



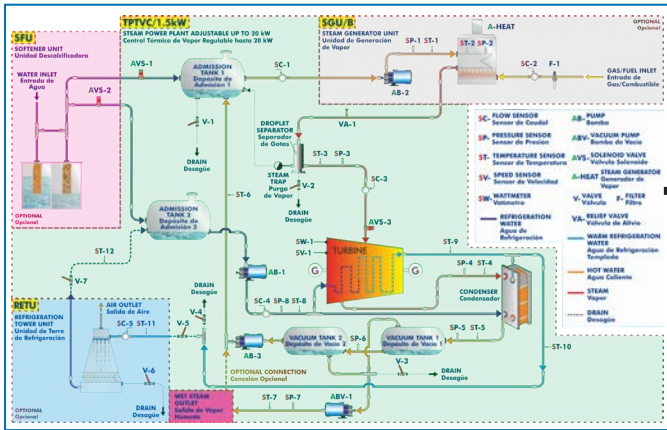
Engineering and Technical
Teaching Equipment

Computer Controlled 1.5 kW Steam Power Plant, with SCADA and PID Control

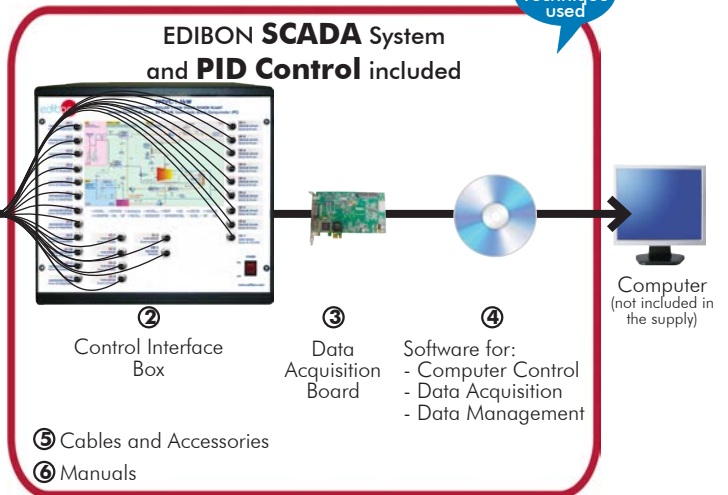
TPTVC/1.5KW

EDIBON PATENT

Teaching
Technique
used



① Unit: TPTVC/1.5kW. Computer Controlled 1.5 kW Steam Power Plant



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

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
↳ 90.- THERMODYNAMICS
& THERMOTECHNICS

For more information about Key Features, click here



ISO 9001: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)



European Union Certificate (total safety)



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



"Worlddidac Quality Charter" and Platinum Member of Worlddidac

INTRODUCTION

The Rankine cycle is a thermodynamic cycle whose objective is to convert heat into work, constituting what is called a power cycle. As any other power cycle, its efficiency is limited by the thermodynamic efficiency of a Carnot cycle working within the same thermal sources (maximum limit imposed by the Second Law of Thermodynamics).

The Computer Controlled 1.5kW Steam Power Plant, "TPTVC/1.5kW", converts thermal energy into mechanical energy and afterwards into electrical energy. It allows the students to understand the entire process and the basic components of a power plant (heat source to generate steam, a turbine with load and a refrigeration system to condense the steam). It also allows for studying the Rankine cycle to generate work, as well as the main variables that take part in the process.

GENERAL DESCRIPTION

The Computer Controlled 1.5kW Steam Power Plant, "TPTVC/1.5kW", represents a laboratory scale power plant, guaranteeing a great similarity with a real system. It offers many practical exercises to familiarize the student with the operation procedure of a steam power plant with process control. Besides, it has different optional modules to adapt to the needs of each working place.

The process starts with a pre-treatment of the water to avoid the introduction of hard water to the process. EDIBON suggests the Softener Unit, "SFU", as an OPTIONAL unit, to remove the salts, impurities and other substances that may dirt the inside of the steam plant components.

Softened water can be directed towards two tanks (inlet tanks) through two computer controlled solenoid valves. The first tank stores the water for the main generation circuit and the second tank stores the water used in the refrigeration circuit.

