edibon
Technical Teaching Equipment

Computer Controlled **Two-Stage Compressor Test Unit**, with SCADA

HCDEC

NEW

EDIBON PATENT

① Unit: HCDEC. Two-Stage Compressor Test Unit

EDIBON SCADA System

Teaching Technique used

② Control Interface Box

③ Data Acquisition Board

④ Software for:
- Computer Control
- Data Acquisition
- Data Management

Computer (not included in the supply)

⑤ Cables and Accessories

⑥ Manuals

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

Key features:

▶ **Advanced Real-Time SCADA.**

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

▶ **Specialized EDIBON Control Software based on Labview.**

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

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

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

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

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

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

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

▶ **Optional CAL software helps the user perform calculations and comprehend the results.**

▶ **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**

www.edibon.com
⤷Products
⤷Products range
⤷Units
⤷8.-Fluid Mechanics & Aerodynamics

For more information about Key Features, click here:

INTRODUCTION

A multi-stage compressor is a type of compressor that compresses air to the required pressure in multiple stages with intercooling between stages. Multi-stage compressors are often used for high pressures.

The Computer Controlled Two-Stage Compressor Test Unit (HCDEC) allows students to investigate the performance of a single and two-stage (with or without intercooling) compressor working at a range of delivery pressures, to study the energy saving benefits of intercooling, and to determine their thermodynamic properties and the characteristic curves (p-V diagrams).

GENERAL DESCRIPTION

The Computer Controlled Two-Stage Compressor Test Unit (HCDEC) provides a detailed analysis of compressor performance and a useful introduction to fundamental thermodynamic analysis of a two-stage air compressor.

This unit consists of a two stage reciprocating compressor, driven by two motors, an intercooler and air receiver. This compressor can be operated as a single stage, two-stage without intercooler or two-stage with intercooler.

Electronic drive units independently control both compressor motors. Independent control of the two compressor motors speeds allows flexibility to match the two compressor motors under different conditions.

The inlet air passes through an air filter and pressure regulator to provide constant pressure, clean and water free air to the unit. Afterwards, it passes through an orifice plate, to determine the flow with a differential pressure sensor, and enters an intake vessel which reduces intake pulsations and allows various inlet conditions to be established.

Three-way directional valves allow the unit to be operated in single stage mode, in two-stage without intercooler or in two-stage with intercooler to study and compare different types of air-compressor systems. These valves allow air to move in different directions. These directions include: from the intake vessel to the 1st stage of the compressor, directly to the 2nd stage of the compressor and to the 2nd stage, by means of the integral water-cooled intercooler. Throttle valves allow discharge pressure to be controlled and adjusted.

The air throughput and the electrical power consumption of each motor are also measured.

Instrumentation allows the motor electrical power consumption to be measured together with the speed and torque (force) of each motor. The product of the torque and speed gives the true shaft power.

