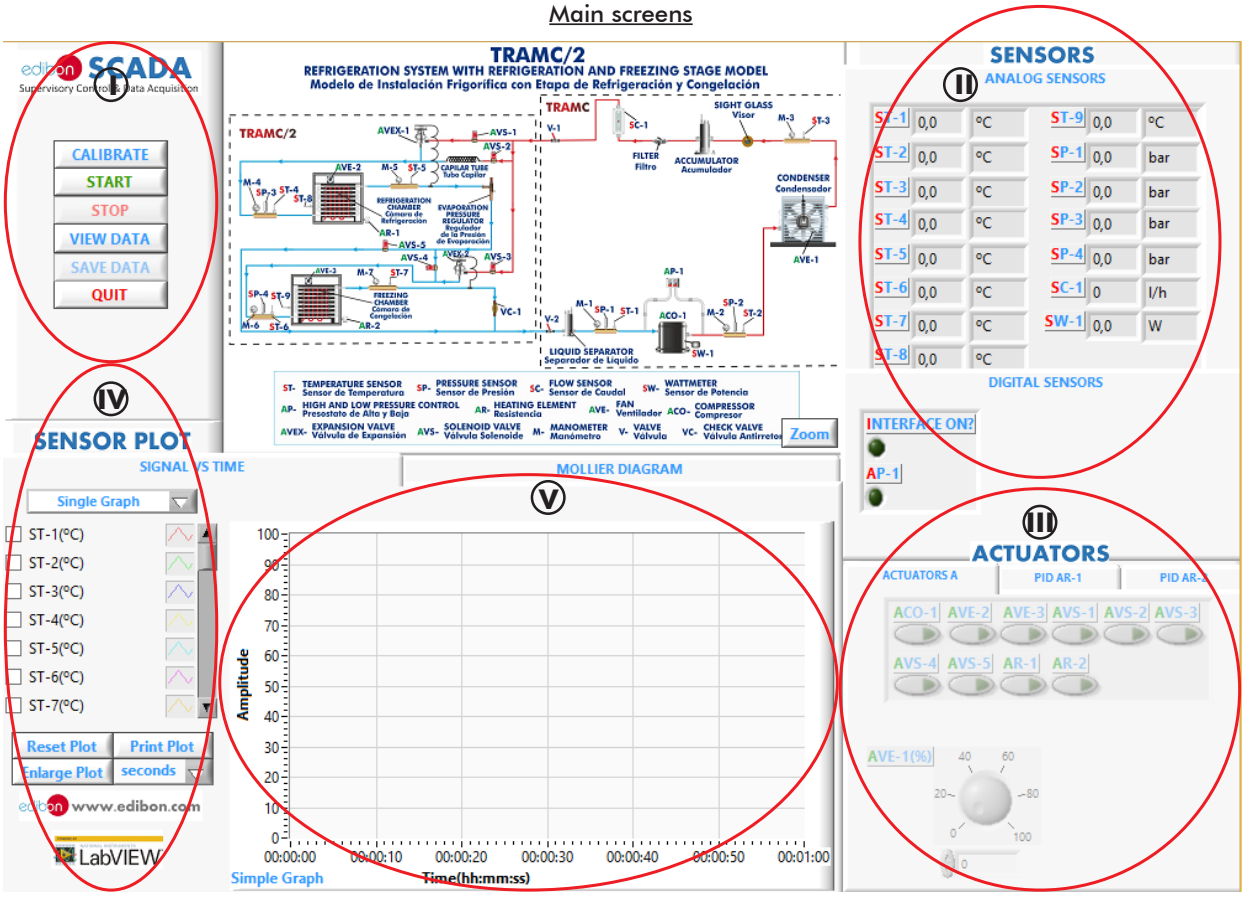
Required (at least one):

- TRAMC/1. Home refrigeration model.
- TRAMC/2. Refrigeration system with refrigeration and freezing stage model.
- TRAMC/3. Simple air conditioning system model for room cooling.
- TRAMC/4. Complete air conditioning system model.

ADDITIONAL RECOMMENDED ELEMENTS (Not included)

-T/KIT1. Maintenance Kit containing Vacuum Pump, Hoses and Manometers.
-T/KIT2. Maintenance Kit containing Leakage Detector.
-T/KIT3. Maintenance Kit containing Refrigerant Filling and Evacuation module.

SCADA and PID Control
Main screens



Ⓘ Main software operation possibilities.