The water of the first inlet tank is introduced by a computer controlled pump in the steam generation system, after passing through a set of sensors that collect information about the inlet temperature, pressure and flow to the generator. For the steam generation, EDIBON recommends the OPTIONAL Steam Generator Unit, "SGU/B". It is a steam generator with a burner that can work with different fuels (diesel oil or natural gas) with control over the working temperature, which generates steam quickly.

When the steam is generated at the working pressure and temperature conditions (superheated steam), it is driven to a turbine after passing through a droplet separator. Before being introduced in the turbine, a set of sensors gathers the values of the steam pressure, temperature and flow and transfer the information to the computer. The turbine is supplied with two generators and the rotation of the turbine vanes generates the electrical current thanks to the motion transferred by the shaft to those generators, coupled to both sides of the turbine. Two working modes are available: an isolated working mode, in which a group of variable resistors consume the electrical energy produced by the generator coupled to the turbine, and a grid synchronization working mode, in which all the electrical parameters (P, Q, S, f, etc.) supplied by the generator to the grid are measured.

The values of power and rpm are displayed in the computer, allowing the user to obtain the characteristic curves of the turbine: electrical power versus steam pressure, rpm versus steam pressure, power versus rpm, among other additional characteristic curves.

The turbine has a computer controlled speed. A pressure sensor and a temperature sensor measure the steam conditions at the outlet of the turbine. The steam coming out of the turbine is condensed in a heat exchanger and is recirculated to its inlet water tank by a computer controlled tank.

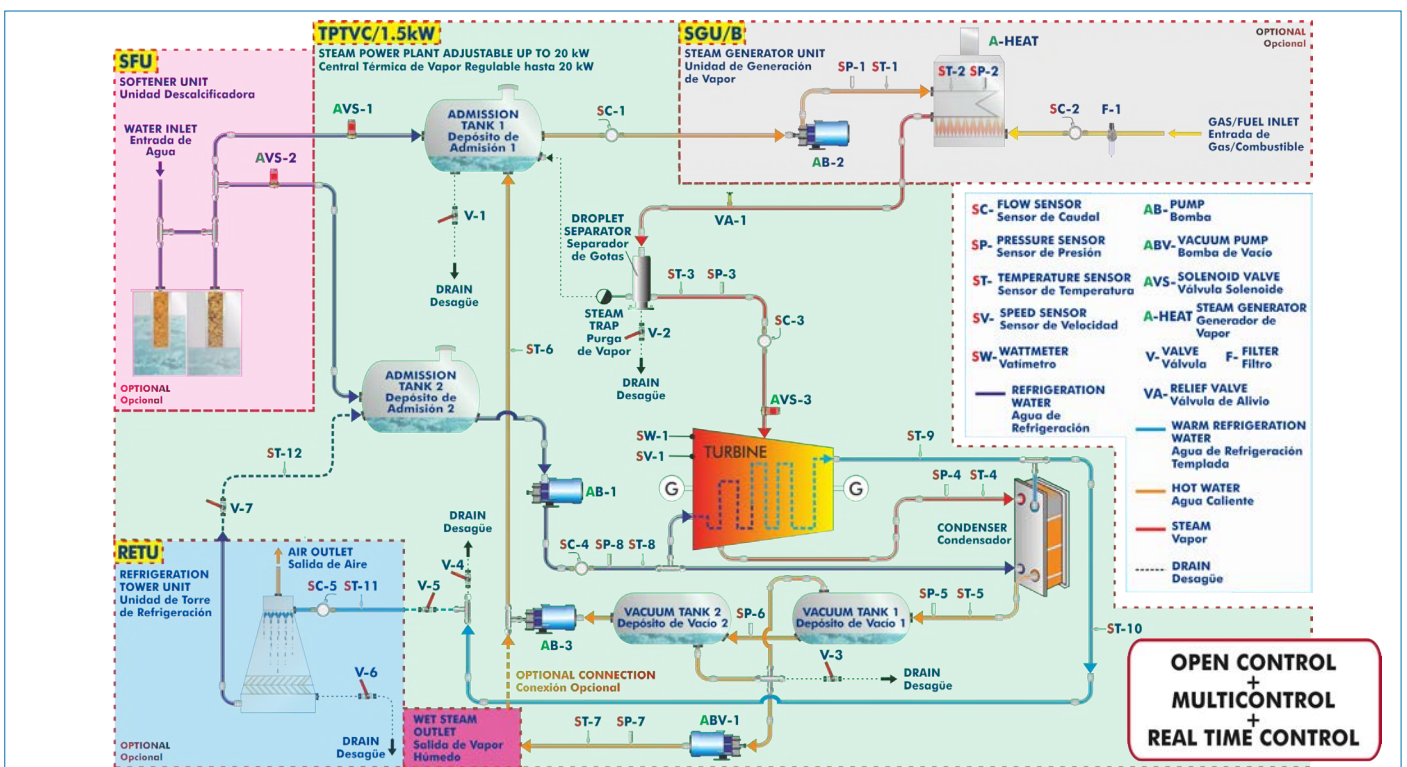
The pressure in the circuit at the outlet of the turbine is negative thanks to a vacuum system consisting of a vacuum pump and two tanks, making the pressure drops easier in the turbine.

