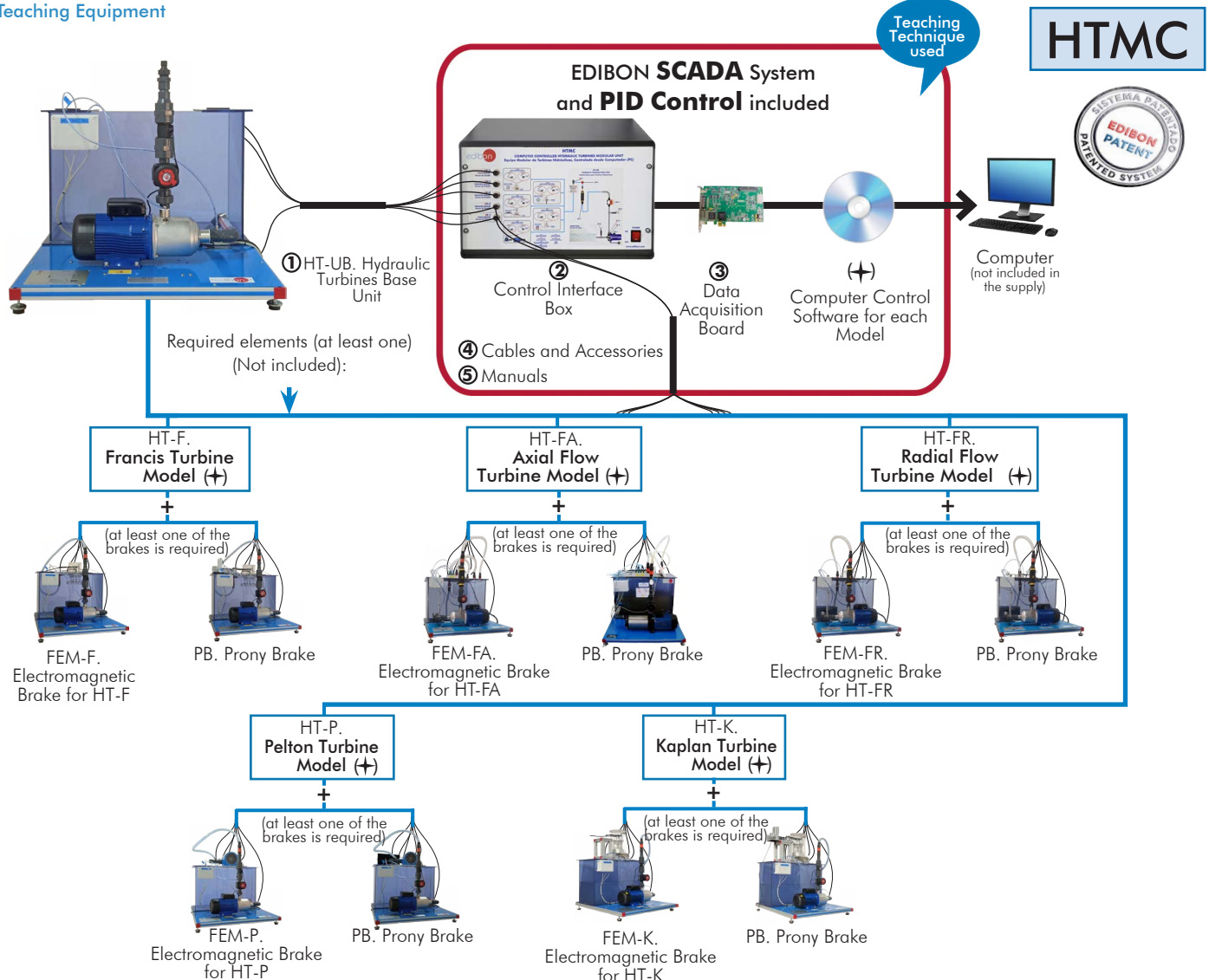


Computer Controlled Hydraulic Turbines Modular Unit with SCADA and PID Control



* The Prony Brake, "PB", can be used in common for all turbines; in the case of the electromagnetic brake it is necessary to purchase the corresponding brake for each turbine.

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**



www.edibon.com
PRODUCTS
8.- FLUID MECHANICS

For more information about key features, click here



INTRODUCTION

A water turbine is a machine whose main element is a runner, through which a fluid passes continuously (water). The kinetic and potential energy of this fluid is used to transform it into mechanical energy by means of the rotation movement of a shaft, which directly moves another machine, or an electric generator, which transforms mechanical energy into electrical energy.

The turbines can be divided into several types, taking into account a series of distinguishing characteristics.

Depending on the arrangement of the shaft, the turbines can be:

Radial-axial: the water enters the impeller radially and leaves parallel to the rotation axis of the turbine.

Axial: the water enters and leaves parallel to the rotation axis of the turbine.

Tangential: water hits the runner at its periphery.

Depending on the degree of reaction, the turbines can be:

Impulse turbines: the water moves the turbine by a direct blow on the blades. The water does not undergo pressure changes as it passes through the runner.

Reaction turbines: the water moves the runner due to the reaction caused by the water exit on the runner. The water undergoes a significant pressure change as it passes through the runner.

Finally, depending on the design of the runner, the turbines can be:

Pelton: useful for high water heads and small flow rates.

Francis: useful in a wide range of heads and flow rates.

Kaplan: useful for small water heads and large flow rates.

The Computer Controlled Hydraulic Turbines Modular, "HTMC", designed by EDIBON is a modular unit this unit allows to determine the operation characteristics of this type of turbine, the hydraulic and mechanical efficiency curves, to obtain the hydraulic and mechanical power, etc.

GENERAL DESCRIPTION

Computer Controlled Modular Hydraulic Turbine Unit, "HTMC", has been designed by EDIBON for the study and comparison of different types of small scale hydraulic turbines, allowing to determine the operation characteristics of this type of turbine, the hydraulic and mechanical efficiency curves, to obtain the hydraulic and mechanical power, etc.

The Hydraulic Turbines Base Unit, "HT-UB", fulfills the following functions:

In order to raise the fluid, it has a computer controlled pump that enables the impelled flow to pass through the turbine, in which part of its energy is left, causing the turbine to turn, overcoming the external resistance caused by an electromagnetic brake. This computer controlled brake makes it possible to vary the braking load on the turbine.

Measurement of the pressure at the pump inlet and outlet, speed and torque sensor in order to obtain its characteristic curve.

Measurement of the water flow, the pressure at the water inlet to the turbine and the speed of the turbine shaft by means of different instrumentation.

The pump-turbine group has a tank and a pipes system which allow to work constantly with recirculated fluid to avoid the indiscriminate water consumption.

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

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

HT-F: The Francis Turbine Model, "HT-F", consists of a small-scale Francis turbine, with a valve that allows flow regulation and has a ring with adjustable guide vanes that allows control of the angle of incidence of the water in the turbine.