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

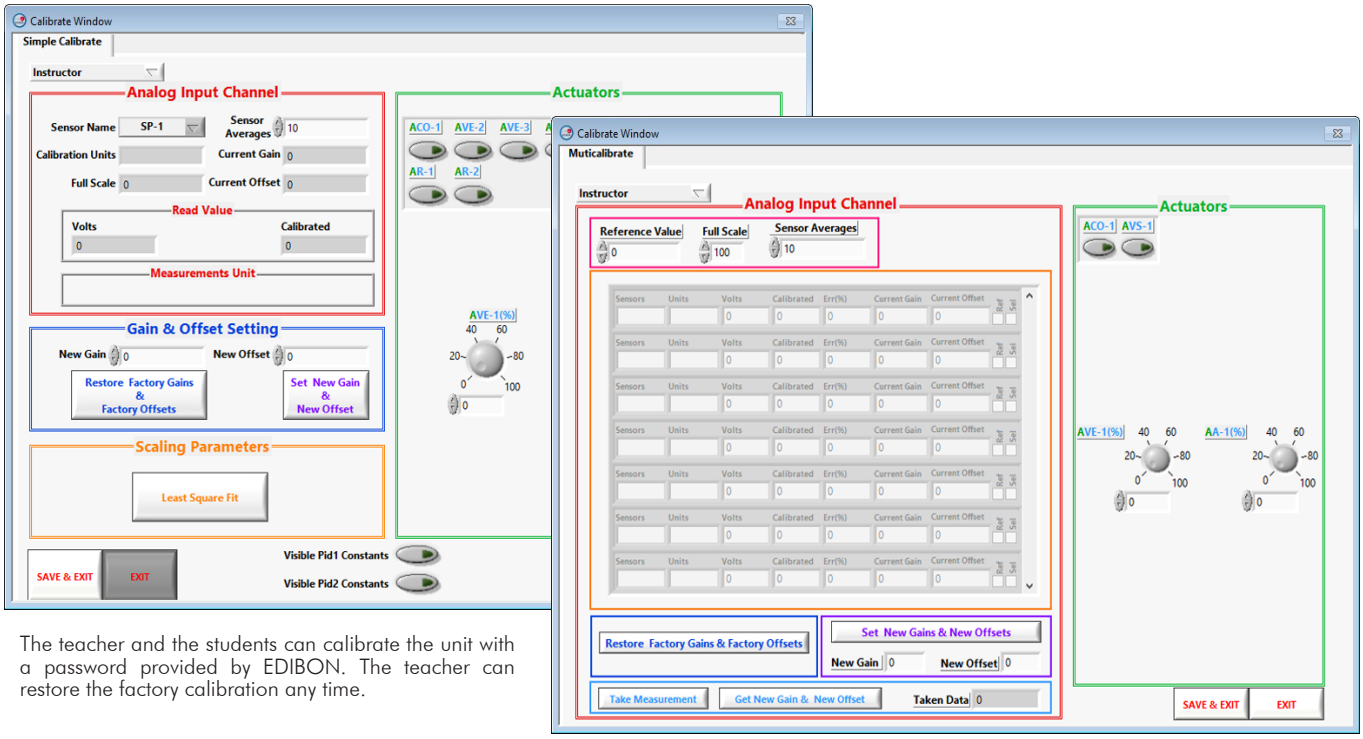
Ⓘⓘⓘ **Actuators controls. Actuators:** ACO=Compressor. AM=Motor. AN=Level switch. AP=High and pressure control. AR=Heating element. AVE=Fan. AVS=Solenoid valve.

Ⓘⓥ Channel selection and other plot parameters.

Ⓥ Real time graphics displays.