The water of the second inlet tank (refrigeration circuit) is impelled by a computer controlled pump inside the turbine and condenser, acting as refrigerant in this circuit. Water coming out of the refrigeration circuit of the turbine and the refrigeration circuit of the condenser are mixed and, with higher temperature than at the beginning of the circuit, it is either drained or refrigerated by the Refrigeration Tower Unit, "RETU", OPTIONAL unit, and returned to the second inlet tank to reuse it.

The corresponding mass and energy balances, as well as the Rankine cycle representation and the calculation of the corresponding efficiencies in the main devices, can be done in the main devices of the unit.

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



COMPLETE TECHNICAL SPECIFICATIONS (for main items)

With this unit there are several options and possibilities:

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

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

① TPTVC/1.5kW. 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.

Transparent panels to protect the unit that allows the user to observe the operation of the unit.

Cooling pump.

Two inlet tanks.

Two vacuum tanks:

- Material: stainless steel.
- Pressure gauge.
- Safety valve.
- Inlet water valve.

Droplet separator.

Turbine:

Until 1.5 kWe.

Inlet conditions: superheated steam: 5.2 bar abs;
temperature: 200 - 220 °C.

Outlet conditions: steam: 0.1 bar abs; temperature:
40 - 50 °C.

Condenser:

18 - 30 kW.

Cooling water: temperature: < 30 °C.

Working pressure: 0.1 - 0.2 bar (max.).

Safety pressure switch.

Relief valve in the steam generator: 12 bar.

Float valve.

Working speed control valve:

Limit the speed of the turbine through the computer controlled solenoid valves.

Relief valve in the steam tank.

Power inverter:

230 V - 400 V; 50 HZ, 60Hz.

Instrumentation:

Pressure sensors:

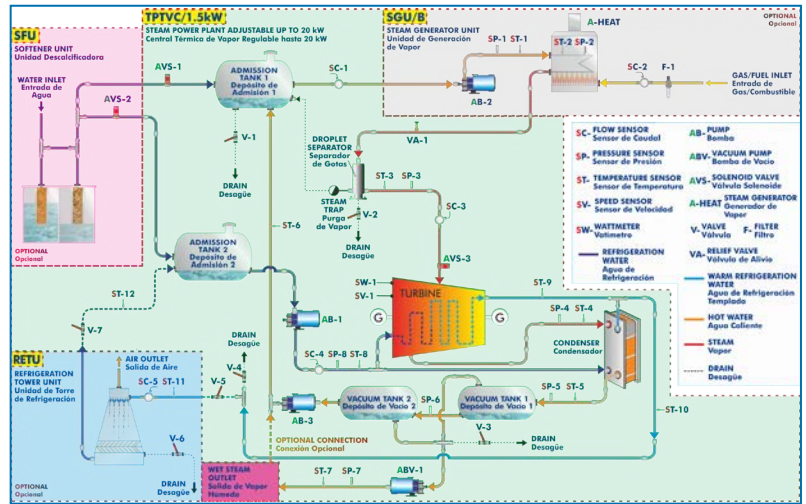
- Water inlet to the steam generator.
- Steam generator.
- Refrigeration water inlet.
- Turbine inlet.
- Steam turbine outlet.
- Condensed water stream.
- Second vacuum tank.
- Wet steam outlet.

"J" type temperature sensors:

- Water inlet to the steam generator.
- Steam generator.
- Refrigeration water inlet.
- Turbine inlet.
- Cooling outlet of the turbine.
- Steam turbine outlet.
- Condensed water stream.
- Inlet and outlet of cooling water in the condenser.
- Wet steam outlet.
- Condensate recovery.
- Water inlet to the refrigeration tower.
- Water outlet to the refrigeration tower.