The inlet, intermediate and delivery pressures are indicated on pressure sensors and manometers. All of the relevant temperatures are recorded by temperature sensors.
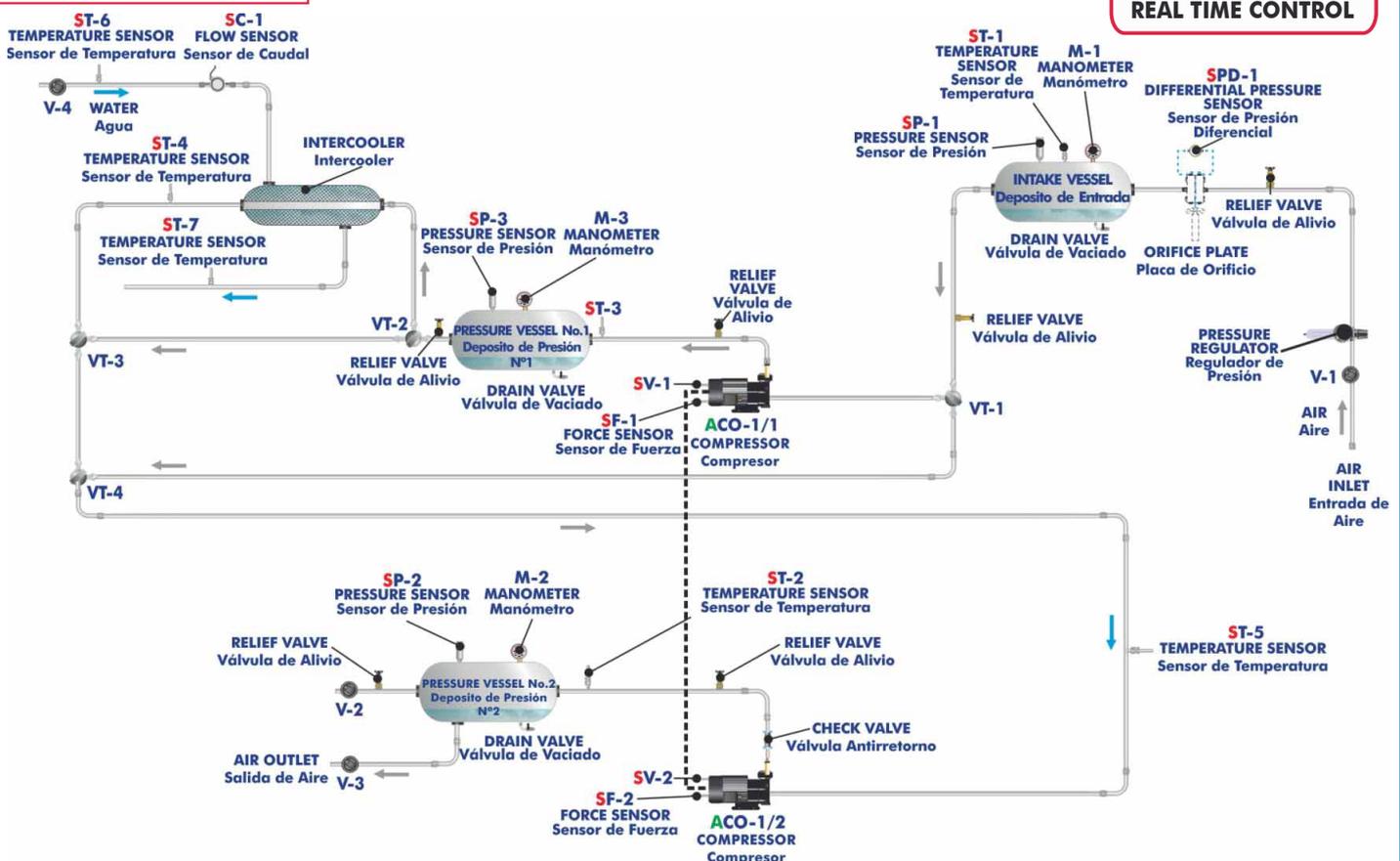
The unit is equipped with safety devices (pressure relief valves, safety valves, silencer, etc.) to prevent misuse and to ensure a completely fail-safe operation for the students. For safety, all pressurized lines have relief valves.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + a Control Interface Box + a Data Acquisition Board + Computer Control, Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

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

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

ST-6 TEMPERATURE SENSOR Sensor de Temperatura
SC-1 FLOW SENSOR Sensor de Caudal
V-4 WATER Agua
ST-4 TEMPERATURE SENSOR Sensor de Temperatura
INTERCOOLER Intercooler
ST-7 TEMPERATURE SENSOR Sensor de Temperatura
SP-3 PRESSURE SENSOR Sensor de Presión
M-3 MANOMETER Manómetro
VT-2
RELIEF VALVE Válvula de Alivio
PRESSURE VESSEL No.1 Deposito de Presión Nº1
ST-3
DRAIN VALVE Válvula de Vaciado
RELIEF VALVE Válvula de Alivio
VT-3
VT-4
SV-1
SF-1 FORCE SENSOR Sensor de Fuerza
ACO-1/1 COMPRESSOR Compresor
ST-1 TEMPERATURE SENSOR Sensor de Temperatura
M-1 MANOMETER Manómetro
SPD-1 DIFFERENTIAL PRESSURE SENSOR Sensor de Presión Diferencial
SP-1 PRESSURE SENSOR Sensor de Presión
INTAKE VESSEL Deposito de Entrada
DRAIN VALVE Válvula de Vaciado
RELIEF VALVE Válvula de Alivio
ORIFICE PLATE Placa de Orificio
RELIEF VALVE Válvula de Alivio
VT-1
PRESSURE REGULATOR Regulador de Presión
V-1
AIR Aire
AIR INLET Entrada de Aire
SP-2 PRESSURE SENSOR Sensor de Presión
M-2 MANOMETER Manómetro
ST-2 TEMPERATURE SENSOR Sensor de Temperatura
RELIEF VALVE Válvula de Alivio
V-2
RELIEF VALVE Válvula de Alivio
PRESSURE VESSEL No.2 Deposito de Presión Nº2
DRAIN VALVE Válvula de Vaciado
AIR OUTLET Salida de Aire V-3
SV-2
SF-2 FORCE SENSOR Sensor de Fuerza
ACO-1/2 COMPRESSOR Compresor
CHECK VALVE Válvula Antirretorno
ST-5 TEMPERATURE SENSOR Sensor de Temperatura

With this unit there are several options and possibilities:
- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8, 9, 10, 11 and 12.