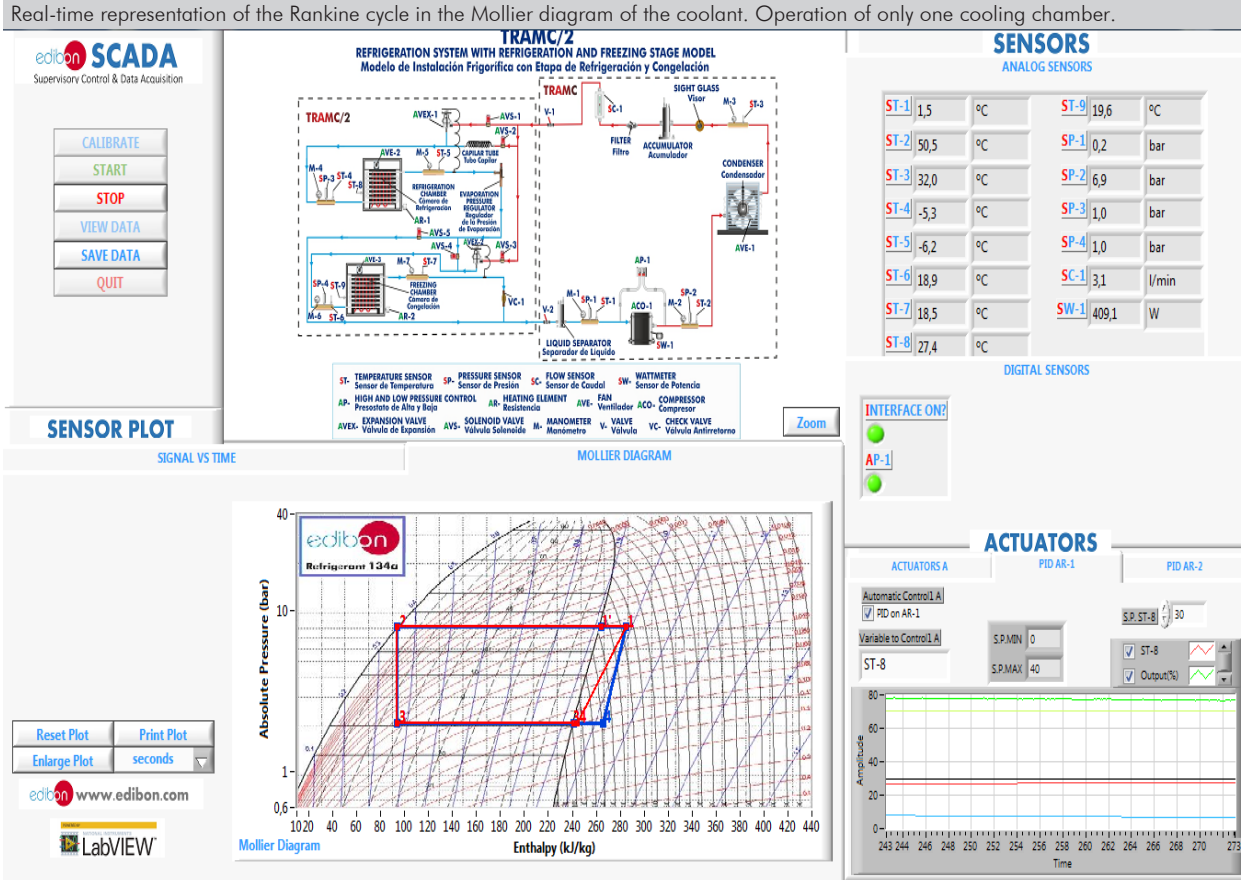
Software for Sensors Calibration

Example of screen

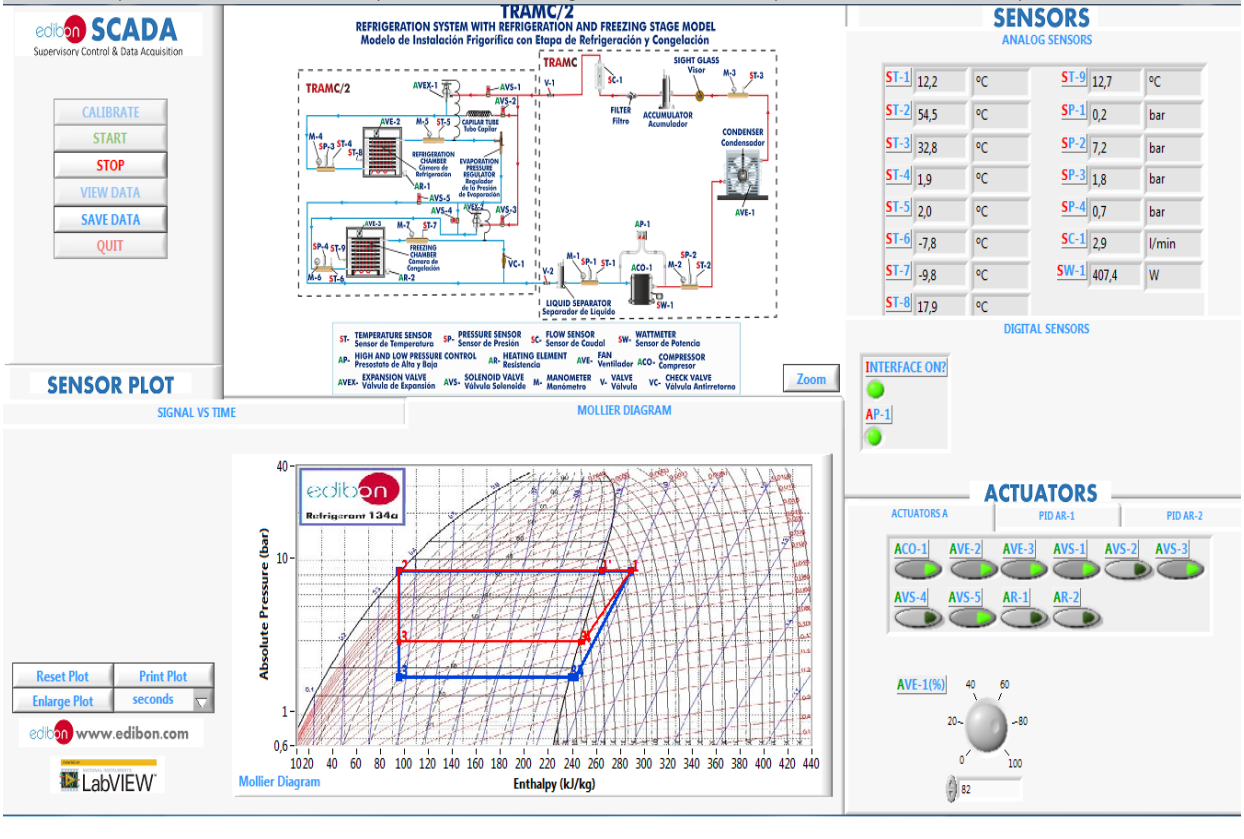


The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

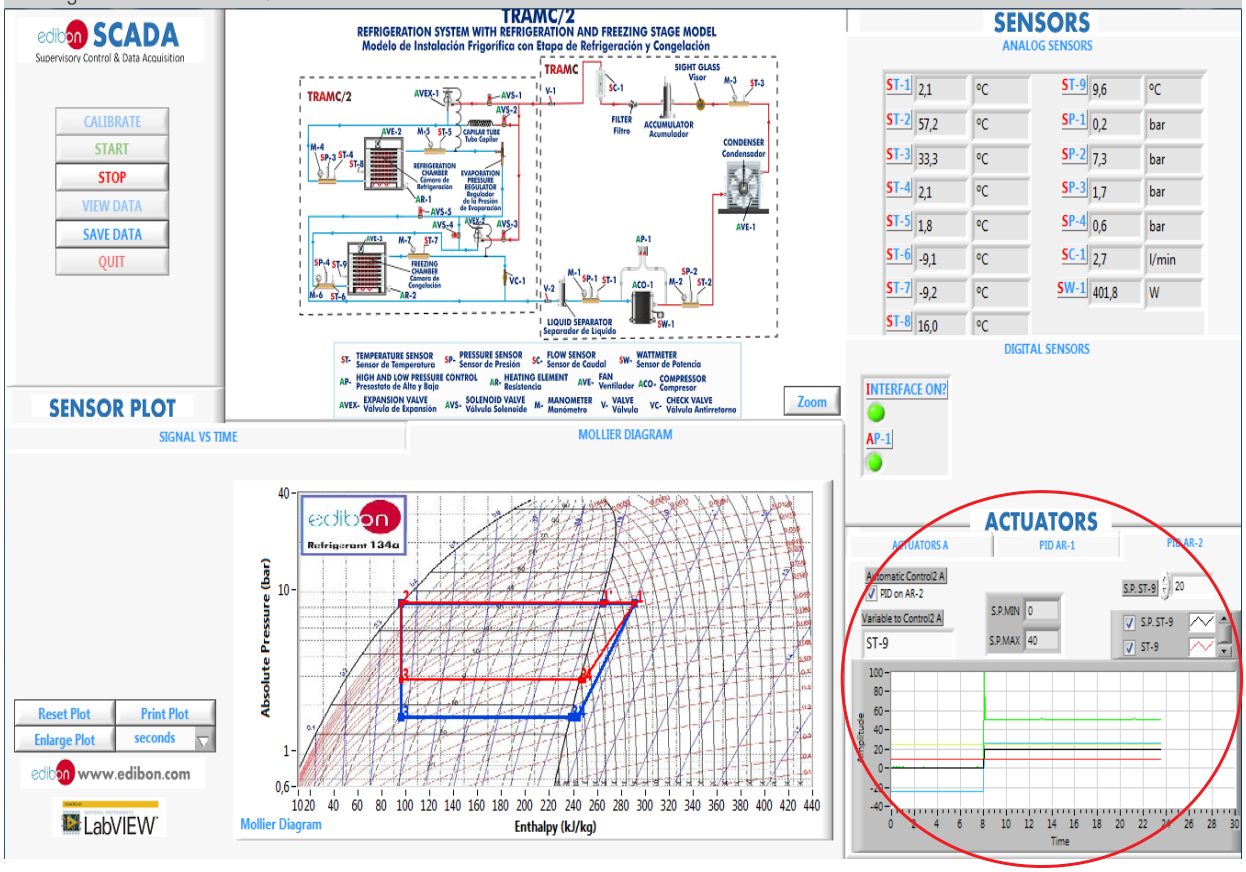
Real-time representation of the Rankine cycle in the Mollier diagram of the coolant. Operation of only one cooling chamber.