Flow sensors:

- Refrigeration water inlet.
- Steam inlet in the turbine.
- Water inlet to the steam generator.
- Water inlet to the refrigeration tower.
- Speed sensor.
- Generated power sensor.



Unit: TPTVC/1.5kW

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.

Optional Models and Accessories: (Not included)

- SFU. Softener Unit.
- RETU. Refrigeration Tower Unit.
- SGU/B. Steam Generator Unit.

② TPTVC/1.5kW/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.

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

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

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

Single cable between the control interface box and computer.

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

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

Calibration of all sensors involved in the process.

Real time curves representation about system responses.

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

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

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

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

Shield and filtered signals to avoid external interferences.

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

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

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

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

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

Possibility of automatization of the actuators involved in the process.

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



TPTVC/1.5kW/CIB

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

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

Analog input:

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

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

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

Analog output:

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

Maximum output rate up to: 900 KS/s.

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

Digital Input/Output:

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

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



DAB

④ **TPTVC/1.5kW/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.

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: TPTVC/1.5kW + TPTVC/1.5kW/CIB + DAB + TPTVC/1.5kW/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.



TPTVC/1.5kW/CCSOF

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

Commissioning experiments:

- 1.- Study, analysis and test of safety systems.
- 2.- Study, analysis and test of measurement systems.
- 3.- Study, analysis and test of pressure in the circuit.
- 4.- Study of the pressure and temperature control techniques in a steam power plant.
- 5.- Study, analysis and test of the water softening unit.
- 6.- Study, analysis, operation and test of the steam boiler.
- 7.- Study, analysis and test of the steam flow sensor.
- 8.- Study, analysis and test of the condenser.
- 9.- Study, analysis and test of the refrigeration tower.
- 10.-Study and analysis of the corresponding maintenance in a steam power plant.
- 11.-Commissioning of a steam power plant.
- 12.-Shut down of a steam power plant.

Operating experiments:

- 13.-Study of the operation of a steam power plant.
- 14.-Familiarization with a water/steam closed circuit.
- 15.-Study and understanding of the first and second laws of thermodynamics.
- 16.-Determination of the steam generator efficiency.
- 17.-Determination of fuel consumption in function of the steam flow generated.
- 18.-Determination of the condenser efficiency.
- 19.-Determination of the amount of heat removed by the condenser.
- 20.-Determination of the ideal mechanical/thermal efficiency of the turbine.
- 21.-Determination of the real mechanical/thermal efficiency of the turbine.
- 22.-Determination of the refrigeration tower efficiency.
- 23.-Determination of the amount of heat removed by the refrigeration tower.
- 24.-Determination of the water-steam ratio required by the plant.
- 25.-Study of the power generated.
- 26.-Study of the global efficiency of the steam cycle.
- 27.-Steam flow and measurements range.

Thermodynamic cycle and study of the power generated:

- 28.-Study, analysis and representation of Rankine cycle for the steam generation plant.
- 29.-Study, analysis and representation of the generated power in function of the steam pressure, with and without load variation in the generator.
- 30.-Study, analysis and representation of the steam pressure in function of the revolutions in the steam turbine, with and without load variation in the generator.
- 31.-Study, analysis and representation of the generated power in function of the type of intake to the turbine, with constant working pressure, with and without load variation in the generator.
- 32.-Study, analysis and representation of the generated power in function of the vacuum pressure at the turbine outlet, with and without load variation in the generator.
- 33.-Study, analysis and representation of the vacuum pressure at the turbine outlet in function of the revolutions of the turbine, with and without load variation in the generator.

Parameters of the power generation:

- 34.-Study of the relation between the power delivered to the grid and the steam flow.
- 35.-Study of the relation between the power delivered to the grid and the steam pressure.
- 36.-Study of the relation between the power delivered to the grid and the vacuum pressure at the turbine outlet.

- 37.-Study of the relation of the active power of the generator in function of the steam flow in an isolated circuit (island mode).
- 38.-Study of the relation of the active power of the generator in function of the steam pressure in an isolated circuit (island mode).
- 39.-Study of the relation of the active power generation of the generator in function of the vacuum pressure at the turbine outlet in an isolated circuit (island mode).
- 40.-Study of the turbine fluctuation and the generator when suffering a sudden change in the power demand.
- 41.-Study of the synchronization procedure of turbine-generator group with the electrical grid through a grid inverter.
- 42.-Study of the consequences suffered when the generator is suddenly uncoupled from the electrical grid. Checking the safety systems of the power plant.