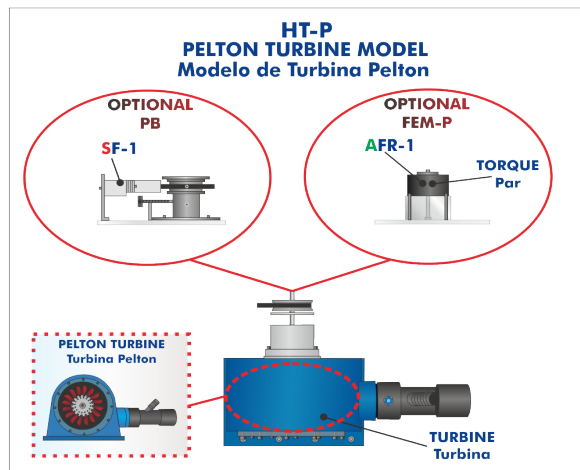
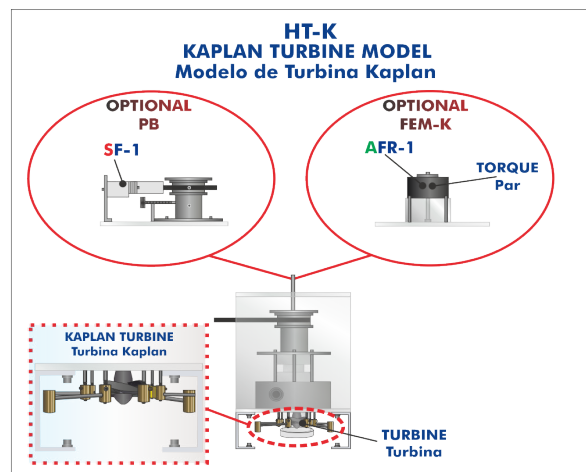
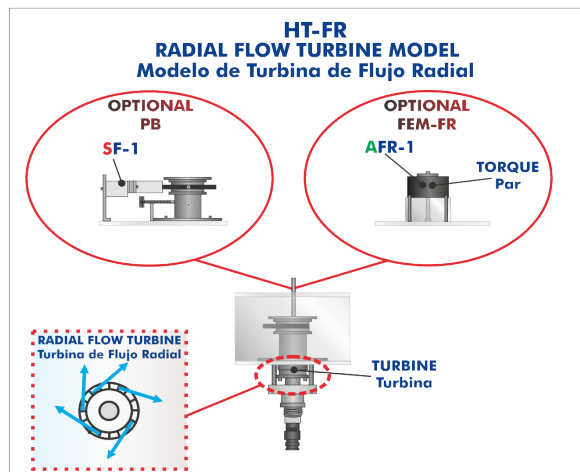
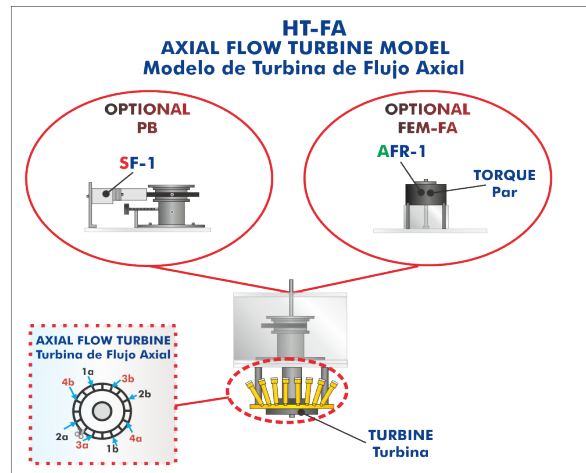
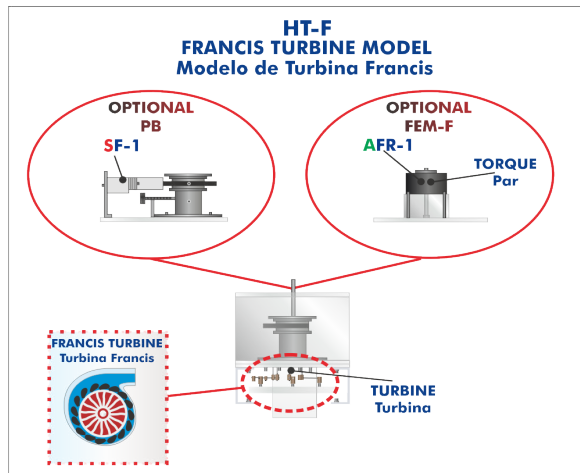
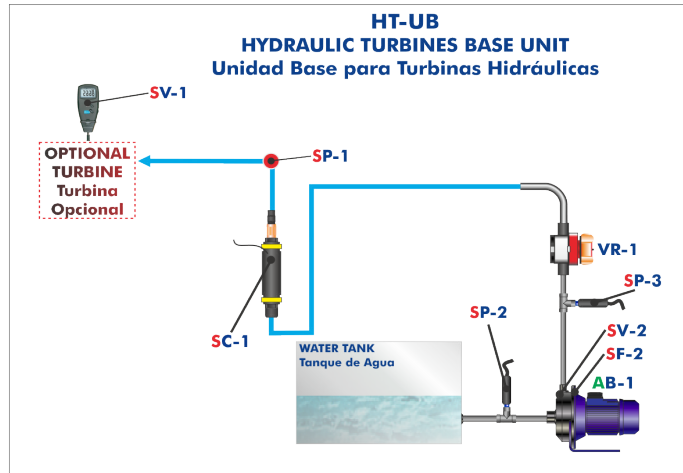
HT-FA: The Axial Flow Turbine Model, "HT-FA", consists of a small-scale turbine with single-stage axial flow input. It has eight nozzles that act as water rings the rotor, four of which have an incidence angle of 20° and the other four of 30° . In this way, it is possible to study the differences in the working regime by varying the entry angles into the turbine through eight valves that allow the water to pass to the different nozzles.

HT-FR: The Radial Flow Turbine Model, "HT-FR", consists of a small-scale radial flow turbine with two nozzles at 90° to the perpendicular direction of the axis of rotation.

HT-P: The Pelton Turbine Model, "HT-P", consists of a small-scale Pelton turbine, with a valve that allows the flow to be regulated. The turbine includes a PELTON runner with 16 buckets, which can be clearly seen through the turbine's transparent casing.

HT-K: The Kaplan Turbine Model, "HT-K", consists of a small-scale Kaplan turbine that has a ring with adjustable guide vanes, which allow the control of water flow in the turbine.

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL



Note: SP=Pressure sensor, SC=Flow sensor, SF=Force sensor, SV=Speed sensor, AFR=Electromagnetic brake, AB= Pump, VR=Regulation valve.

With this unit there are several options and possibilities:

- Main items: 1, 2, 3, 4 and 5.
- Optional items: 6, 7, 8, 9 and 10.

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

① **HT-UB. Hydraulic Turbines Base 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.

Computer controlled centrifugal water pump:

Maximum pressure: 7 bar.

Maximum water flow: 160 l/min.

Power: 1.5 kW.

Speed adjustable through variable-speed drive.

Transparent water tank, capacity: 120 l approx.

Regulation valve.

Instrumentation and sensors:

Two water pressure sensors for inlet (range: 0 - 15 psi) and outlet (range: 0 - 100 psi) of the pump.

Pump speed sensor.

Pump torque sensor.

Water flow sensor, range: 2 - 150 l/min.

Turbine inlet pressure sensor: 0 - 100 psi.

Optical sensor to measure the speed, range: 0 - 60000 rpm (turbine speed).

The complete unit includes as well:

Advanced Real-Time SCADA and PID Control.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on LabVIEW.

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

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

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

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

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

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

Designed and manufactured under several quality standards.

Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.

This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

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

- HT-F. Francis Turbine Model.
- HT-FA. Axial Flow Turbine Model.
- HT-FR. Radial Flow Turbine Model.
- HT-K. Kaplan Turbine Model.
- HT-P. Pelton Turbine Model.



HT-UB. Unit

② HTMC/CIB. Control Interface Box:

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

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

All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.

Single cable between the control interface box and computer.

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

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

Calibration of all sensors involved in the process.

Real time curves representation about system responses.

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

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

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

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

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.

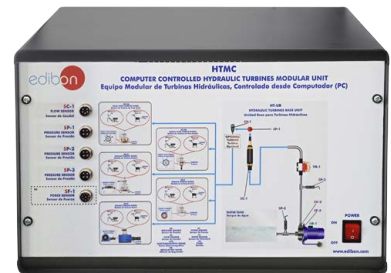
Real time PID control for parameters involved in the process simultaneously.

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.



HTMC/CIB

③ DAB. Data Acquisition Board:

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

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

Analog input:

Number of channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536.

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

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

Analog output:

Number of channels=2. Resolution=16 bits, 1 in 65536.

Maximum output rate up to: 900 KS/s.

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

Digital Input/Output:

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

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

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



DAB

④ Cables and Accessories, for normal operation.