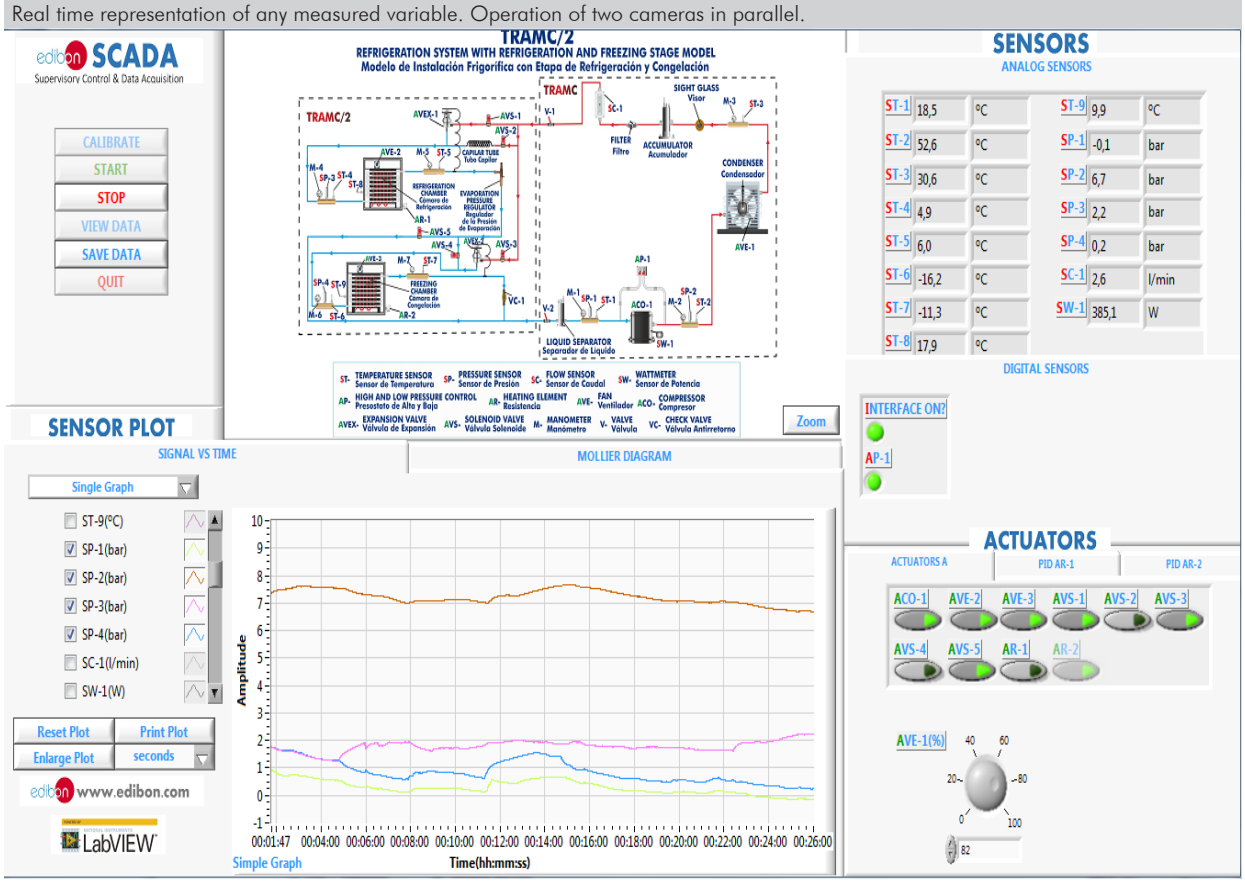
Real-time representation of the Rankine cycle in the Mollier diagram of the coolant. Operation of two cameras in parallel.



Heating temperature control is done through a PID control. When the target temperature is reached at the temperature sensor (ST-9), the heating element is turned off.