Additional practical possibilities:

- 43.-Study of heat losses in pipes.
- 44.-Study of the most important parameters in a steam power plant.
- 45.-Study of the steam generator efficiency in function of fuel used.
- 46.-Sensors calibration.

Other possibilities to be done with this Unit:

- 47.-Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
 - 48.-Open Control, Multicontrol and Real Time Control.
This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.
 - 49.-The Computer Control System with SCADA and PID Control allow a real industrial simulation.
 - 50.-This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
 - 51.-This unit can be used for doing applied research.
 - 52.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
 - 53.-Control of the TPTVC/1.5kW unit process through the control interface box without the computer.
 - 54.-Visualization of all the sensors values used in the TPTVC/1.5kW unit process.
- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: single-phase 220V/50 Hz or 110V/60 Hz.
- Water supply.
- Drain.
- Air vent and/or fumes outlet.
- Computer.

DIMENSIONS AND WEIGHTS

TPTVC/1.5kW:

- Dimensions: 2200 x 2250 x 500 mm approx.
(86.61 x 88.58 x 19.68 inches approx.)
- Weight: 300 Kg approx.
(661 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.).

SFU:

- Dimensions: 200 x 350 x 150 mm approx.
(7.87 x 13.77 x 5.90 inches approx.)
- Weight: 50 Kg approx.
(110 pounds approx.).

RETU:

- Dimensions: 1500 x 1250 x 750 mm approx.
(59.05 x 49.21 x 29.52 inches approx.)
- Weight: 200 Kg approx.
(440 pounds approx.).

SGU/B:

- Dimensions: 800 x 850 x 1000 mm approx.
(31.49 x 33.46 x 39.37 inches approx.)
- Weight: 300 Kg approx.
(661 pounds approx.).

OPTIONAL MODELS AND ACCESSORIES (Not included)

- SFU. Softener Unit.
- RETU. Refrigeration Tower Unit.
- SGU/B. Steam Generator Unit.

COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 10.

All these items try to give more possibilities for:

- a) Technical and Vocational Education configuration. (ICAI and FSS)
- b) Multipost Expansions options. (MINI ESN and ESN)

a) Technical and Vocational Education configuration

⑦ **TPTVC/1.5kW/ICAI. Interactive Computer Aided Instruction Software System.**

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

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

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

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

Innovative features:

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

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

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

Innovative features:

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

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

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

Instructor Software



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

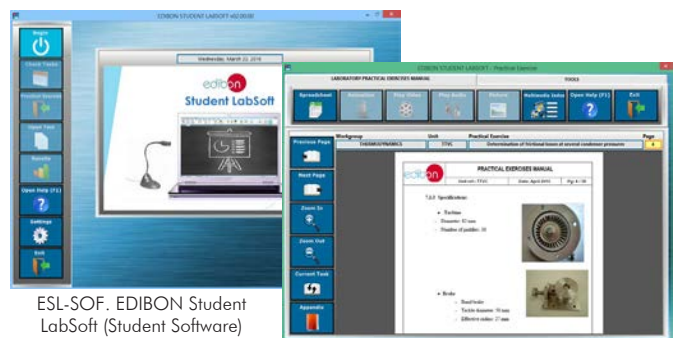
ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

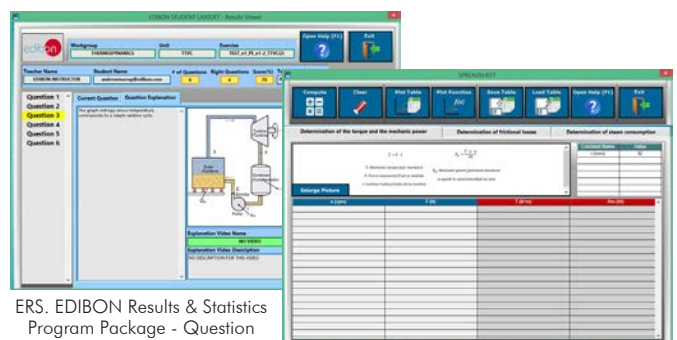
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