Let us describe first the main items (1 to 6):

① **HCDEC. Unit:**

The unit is mounted on a metallic frame and is designed to support the different components of the unit. It includes wheels for its mobility.

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

Two stage air compressor with two cylinders, which may be operated as a single stage, two stages without intercooler or two stages with intercooler:

Compressors: twin cylinders.

The unit includes two computer controlled electrical motors and two low-maintenance toothed belts to drive the compressor. Speed range: 200-1000 rpm.

Maximum delivery pressure: 10 bar approx.

A "J" type temperature sensor is located at the inlet of the 2nd stage of the compressor.

Two speed sensors to measure the speed of each motor.

Two load cells (force sensors) to measure the torque (force) of each motor.

The software can determine the electrical power consumption of each motor.

An air filter and pressure regulator, located at the inlet air, provides constant pressure, clean and water free air to the unit.

An orifice plate and a differential pressure sensor located at the inlet of the horizontal intake vessel allow to measure the airflow rate; differential pressure sensor range: 0 - 25 mbar.

A horizontal intake vessel, which reduces pulsations and allows various inlet conditions to be established. (Pressure: 16 bar, capacity: 20 l., approx.)

It includes:

A pressure sensor, range: 0 - 20 bar.

A manometer, range: 0 - 25 bar.

A "J" type temperature sensor.

A valve is used to drain the vessel.

A horizontal pressure vessel in the 1st stage working as intermediate reservoir. (Pressure: 16 bar, capacity: 5 l., approx.)

It includes:

A pressure sensor, range: 0 - 20 bar.

A manometer, range: 0 - 25 bar.

A "J" type temperature sensor is located at the inlet of the pressure vessel on the 1st stage.

A valve is used to drain the vessel.

A horizontal pressure vessel in the 2nd stage. (Pressure: 16 bar, capacity: 20 l., approx.).

It includes:

A pressure sensor, range: 0 - 20 bar.

A manometer, range: 0 - 25 bar.

A "J" type temperature sensor is located at the inlet of the pressure vessel on the 2nd stage.

A valve is used to drain the vessel.

An intercooler.

Three "J" type temperature sensors are located in the intercooler.

A flow sensor to measure the water flow in the intercooler, range: 0.25-6.5 l./min.

Four 3-way directional valves allow to move the air in different directions and to operate the unit in several modes.

The unit is equipped with safety devices (pressure relief valves, safety valves, silencer, etc.).

The complete unit includes as well:

Advanced Real-Time SCADA.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on Labview.

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

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

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

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

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

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

Designed and manufactured under several quality standards.

Optional CAL software helps the user perform calculations and comprehend the results.

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.

HCDEC. Unit

② HCDEC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.

<u>Control interface box with process diagram in the front panel</u> and with the same distribution that the different elements located in the unit, for an easy understanding by the student.

All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output.

Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.

Single cable between the control interface box and computer.

The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.

Simultaneous visualization in the computer of all parameters involved in the process.

Calibration of all sensors involved in the process.

Real time curves representation about system responses.

Storage of all the process data and results in a file.

Graphic representation, in real time, of all the process/system responses.

All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.

All the actuators and sensors values and their responses are displayed on only one screen in the computer.

Shield and filtered signals to avoid external interferences.

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

Real time computer control for pumps, compressors, resistances, control valves, etc.

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

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

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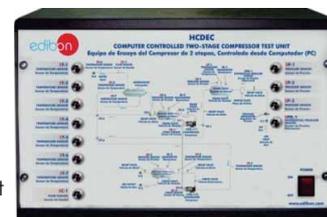
HCDEC/CIB

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: <u>250 KS/s (kilo samples per second)</u>.

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

Analog output:

Number of **channels=2**. **Resolution=16 bits,** 1 in 65536. Maximum output rate up to: 900 KS/s.

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

Digital Input/Output:

Number of **channels=24 inputs/outputs**. D0 or DI Sample Clock frequency: 0 to 100 MHz.

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

DAB

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

The three softwares are part of the SCADA system.