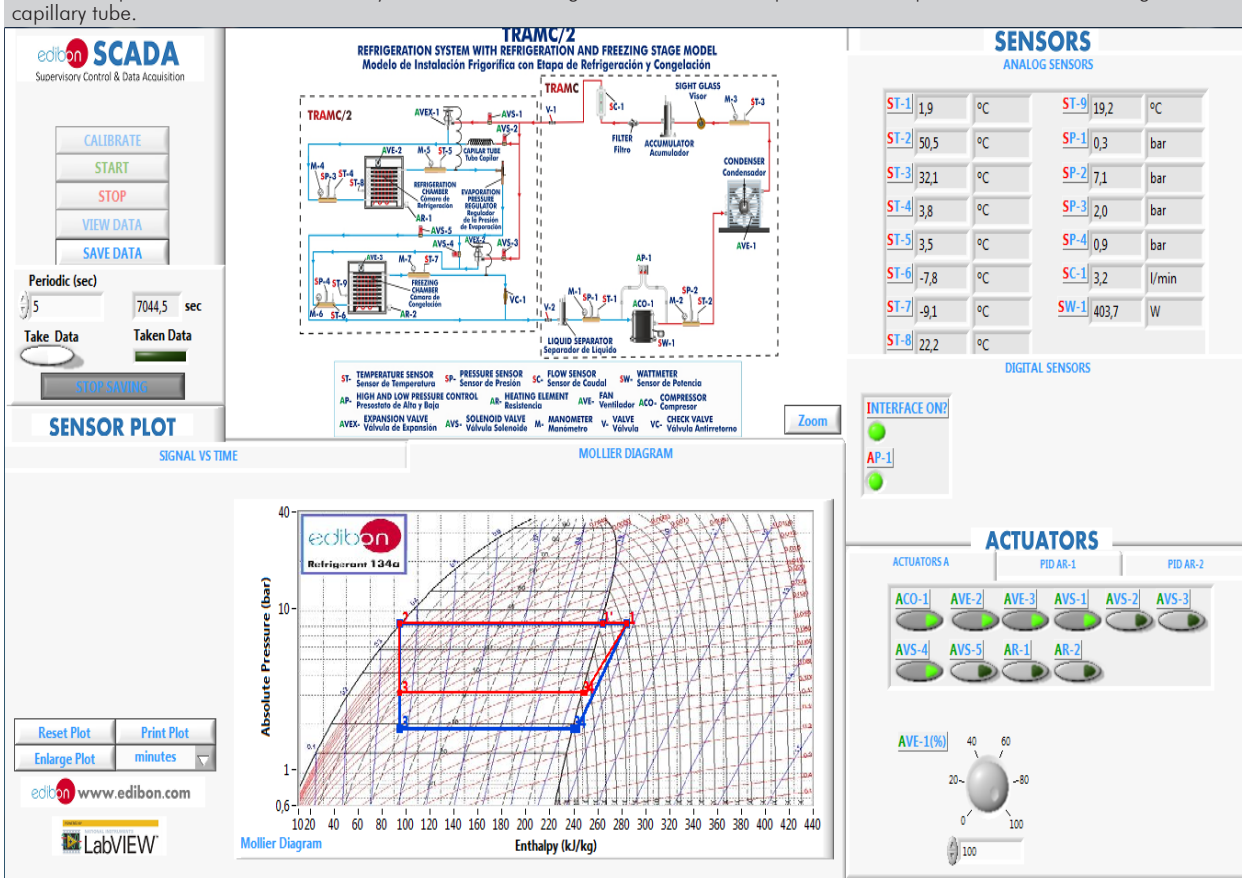


Real time representation of any measured variable. Operation of two cameras in parallel.



Some **real** results obtained from this Unit

Real-time representation of the Rankine cycle in the Mollier diagram of the coolant. Operation of two parallel chambers working with capillary tube.



Additionally to the main items (1 to 5) described, we can offer, as optional, other items from 6 to 10.
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

⑥ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

This unit is common for the modules type "TI" and can work with one or several modules.

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.

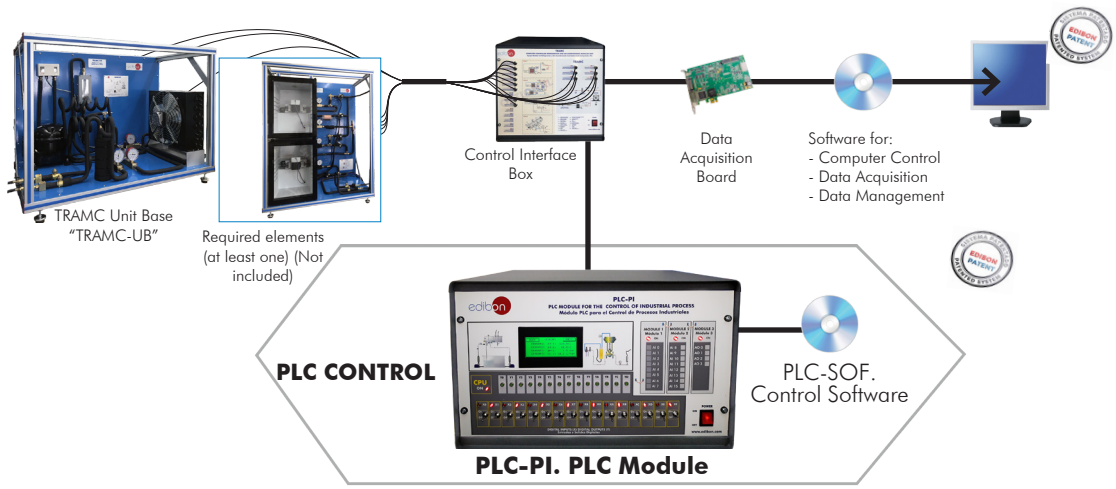
Communication RS232 wire to computer (PC).

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.).

-TRAMC/PLC-SOF. PLC Control Software:

Always included with PLC supply.

Each module has its own Software.