Student Software



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

EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation

ECAL. EDIBON Calculations Program Package Main Screen

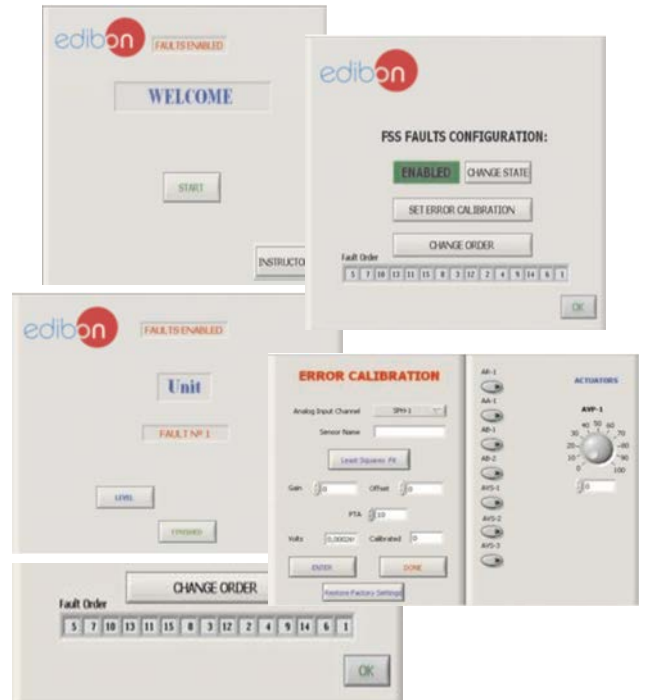
⑧ **TPTVC/1.5kW/FSS. Faults Simulation System.**

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

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

- Faults affecting the sensors measurement:
 - An incorrect calibration is applied to them.
 - Non-linearity.
- Faults affecting the actuators:
 - Actuators channels interchange at any time during the program execution.
 - Response reduction of an actuator.
- Faults in the controls execution:
 - Inversion of the performance in ON/OFF controls.
 - Reduction or increase of the calculated total response.
 - The action of some controls is annulled.
- On/off faults:
 - Several on/off faults can be included.

Example of some screens



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

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

b) Multipost Expansions options

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

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

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

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

Main characteristics:

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

Main advantages:

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

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

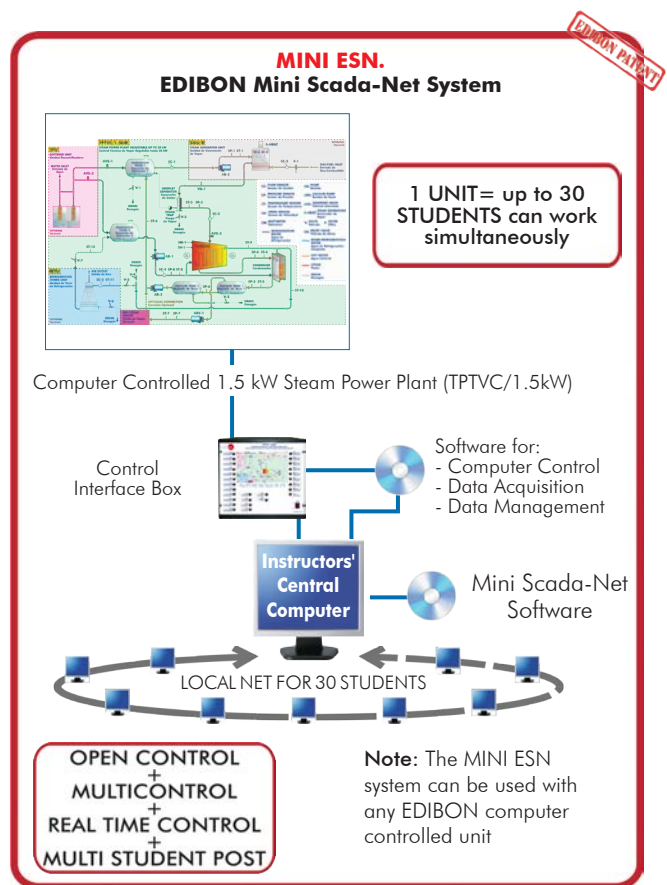
www.edibon.com/en/files/expansion/MINI-ESN/catalog

⑩ **ESN. EDIBON Scada-Net Systems.**

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

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

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



ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

- ① Unit: TPTVC/1.5kW. Computer Controlled 1.5 kW Steam
- ② Power Plant.
- ③ TPTVC/1.5kW/CIB. Control Interface Box.
- ④ DAB. Data Acquisition Board.
TPTVC/1.5kW/CCSOF. PID Computer Control + Data
- ⑤ Acquisition + Data Management Software.
- ⑥ Cables and Accessories, for normal operation.
- Manuals.