Compatible with actual Windows operating systems.

Graphic and intuitive simulation of the process in screen.

Compatible with the industry standards.

Registration and visualization of all process variables in an automatic and simultaneous way.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data.

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

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.

HCDEC/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: HCDEC + HCDEC/CIB + DAB + HCDEC/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 MAIN ITEMS

1.- Study of the layout and function of a two-stage compressor.

2.- Determination of the intake airflow rate.

3.- Calculation of the inlet air dryness.

4.- Study of the compression process on a p-V diagram.

5.- Study of the work done by a two-stage compressor.

6.- Study of the motor output power (compressor shaft power).

7.- Determination of the efficiency of a two-stage compressor.

8.- Study of the pressure ratio in a two-stage compressor.

9.- Study of the temperature ratio in a two-stage compressor.

10.- Investigation of variation in air flow rate, with compressor pressure ratio without intercooler.

11.- Investigation of variation in air flow rate, with compressor pressure ratio with intercooler.

12.- Investigation of variation in volumetric efficiency with compressor pressure ratio without intercooler.

13.- Investigation of variation in volumetric efficiency with compressor pressure ratio with intercooler.

14.- Investigation of variation of isothermal efficiency with compressor pressure ratio without intercooler.

15.- Investigation of variation of isothermal efficiency with compressor pressure ratio with intercooler.

16.- Investigation of variation of mechanical efficiency with compressor pressure ratio without intercooler.

17.- Investigation of variation of mechanical efficiency with compressor pressure ratio with intercooler.

18.- Investigation of the compressor performance relative to electrical power, shaft power, and heat loss without intercooler.

19.- Investigation of the compressor performance relative to electrical power, shaft power, and heat loss with intercooler.

20.- Study of the effect of inter-stage cooling on compressor total power requirements and effect on cycle temperatures.

21.- Study of the effect of two-stage compression and inter-stage pressure on power requirements.

Additional practical possibilities:

22.- Sensors calibration.

Other possibilities to be done with this Unit:

23.- Many students view results simultaneously.

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

24.- 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.

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

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

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

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

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

30.- Visualization of all the sensors values used in the HCDEC 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 with ground, 220V/50Hz or 110V/60Hz.

- Water supply for the intercooler (3 l./min. approx.) and draining system.

- Computer (PC).

DIMENSIONS & WEIGHTS

HCDEC:

Unit:	-Dimensions:	1500 x 800 x 1700 mm. approx.
		(59.05 x31.50 x 66.93 inches approx.)
	-Weight:	270 Kg. approx.
		(595.25 pounds approx.)
Control-Interface Box:	-Dimensions:	490 x 330 x 310 mm. approx.
		(19.29 x 12.99 x 12.2 inches approx.)
	-Weight:	10 Kg. approx.
		(22 pounds approx.)

Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 12.
All these items try to give more possibilities for:

    a) Industrial configuration. (PLC)
    b) Technical and Vocational Education configuration. (CAI and FSS)
    c) Higher Education and/or Technical and Vocational Education configuration. (CAL)
    d) Multipost Expansions options. (Mini ESN and ESN)