⑤ Manuals:

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

HT-F. Francis Turbine Model

Functional model of Francis Turbine, a ring with adjustable guide vanes that allows to control the water flow in the turbine:

Diameter of the turbine: 52 mm.

Speed range: 0 - 1200 rpm approx.

Rotor:

Number of blades of the turbine: 15.

Stator:

Number of adjustable guide vanes of the distributor: 10.

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

FEM-F. Electromagnetic Brake for HT-F.

Magnetic powder brake:

Nominal braking torque: 2 N/m.

Rated current: 0.45 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

(+) HT-F/CCSOFT. 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.

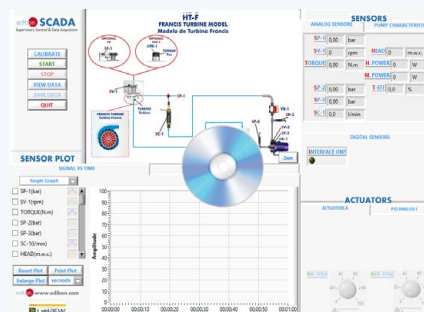
This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.



FEM-F



PB



HT-FA. Axial Flow Turbine Model

Functional model of Axial Flow Turbine:

Nozzles (four 20° nozzles and four 30° nozzles):

Throat inlet diameter: 2 mm. Throat outlet diameter: 2 mm.

Discharge angle: 20° and 30°.

Turbine rotor:

External diameter: 53 mm. Internal diameter: 45 mm. Number of blades: 40.

Inlet angle of the blades: 40°. Outlet angle of the blades: 40°.

Used material: brass.

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

FEM-FA. Electromagnetic Brake for HT-FA.

Magnetic powder brake:

Nominal braking torque: 2 N/m.

Rated current: 0.45 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

(+) HT-FA/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.

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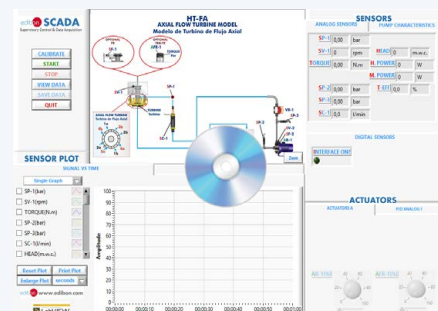
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FEM-FA



PB



HT-FR. Radial Flow Turbine Model

Functional model of Radial Flow Turbine:

Nozzle:

Inlet diameter: 21 mm.

Outlet diameter: 2 mm.

Discharge angle: 180°.

Turbine rotor:

External diameter: 69 mm.

Internal diameter: 40 mm.

Number of nozzles: 2.

Inlet angle of the nozzle: 180°.

Outlet angle of the nozzle: 180°.

Material: aluminum.

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

FEM-FR. Electromagnetic Brake for HT-FR.

Magnetic powder brake:

Nominal braking torque: 2 N/m.

Rated current: 0.45 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

✦ HT-FR/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).

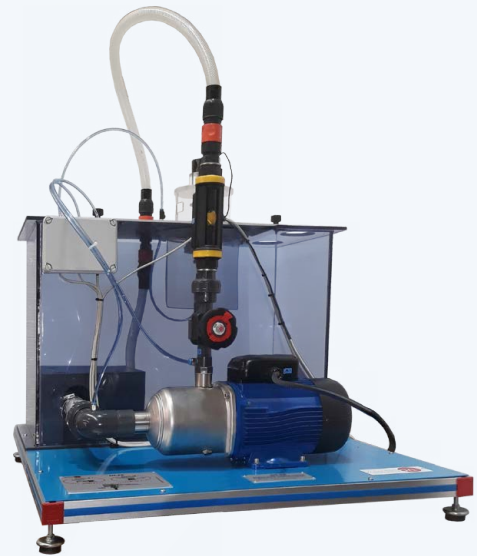
Calibration system for the sensors involved in the process.

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.

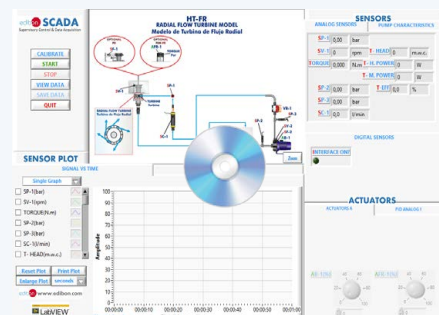
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FEM-FR



PB



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

HT-K. Kaplan Turbine Model

Functional model of Kaplan Turbine, a ring with adjustable guide vanes that allows to control the water flow in the turbine:

Speed range: 0 - 2500 rpm.

Number of blades of the turbine: 4.

Diameter of the turbine: 52 mm.

Number of wicket gates of the ring: 8.

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

FEM-K. Electromagnetic Brake for HT-K.

Magnetic powder brake:

Nominal braking torque: 0.2 N/m.

Rated current: 0.5 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

✚ HT-K/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.

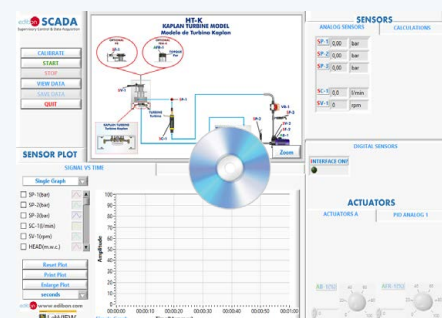
This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.



FEM-K



PB



HT-P. Pelton Turbine Model

Functional model of Pelton Turbine:

Speed range: 0 - 4000 rpm.

Torque: 40 N.

Number of buckets: 16.

Drum radius: 30 mm.

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

FEM-P. Electromagnetic Brake for HT-P.

Magnetic powder brake:

Nominal braking torque: 5 N/m.

Rated current: 0.5 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

⚡ HT-P/CCSOFT. 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).

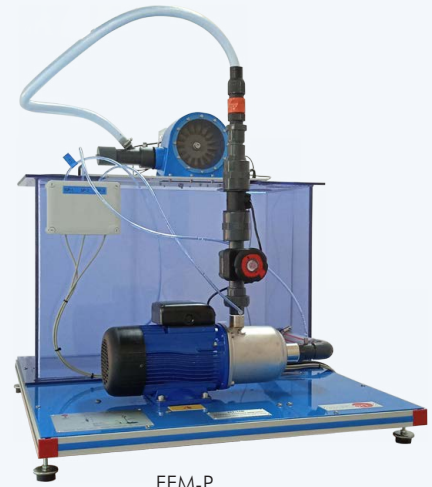
Calibration system for the sensors involved in the process.

It allows the registration of the alarms state and the graphic representation in real time.

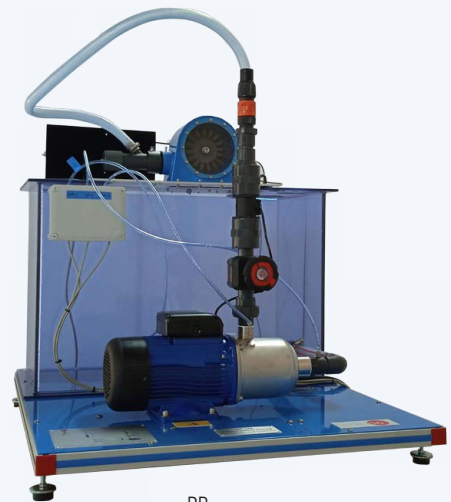
Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

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.

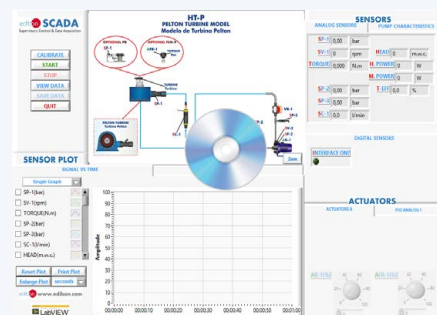
This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.



FEM-P



PB



EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

- 1.- To determination of the operating characteristics of the different turbines at different speeds.
 - 2.- Determination of the hydraulic jump of the turbines.
 - 3.- Determination of the characteristic curves of the different turbines: power (W), torque (Nm) and efficiency (%) as a function of the turbine speed and the inlet flow rate.
 - 4.- Investigation of the conversion of hydraulic energy into mechanical energy.
 - 5.- Calculation of the power of the turbine.
 - 6.- Determination of the hydraulic efficiency of the turbine.
 - 7.- Determination of the torque and speed of the turbine.
 - 8.- Determination of the characteristic curve of a centrifugal pump.
 - 9.- Study of the characteristic variables of a centrifugal pump.
- Additional practical possibilities:
- 10.- Sensors calibration.
- Other possibilities to be done with this unit:
- 11.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
- 12.- 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.
 - 13.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
 - 14.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
 - 15.- This unit can be used for doing applied research.
 - 16.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
 - 17.- Control of the HTMC unit process through the control interface box without the computer.
 - 18.- Visualization of all the sensors values used in the HTMC 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

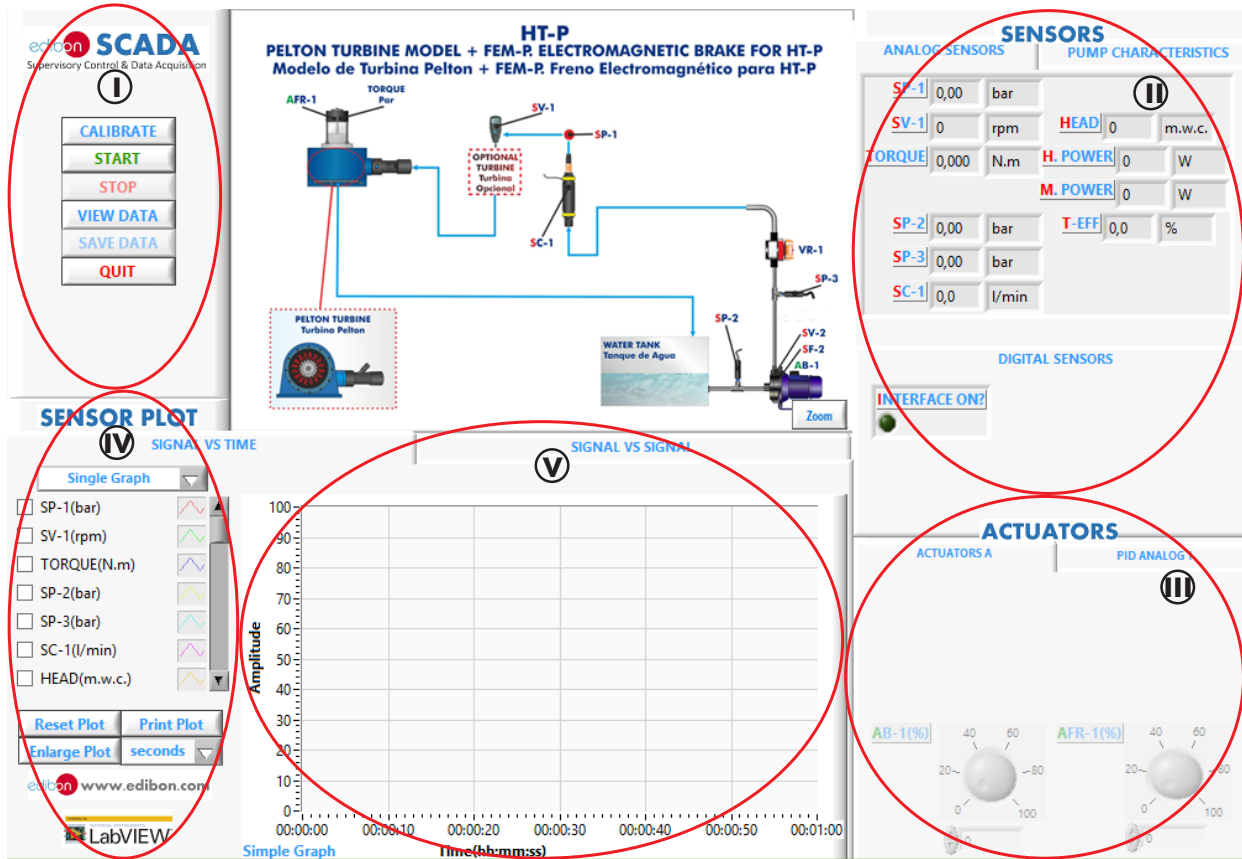
- HTMC:
- HT-UB. Hydraulic Turbines Base Unit:
- Dimensions: 800 x 900 x 1100 mm approx.
(31.49 x 35.43 x 43.30 inches approx.)
 - Weight: 50 Kg approx.
(110 pounds approx.)
- HT-F. Unit:
- Dimensions: 800 x 900 x 800 mm approx.
(31.49 x 35.43 x 31.49 inches approx.)
 - Weight: 75 Kg approx.
(165.34 pounds approx.)
- HT-FA. Unit:
- Dimensions: 800 x 900 x 800 mm approx.
(31.49 x 35.43 x 31.49 inches approx.)
 - Weight: 100 Kg approx.
(220.46 pounds approx.)
- HT-FR. Unit:
- Dimensions: 800 x 900 x 800 mm approx.
(31.49 x 35.43 x 31.49 inches approx.)
 - Weight: 100 Kg approx.
(220.46 pounds approx.)
- HT-K. Unit:
- Dimensions: 800 x 900 x 1100 mm approx.
(31.49 x 35.43 x 43.30 inches approx.)
 - Weight: 75 Kg approx.
(165.34 pounds approx.)
- HT-P. Unit:
- Dimensions: 800 x 900 x 800 mm approx.
(31.49 x 35.43 x 31.49 inches approx.)
 - Weight: 75 Kg approx.
(165.34 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.)

REQUIRED ELEMENTS (Not included)

- Required (at least one):
- HT-F. Francis Turbine Model.
 - HT-FA. Axial Flow Turbine Model.
 - HT-FR. Radial Flow Turbine Model.
 - HT-K. Kaplan Turbine Model.
 - HT-P. Pelton Turbine Model.

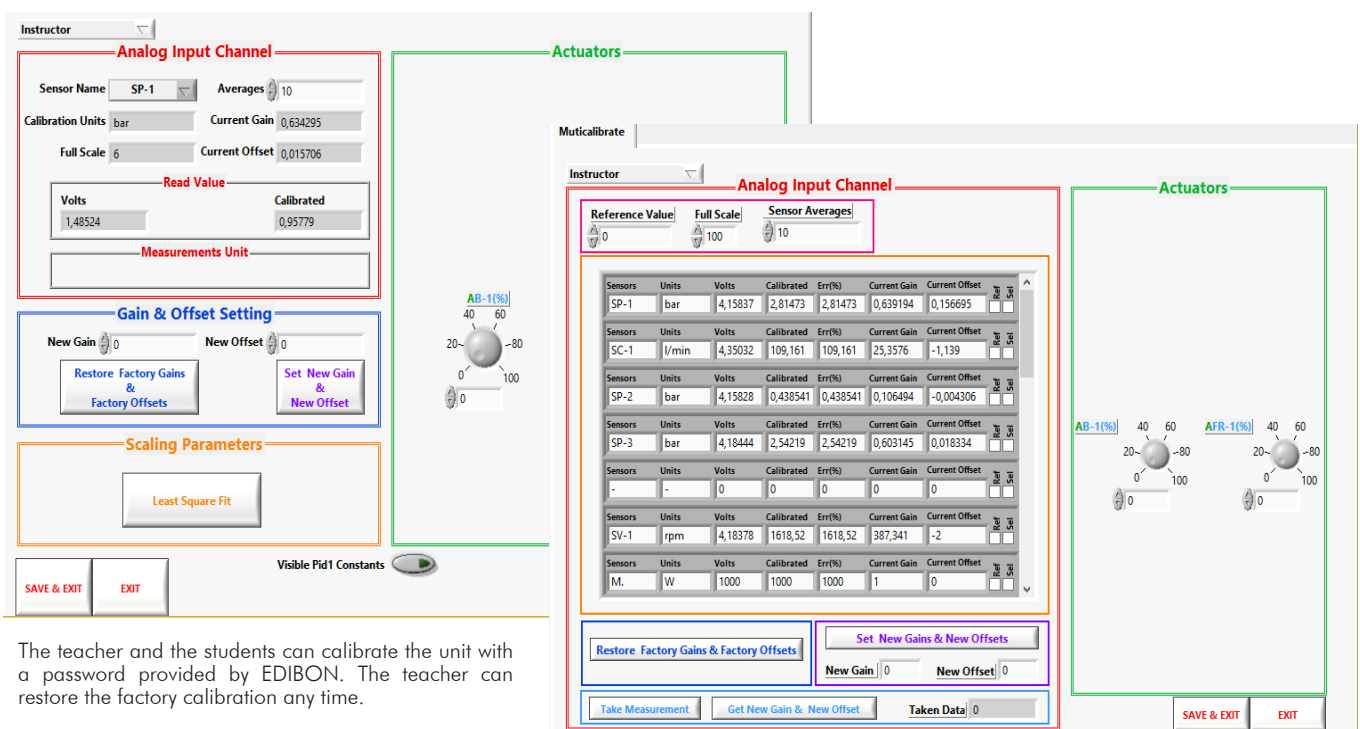
SOFTWARE MAIN SCREENS

SCADA and PID Control Main screens



- ❶ Main software operation possibilities.
- ❷ Sensors displays, real time values, and extra output parameters. Sensors: SC=Flow sensor. SP=Pressure sensor. SV=Speed sensor.
- ❸ Actuators controls. Actuators: AB=Pump. AFR=Electromagnetic brake.
- ❹ Channel selection and other plot parameters.
- ❺ Real time graphics displays.

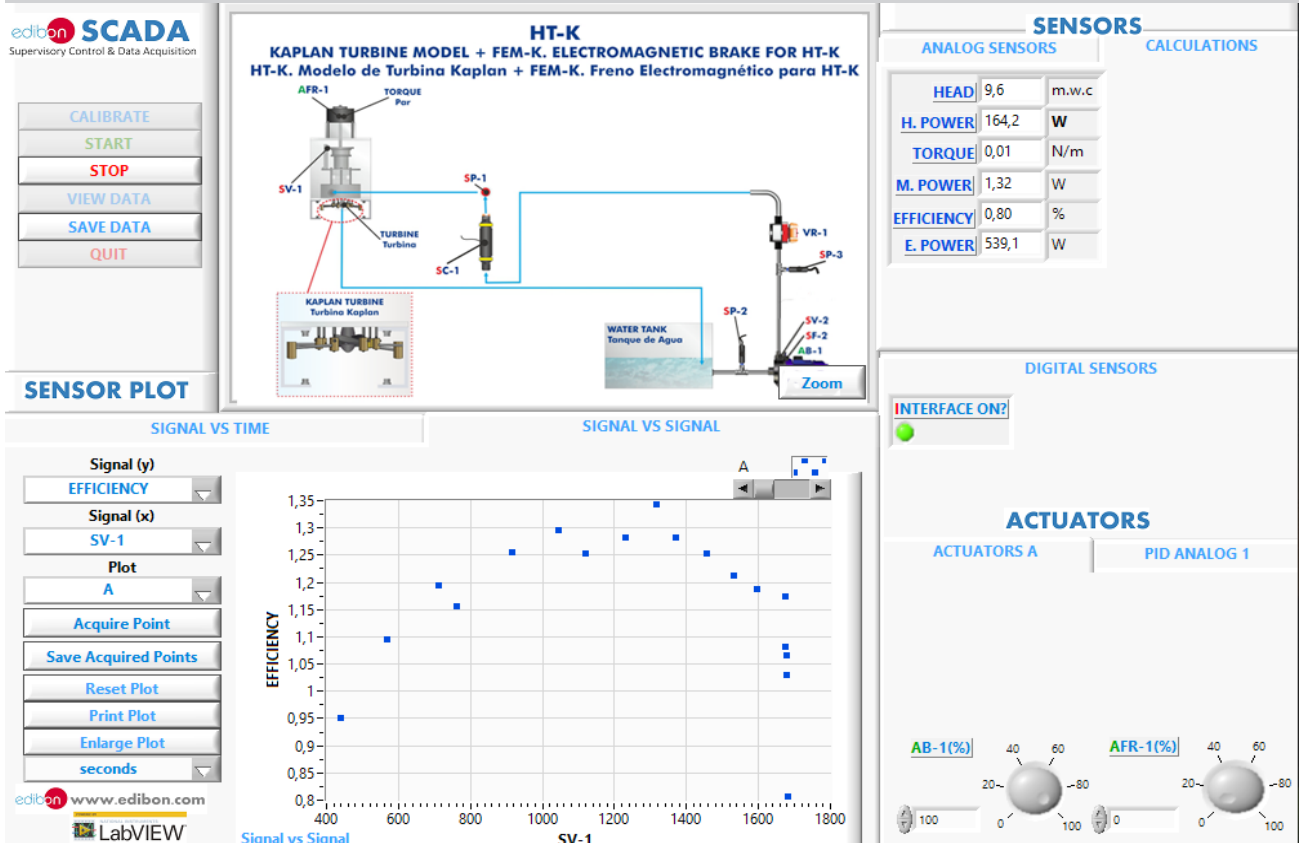
Software for Sensors Calibration Example of screen



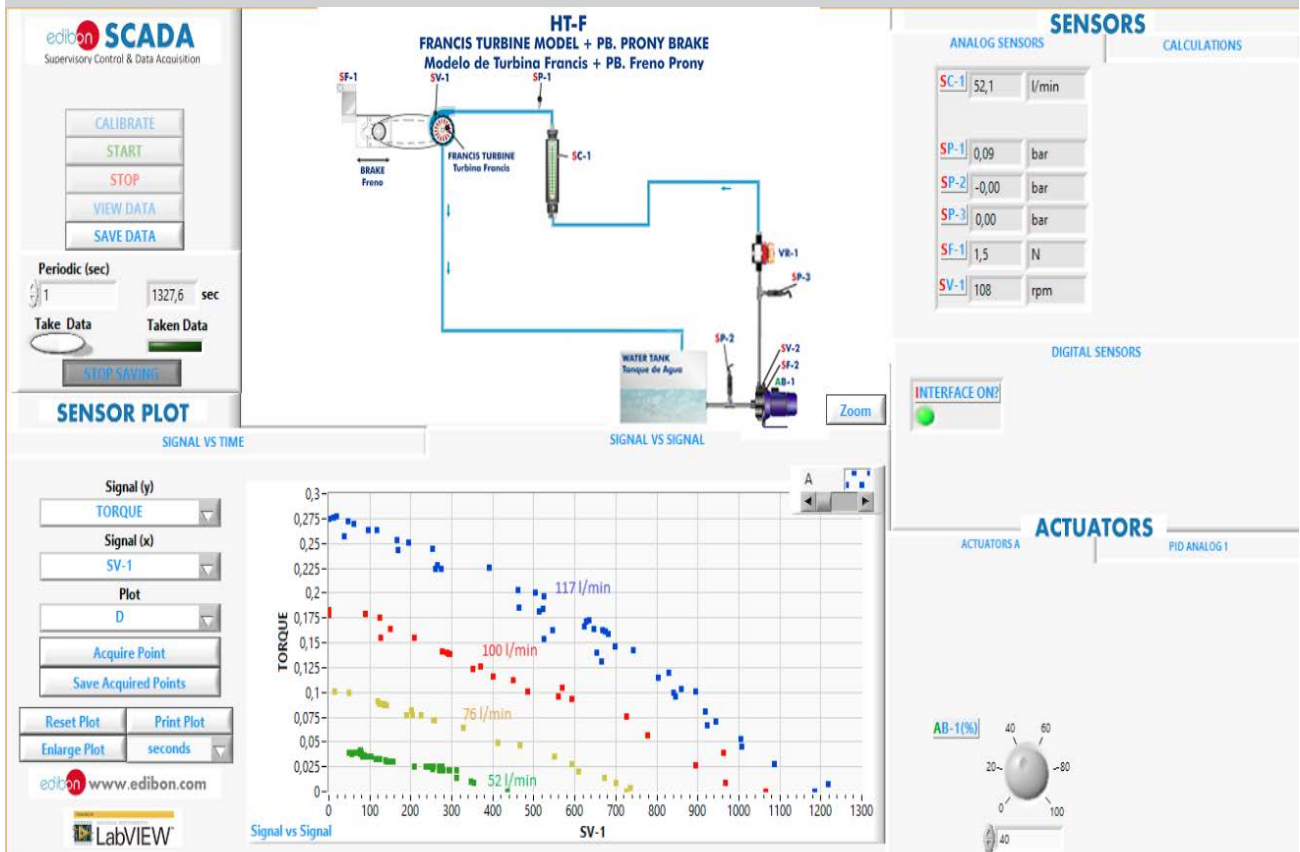
The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

SOME REAL RESULTS OBTAINED FROM THIS UNIT

Representation of the characteristic curve of the efficiency of the KAPLAN turbine as a function of speed. Operation with Electromagnetic Brake FEM-K.

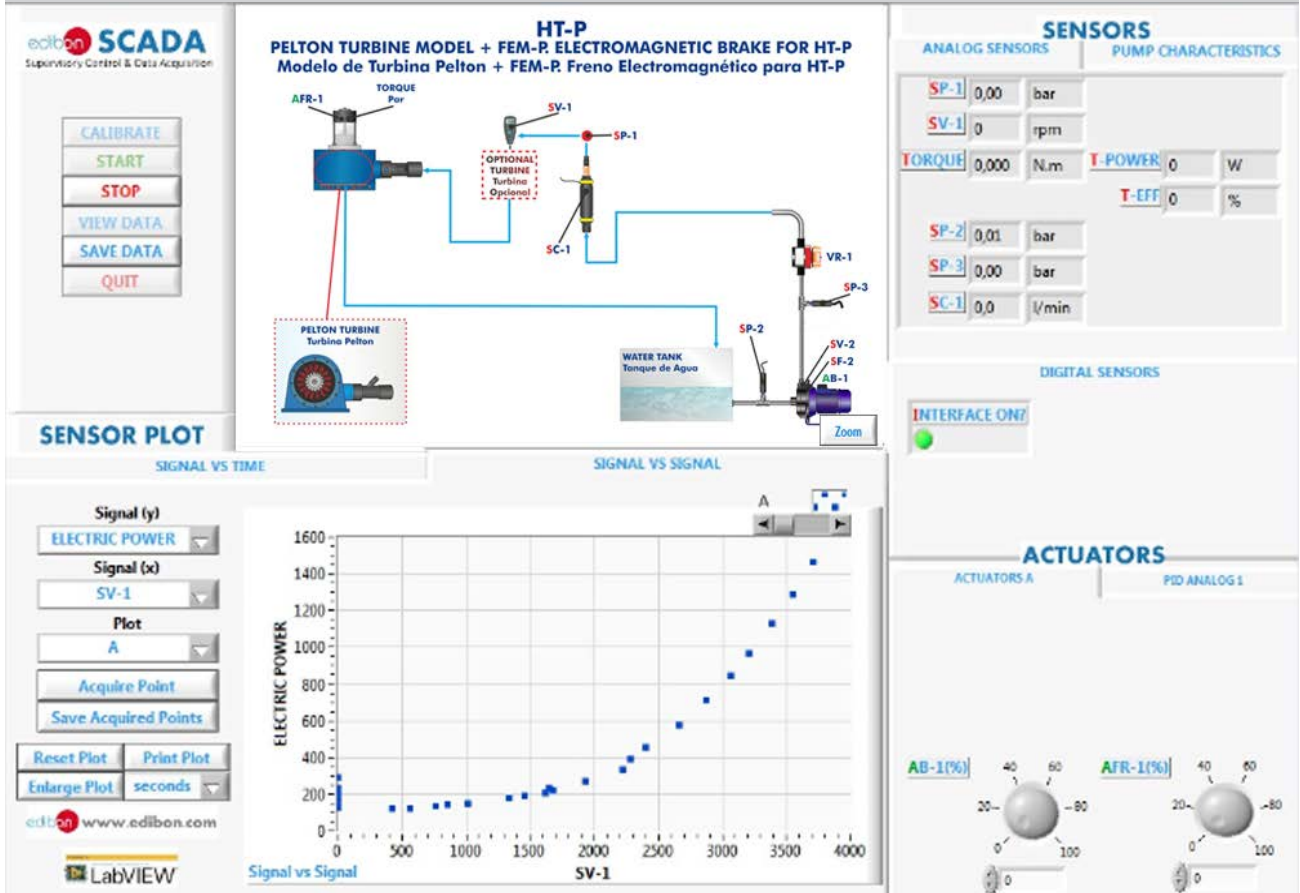


Representation of the characteristic curve of the FRANCIS turbine torque as a function of the speed at different flows. Operation with Prony PB brake.



Some **real** results obtained from this Unit

Representation of the characteristic curve of the electrical power of the PELTON turbine as a function of speed. Operation with Electromagnetic Brake FEM-P.



COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

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

All these items try to give more possibilities for:

- a) Industrial configuration. (PLC)
- b) Technical and Vocational Education configuration. (ICAL and FSS)
- c) Multipost Expansions options. (MINI ESN and ESN)

a) Industrial configuration

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

-PLC-PI. PLC Module:

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

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 SCS connector) with 14 LEDs for message (green).

Analog inputs block:

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

Analog outputs block:

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

Touch screen:

High visibility and multi-fe 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.

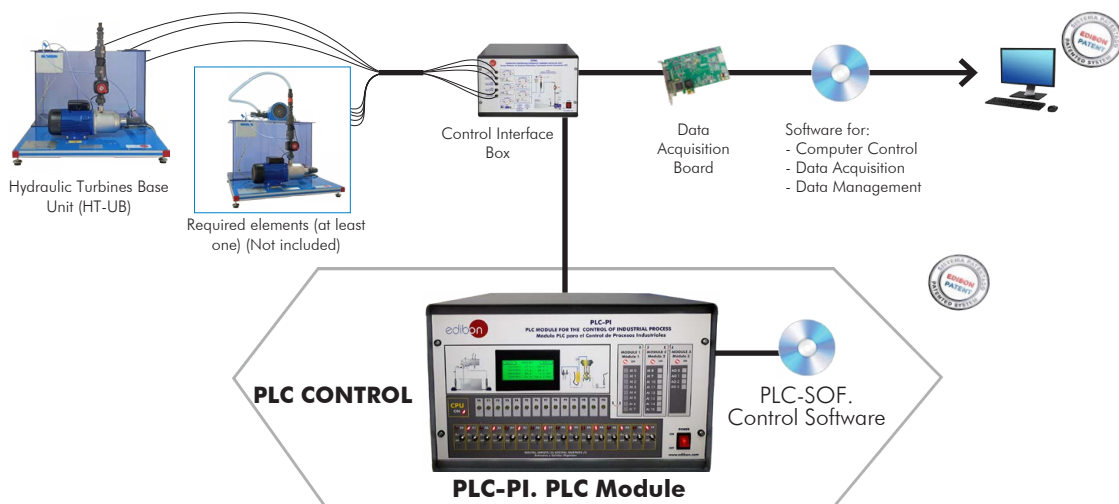
Communication RS232 wire to computer (PC).

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.).

-HTMC/PLC-SOF. PLC Control Software:

Always included with PLC supply.

Each turbine model has its own software.



Practices to be done with PLC-PI:

- 1.- Control of the particular unit process through the control interface box without the computer.
- 2.- Visualization of all the sensors values used in the particular unit process.
- 3.- Calibration of all sensors included in the particular unit process.
- 4.- Hand on of all the actuators involved in the particular unit process.
- 5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
- 6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary 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

⑦ HTMC/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.

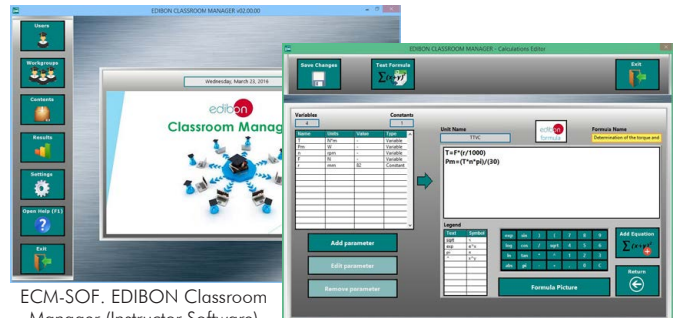
Innovative features:

- 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/interactive-computer-aided-instruction-software

Instructor Software



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

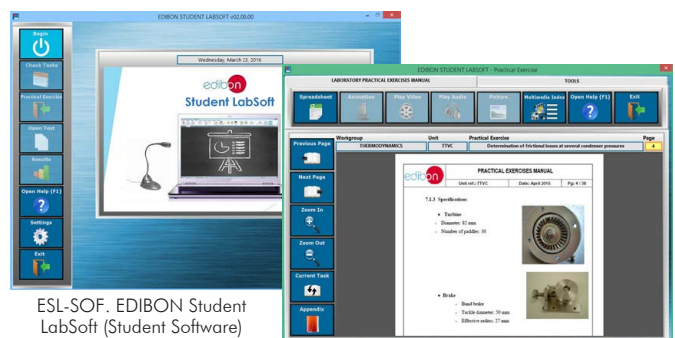
ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

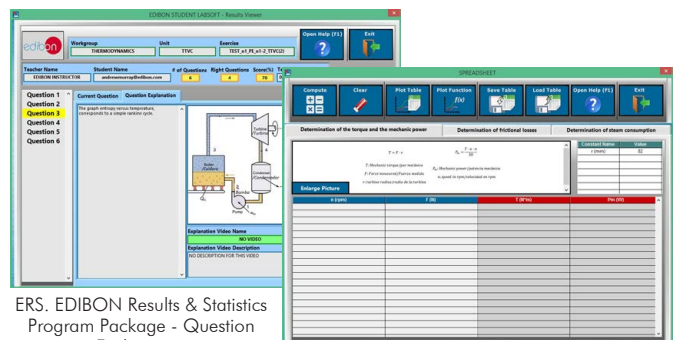
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

Student Software



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

EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation

ECAL. EDIBON Calculations Program Package Main Screen

⑧ HTMC/FSS. Faults Simulation System.

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit. It is useful for Technical and Vocational level.

The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them. There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:

- Actuators channels interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

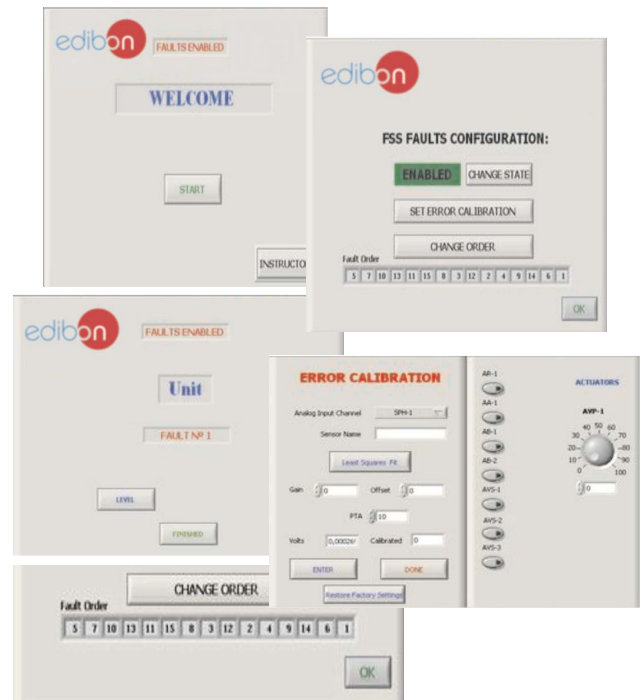
On/off faults:

- Several on/off faults can be included.

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

www.edibon.com/en/fault-simulation-system

Example of some screens



c) Multipost Expansions options

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

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

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA and PID Control integrated in a local network.

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

Main characteristics:

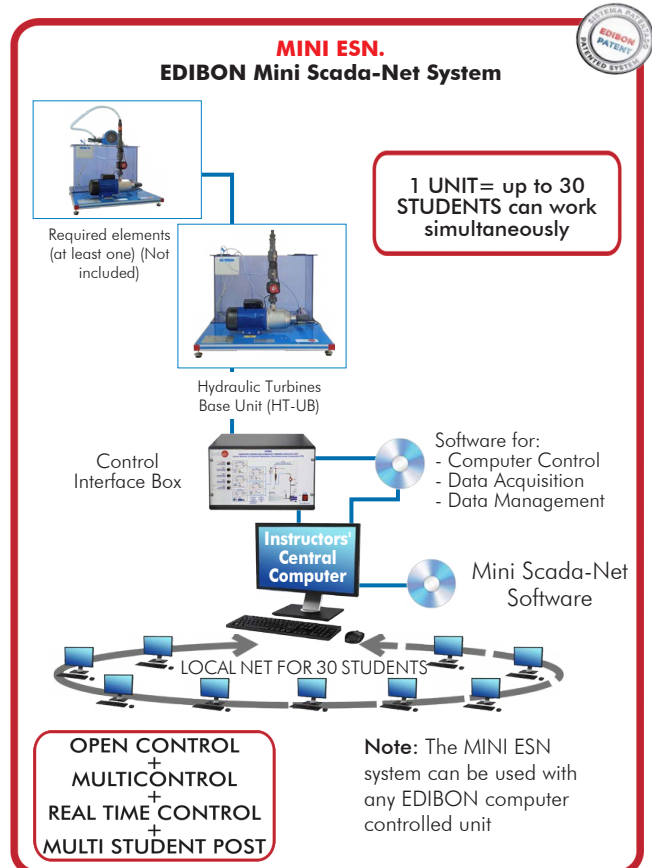
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA and PID Control, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student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

Main advantages:

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

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

www.edibon.com/en/edibon-scada-net



⑩ ESN. EDIBON Scada-Net Systems.

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

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

www.edibon.com/en/edibon-scada-net

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

- ① **HT-UB. Hydraulic Turbines Base Unit.**
- ② **HTMC/CIB. Control Interface Box.** (Can work with the required elements (at least one) (Not included).
- ③ **DAB. Data Acquisition Board.** (Common for the required elements (at least one) (Not included).
- ④ **Cables and Accessories,** for normal operation.
- ⑤ **Manuals.**

Required elements (at least one) to be used with the HTMC Unit Base "HT-UB":

- HT-F. Francis Turbine Model. (✚)
- HT-FA. Axial Flow Turbine Model. (✚)
- HT-FR. Radial Flow Turbine Model. (✚)
- HT-K. Kaplan Turbine Model. (✚)
- HT-P. Pelton Turbine Model. (✚)

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

Optional items (supplied under specific order)

a) Industrial configuration

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

b) Technical and Vocational Education configuration

- ⑦ HTMC/ICAI. Interactive Computer Aided Instruction Software.
- ⑧ HTMC/FSS. Faults Simulation System.

c) Multipost Expansions options

- ⑨ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.
- ⑩ ESN. EDIBON Scada-Net Systems.

① HT-UB. Hydraulic Turbines Base 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.

Computer controlled centrifugal water pump:

Maximum pressure: 7 bar.

Maximum water flow: 160 l/min.

Power: 1.5 kW.

Speed adjustable through variable-speed drive.

Transparent water tank, capacity: 120 l approx.

Regulation valve.

Instrumentation and sensors:

Two water pressure sensors for inlet (range: 0 - 15 psi) and outlet (range: 0 - 100 psi) of the pump.

Pump speed sensor.

Pump torque sensor.

Water flow sensor, range: 2 - 150 l/min.

Turbine inlet pressure sensor: 0 - 100 psi.

Optical sensor to measure the speed, range: 0 - 60000 rpm (turbine speed).

The complete unit includes as well:

Advanced Real-Time SCADA and PID Control.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on LabVIEW.

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

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

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

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

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

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

Designed and manufactured under several quality standards.

Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.

This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

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

HT-F. Francis Turbine Model.

Functional model of Francis Turbine, a ring with adjustable guide vanes that allows to control the water flow in the turbine:

Diameter of the turbine: 52 mm.

Speed range: 0 - 1200 rpm approx.

Rotor:

Number of blades of the turbine: 15.

Stator:

Number of adjustable guide vanes of the distributor: 10.

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

FEM-F. Electromagnetic Brake for HT-F.

Magnetic powder brake:

Nominal braking torque: 2 N/m.

Rated current: 0.45 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

(+) HT-F/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.

HT-FA. Axial Flow Turbine Model.

Functional model of Axial Flow Turbine:

Nozzles (four 20° nozzles and four 30° nozzles):

Throat inlet diameter: 2 mm. Throat outlet diameter: 2 mm.

Discharge angle: 20° and 30°.

Turbine rotor:

External diameter: 53 mm. Internal diameter: 45 mm. Number of blades: 40.

Inlet angle of the blades: 40°. Outlet angle of the blades: 40°.

Used material: brass.

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

FEM-FA. Electromagnetic Brake for HT-FA.

Magnetic powder brake:

Nominal braking torque: 2 N/m.

Rated current: 0.45 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

(+) HT-FA/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.

HT-FR. Radial Flow Turbine Model.

Functional model of Radial Flow Turbine:

Nozzle:

Inlet diameter: 21 mm.

Outlet diameter: 2 mm.

Discharge angle: 180°.

Turbine rotor:

External diameter: 69 mm.

Internal diameter: 40 mm.

Number of nozzles: 2.

Inlet angle of the nozzle: 180°.

Outlet angle of the nozzle: 180°.

Material: aluminum.

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

FEM-FR. Electromagnetic Brake for HT-FR.

Magnetic powder brake:

Nominal braking torque: 2 N/m.

Rated current: 0.45 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

(+) HT-FR/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.

HT-K. Kaplan Turbine Model.

Functional model of Kaplan turbine, a ring with adjustable guide vanes that allows to control the water flow in the turbine:

Speed range: 0 – 2500 rpm.

Number of blades of the turbine: 4.

Diameter of the turbine: 52 mm.

Number of wicket gates of the ring: 8.

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

FEM-K. Electromagnetic Brake for HT-K.

Magnetic powder brake:

Nominal braking torque: 0.2 N/m.

Rated current: 0.5 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

(+) HT-K/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.

HT-P. Pelton Turbine Model.

Functional model of Pelton Turbine:

Speed range: 0 - 4000 rpm.

Torque: 40 N.

Number of buckets: 16.

Drum radius: 30 mm.

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

FEM-P. Electromagnetic Brake for HT-P.

Magnetic powder brake:

Nominal braking torque: 5 N/m.

Rated current: 0.5 A.

PB. Prony Brake.

Band brake:

Adjustable braking voltage.

Pulley diameter: 50 mm.

Load cell - force sensor, range: 0 - 50 N.

Easy connection to the Hydraulic Turbines Base Unit, "HT-UB".

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

(+) HT-P/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.

② HTMC/CIB. Control Interface Box:

This control interface is common for the required elements (at least one) (Not included).
 Control interface box with process diagram in the front panel.
 The unit control elements are permanently computer controlled.
 Simultaneous visualization in the computer of all parameters involved in the process.
 Calibration of all sensors involved in the process.
 Real time curves representation about system responses.
 All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.
 Shield and filtered signals to avoid external interferences.
 Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.
 Real time PID control for parameters involved in the process simultaneously.
 Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).
 Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.
 Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

③ DAB. Data Acquisition Board:

Common for the required elements (at least one) (Not included).
 PCI Express Data acquisition board (National Instruments) to be placed in a computer slot.
 Analog input: Channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).
 Analog output: Channels=2. Resolution=16 bits, 1 in 65536.
 Digital Input/Output: Channels=24 inputs/outputs.
 The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

④ Cables and Accessories, for normal operation.

⑤ Manuals:

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

Exercises and Practical Possibilities to be done with the Main Items

- 1.- To determination of the operating characteristics of the different turbines at different speeds.
- 2.- Determination of the hydraulic jump of the turbines.
- 3.- Determination of the characteristic curves of the different turbines: power (W), torque (Nm) and efficiency (%) as a function of the turbine speed and the inlet flow rate.
- 4.- Investigation of the conversion of hydraulic energy into mechanical energy.
- 5.- Calculation of the power of the turbine.
- 6.- Determination of the hydraulic efficiency of the turbine.
- 7.- Determination of the torque and speed of the turbine.
- 8.- Determination of the characteristic curve of a centrifugal pump.
- 9.- Study of the characteristic variables of a centrifugal pump.

Additional practical possibilities:

- 10.- Sensors calibration.

Other possibilities to be done with this unit:

- 11.- Many students view results simultaneously.
 To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
 - 12.- 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.
 - 13.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
 - 14.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
 - 15.- This unit can be used for doing applied research.
 - 16.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
 - 17.- Control of the HTMC unit process through the control interface box without the computer.
 - 18.- Visualization of all the sensors values used in the HTMC unit process.
- By using PLC-PI additional 19 more exercises can be done.
 - Several other exercises can be done and designed by the user.

a) Industrial configuration

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

-PLC-PI. PLC Module:

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

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.

-HTMC/PLC-SOF. PLC Control Software:

Always included with PLC supply. each turbine model has its own software.

Practices to be done with PLC-PI:

- 1.- Control of the particular unit process through the control interface box without the computer.
- 2.- Visualization of all the sensors values used in the particular unit process.
- 3.- Calibration of all sensors included in the particular unit process.
- 4.- Hand on of all the actuators involved in the particular unit process.
- 5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
- 6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary 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

⑦ **HTMC/ICAI. Interactive Computer Aided Instruction Software.**

This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc...so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.
- Updatable Contents.
- Report generation, User Progression Monitoring and Statistics.

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

- Student Log-In & Self-Registration.
- Existing Tasks checking & Monitoring.
- Default contents & scheduled tasks available to be used from the first session.
- Practical Exercises accomplishment by following the Manual provided by EDIBON.
- Evaluation Methods to prove your knowledge and progression.
- Test self-correction.
- Calculations computing and plotting.
- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

⑧ HTMC/FSS. Faults Simulation System.

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit. The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them. There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:

- Actuators channels interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

On/off faults:

- Several on/off faults can be included.

c) Multipost Expansions options

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

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

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA and PID Control integrated in a local network. This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit.

Main characteristics:

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

Main advantages:

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

The system basically will consist of:

This system is used with a Computer Controlled Unit.

- Instructor's computer.
- Students' computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- MINI ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

* Specifications subject to change without previous notice, due to the convenience of improvement of the product.



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