***IMPORTANT:** Under TPTVC/1.5kW we always supply all the elements for immediate running as 1, 2, 3, 4, 5 and 6.

Optional items (supplied under specific order)

a) Technical and Vocational Education configuration

- ⑦ TPTVC/1.5kW/ICAI. Interactive Computer Aided Instruction Software System.
- ⑧ TPTVC/1.5kW/FSS. Faults Simulation System.

b) Multipost Expansions options

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

TENDER SPECIFICATIONS (for main items)

① TPTVC/1.5kW. 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.
Transparent panels to protect the unit that allows the user to observe the operation of the unit.
Cooling pump.
Two inlet tanks.
Two vacuum tanks:
Material: stainless steel.
Pressure gauge.
Safety valve.
Inlet water valve.
Droplet separator.
Turbine:
Until 1.5 kW.
Inlet conditions: superheated steam: 5.2 bar abs; temperature: 200 - 220 °C.
Outlet conditions: steam: 0.1 bar abs; temperature: 40 – 50 °C.
Condenser:
18 - 30 kW.
Cooling water: temperature: < 30 °C.
Working pressure: 0.1 - 0.2 bar (max.).
Safety pressure switch.
Relief valve in the steam generator: 12 bar.
Float valve.
Working speed control valve:
Limit the speed of the turbine through the computer controlled solenoid valves.
Relief valve in the steam tank.
Power inverter:
230 V - 400 V; 50 HZ, 60Hz.

Instrumentation:

Pressure sensors:

Water inlet to the steam generator.
Steam generator.
Refrigeration water inlet.
Turbine inlet.
Steam turbine outlet.
Condensed water stream.
Second vacuum tank.
Wet steam outlet.

"J" type temperature sensors:

Water inlet to the steam generator.
Steam generator.
Refrigeration water inlet.
Turbine inlet.
Cooling outlet of the turbine.
Steam turbine outlet.
Condensed water stream.
Inlet and outlet of cooling water in the condenser.
Wet steam outlet.
Condensate recovery.
Water inlet to the refrigeration tower.
Water outlet to the refrigeration tower.

Flow sensors:

Refrigeration water inlet.
Steam inlet in the turbine.
Water inlet to the steam generator.
Water inlet to the refrigeration tower.
Speed sensor.
Generated power sensor.

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.

Optional Models and Accessories: (Not included)

- SFU. Softener Unit.
- RETU. Refrigeration Tower Unit.
- SGU/B. Steam Generator Unit.

② TPTVC/1.5kW/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.
Control interface box with process diagram in the front panel.
The unit control elements are permanently computer controlled.
Simultaneous visualization in the computer of all parameters involved in the process.
Calibration of all sensors involved in the process.
Real time curves representation about system responses.
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.
Shield and filtered signals to avoid external interferences.
Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.
Real time PID control for parameters involved in the process simultaneously.
Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).
Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.
Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.
PCI Express Data acquisition board (National Instruments) to be placed in a computer slot.
Analog input: Channels= 16 single-ended or 8 differential. Resolution= 16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).
Analog output: Channels=2. Resolution= 16 bits, 1 in 65536.
Digital Input/Output: Channels=24 inputs/outputs.

④ TPTVC/1.5kW/CCSOF. PID Computer Control + Data Acquisition + Data Management Software:

The three softwares are part of the SCADA system.
 Compatible with the industry standards.
 Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 Analog and digital PID control. PID menu and set point selection required in the whole work range.
 Management, processing, comparison and storage of data.
 Sampling velocity up to 250 KS/s (kilo samples per second).
 Calibration system for the sensors involved in the process.
 It allows the registration of the alarms state and the graphic representation in real time.
 Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.
 This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:

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

Exercises and Practical Possibilities to be done with the Main Items

Commissioning experiments:

- 1.- Study, analysis and test of safety systems.
- 2.- Study, analysis and test of measurement systems.
- 3.- Study, analysis and test of pressure in the circuit.
- 4.- Study of the pressure and temperature control techniques in a steam power plant.
- 5.- Study, analysis and test of the water softening unit.
- 6.- Study, analysis, operation and test of the steam boiler.
- 7.- Study, analysis and test of the steam flow sensor.
- 8.- Study, analysis and test of the condenser.
- 9.- Study, analysis and test of the refrigeration tower.
- 10.- Study and analysis of the corresponding maintenance in a steam power plant.
- 11.- Commissioning of a steam power plant.
- 12.- Shut down of a steam power plant.

Operating experiments:

- 13.- Study of the operation of a steam power plant.
- 14.- Familiarization with a water/steam closed circuit.
- 15.- Study and understanding of the first and second laws of thermodynamics.
- 16.- Determination of the steam generator efficiency.
- 17.- Determination of fuel consumption in function of the steam flow generated.
- 18.- Determination of the condenser efficiency.
- 19.- Determination of the amount of heat removed by the condenser.
- 20.- Determination of the ideal mechanical/thermal efficiency of the turbine.
- 21.- Determination of the real mechanical/thermal efficiency of the turbine.
- 22.- Determination of the refrigeration tower efficiency.
- 23.- Determination of the amount of heat removed by the refrigeration tower.
- 24.- Determination of the water-steam ratio required by the plant.
- 25.- Study of the power generated.
- 26.- Study of the global efficiency of the steam cycle.
- 27.- Steam flow and measurements range.

Thermodynamic cycle and study of the power generated:

- 28.- Study, analysis and representation of Rankine cycle for the steam generation plant.
- 29.- Study, analysis and representation of the generated power in function of the steam pressure, with and without load variation in the generator.
- 30.- Study, analysis and representation of the steam pressure in function of the revolutions in the steam turbine, with and without load variation in the generator.
- 31.- Study, analysis and representation of the generated power in function of the type of intake to the turbine, with constant working pressure, with and without load variation in the generator.
- 32.- Study, analysis and representation of the generated power in function of the vacuum pressure at the turbine outlet, with and without load variation in the generator.
- 33.- Study, analysis and representation of the vacuum pressure at the turbine outlet in function of the revolutions of the turbine, with and without load variation in the generator.

Parameters of the power generation:

- 34.- Study of the relation between the power delivered to the grid and the steam flow.
- 35.- Study of the relation between the power delivered to the grid and the steam pressure.
- 36.- Study of the relation between the power delivered to the grid and the vacuum pressure at the turbine outlet.
- 37.- Study of the relation of the active power of the generator in function of the steam flow in an isolated circuit (island mode).
- 38.- Study of the relation of the active power of the generator in function of the steam pressure in an isolated circuit (island mode).
- 39.- Study of the relation of the active power generation of the generator in function of the vacuum pressure at the turbine outlet in an isolated circuit (island mode).
- 40.- Study of the turbine fluctuation and the generator when suffering a sudden change in the power demand.
- 41.- Study of the synchronization procedure of turbine-generator group with the electrical grid through a grid inverter.
- 42.- Study of the consequences suffered when the generator is suddenly uncoupled from the electrical grid. Checking the safety systems of the power plant.

Additional practical possibilities:

- 43.- Study of heat losses in pipes.
- 44.- Study of the most important parameters in a steam power plant.
- 45.- Study of the steam generator efficiency in function of fuel used.
- 46.- Sensors calibration.
- Other possibilities to be done with this Unit:
- 47.- Many students view results simultaneously.
 To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
- 48.- Open Control, Multicontrol and Real Time Control.

- This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.
- 49.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
- 50.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
- 51.- This unit can be used for doing applied research.
- 52.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
- 53.- Control of the TPTVC/1.5kW unit process through the control interface box without the computer.
- 54.- Visualization of all the sensors values used in the TPTVC/1.5kW unit process.
- Several other exercises can be done and designed by the user.

a) Technical and Vocational Education configuration

⑦ TPTVC/1.5kW/ICAI. Interactive Computer Aided Instruction Software System.

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 TPTVC/1.5kW/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.

b) Multipost Expansions options

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

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

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

Main characteristics:

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

Main advantages:

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

The system basically will consist of:

This system is used with a Computer Controlled Unit.

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

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



C/ Del Agua, 14. Polígono Industrial San José de Valderas.
28918 LEGANÉS. (Madrid). ESPAÑA - SPAIN.
Tel.: 34-91-6199363 Fax: 34-91-6198647
E-mail: edibon@edibon.com Web: www.edibon.com

Edition: ED01/18
Date: February/2018

REPRESENTATIVE: