

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

① Unit: TBTC. Computer Controlled Thermo-Electric Heat Pump

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**



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↳ PRODUCTS
↳ 5.- ENERGY
AND
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

Thermoelectricity is considered a branch of thermodynamics and the electricity which studies the phenomena involving heat and electricity. The best known phenomenon is that of the electricity generated by the application of heat to the junction of two different materials. This effect is known as the Seebeck effect.

When a current passes through a circuit composed of different materials whose junctions are at the same temperature, the inverse effect takes place. In this case, heat is absorbed in one junction and is given off in the other one. This phenomenon is known as the Peltier effect (nowadays, this application is becoming more important; the reason is that it enables the use of semiconductor systems based on the Peltier effect as refrigerators in numerous applications).

The Computer Controlled Thermo-Electric Heat Pump, "TBTC", consists of a thermoelectric heat pump completely equipped to demonstrate the Seebeck effect, the Peltier effect and Thomson or Lenz effect.

GENERAL DESCRIPTION

The Computer Controlled Thermo-Electric Heat Pump, "TBTC", allows the study of different phenomena in which heat and electricity take place (Thermoelectricity). Some of them are the Peltier effect, the Thomson or Lenz effect and the Seebeck effect. The application of the Peltier effect as a refrigeration method can also be studied.

We will be able to carry out with this unit the study and use of a Peltier element as a heat pump and for the refrigeration.

This thermoelectric heat pump consists of a thermoelectric cell or module mounted over two sides. There is a heating element, computer controlled, covered by a thermally insulated conductor made of stainless steel, over the cold side of the module. A heatsink is located in the hot side of the module; it is composed of a heat exchanger and a fan placed inside an insulated box.

Different experimental configurations of the unit can be easily established through the activation of different switches.

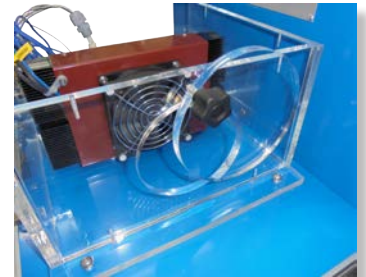
The thermoelectric module is composed of two small semiconductor pieces, A and B, one of them of the n-type and the other one of the p-type. They are joined by one of their ends through a metallic joint or weld. If this joint is subjected to a heat source, keeping it at a high temperature meanwhile the rest is kept at a lower temperature, a small electromotive force is generated that produces an electric current in the circuit.

In a similar way, due to Peltier's effect, if a current passes through the semiconductor joints circuit p-n and n-p, some of them heat up and other cool down, generating a temperature gradient among the plates.

The thermoelectric element consists of a variable number of joints placed electrically in series, but thermally in parallel.

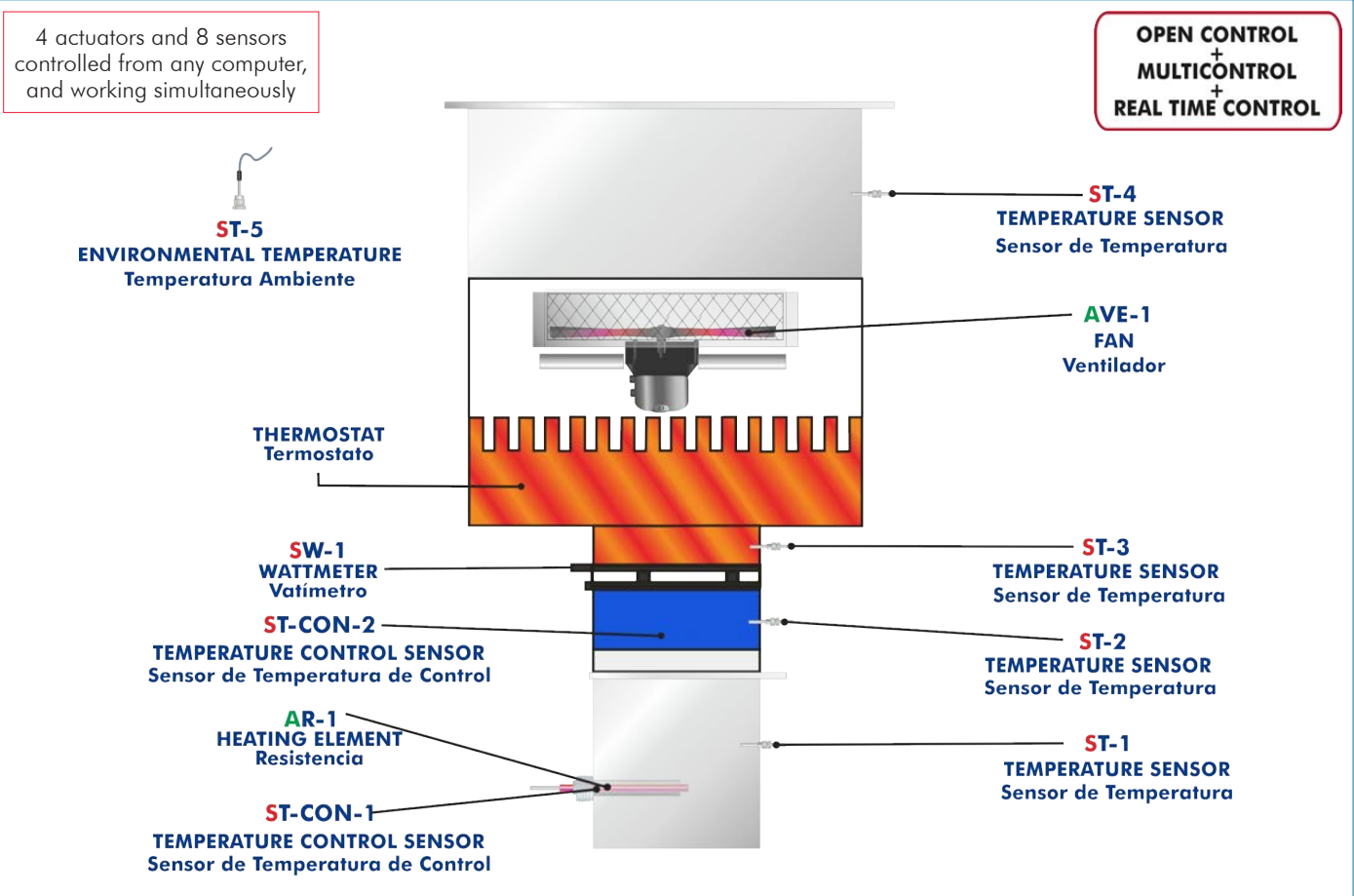
The unit includes two temperature control sensors, situated in the heating element and in one side of the module.

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.



TBTC detail

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



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 **TBTC. Unit:**

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.

Thermoelectric module-Peltier device mounted over two sides.

There is a heating element on the cold side of the module, covered by a thermally insulated conductor made of stainless steel.

There is a heatsink and a fan on the hot side of the module, they are placed inside an insulated box with a gate.

Heat transfer rate up to 89 W.

Heating element, computer controlled (PID control): 75 W, 230 V.

Fan, computer controlled (air flow of 50 m³/h).

Heatsink.

Energy/power supply to the thermoelectric module, computer controlled. Mounted internally, power supply: 24 V.

Polarity reverser.

Five temperature sensors ("J" type) at different points, to measure the temperature in the hot side, in the cold side and the environmental temperature.

Sensors to measure voltage, current and power related to the power supply to the thermoelectric module.

Measurement of the voltage generated by the thermoelectric module.

Thermostat situated in the thermoelectric cell that cuts when the temperature is 80 °C, approximately.

Two temperature control sensors, situated in the heating element and in one side of the module.

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.



Unit TBTC

② **TBTC/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 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.



TBTC/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**. DO 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 **TBTC/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).

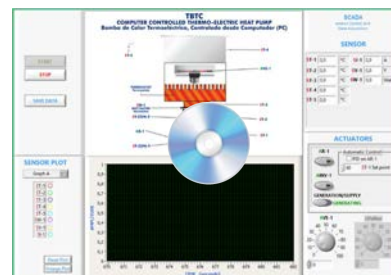
Calibration system for the sensors involved in the process.

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.



TBTC/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: TBTC + TBTC/CIB + DAB + TBTC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

- 1.- Investigation of the effects upon the surface temperature of either face of the module with increasing power supply (Peltier Effect).
 - 2.- Investigation of the effect upon heat transfer of reversing the polarity of the power supply (Thomson or Lenz Effect).
 - 3.- Investigation of the variation in open circuit voltage across the module due to the variation in surface temperature difference (Seebeck Effect).
 - 4.- Estimation of the module's efficiency coefficient acting as refrigerator (COP).
- Additional practical possibilities:
- 5.- Sensors calibration.
 - 6.- Energy balance.
- Other possibilities to be done with this Unit:
- 7.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
 - 8.- 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.
 - 9.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
 - 10.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
- 11.- This unit can be used for doing applied research.
 - 12.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
 - 13.- Control of the TBTC unit process through the control interface box without the computer.
 - 14.- Visualization of all the sensors values used in the TBTC 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

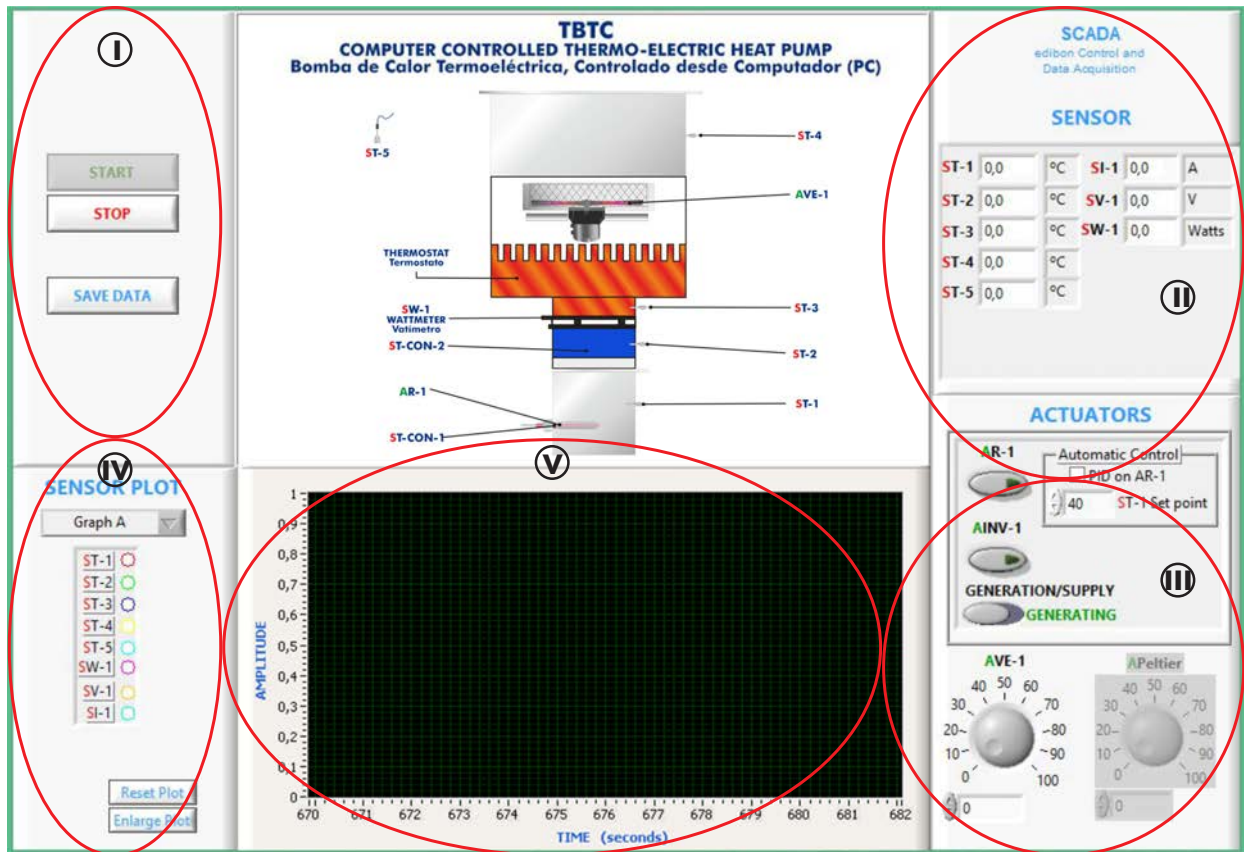
- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Computer.

DIMENSIONS AND WEIGHTS

- TBTC:
Unit:
- Dimensions: 500 x 400 x 550 mm approx.
(19.7 x 15.75 x 21.65 inches approx.)
 - Weight: 20 kg approx.
(44 pounds approx.).
- Control Interface Box:
- Dimensions: 490 x 330 x 310 mm approx.
(19.29 x 12.99 x 12.20 inches approx.)
 - Weight: 10 kg approx.
(22 pounds approx.).

SOFTWARE MAIN SCREENS

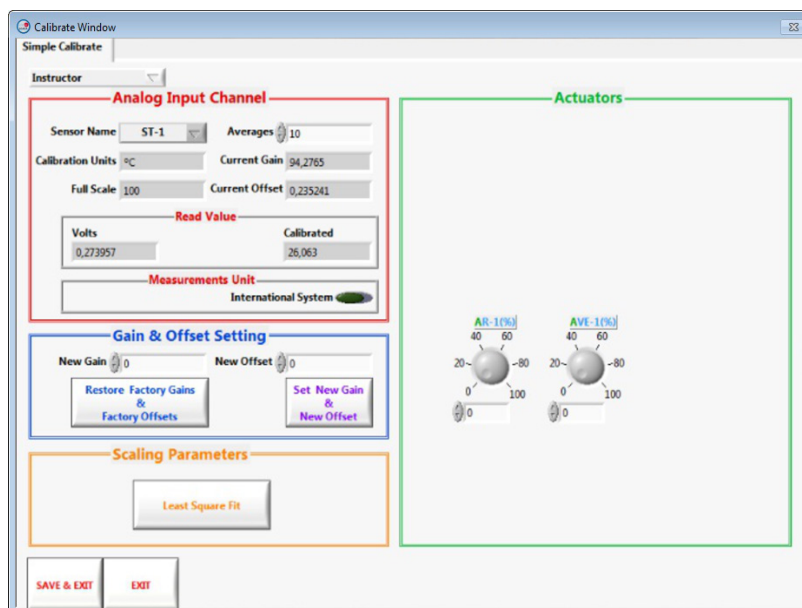
SCADA and PID Control Main screen



- ❶ Main software operation possibilities.
- ❷ Sensors displays, real time values, and extra output parameters. Sensors: ST=Temperature sensor. SW=Power sensor. SV=Voltage sensor. SI=Current sensor.
- ❸ Actuators controls. Actuators: AR=Heating element. AINV=Polarity inverter. AVE=Fan. APeltier=Peltier
- ❹ Channel selection and other plot parameters.
- ❺ Real time graphics displays.

Software for Sensors Calibration

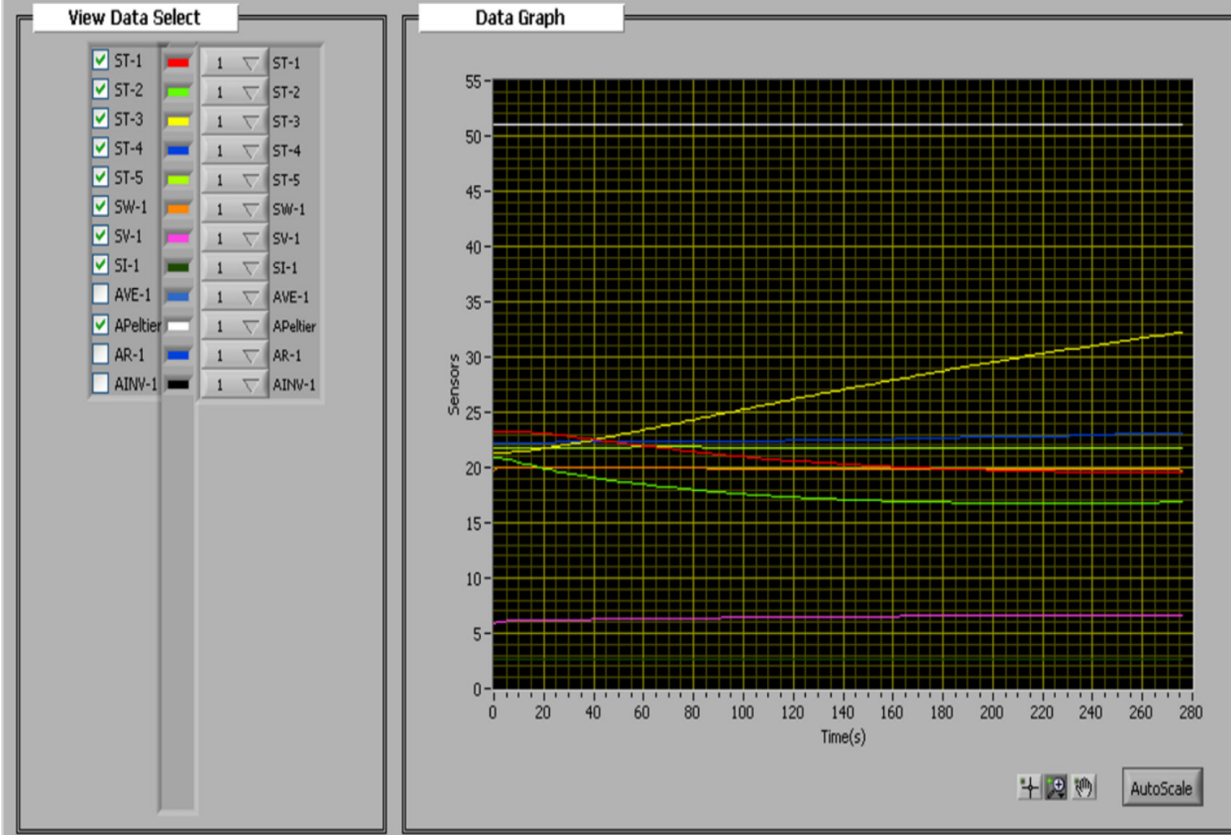
Example of screen



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

SOME REAL RESULTS OBTAINED FROM THIS UNIT

Peltier effect: This plot shows the effects produced on the temperature of the module's sides surface when increasing the power supplied. It is demonstrated that the temperature of the hot side (ST-3 sensor) increases (yellow curve) and the temperature of the cold side (ST-2 sensor) decreases with time (green curve).



Thomson effect: we observe in this screen how the temperature of the hot side (ST-3 sensor) is lower than the temperature of the cold side (ST-2 sensor) when the polarity of the module changes (AINV-1 is on).

TBTC COMPUTER CONTROLLED THERMO-ELECTRIC HEAT PUMP Bomba de Calor Termoeléctrica, Controlado desde Computador (PC)

START

STOP

SAVE DATA

SCADA
edibon Control and
Data Acquisition

SENSOR

ST-1	45,4	°C	SI-1	3,68	A
ST-2	49,7	°C	SV-1	9,3	V
ST-3	24,9	°C	SW-1	34,3	Watts
ST-4	24,4	°C			
ST-5	22,0	°C			

ACTUATORS

AR-1 Automatic Control
 PID on AR-1
40 ST-1 Set point

AINV-1

GENERATION/SUPPLY
SUPPLYING

AVE-1

APeltier

SENSOR PLOT

Graph A

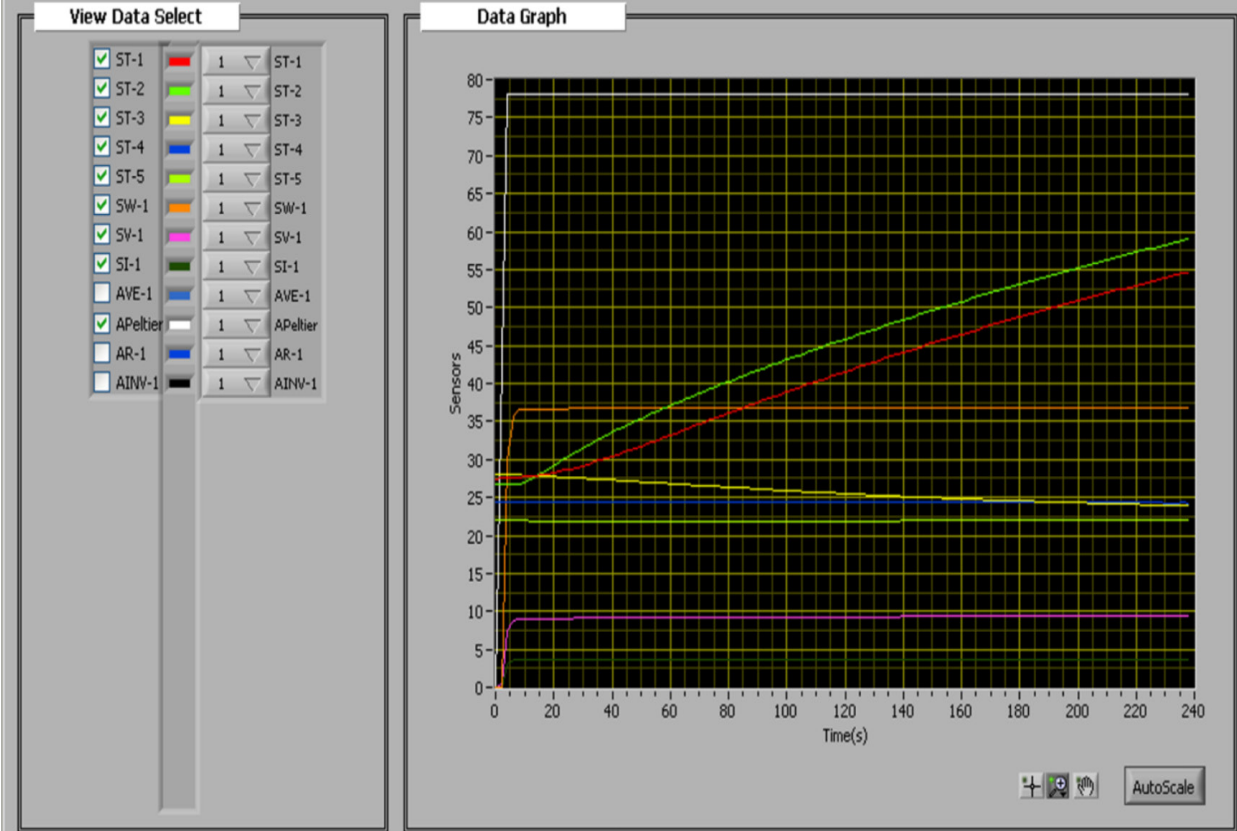
- ST-1
- ST-2
- ST-3
- ST-4
- ST-5
- SW-1
- SV-1
- SI-1

Reset Plot
Enlarge Plot

TIME (seconds)

Some **real** results obtained from this Unit

We can verify in this results plot that the temperature of the hot side is decreasing (yellow curve), meanwhile the temperature of the cold side is increasing (green curve).



Estimation of the module's efficiency coefficient acting as refrigerator: It can be observed how heat is introduced by means of the heating element (AR-1 is on) and power is applied in the module through the Apeltier actuator. Under these conditions, the temperature of the cold side of the module remains at room temperature. It can be assumed that heat is not absorbed by the atmosphere, and that all the heat supplied by the heating element is absorbed by the module working in refrigerator mode. This can be checked by means of the ST-3 sensor and ST-4 sensor, observing that the temperature is much more lower.

START

STOP

SAVE DATA

TBTC
COMPUTER CONTROLLED THERMO-ELECTRIC HEAT PUMP
Bomba de Calor Termoelectrica, Controlado desde Computador (PC)

SCADA
edibon Control and Data Acquisition

SENSOR

ST-1	72.3	°C	SI-1	2,48	A
ST-2	72.2	°C	SV-1	6,4	V
ST-3	36,0	°C	SW-1	15,9	Watts
ST-4	28,2	°C			
ST-5	23,7	°C			

SENSOR PLOT

Graph A

- ST-1
- ST-2
- ST-3
- ST-4
- ST-5
- SW-1
- SV-1
- SI-1

Reset Plot

Enlarge Plot

Graph A

Graph B

ACTUATORS

AR-1 Automatic Control

PID on AR-1

40 ST-1 Set point

AINV-1

GENERATION/SUPPLY

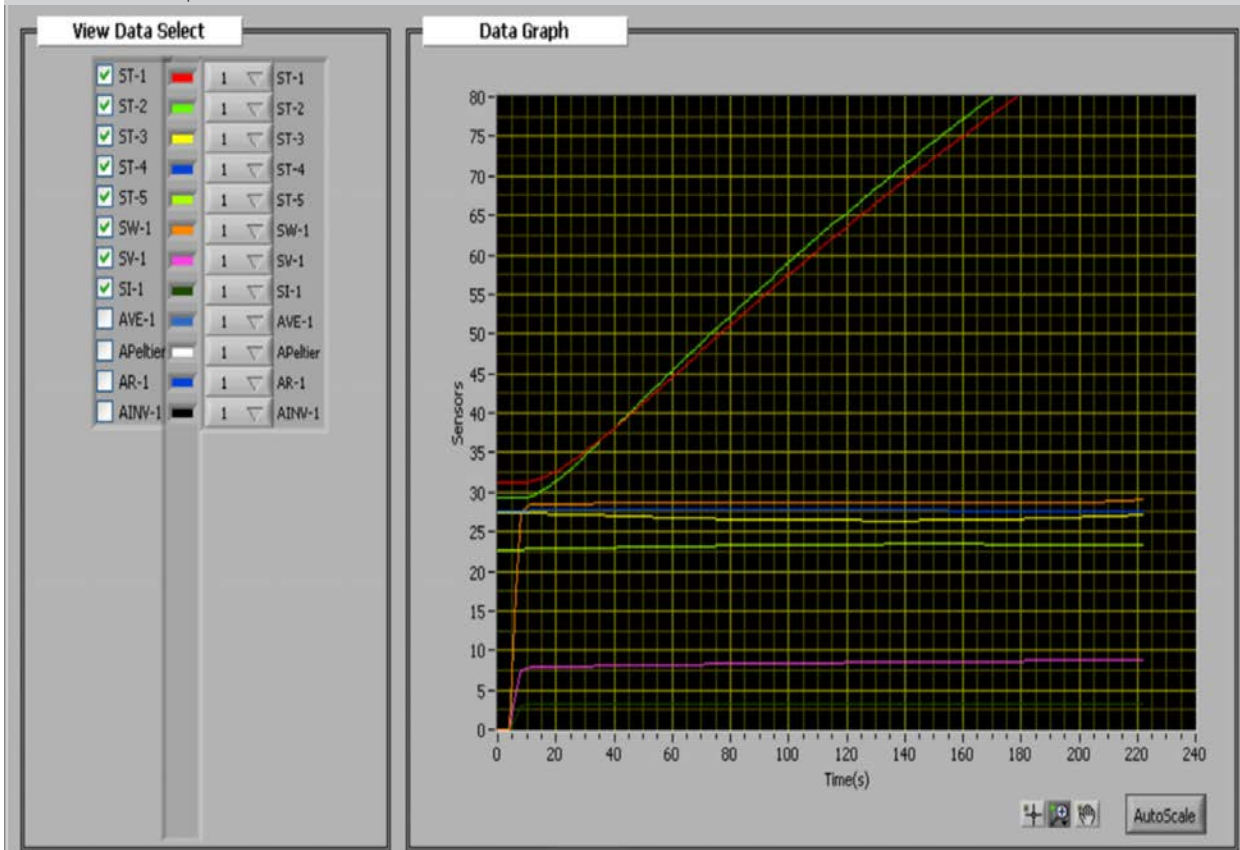
SUPPLYING

AVE-1

APeltier

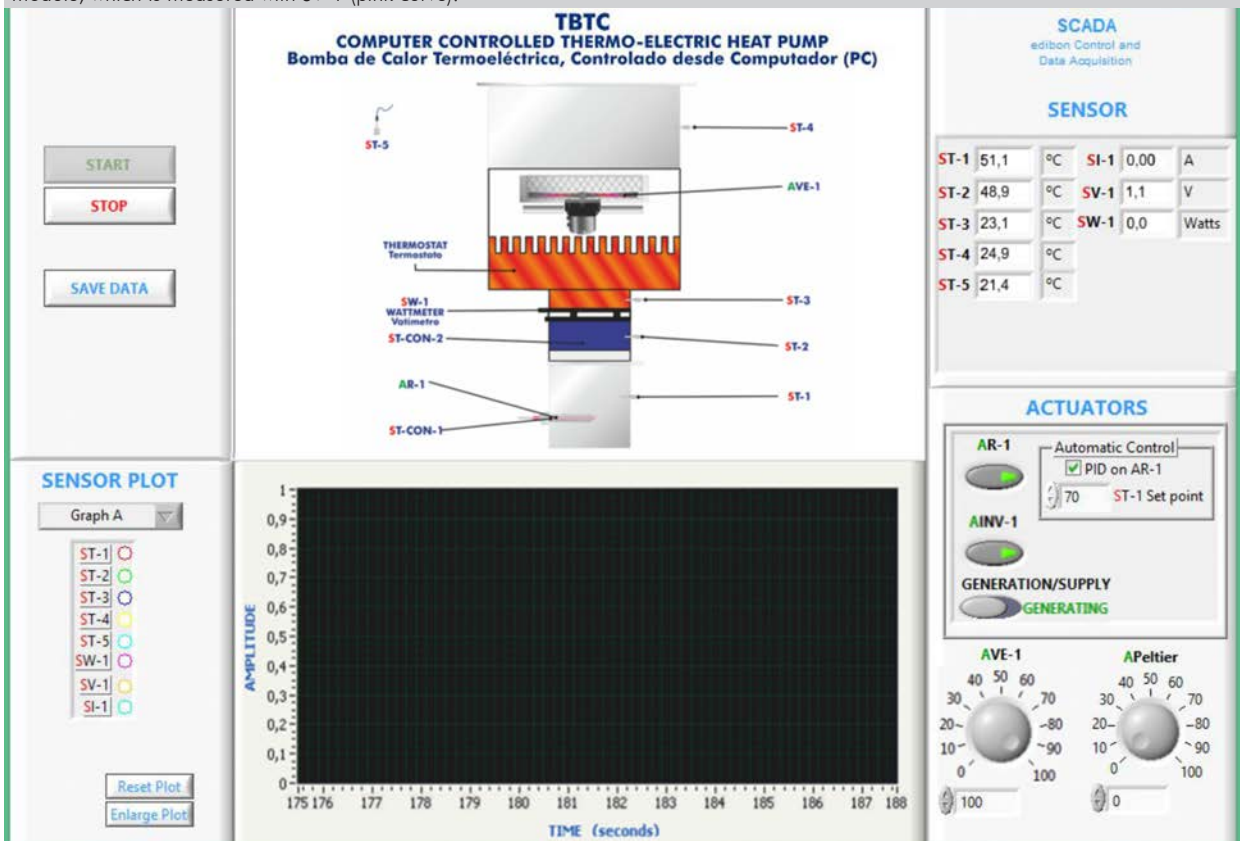
Some **real** results obtained from this Unit

Visualization and representation of saved data.



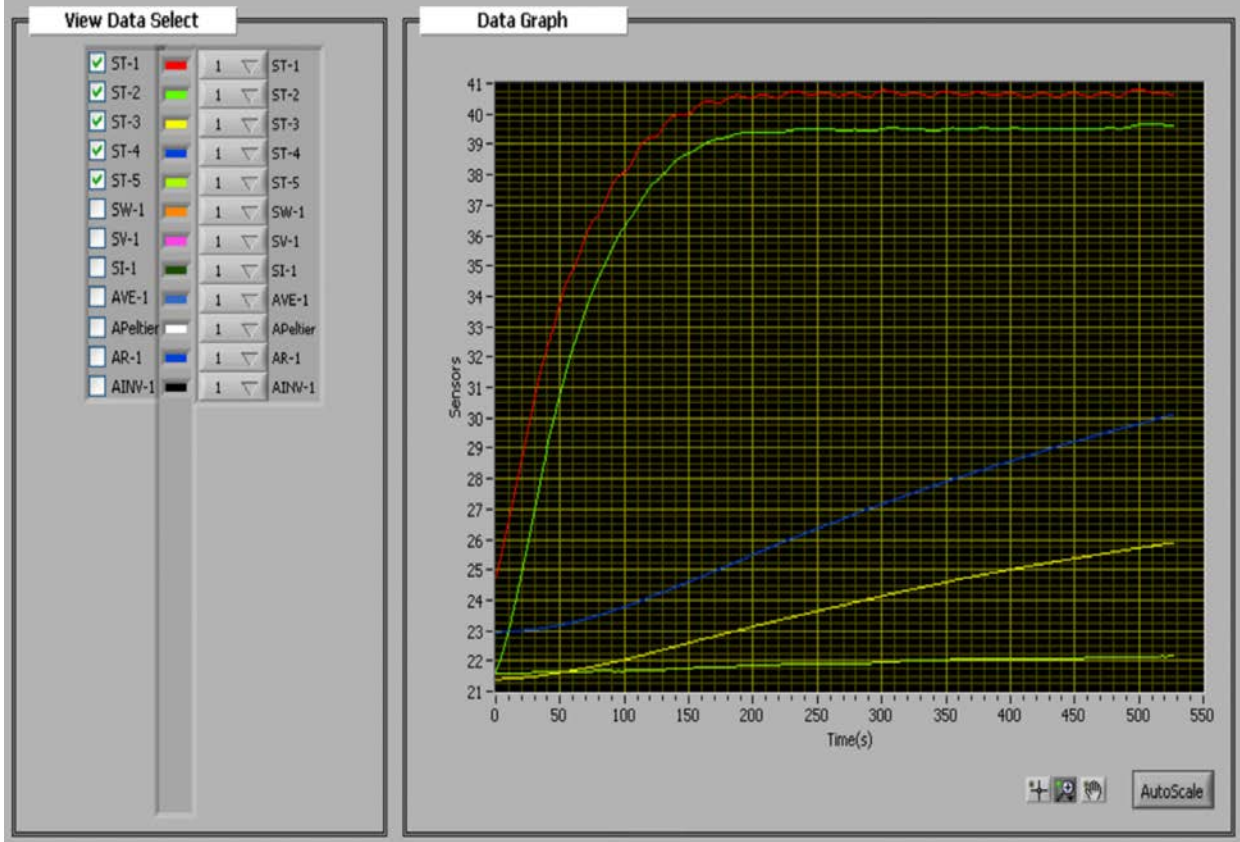
Seebeck effect: in this practical exercise we study the variation of the voltage, generated in open circuit by the module due to the variation of the temperatures difference between the surface of both sides of the module.

It can be observed in the graph how when the heating element and the fan are on, which corresponds with a temperature increase of the cold side (ST-2 sensor, green curve) and a temperature decrease of the hot side (ST-3 sensor, yellow curve), a voltage is generated in the module, which is measured with SV-1 (pink curve).



Some **real** results obtained from this Unit

Visualization and representation of saved data.



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 μ 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.

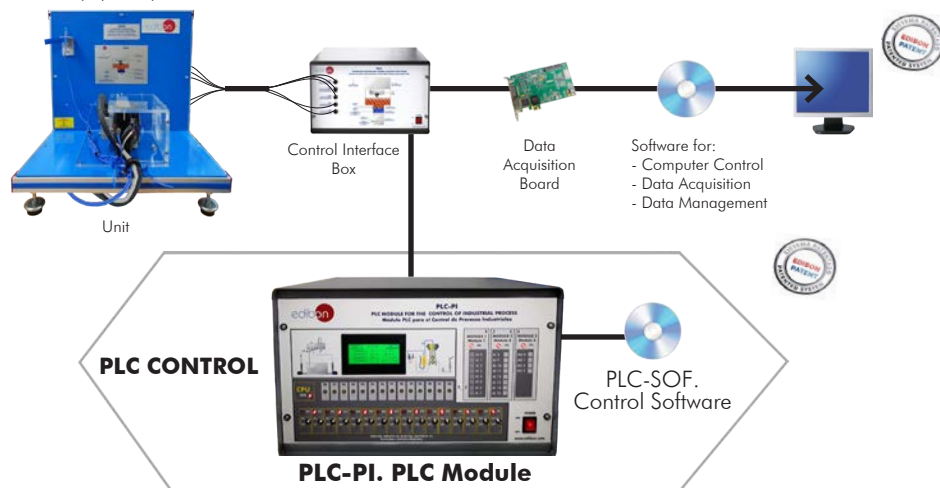
Communication RS232 wire to computer (PC).

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.).

-TBTC/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 Thermo-Electric Heat Pump (TBTC).



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 **TBTC/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

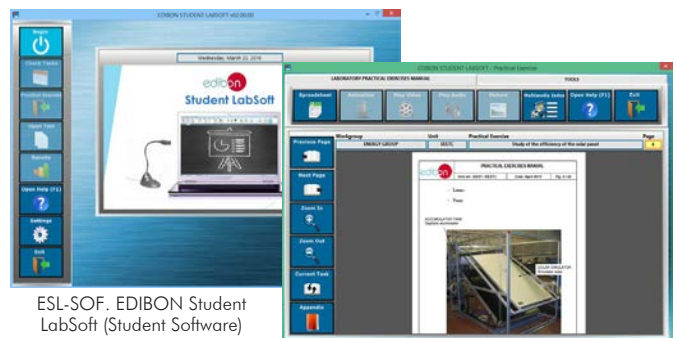
ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

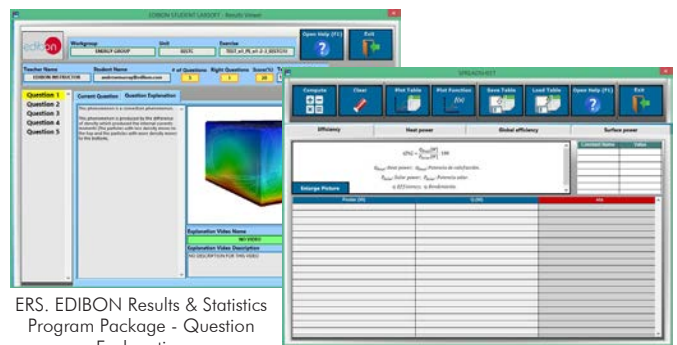
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

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

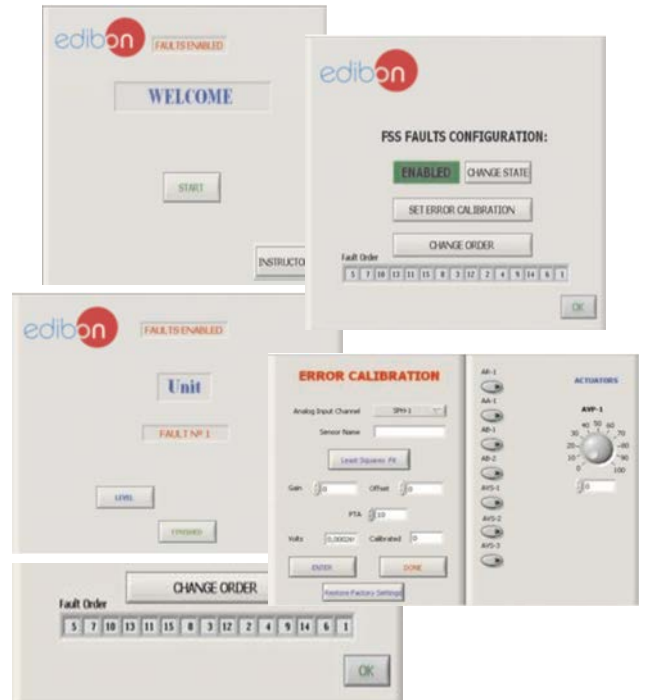
⑨ **TBTC/FSS. Faults Simulation System.**

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

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 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:

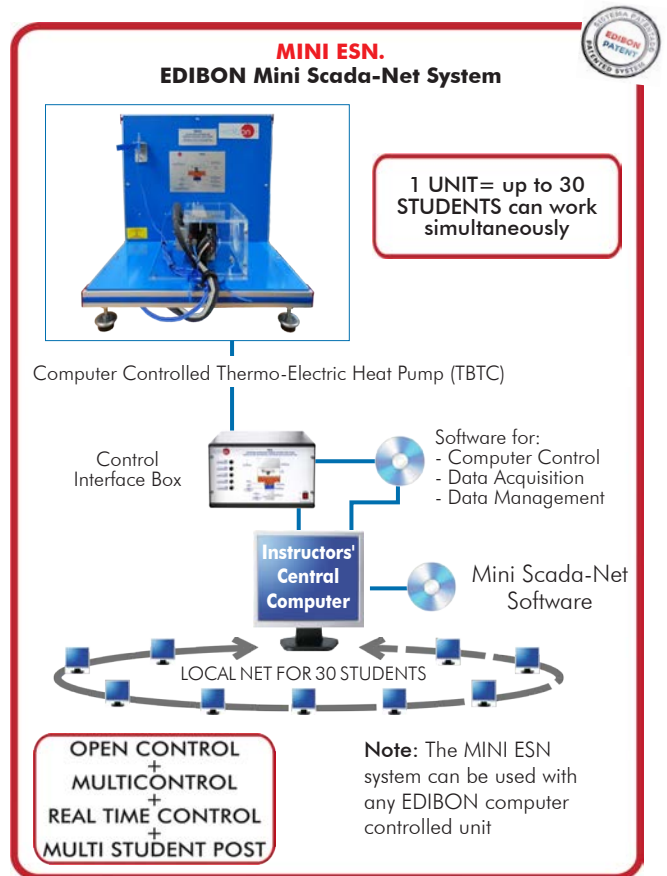
www.edibon.com/en/files/expansion/MINI-ESN/catalog

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



ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

- ① **Unit: TBTC. Computer Controlled Thermo-Electric Heat Pump.**
- ② **TBTC/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **TBTC/CCSOF. PID Computer Control + Data Acquisition + Data Management Software.**
- ⑤ **Cables and Accessories**, for normal operation.
- ⑥ **Manuals.**

***IMPORTANT:** Under TBTC 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.
 - TBTC/PLC-SOF. PLC Control Software.

b) Technical and Vocational Education configuration

- ⑧ TBTC/ICAI. Interactive Computer Aided Instruction Software.
- ⑨ TBTC/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.

① TBTC. Unit:

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.
 Thermoelectric module-Peltier device mounted over two sides.
 There is a heating element on the cold side of the module, covered by a thermally insulated conductor made of stainless steel.
 There is a heatsink and a fan on the hot side of the module, they are placed inside an insulated box with a gate.
 Heat transfer rate up to 89 W.
 Heating element, computer controlled (PID control): 75 W, 230 V.
 Fan, computer controlled (air flow of 50 m³/h).
 Heatsink.
 Energy/power supply to the thermoelectric module, computer controlled. Mounted internally, power supply: 24 V.
 Polarity reverser.
 Five temperature sensors ("J" type) at different points, to measure the temperature in the hot side, in the cold side and the environmental temperature.
 Sensors to measure voltage, current and power related to the power supply to the thermoelectric module.
 Measurement of the voltage generated by the thermoelectric module.
 Thermostat situated in the thermoelectric cell that cuts when the temperature is 80 °C, approximately.
 Two temperature control sensors, situated in the heating element and in one side of the module.
 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.

② TBTC/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 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:

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 TBTC/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.

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.- Investigation of the effects upon the surface temperature of either face of the module with increasing power supply (Peltier Effect).
- 2.- Investigation of the effect upon heat transfer of reversing the polarity of the power supply (Thomson or Lenz Effect).
- 3.- Investigation of the variation in open circuit voltage across the module due to the variation in surface temperature difference (Seebeck Effect).
- 4.- Estimation of the module's efficiency coefficient acting as refrigerator (COP).

Additional practical possibilities:

- 5.- Sensors calibration.
- 6.- Energy balance.

Other possibilities to be done with this Unit:

- 7.- Many students view results simultaneously.

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

- 8.- 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.

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

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

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

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

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

14.-Visualization of all the sensors values used in the TBTC 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 μ sec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.

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

-TBTC/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 **TBTC/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 **TBTC/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

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