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

⑦ TRAMC/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.

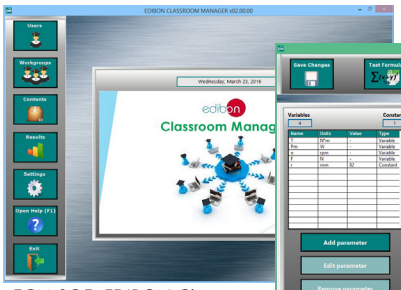
Innovative features:

- **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.**

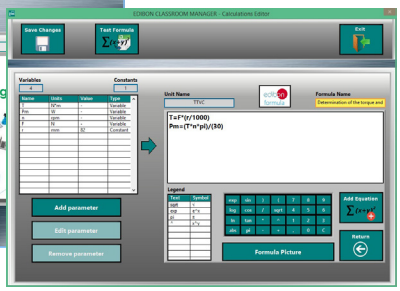
For more information see **ICAI** catalogue. Click on the following link:

www.edibon.com/en/files/expansion/ICAI/catalog

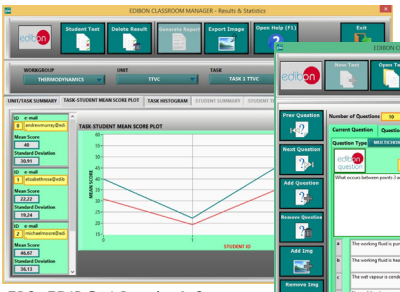
Instructor Software



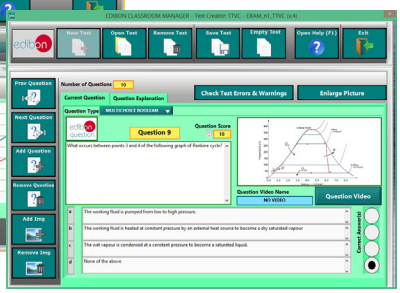
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



ECAL. EDIBON Calculations Program Package - Formula Editor Screen

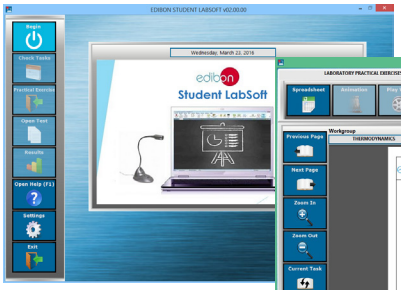


ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram

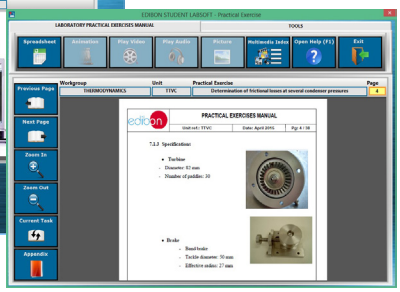


ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

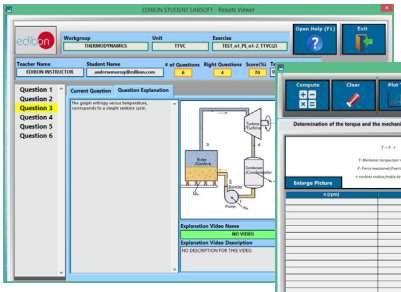
Student Software



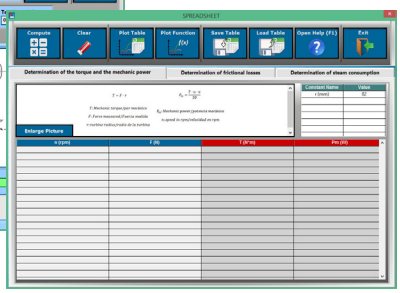
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

⑧ TRAMC/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.**

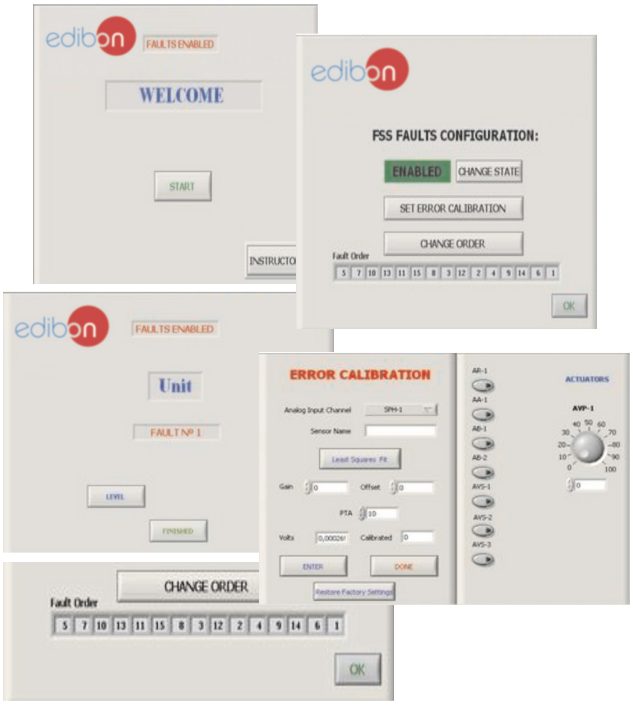
Faults in the controls execution:

- **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.**

Example of some screens



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

www.edibon.com/en/files/expansion/FSS/catalog

c) Multipost Expansions options

⑨ 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 and PID Control integrated in a local network.