a) Industrial configuration

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

-PLC-PI. PLC Module:
Metallic box.
Circuit diagram in the module front panel.
Front panel:
  Digital inputs(X) and Digital outputs (Y) block:
    16 **Digital inputs,** activated by switches and 16 LEDs for confirmation (red).
    14 **Digital outputs** (through SCSI connector) with 14 LEDs for message (green).
  Analog inputs block:
    16 **Analog inputs** (-10 V. to + 10 V.) (through SCSI connector).
  Analog outputs block:
    4 **Analog outputs** (-10 V. to + 10 V.) (through SCSI connector).
  Touch screen:
    High visibility and multiple functions. Display of a highly visible status. Recipe function. Bar graph function. Flow display function. Alarm list.
    Multi language function. True type fonts.
Back panel:
  Power supply connector. Fuse 2A. RS-232 connector to PC. USB 2.0 connector to PC.
Inside:
  Power supply outputs: 24 Vdc, 12 Vdc, -12 Vdc, 12 Vdc variable.
  Panasonic PLC:
    High-speed scan of 0.32 μsec. for a basic instruction.
    Program capacity of 32 Ksteps, with a sufficient comment area.
    Power supply input (100 to 240 V AC).
    DC input: 16 (24 V DC).
    Relay output: 14.
    High-speed counter.
    Multi-point PID control.
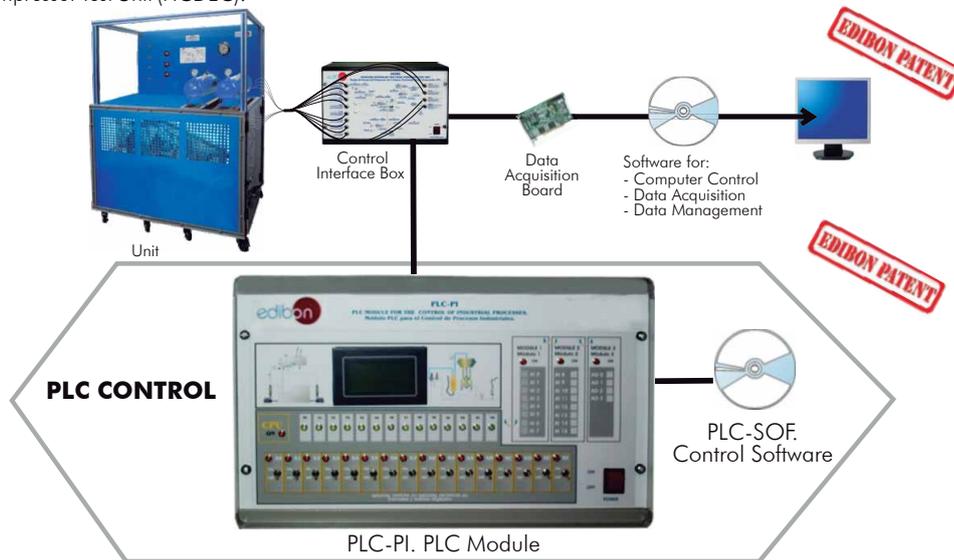 Digital inputs/outputs and analog inputs/outputs Panasonic modules.
Communication RS232 wire to computer (PC).
Dimensions: 490 x 330 x 310 mm. approx. (19.29 x 12.99 x 12.20 inches approx.).　　Weight: 30 Kg. approx. (66 pounds approx.).

-HCDEC/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 Two-Stage Compressor Test Unit (HCDEC).

Practices to be done with PLC-PI:

1.- Control of the HCDEC unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the HCDEC unit process.
3.- Calibration of all sensors included in the HCDEC unit process.
4.- Hand on of all the actuators involved in the HCDEC unit process.
5.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
6.- Simulation of outside actions, in the cases hardware elements do not exist. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
7.- PLC hardware general use and manipulation.
8.- PLC process application for HCDEC unit.
9.- PLC structure.
10.- PLC inputs and outputs configuration.
11.- PLC configuration possibilities.
12.- PLC programming languages.
13.- PLC different programming standard languages.
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 HCDEC unit process.
17.- Possibility of creating new process in relation with the HCDEC unit.
18.- PLC Programming exercises.
19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ HCDEC/CAI. Computer Aided Instruction Software System.

This complete software package includes two Softwares: the INS/SOF. Classroom Management Software (Instructor Software) and the HCDEC/SOF. Computer Aided Instruction Software (Student Software).

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

This complete software package consists on an Instructor Software (INS/SOF) totally integrated with the Student Software (HCDEC/SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

- INS/SOF. Classroom Management Software (Instructor Software):
  The Instructor can:

  Organize Students by Classes and Groups.

  Create easily new entries or delete them.

  Create data bases with student information.

  Analyze results and make statistical comparisons.

  Generate and print reports.

  Detect student's progress and difficulties.

  …and many other facilities.

Instructor Software

- HCDEC/SOF. Computer Aided Instruction Software (Student Software):

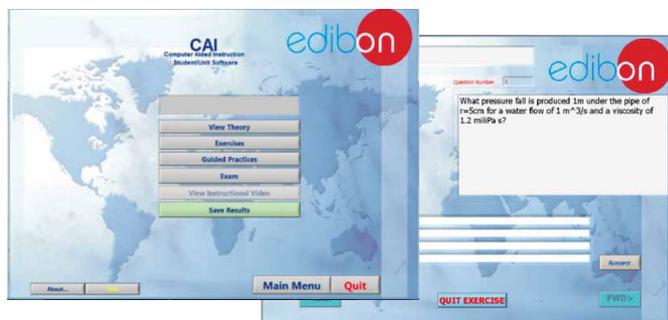 It explains how to use the unit, run the experiments and what to do at any moment.

  This Software contains:

  Theory.

  Exercises.

  Guided Practices.

  Exams.

For more information see **CAI** catalogue. Click on the following link:
  www.edibon.com/products/catalogues/en/CAI.pdf

Student Software

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

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

Faults affecting the sensors measurement:

- **An incorrect calibration is applied to them.**

- **Non-linearity.**

Faults affecting the actuators:

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

- **Response reduction of an actuator.**

Faults in the controls execution:

- **Inversion of the performance in ON/OFF controls.**

- **Reduction or increase of the calculated total response.**

- **The action of some controls is annulled.**

On/off faults:

- **Several on/off faults can be included.**

For more information see **FSS** catalogue. Click on the following link:
  www.edibon.com/products/catalogues/en/FSS.pdf

Example of some screens

c) Higher Education and/or Technical and Vocational Education configuration

⑩ HCDEC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

This Computer Aided Learning Software (CAL) is a Windows based software, **simple and very easy to use**, specifically developed by EDIBON. It is very useful for Higher Education level.

CAL is a class assistant that helps in doing the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL computes the value of all the variables involved and performs the calculations.

It allows to plot and print the results. Within the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.
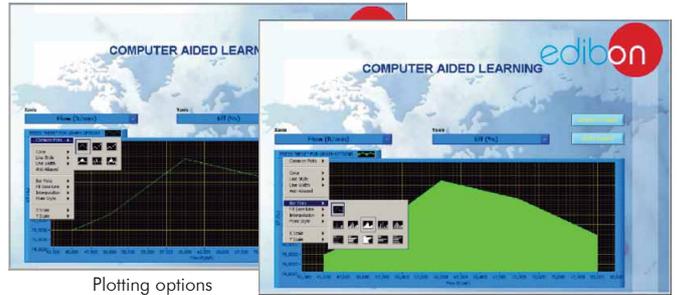
For more information see **CAL** catalogue. Click on the following link:

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

Calculations

Information of constant values, unit conversion factors and integral and derivative tables

Plotting options

d) Multipost Expansions options

⑪ Mini ESN. EDIBON Mini Scada-Net System.

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

The Mini ESN system consists on the adaptation of any EDIBON computer controlled unit with SCADA integrated in a local network.

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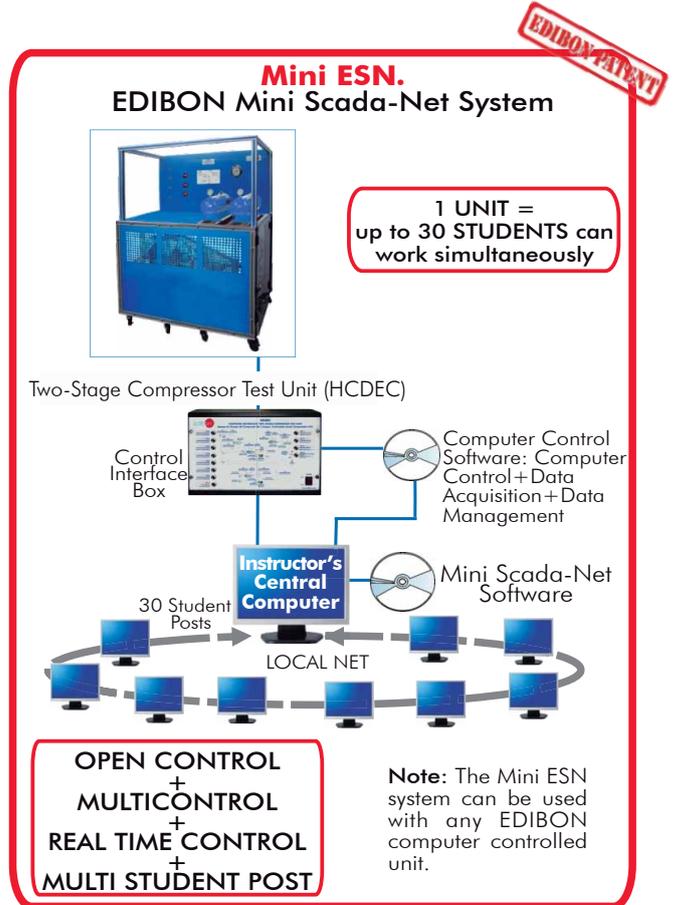
Main characteristics:

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

Main advantages:

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

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

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

Mini ESN.
EDIBON Mini Scada-Net System

1 UNIT =
up to 30 STUDENTS can work simultaneously

Two-Stage Compressor Test Unit (HCDEC)

Control Interface Box

Computer Control Software: Computer Control+Data Acquisition+Data Management

Instructor's Central Computer

Mini Scada-Net Software

30 Student Posts

LOCAL NET

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

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

⑫ ESN. EDIBON Scada-Net System.

This unit can be integrated, in the future, into a Complete Laboratory with many Units and many Students.

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

www.edibon.com/products/catalogues/en/units/fluidmechanicsaerodynamics/esn-fluidmechanics/ESN-FLUID_MECHANICS.pdf

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: HCDEC. Two-Stage Compressor Test Unit.**

② **HCDEC/CIB. Control Interface Box.**

③ **DAB. Data Acquisition Board.**

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

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

⑥ **Manuals.**

* IMPORTANT: Under HCDEC 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.

- HCDEC/PLC-SOF. PLC Control Software.

b) Technical and Vocational configuration

⑧ HCDEC/CAI. Computer Aided Instruction Software System.

⑨ HCDEC/FSS. Faults Simulation System.

c) Higher Education and/or Technical and Vocational Education configuration

⑩ HCDEC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

d) Multipost Expansions options

⑪ Mini ESN. EDIBON Mini Scada-Net System.

⑫ ESN. EDIBON Scada-Net System.

① **HCDEC. Unit:**

The unit is mounted on a metallic frame and is designed to support the different components of the unit. It includes wheels for its mobility.

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

Two stage air compressor with two cylinders, which may be operated as a single stage, two stages without intercooler or two stages with intercooler:

Compressors: twin cylinders.

The unit includes two computer controlled electrical motors and two low-maintenance toothed belts to drive the compressor. Speed range: 200-1000 rpm.

Maximum delivery pressure: 10 bar approx.

A "J" type temperature sensor is located at the inlet of the 2nd stage of the compressor.

Two speed sensors to measure the speed of each motor.

Two load cells (force sensors) to measure the toque (force) of each motor.

The software can determine the electrical power consumption of each motor.

An air filter and pressure regulator, located at the inlet air, provides constant pressure, clean and water free air to the unit.

An orifice plate and a differential pressure sensor located at the inlet of the horizontal intake vessel allow to measure the airflow rate; differential pressure sensor range: 0 - 25 mbar.

A horizontal intake vessel, which reduces pulsations and allows various inlet conditions to be established. (Pressure: 16 bar, capacity: 20 l., approx.)

It includes:

A pressure sensor, range: 0 - 20 bar.

A manometer, range: 0 - 25 bar.

A "J" type temperature sensor.

A valve is used to drain the vessel.

A horizontal pressure vessel in the 1st stage working as intermediate reservoir. (Pressure: 16 bar, capacity: 5 l., approx.)

It includes:

A pressure sensor, range: 0 - 20 bar.

A manometer, range: 0 - 25 bar.

A "J" type temperature sensor is located at the inlet of the pressure vessel on the 1st stage.

A valve is used to drain the vessel.

A horizontal pressure vessel in the 2nd stage. (Pressure: 16 bar, capacity: 20 l., approx.).

It includes:

A pressure sensor, range: 0 - 20 bar.

A manometer, range: 0 - 25 bar.

A "J" type temperature sensor is located at the inlet of the pressure vessel on the 2nd stage.

A valve is used to drain the vessel.

An intercooler.

Three "J" type temperature sensors are located in the intercooler.

A flow sensor to measure the water flow in the intercooler, range: 0.25-6.5 l./min.

Four 3-way directional valves allow to move the air in different directions and to operate the unit in several modes.

The unit is equipped with safety devices (pressure relief valves, safety valves, silencer, etc.).

The complete unit includes as well:

Advanced Real-Time SCADA.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on Labview.

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

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

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

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

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

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

Designed and manufactured under several quality standards.

Optional CAL software helps the user perform calculations and comprehend the results.

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 **HCDEC/CIB. Control Interface Box:**

The Control Interface Box is part of the SCADA system.

Control interface box with process diagram in the front panel.

The unit control elements are permanently computer controlled.

Simultaneous visualization in the computer of all parameters involved in the process. Calibration of all sensors involved in the process.

Real time curves representation about system responses.

All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.

Shield and filtered signals to avoid external interferences.

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

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

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

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

③ **DAB. Data Acquisition Board:**

The Data Acquisition board is part of the SCADA system.

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

Analog input: Channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).

Analog output: Channels=2. Resolution=16 bits, 1 in 65536.

Digital Input/Output: Channels=24 inputs/outputs.

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

The three softwares are part of the SCADA system.

Compatible with the industry standards.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data. Sampling velocity up to 250 KS/s (kilo samples per second).

Calibration system for the sensors involved in the process. It allows the registration of the alarms state and the graphic representation in real time.

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

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

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

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

Exercises and Practical Possibilities to be done with Main Items

1.- Study of the layout and function of a two-stage compressor.

2.- Determination of the intake airflow rate.

3.- Calculation of the inlet air dryness.

4.- Study of the compression process on a p-V diagram.

5.- Study of the work done by a two-stage compressor.

6.- Study of the motor output power (compressor shaft power).

7.- Determination of the efficiency of a two-stage compressor.

8.- Study of the pressure ratio in a two-stage compressor.

9.- Study of the temperature ratio in a two-stage compressor.

10.- Investigation of variation in air flow rate, with compressor pressure ratio without intercooler.

11.- Investigation of variation in air flow rate, with compressor pressure ratio with intercooler.

12.- Investigation of variation in volumetric efficiency with compressor pressure ratio without intercooler.

13.- Investigation of variation in volumetric efficiency with compressor pressure ratio with intercooler.

14.- Investigation of variation of isothermal efficiency with compressor pressure ratio without intercooler.

15.- Investigation of variation of isothermal efficiency with compressor pressure ratio with intercooler.

16.- Investigation of variation of mechanical efficiency with compressor pressure ratio without intercooler.

17.- Investigation of variation of mechanical efficiency with compressor pressure ratio with intercooler.

18.- Investigation of the compressor performance relative to electrical power, shaft power, and heat loss without intercooler.

19.- Investigation of the compressor performance relative to electrical power, shaft power, and heat loss with intercooler.

20.- Study of the effect of inter-stage cooling on compressor total power requirements and effect on cycle temperatures.

21.- Study of the effect of two-stage compression and inter-stage pressure on power requirements.

Additional practical possibilities:

22.- Sensors calibration.

Other possibilities to be done with this Unit:

23.- Many students view results simultaneously.

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

24.- 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.

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

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

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

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

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

30.- Visualization of all the sensors values used in the HCDEC unit process.

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

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

a) Industrial configuration

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

-**PLC-PI. PLC Module:**

Metallic box.

Circuit diagram in the module front panel.

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

Analog inputs block: 16 Analog inputs.

Analog outputs block: 4 Analog outputs.

Touch screen.

Panasonic PLC:

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

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

-**HCDEC/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 HCDEC unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the HCDEC unit process.
3.- Calibration of all sensors included in the HCDEC unit process.
4.- Hand on of all the actuators involved in the HCDEC unit process.
5.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
6.- Simulation of outside actions, in the cases hardware elements do not exist. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
7.- PLC hardware general use and manipulation.
8.- PLC process application for HCDEC unit.
9.- PLC structure.
10.- PLC inputs and outputs configuration.
11.- PLC configuration possibilities.
12.- PLC programming languages.
13.- PLC different programming standard languages.
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 HCDEC unit process.
17.- Possibility of creating new process in relation with the HCDEC unit.
18.- PLC Programming exercises.
19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ **HCDEC/CAI. Computer Aided Instruction Software System.**

This complete software package consists on an Instructor Software (INS/SOF) totally integrated with the Student Software (HCDEC/SOF).

-INS/SOF. Classroom Management Software (Instructor Software):

The Instructor can:

Organize Students by Classes and Groups.

Create easily new entries or delete them.

Create data bases with student information.

Analyze results and make statistical comparisons.

Generate and print reports.

Detect student's progress and difficulties.

-HCDEC/SOF. Computer Aided Instruction Software (Student Software):

It explains how to use the unit, run the experiments and what to do at any moment.

This Software contains:

Theory.

Exercises.

Guided Practices.

Exams.

⑨ **HCDEC/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 on 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) Higher Education and/or Technical and Vocational Education configuration

⑩ HCDEC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

This Computer Aided Learning Software (CAL) is a Windows based software, simple and very easy to use.

CAL is a class assistant that helps in doing the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL computes the value of all the variables involved and performs the calculations.

It allows to plot and print the results. Within the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

d) Multipost Expansions options

⑪ Mini ESN. EDIBON Mini Scada-Net System.

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

The Mini ESN system consists on the adaptation of any EDIBON computer controlled unit with SCADA integrated in a local network.

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

Main characteristics:

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

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

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

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

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

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

Main advantages:

-It allows an easier a 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 improvements of the product.

REPRESENTATIVE: