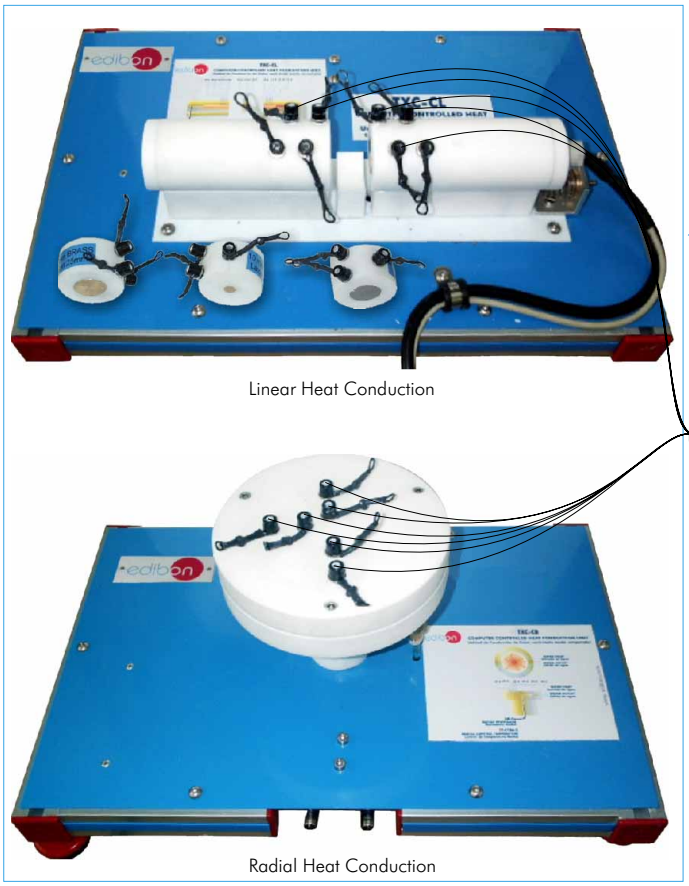
# Computer Controlled **Heat Conduction Unit**

## TCCC

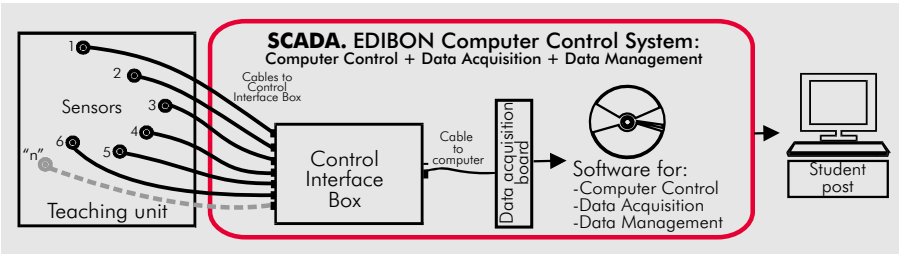
Technical Teaching Equipment

EDIBON PATENT




① Unit: TCCC. Heat Conduction Unit

**OPEN CONTROL**
**+**
**MULTICONTROL**
**+**
**REAL TIME CONTROL**

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**Certificate of Approval**

**European Union Certificate**

**Certificates ISO 14001: 2004** and
**ECO-Management and Audit Scheme**
(environmental management)

**Worlddidac Quality Charter Certificate**
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## DESCRIPTION

Heat Conduction Unit "TCCC" has been designed to demonstrate the heat transmission principles for conduction, allowing the study of the linear and radial conduction.

This unit consists on two modules electrically heated.

One of the modules is provided of a cylindrical metal bar for the realization of a series of experiments of linear transmission of heat. While the other one consists on a metallic disk that allows studying the heat radial transmission. Both models are provided with a series of takings for the connection of a series of temperature sensors included with the equipment. To maintain the gradient of constant temperature, on a lateral of the models, a cooling system has been inserted by circulating water.

The instrumentation provided with the unit allows making the measuring of the temperature and the electric power given to the heater element. For the control of the given energy it has a control circuit that allows the variation from 0 to 100% of the maximum resistance power.

The linear experimental group is given with interchangeable samples of different materials, different diameters and different insulating materials that allow to demonstrate the area effects, the conductivity and the combinations in series in the heat transmission process.

The radial module consists of a disk with a refrigeration system in its end. In this module, there are 6 temperature takings placed along its radius. The contact resistance is placed exactly in its central point surrounded by an effective insulating material.

The two modules incorporate a water regulation valve ,which allows the flow of cooling water to be varied; a water flow sensor; and temperature sensors at the water inlet and outlet.

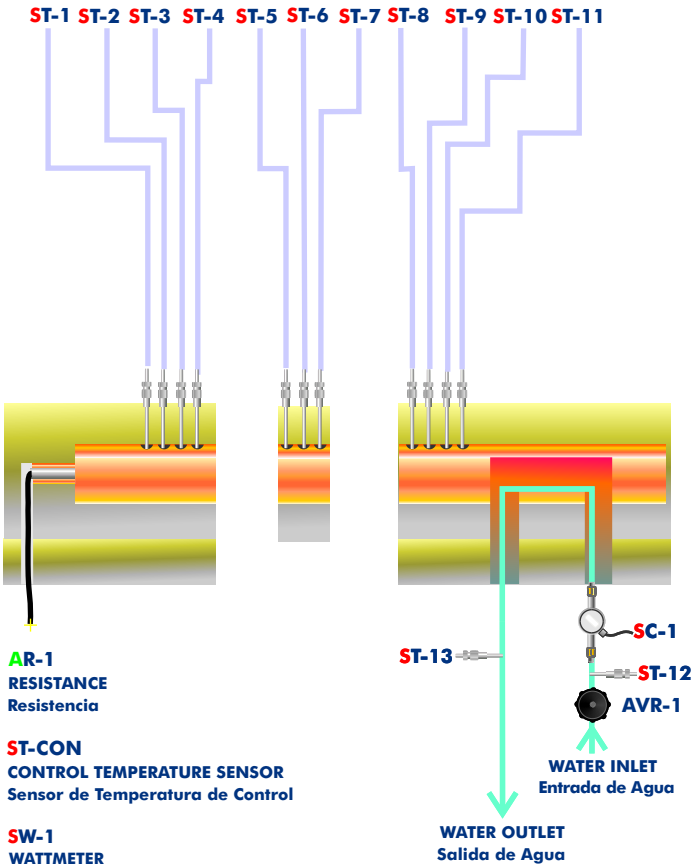
This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), including: Control Interface Box + Data Acquisition Board +Computer Control and Data Acquisition Software, for controlling the process and the parameters involved.

## PROCESS DIAGRAM AND ELEMENTS ALLOCATION

2 actuators and 14 sensors controlled from any computer, and working simultaneously

**OPEN CONTROL**
**+**
**MULTICONTROL**
**+**
**REAL TIME CONTROL**

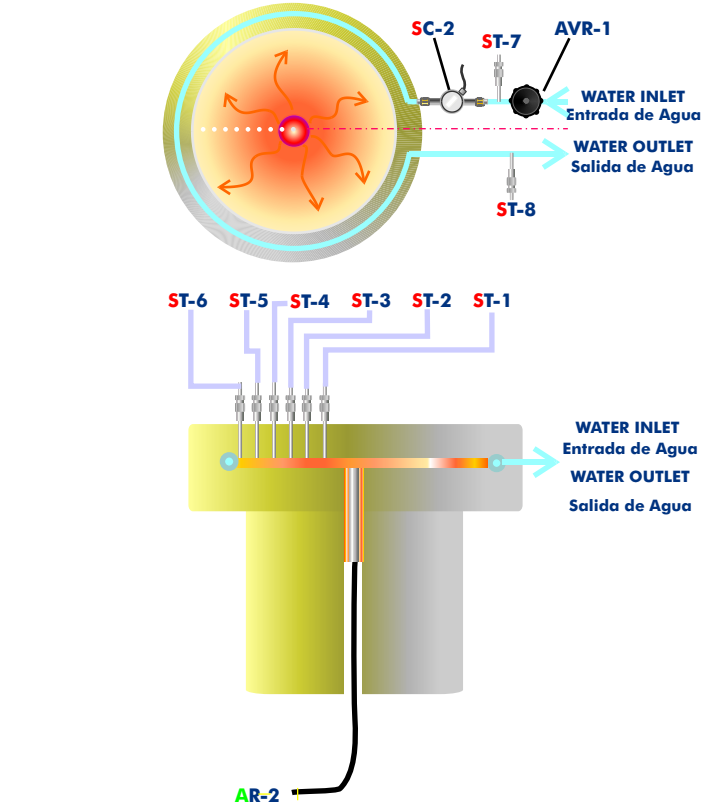
TXC/CL. **Linear Heat Conduction Module**




Note:

ST=Temperature sensor.
SC=Flow sensor.
AVR=Regulation valve.

TXC/CR. **Radial Heat Conduction Module**



## SPECIFICATIONS

**Items supplied as standard**

**① TCCC. Unit:**

Bench top unit consist of two separate modules.
Anodized aluminium structure and panels in painted steel.
Diagrams in the front panels with similar distribution to the elements in the real units.
TXC/CL. Linear Heat Conduction Module:
- Input heat section.
- Electric heater (heating resistance) with power regulation (150W, temperature max.: 150° C), computer controlled.
- Refrigeration section with a surface cooled by water.
- Central sections:
  - With brass of 25 mm of diameter.
  - With brass of 10 mm of diameter.
  - With stainless steel of 25 mm of diameter.
- Water flow sensor.
- Water regulation flow valve.
- Thermal paste is supplied to demonstrate the difference between poor and good thermal contact between the sections.
- 13 Temperature sensors, "J" type:
  - 11 Temperature sensors distributed in the heating section, refrigeration section and central sections.
  - 1 Temperature sensor at the water inlet of the unit.
  - 1 Temperature sensor at the water outlet of the unit.

TXC/CR. Radial Heat Conduction Module:
- Brass disk of 110 mm of diameter and 3 mm of thickness.
- Incorporated electric heater (heating resistance of 150W, temperature max.: 150° C), computer controlled.
- Peripheral cooling tube.
- Water flow sensor.
- Water regulation flow valve .
- 8 Temperature sensors, "J" type:
  - 6 Temperature sensors distributed in the unit.
  - 1 Temperature sensor at the water inlet of the unit.
  - 1 Temperature sensor at the water outlet of the unit.

Power measurement from the computer (PC).

TCCC Unit

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

**Control interface box with process diagram in the front panel** and with the same distribution that the different elements located in the unit, for an easy understanding by the student.
All sensors, with their respective signals, are properly manipulated from -10V. to +10V computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.
Single cable between the control interface box and computer.
**The unit control elements are permanently computer controlled,** without necessity of changes or connections during the whole process test procedure. **Simultaneously visualization in the computer of all parameters involved in the process. Calibration of all sensors involved in the process.**
**Real time curves representation about system responses.** Storage of all the process data and results in a file. Graphic representation, in real time, of all the process/system responses.
**All the actuators' values can be changed at any time from the keyboard** allowing the analysis about curves and responses of the whole process. All the actuators and sensors values and their responses are placed in only one computer screen.
**Shield and filtered signals to avoid external interferences.**
**Real time 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, resistances, 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 time and in a 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, other electronic in control interface and the third one in the control software.**

TCCC/CIB

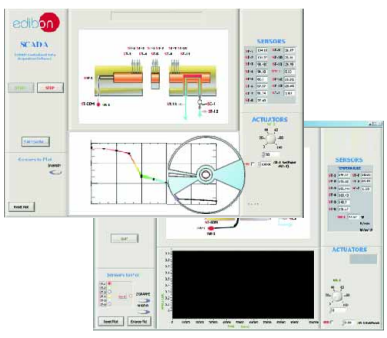
**③ DAB. Data Acquisition Board:**

PCI Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI.
**Analog input:** Number of **channels= 16** single-ended or 8 differential. **Resolution=16 bits**, 1 in 65536. **Sampling rate up to: 250 KS/s** (Kilo samples per second). Input range (V)= ±10V. Data transfers=DMA, interrupts, programmed I/0. DMA channels=6.
**Analog output:** Number of **channels=2**. **Resolution=16 bits**, 1 in 65536. Max. output rate up to: 833 KS/s. Output range(V)=± 10V. Data transfers=DMA, interrupts, programmed I/0.
**Digital Input/Output: Channels=24 inputs/outputs**. D0 or DI Sample Clock frequency: 0 to 1 MHz.
Timing: **Counter/timers=2**. Resolution: Counter/timers: 32 bits.

DAB

**④ TCCC/CCSOF. Computer Control+Data Acquisition+Data Management Software:**

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.**
Registration and visualization of all process variables in an automatic and simultaneously way.
**Flexible, open and multicontrol software**, developed with actual windows graphic systems, acting simultaneously on all process parameters.
Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
**Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed. Calibration system for the sensors involved in the process.**
**It allows the registration of the alarms state and the graphic representation in real time.**
Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
**Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords** to facilitate the teacher's control on the student, and allowing the access at different work levels.
**This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.**




TCCC/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: TCCC + TCCC/CIB + DAB + TCCC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply, enabling a normal operation.**

Continue...

## Complementary items to the standard supply

PLC. Industrial Control using PLC (7 and 8):

**⑦ PLC-PI. PLC Module:**

Circuit diagram in the front panel.

Front panel:

**Digital inputs(X) and Digital outputs (Y) block:**

**16 Digital inputs,** activated by switches and 16 LEDs for confirmation (red).

**14 Digital outputs** (through SCSI connector) with 14 LEDs for message (green).

**Analog inputs block:**

**16 Analog inputs** (-10V. to + 10V.)( through SCSI connector).

**Analog outputs block:**

**4 Analog outputs** (-10V. to + 10V) (through SCSI connector).

**Touch screen**:

High visibility and multiple functions.

Display of a highly visible status.

Recipe function.

Bar graph function.

Flow display function.

Alarm list.

Multi language function.

True type fonts.

Back panel:

Power supply connector.

Fuse 2A.

RS-232 connector to PC.

Inside:

Power supply outputs: 24 Vdc, 12 Vdc, -12 Vdc, 12 Vdc variable.

**Panasonic PLC**:

**High-speed scan of 0.32 μsec.** for a basic instruction.

**Program capacity of 32 Ksteps**, with a sufficient comment area.

Free input AC voltage(100 to 240 V AC).

DC input:16 (24 V DC).

Relay output: 14 (250 V A AC/2 A).

**High-speed counter**.

**Multi-point PID control**.

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

Communication RS232 wire, to computer (PC).

PLC-PI

**⑧ TCCC/PLC-SOF. PLC Control Software:**

For this particular unit, always included with PLC supply.

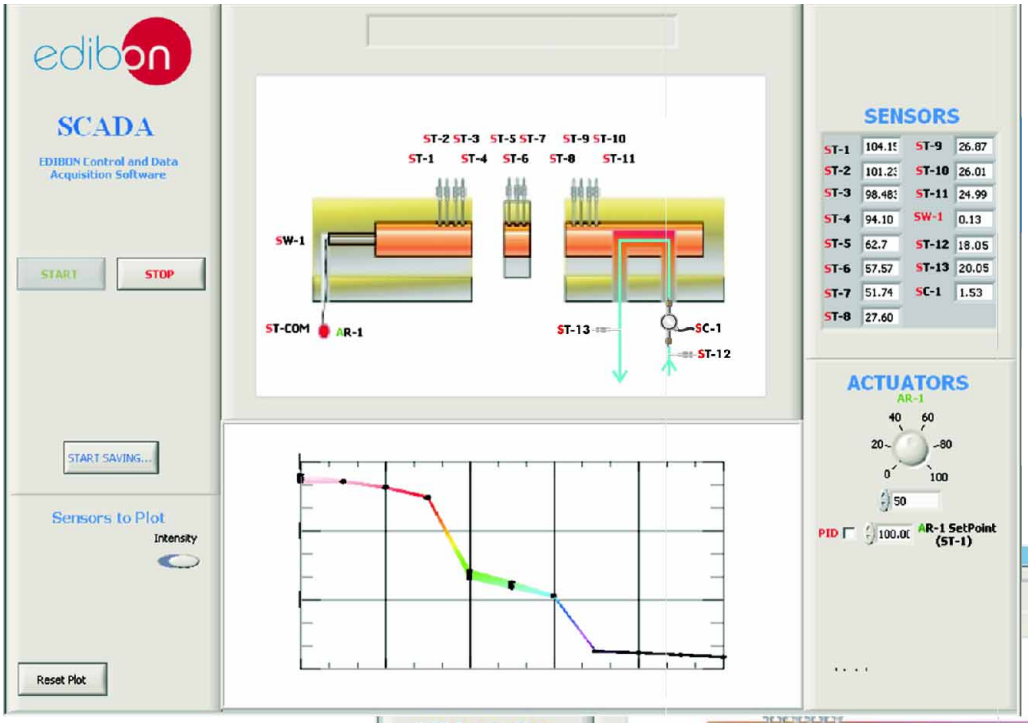
## Items available on request

**⑨TCCC/CAL. Computer Aided Learning Software (Results Calculation and Analysis)**.

**⑩TCCC/FSS. Faults Simulation System.**

## Software Main Screens

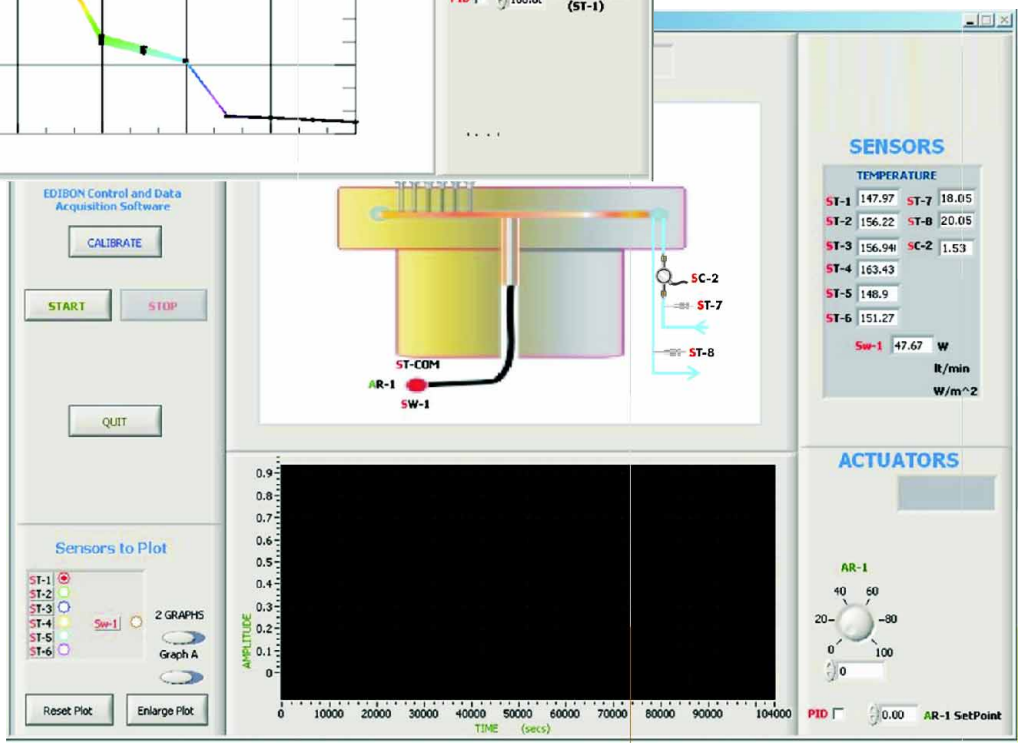
Main screens




← Linear Heat Conduction

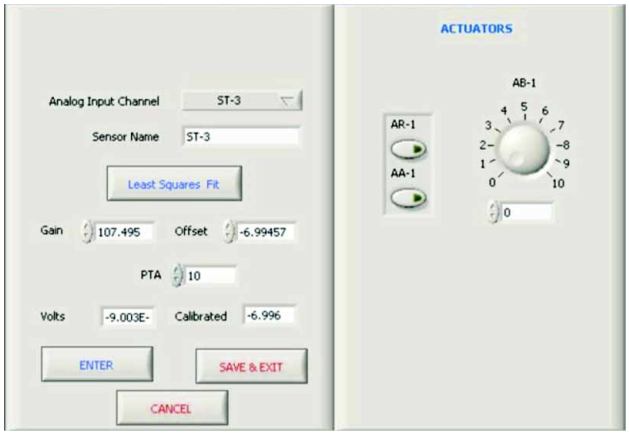
**Note:** ST= Temperatura sensor.
SW= Power sensor.
AR= Heating resistance.
SC= Flow sensor.

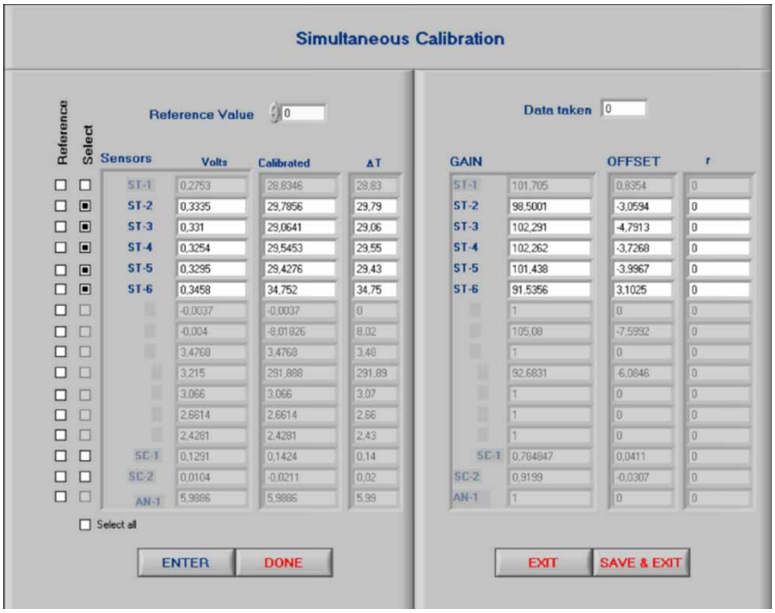
Radial Heat Conduction →




**Note:** ST= Temperature sensor.
SW= Power sensor.
AR= Heating resistance.
SC= Flow sensor.

Examples of Sensors Calibration screens



## EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Conduction through a simple bar.

2.- Conduction through a compound bar.

3.- Determination of the thermal conductivity "k" of different materials (conductors and insulators).

4.- The thermal conductivity properties of insulators may be found by inserting paper or other elements between the heating and cooling sections.

5.- Insulation effect.

6.- Determination of the thermal contact resistance $R_{tc}$.

7.- Effect of the crossing sectional area.

8.- Radial conduction.

9.- Understanding the use of the Fourier equation in determining rate of heat flow through solid materials.

10.-Observing unsteady-state conduction.

Other possible practices:

11.-Calibration processes.

12.-Calibration of the temperature sensors.

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

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

14.-Visualization of all the sensors values used in the TCCC unit process.

15.-Calibration of all sensors included in the TCCC unit process.

16.-Hand on of all the actuators involved in the TCCC unit process.

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

18.-Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).

19.-PLC hardware general use and manipulation.

20.-PLC process application for TCCC unit.

21.-PLC structure.

22.-PLC inputs and outputs configuration.

23.-PLC configuration possibilities.

24.-PLC program languages.

25.-PLC different programming standard languages.

26.-New configuration and development of new process.

27.-Hand on an established process.

28.-To visualize and see the results and to make comparisons with the TCCC unit process.

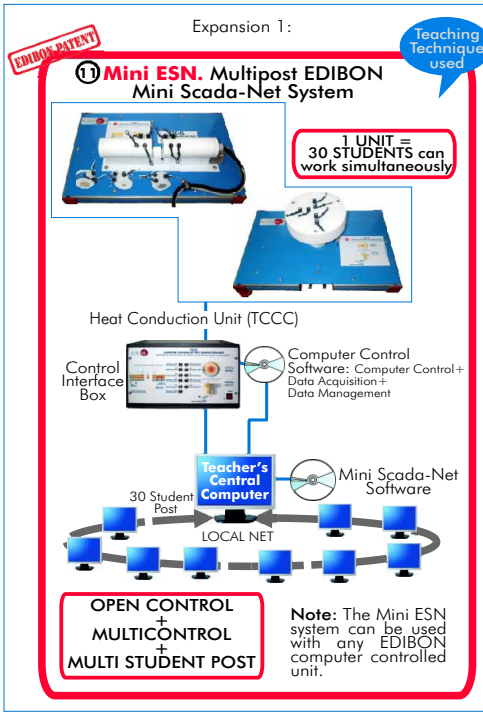
29.-Possibility of creating new process in relation with the TCCC unit.

30.-PLC Programming Exercises.

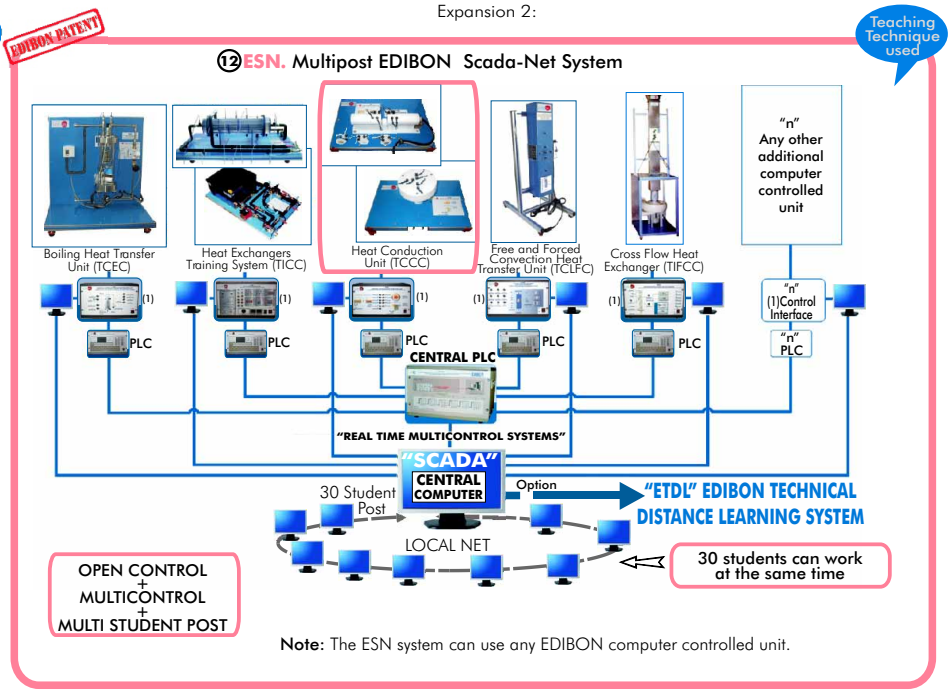
31.-Own PLC applications in accordance with teacher and student requirements.

## POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS

Expansion 1:




Expansion 2:




## ORDER INFORMATION

### Items supplied as standard

**Minimum configuration** for normal operation includes:

① **Unit: TCCC. Heat Conduction Unit.**

② **TCCC/CIB.Control Interface Box.**

③ **DAB.Data Acquisition Board.**

④ **TCCC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**

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

⑥ **Manuals.**

*** IMPORTANT: Under TCCC we always supply all the elements for immediate running as 1, 2, 3, 4, 5 and 6.**

### Complementary items to the standard supply

PLC. Industrial Control using PLC (7 and 8):

⑦ PCL-PI.PLC Module.

⑧ TCCC/PLC-SOF. PLC Control Software.

⑨ TCCC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).

⑩ TCCC/FSS. Faults Simulation System. (Available on request).

Expansions

⑪ Mini ESN. Multipost EDIBON Mini Scada-Net System.

⑫ ESN. Multipost EDIBON Scada-Net System.

## REQUIRED SERVICES

-Electrical supply: 220-110 V / 50-60 Hz.
-Water supply.
-Computer (PC).

## DIMENSIONS & WEIGHTS

TCCC Unit:
Linear Heat Conduction Module (TXC/CL):
-Dimensions: 400 x 300 x 300 mm. approx.
-Weight: 20 Kg. approx.
Radial Heat Conduction Module (TXC/CR):
-Dimensions: 400 x 300 x 300 mm. approx.
-Weight: 20 kg. approx.
Control Interface Box: -Dimensions: 490 x 330 x 310 mm. approx.
-Weight: 10 Kg. approx.
PLC Module (PLC-PI): -Dimensions: 490 x 330 x 310 mm. approx.
-Weight: 30 Kg. approx.

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

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