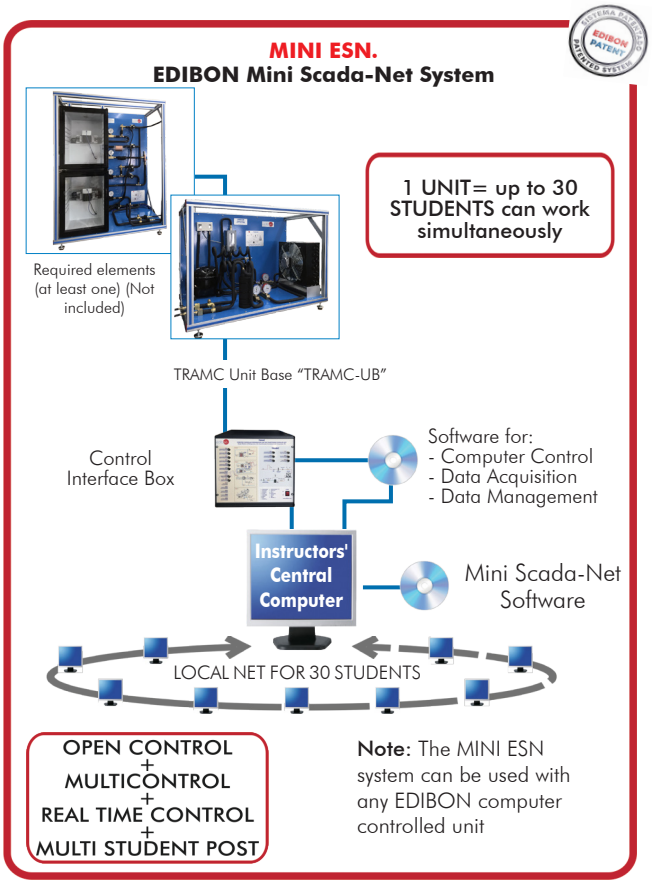
This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

Main characteristics:

- **It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA and PID Control, 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

⑩ 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

ORDER INFORMATION

Main items (always included in the supply)

① **TRAMC-UB. TRAMC Unit Base.**

② **TRAMC/CIB. Control Interface Box.** (Can work with the Required elements (at least one) (Not included)).

③ **DAB. Data Acquisition Board.** (Can work with the Required elements (at least one) (Not included)).

④ **Cables and Accessories**, for normal operation.

⑤ **Manuals.**

Required elements (at least one) to be used with theTRAMC Unit Base "TRAMC-UB":

TRAMC/1. Home refrigeration model. (+)

TRAMC/2. Refrigeration system with refrigeration and freezing stage model. (+)

TRAMC/3. Simple air conditioning system model for room cooling. (+)

TRAMC/4. Complete air conditioning system model. (+)

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

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

Optional items (supplied under specific order)

a) Industrial configuration

⑥ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

- PCL-PI. PLC Module.
- TSTCC/PLC-SOF. PLC Control Software.

b) Technical and Vocational Education configuration

⑦ TRAMC//ICAI. Interactive Computer Aided Instruction Software.

⑧ TRAMC/FSS. Faults Simulation System.

c) Multipost Expansions options

⑨ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

⑩ ESN. EDIBON Scada-Net Systems.

① TRAMC-UB. TRAMC Unit Base:

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Base unit that allows, together with the models, the performance of experiments for the study of the operation of refrigeration and air conditioning systems.

Models safely coupled through refrigerant hoses with shut-off valves.

Computer controlled hermetic compressor. Power: 3/8 HP.

Condenser. Finned tube heat exchanger with computer controlled fan. Air flow: 580 m^3/h.

Storage vessel to prevent a wrong operation of the compressor, capacity: 0.5 l.

Filter for the refrigerant.

Sight glass for the refrigerant.

Liquid separator to prevent liquid from entering the compressor, capacity: 0.73 l.

High and low pressure switch, range: 0.7 – 4 bar for low pressure and 8 – 32 bar for high pressure.

Two pressure sensors:

- Pressure measurement before the compressor. Low pressure range: 0 – 10 bar.
- Pressure measurement after the compressor. High pressure range: 0 – 25 bar.

Flow sensor for the refrigerant, range: 5 – 60 l/h.

Three "J" type temperature sensors.

Power sensor for the compressor.

Low pressure manometer at the intake side (before the compressor), range: from -1 to 10 bar/from -50 – 40 °C.

Two high pressure manometers in the delivery side (after the compressor and after the condenser), range: from -1 to 30 bar/from -40 – 80 °C.

Enthalpy diagram of the R134a refrigerant.

The unit has been designed to be used with the CFC-free and environmentally friendly R134a refrigerant.

The complete unit includes as well:

- Advanced Real-Time SCADA and PID Control.
- 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.

Required elements (at least one) (Not included):

TRAMC/1: Home refrigeration model.

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Insulated refrigeration chamber with transparent front side and capacity of 35 l. The chamber includes:

- Finned tube evaporator with fan. Air flow: 50 m^3/h.
- Computer controlled finned heating element, power: 100 W.

Two computer controlled solenoid valves to select the circuits.

Thermal expansion valve.

Capillary tube made of copper with a length of 6 m.

Pressure sensor. Low pressure range: 0 – 10 bar.

Three "J" type temperature sensors.

Two low pressure manometers, range: from -1 – 10 bar/from -50 – 40 °C.

Easy connection to the TRAMC Unit Base, "TRAMC-UB".

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

(+)TRAMC/1/CCSOF. PID 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.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

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.

TRAMC/2. Refrigeration System with Refrigeration and Freezing Stage Model:

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Insulated refrigeration chamber with transparent front side and capacity of 35 l. The chamber includes:

Finned tube evaporator with fan. Air flow: 50 m^3/h.

Computer controlled finned heating element, power: 100 W.

Insulated freezing chamber with transparent front side and capacity of 35 l. The chamber includes:

Finned tube evaporator with fan. Air flow: 50 m^3/h.

Computer controlled finned heating element, power: 100 W.

Five computer controlled solenoid valves to select the circuits. The evaporators can operate in series or in parallel.

Thermal expansion valve for the refrigeration chamber.

Capillary tube made of copper for the refrigeration chamber with a length of 6 m.

Thermal expansion valve for the freezing chamber.

Adjustable evaporation pressure regulator.

Non-return valve.

Two pressure sensors. Low pressure range: 0 – 10 bar.

Six "J" type temperature sensors.

Four low pressure manometers, range: from -1 – 10 bar/from -50 – 40 °C.

Easy connection to the TRAMC Unit Base, "TRAMC-UB".

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

(+)TRAMC/2/CCSOF. PID 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.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

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.

TRAMC/3. Simple Air Conditioning System Model for Room Cooling:

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Air tunnel with windows to look inside.

Fan with computer controlled speed.

Evaporator: radiator to cool air.

"J" type temperature sensor and humidity sensor in the tunnel, before and after the evaporator.

Differential pressure sensor to measure air flow.

Refrigeration circuit:

- Thermal expansion valve.
- Pressure sensor. Low pressure range: 0 – 10 bar.
- Two "J" type temperature sensors.
- Two low pressure manometers, range: from -1 – 10 bar/from -50 – 40 ºC.

Easy connection to the TRAMC Unit Base, "TRAMC-UB".

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

(+) TRAMC/3/CCSOF. PID 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.
- Analog and digital PID control.
- PID menu and set point selection required in the whole work range.
- 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.

TRAMC/4. Complete Air Conditioning System Model:

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Air tunnel with windows to look inside.

Fan with computer controlled speed.

Evaporator: radiator to cool air.

"J" type temperature sensor and humidity sensor in the tunnel, before and after the evaporator.

Differential pressure sensor to measure air flow.

Refrigeration circuit:

- Thermal expansion valve.
- Pressure sensor. Low pressure range: 0 – 10 bar.
- Two "J" type temperature sensors.
- Two low pressure manometers, range: from -1 – 10 bar/from -50 – 40 ºC.

Easy connection to the TRAMC Unit Base, "TRAMC-UB".

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

(+) TRAMC/4/CCSOF. PID 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.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

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.

Additional recommended elements (Not included):

-T/KIT1. Maintenance Kit containing Vacuum Pump, Hoses and Manometers.

-T/KIT2. Maintenance Kit containing Leakage Detector.

-T/KIT3. Maintenance Kit containing Refrigerant Filling and Evacuation module.

② TRAMC/CIB. Control Interface Box:

This control interface is common for the required elements (at least one) (Not included).

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

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

Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).

Open control allowing modifications, at any 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:

Common for the required elements (at least one) (Not included).

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 Cables and Accessories, for normal operation.

⑤ 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

Practices to be done with the Home Refrigeration Model (TRAMC/1):

1.- Function and behavior of the refrigeration circuit components.
2.- Study and comparation of work with different expansion elements:
    Expansion valve.
    Capillary tube.
3.- Representation of the thermodynamic cycle in the p-h log diagram.

Additional practical possibilities:

4.- Sensors calibration.
5.- Properties of the refrigerant R134a.
6.- Enthalpy-pressure diagram for the refrigerant R134a.

Practices to be done with the Refrigeration System with Refrigeration and Freezing Stage Model (TRAMC/2):

7.- Function and behavior of the refrigeration circuit components.
8.- Study and comparation of work with different expansion elements:
    Expansion valve.
    Capillary tube.
9.- Representation of the thermodynamic cycle in the p-h log diagram.
10.- Study of a refrigeration system with two evaporators in series and in parallel.
11.-Study of a refrigeration system with two evaporators in series and in parallel.

Additional practical possibilities:

12.-Sensors calibration.
13.-Properties of the refrigerant R134a.
14.-Enthalpy-pressure diagram for the refrigerant R134a.

Practices to be done with the Simple Air Conditioning System Model for Room Cooling (TRAMC/3):

15.-Study of the function and behavior of an air conditioning system.
16.-Study of the room air conditioning.
17.-Study of the operation of an evaporator as air cooler.
18.-Representation of the thermodynamic cycle in the p-h log diagram.

Additional practical possibilities:

19.-Sensors calibration.
20.-Properties of the refrigerant R134a.
21.-Enthalpy-pressure diagram for the refrigerant R134a.

Practices to be done with the Complete Air Conditioning System Model (TRAMC/4):

22.-Study of the components of an air conditioning system for room cooling and a complete air conditioning system.
23.- Demonstration of air heating, cooling, humidifying and de-humidifying processes.
24.-Representation in the h-x diagram for humid air: heating and cooling, humidifying and de-humidifying.
25.-Recirculation and outer air operation modes.

Additional practical possibilities:

26.-Sensors calibration.
27.-Properties of the refrigerant R134a.
28.-Enthalpy-pressure diagram for the refrigerant R134a.

Other possibilities to be done with this System:

29.- Many students view results simultaneously. To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
30.- 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.
31.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
32.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
33.- This unit can be used for doing applied research.
34.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
35.- Control of the unit process through the control interface box without the computer.
36.- Visualization of all the sensors values used in the 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

⑥ **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.

-TRAMC/PLC-SOF. PLC Control Software:

Always included with PLC supply. Each module has its own Software.

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

⑦ **TRAMC/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.

⑧ TRAMC/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

⑨ 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 and PID Control 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 and PID Control, 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.

C/ Julio Cervera, 10-12-14. Móstoles Tecnológico.
28935 MÓSTOLES. (Madrid). ESPAÑA - SPAIN.
Tel.: 34-91-6199363 Fax: 34-91-6198647
E-mail: edibon@edibon.com Web: **www.edibon.com**

Edition: ED01/20
Date: October/2020

REPRESENTATIVE: