edibon

Technical Teaching Equipment

Computer Controlled **Gas Laws Unit (Boyle and Gay-Lussac Laws),** with SCADA and PID Control

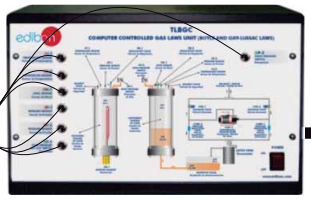
TLBGC

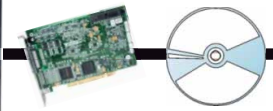
① Unit: TLBGC. Gas Laws Unit (Boyle and Gay-Lussac Laws)

EDIBON PATENT

Teaching Technique used

EDIBON **SCADA** System
and **PID CONTROL** included





② Control Interface Box

③ Data Acquisition Board

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

Computer (not included in the supply)

⑤ Cables and Accessories

⑥ Manuals

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

Key features:

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

- **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 CAL software helps the user perform calculations and comprehend the results.**
- **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

www.edibon.com
Products
Products range
Units
9.-Thermodynamics & Thermotechnics

For more information about Key Features, click here:

ISO 9000: Quality Management
(for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate
(total safety)

Certificates ISO 14000 and
ECO-Management and Audit Scheme
(environmental management)

Worlddidac Quality Charter Certificate and
Worlddidac Member

INTRODUCTION

The state of a gas is determined by temperature, pressure, volume and number of moles. For the case of ideal gases, these state variables are interrelated via the Ideal Gas Law. When one of these variables is changed, the others will change correspondingly.

The Ideal Gas Law is a good approximation to the behaviour of many gases under many conditions, although it has several limitations.

For a change of state under isobaric conditions (constant pressure) this equation becomes Gay-Lussac's Law. In the case of isothermal conditions (constant temperature) the ideal gas law converts to Boyle and Mariotte's Law.

The Computer Controlled Gas Laws Unit (Boyle and Gay-Lussac Law) "TLBGC" allows to demonstrate two fundamental gas laws: Boyle-Mariotte's Law (isothermal change of state) and Gay-Lussac's 2nd Law (isochoric change of state).

GENERAL DESCRIPTION

The Computer Controlled Gas Laws Unit (Boyle and Gay-Lussac Law) "TLBGC" allows to demonstrate two fundamental gas laws: Boyle-Mariotte's Law (isothermal change of state) and Gay-Lussac's 2nd Law (isochoric change of state).

The unit consists of a rigid frame containing two transparent vessels, that enables to observe the change of state in the test gas (air).

In the first vessel, for investigation of isochoric change of state, the temperature of the test gas is increased by a computer controlled electrical heating element, and the resulting pressure rise is measured. The volume of the enclosed gas remains constant. A valve at the bottom of the vessel allows students to normalize the air in the vessel to room conditions.

In the second vessel, for investigation of isothermal change of state, students use a compressor/vacuum pump to increase or decrease the pressure in a reservoir vessel that moves a "liquid piston" of oil in the test vessel. This piston compresses or decompresses a trapped column of air in the test vessel. If the changes occur slowly, the change of state takes place at an almost constant temperature.

Temperatures, pressures and level are measured by means of sensors. The unit includes two pressure switches and relief valves to ensure the safety of the user.

A PID control enables constant temperature operation by controlling the power of the electrical heating element in the first vessel.

Two solenoid valves and two pressure regulator valves enables to control the level of oil inside the second vessel.

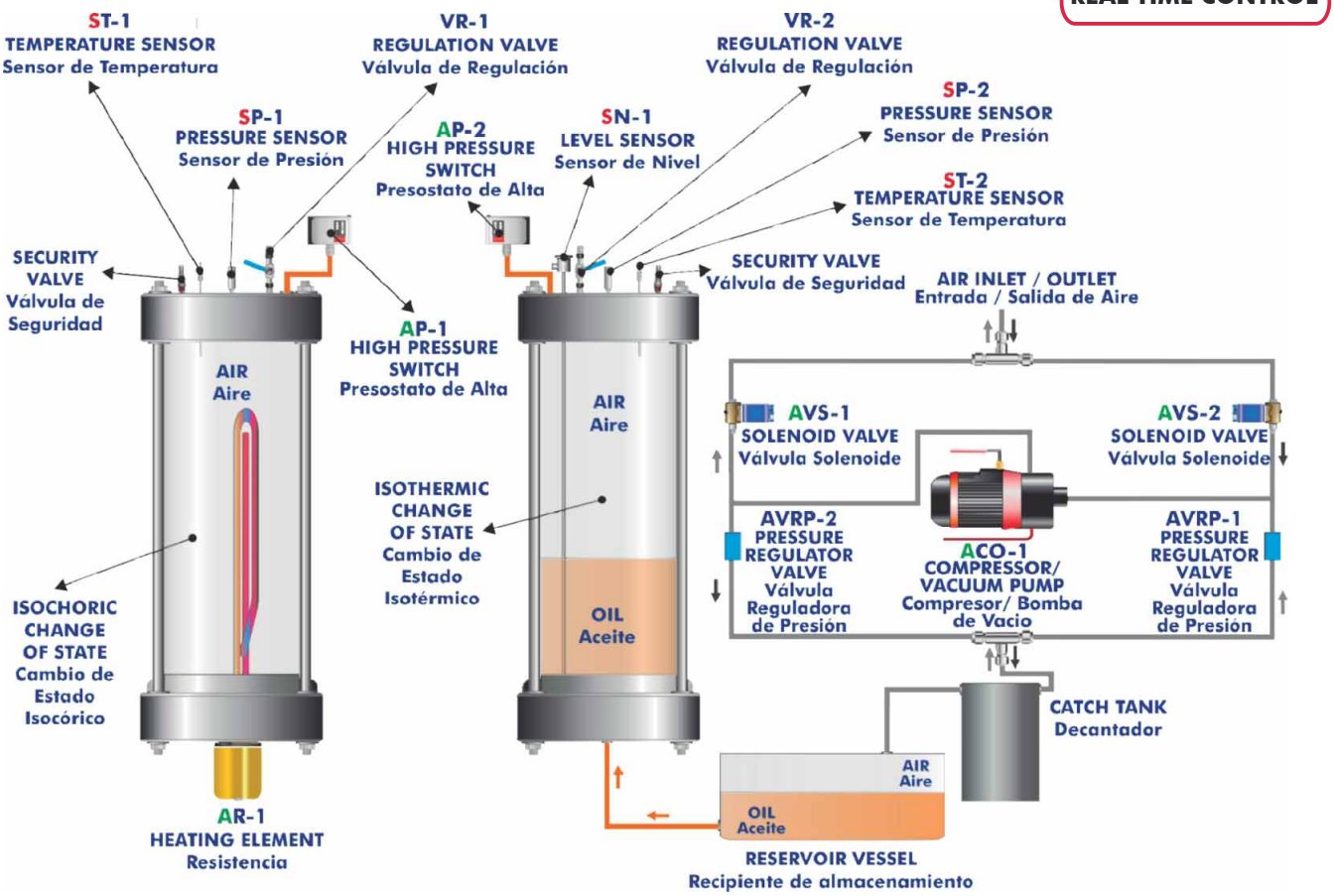
The unit uses air that behaves as an ideal gas within the range of pressures used in this unit.

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

8 actuators and 5 sensors controlled from any computer, and working simultaneously

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL



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, 10, 11 and 12.

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

① TLBGC. 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 layout of the elements similar to the real unit.

A transparent measuring vessel for investigation of isochoric change of state (dimensions: diameter = 100mm, height = 450 mm). It includes:

A computer controlled electrical heating element, 300W, with PID temperature control, limited to 80ºC.

One "J type" temperature sensor to measure the temperature of the air in the vessel.

One pressure sensor to measure the pressure of the heated air in the vessel, range: 0-6 bar.

A hand-operated regulation valve to normalize the air in the vessel to room conditions.

One relief valve, working pressure: 0-2.5 bar.

A transparent measuring vessel for investigation of isothermal change of state, (dimensions: diameter = 100mm, height = 450 mm). It includes:

A graduated scale.

One "J type" temperature sensor to measure the trapped air temperature.

One pressure sensor to measure the trapped air pressure, range: 0-6 bar.

One level sensor to measure the change in height of the trapped air column. Length of the level sensor probe: 400 mm.

A hand-operated regulation valve to normalize the air in the vessel to room conditions.

One relief valve, working pressure: 0-2.5 bar.

Compressor/vacuum pump to ensure necessary pressure differences to move the oil volume. Max. pressure = 2 bar, power = 300W.

Two solenoid valves and two proportional pressure valves to ensure a constant level operation by controlling the opening/closing of the valves.

A reservoir vessel to store the hydraulic oil.

A catch tank to collect oil and prevent it to go to the pressure regulator valves.

Hydraulic oil to change the volume of the testing gas.

Two pressure switches to limit the maximum pressure in the vessels.

TLBGC Unit

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

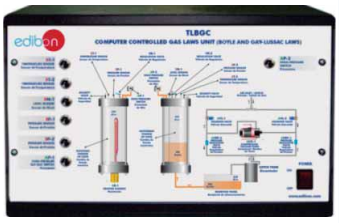
This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② TLBGC/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.



TLBGC/CIB

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, resistances, control valves, etc. **Real time PID control for parameters involved in the process simultaneously. Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time,** of the three control constants (proportional, integral and derivative constants).

Open control allowing modifications, at any 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.

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/0. DMA channels=6.

DAB

Analog output:

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

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

Digital Input/Output:

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

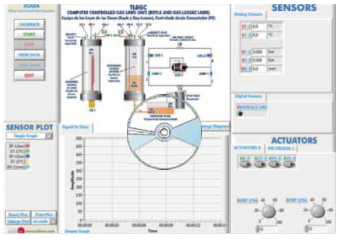
Timing: Number of **Counter/timers=4**. Resolution: Counter/timers: 32 bits.

④ TLBGC/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.



TLBGC/CCSOF

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

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH MAIN ITEMS

1.- Experimental demonstration of the laws of state changes in gases.

2.- Investigation of the characteristic equation of air $P \cdot V = n \cdot R \cdot T$ at room temperature.

3.- Demonstration of the change of pressure of a fixed volume of air during heating.

4.- Demonstration of Gay-Lussac's Law $V \approx T \cdot$Constant for air.

5.- Demonstration of gas temperature change during compression and decompression.

6.- Demonstration of Boyle's Law $P \cdot V =$ Constant for air.

Additional practical possibilities:

7.- Sensors calibration.

Other possibilities to be done with this Unit:

8.- Many students view results simultaneously.

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

9.- 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.

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

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

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

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

14.- Control of the TLBGC unit process through the control interface box without the computer.

15.- Visualization of all the sensors values used in the TLBGC 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, 220V./50Hz or 110V./60Hz.

-Hydraulic oil.

-Computer (PC).

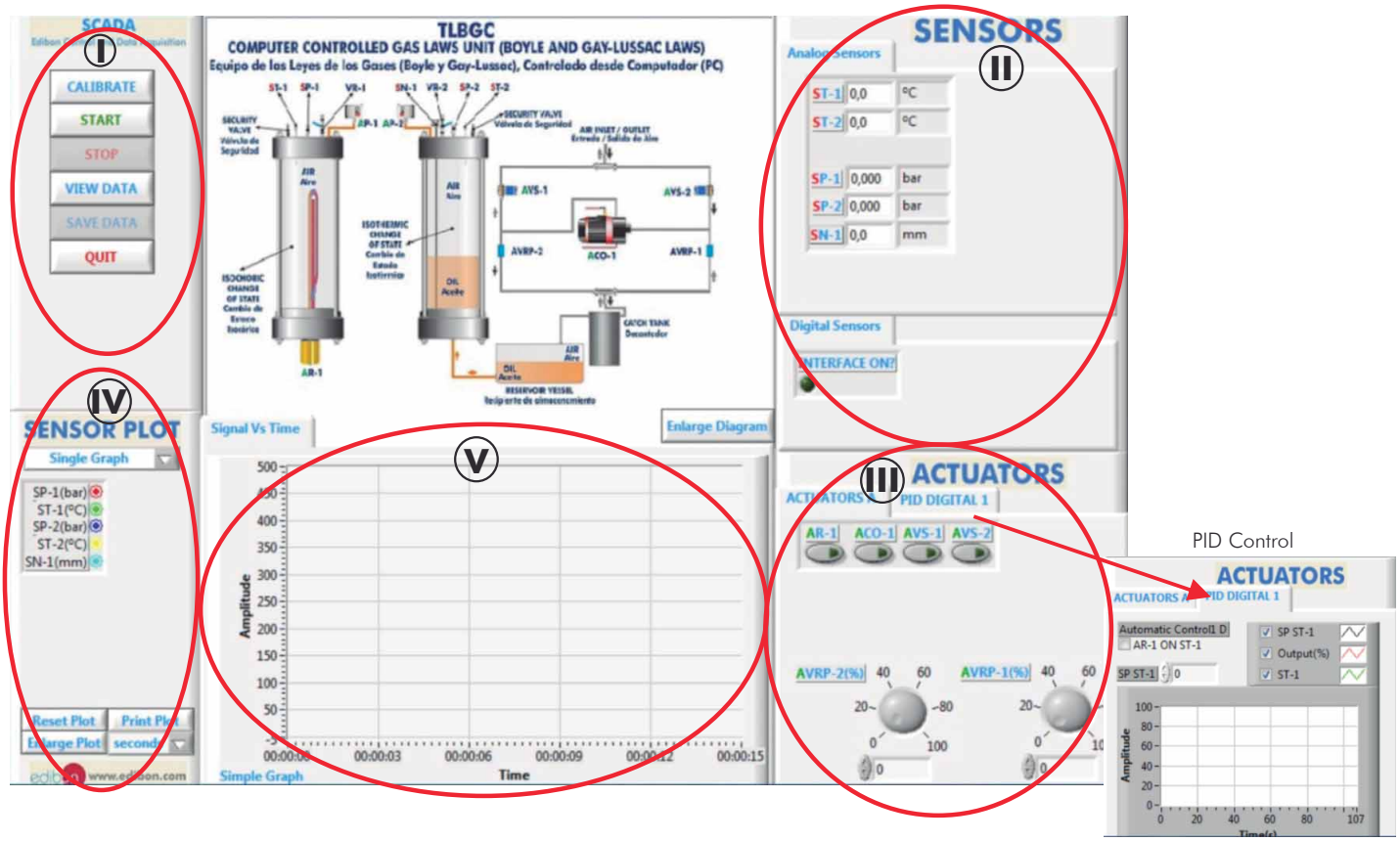
DIMENSIONS & WEIGHTS

TLBGC:

Unit:	-Dimensions:	900 x 600 x 900 mm. approx. (35.43 x 23.62 x 35.43 inches approx.).
	-Weight:	50 Kg. approx. (110.23 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.).

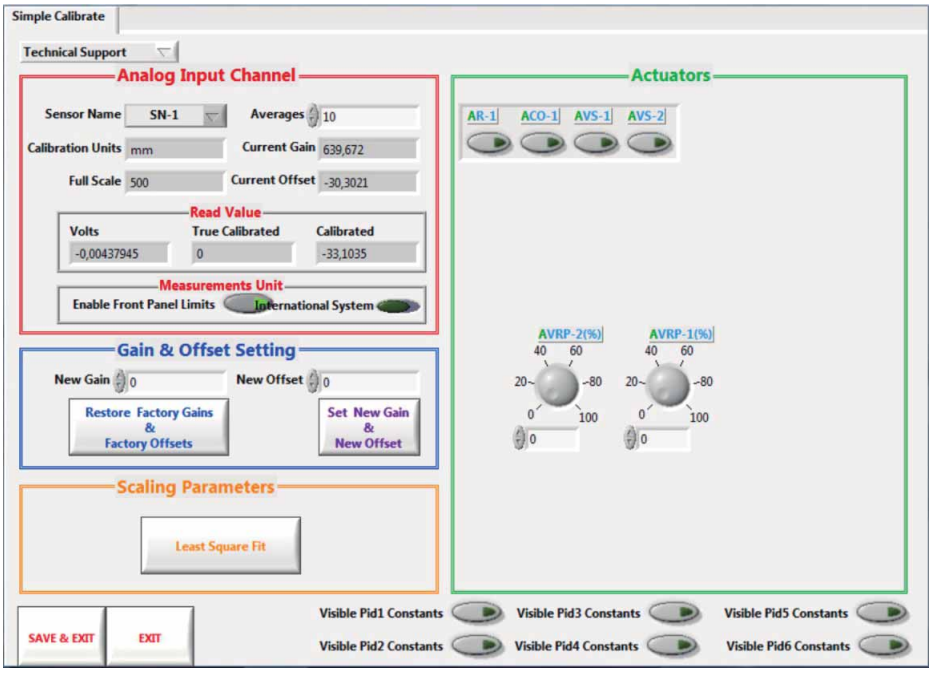
SCADA and PID Control

Main screen



Ⓘ Main software operation possibilities.
Ⓘ Sensors displays, real time values, and extra output parameters. **Sensors:** ST=Temperature sensor. SP=Pressure sensor. SN=Level sensor.
Ⓘ **Actuators controls. Actuators:** AR=Heating element. ACO=Compressor/Vacuum pump. AVS=Solenoid valve. AP=High pressure switch. AVRP=Pressure regulator valve.
Ⓘ Channel selection and other plot parameters.
Ⓘ Real time graphics displays.

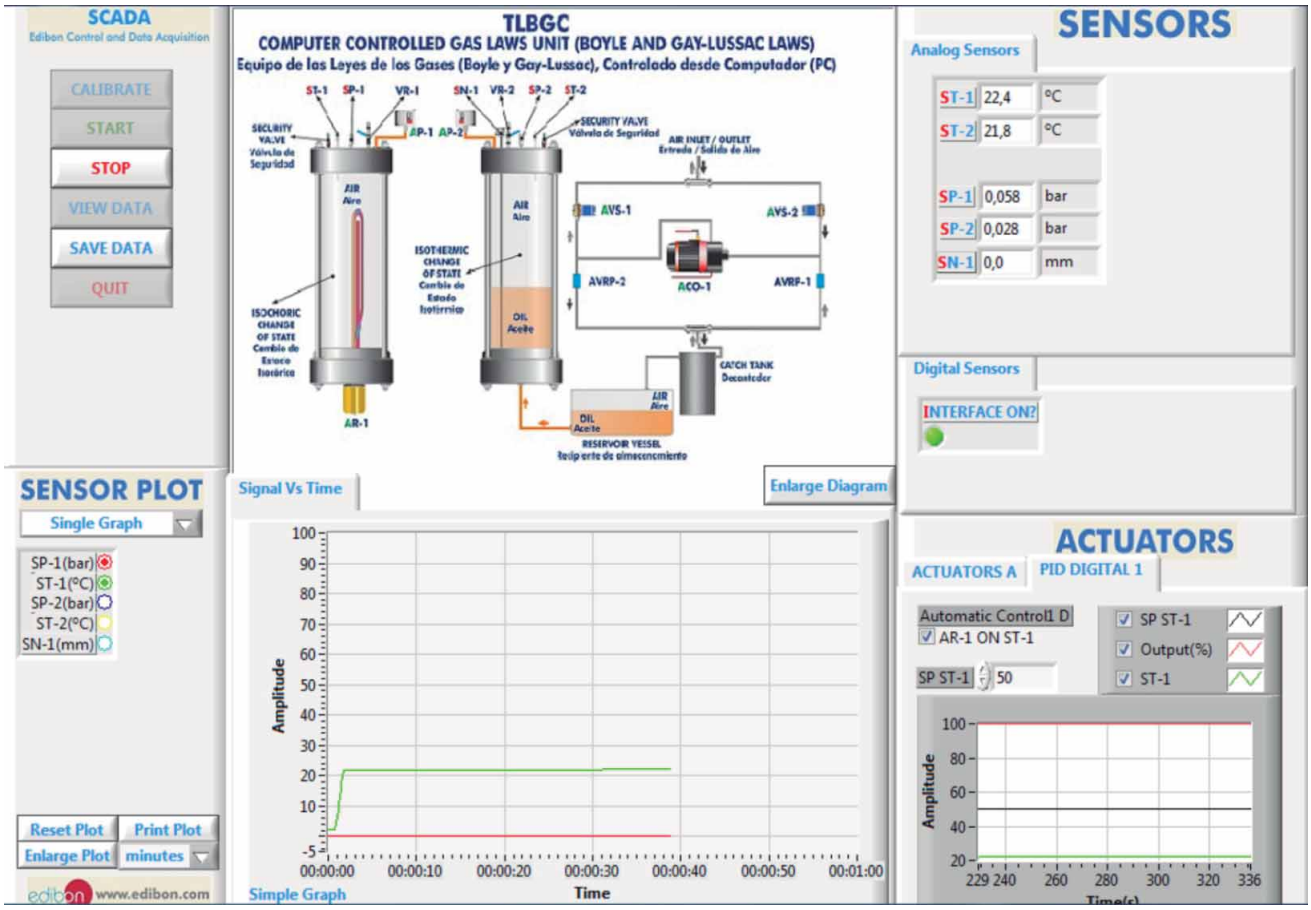
Software for Sensors Calibration



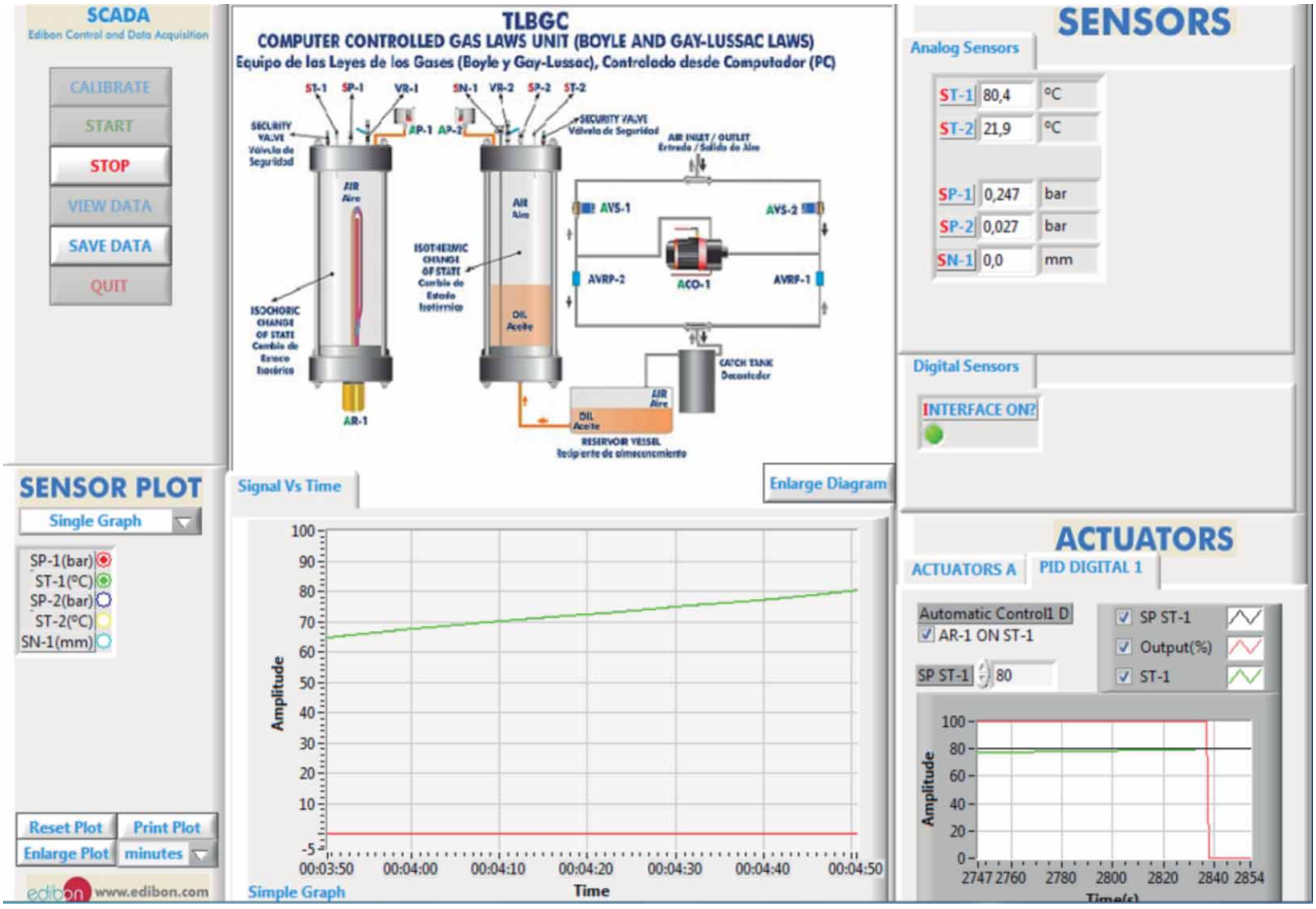
By using a free of charge code, the teacher and the students can calibrate the unit.

The teacher can recover his/her own calibration by using the EDIBON code that we give free of charge.

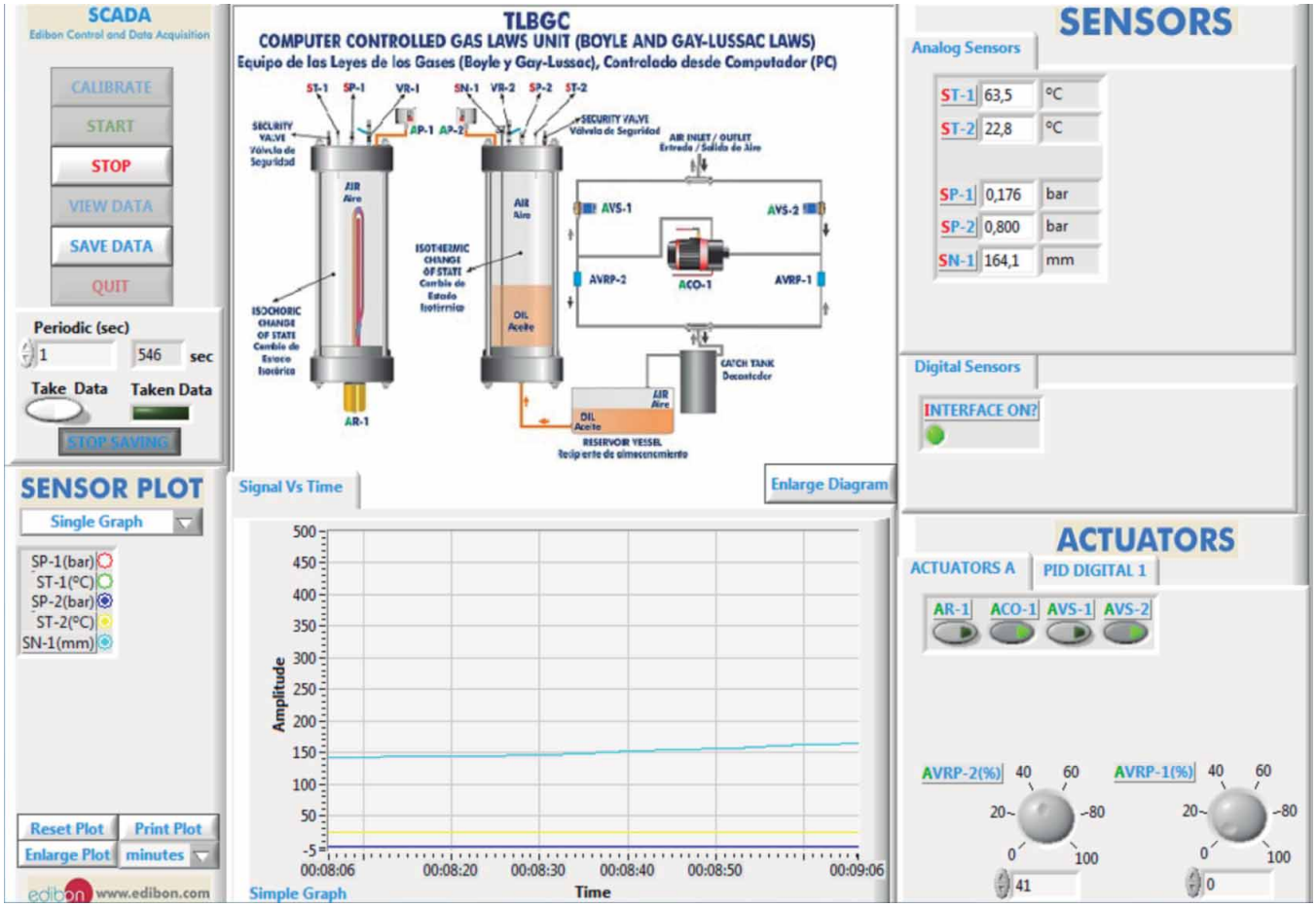
This screen shows the PID control used to maintain the desired temperature inside the vessel for the investigation of isochoric change of state.



This screen shows how the increase of the temperature inside the vessel for the investigation of isochoric change of state implies an increase of the pressure.



This screen shows how the oil enters the vessel for the study of isothermal change of state. For that end, it is necessary to activate the compressor/ vaccum pump (ACO-1), the solenoid valve (AVS-2) and the pressure regulator valve (AVRP-2). To reduce the volume of air inside the vessel the compressor/vaccum pump (ACO-1), the solenoid valve (AVS-1) and the pressure regulator valve (AVRP-1) must be activated.



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 12.
All these items try to give more possibilities for:

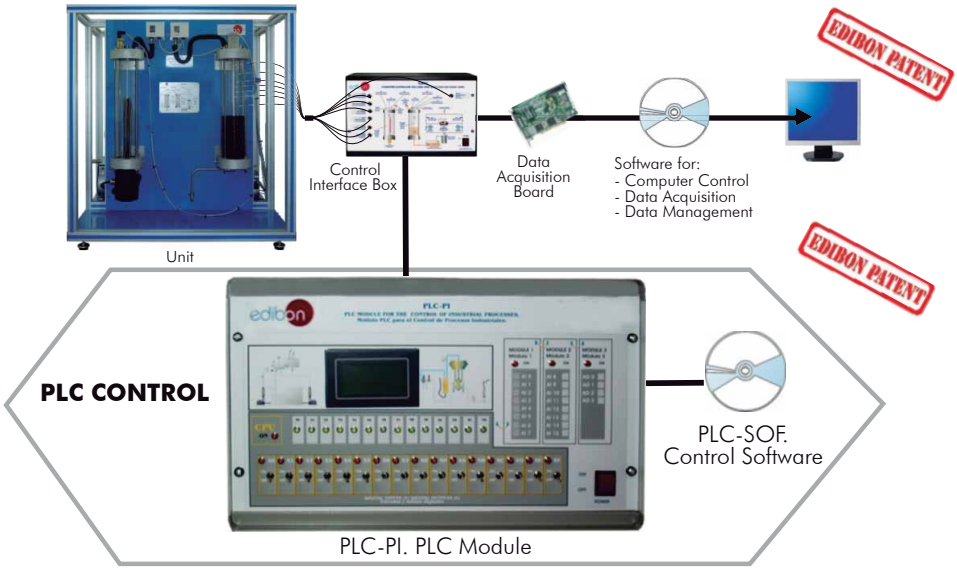
a) Industrial configuration. (PLC)
b) Technical and Vocational Education configuration. (CAI and FSS)
c) Higher Education and/or Technical and Vocational Education configuration. (CAL)
d) Multipost Expansions options. (Mini ESN and ESN)

a) Industrial configuration

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

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

-**TLBGC/PLC-SOF. PLC Control Software:**
For this particular unit, always included with PLC supply.
The software has been designed using Labview and it follows the unit operation procedure and linked with the Control Interface Box used in the Computer Controlled Gas Laws Unit (Boyle and Gay-Lussac Laws)"TLBGC".



Practices to be done with PLC-PI:

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

b) Technical and Vocational Education configuration

⑧ TLBGC/CAI. Computer Aided Instruction Software System.

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

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

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

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

The Instructor can:

Organize Students by Classes and Groups.

Create easily new entries or delete them.

Create data bases with student information.

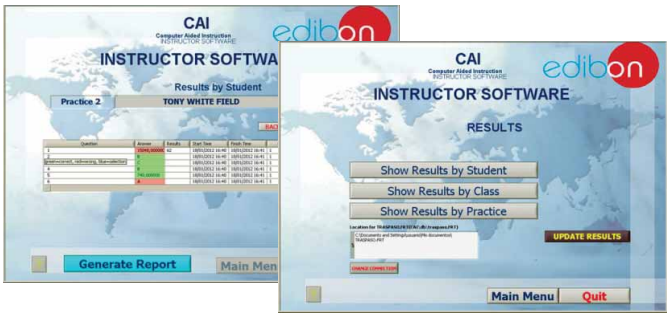
Analyze results and make statistical comparisons.

Generate and print reports.

Detect student's progress and difficulties.

...and many other facilities.

Instructor Software



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

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

This Software contains:

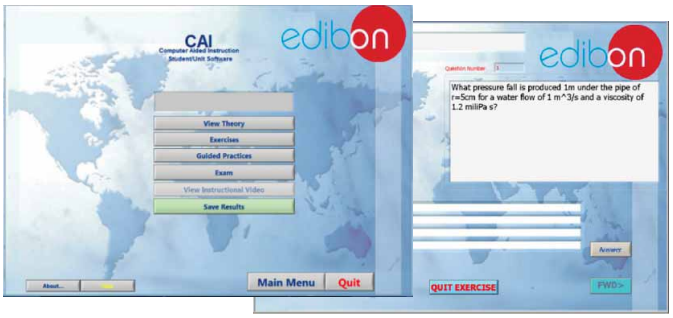
Theory.

Exercises.

Guided Practices.

Exams.

Student Software



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

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

⑨ TLBGC/FSS. Faults Simulation System.

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

The "FAULTS" mode consists on causing several faults in the unit normal operation. The student must find them and solve them.

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

Faults affecting the sensors measurement:

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

Faults affecting the actuators:

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

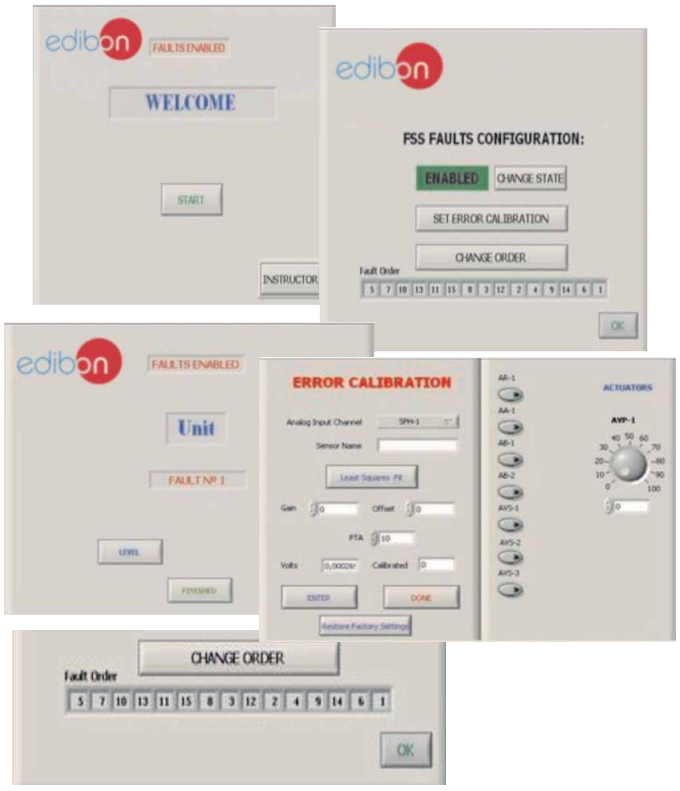
Faults in the controls execution:

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

On/off faults:

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

Example of some screens



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

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

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

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

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

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

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

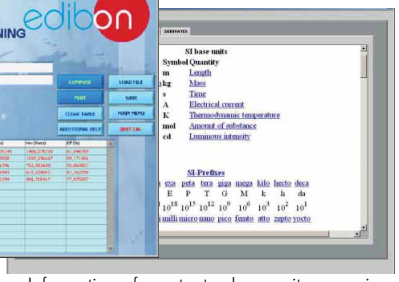
It allows to plot and print the results. Within the plotting options, any variable can be represented against any other.

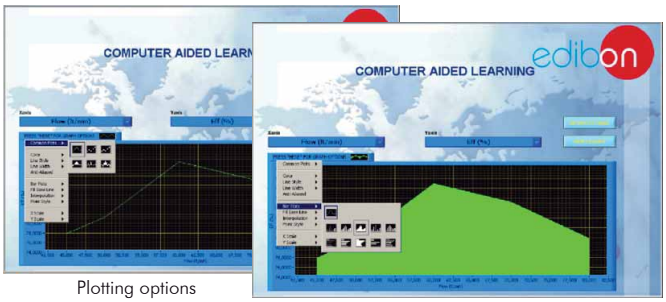
Different plotting displays.

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

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

Calculations


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



Plotting options

d) Multipost Expansions options

⑪ Mini ESN. EDIBON Mini Scada-Net System.

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

The Mini ESN system consists on the adaptation of any EDIBON Computer Controlled Unit with SCADA 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).

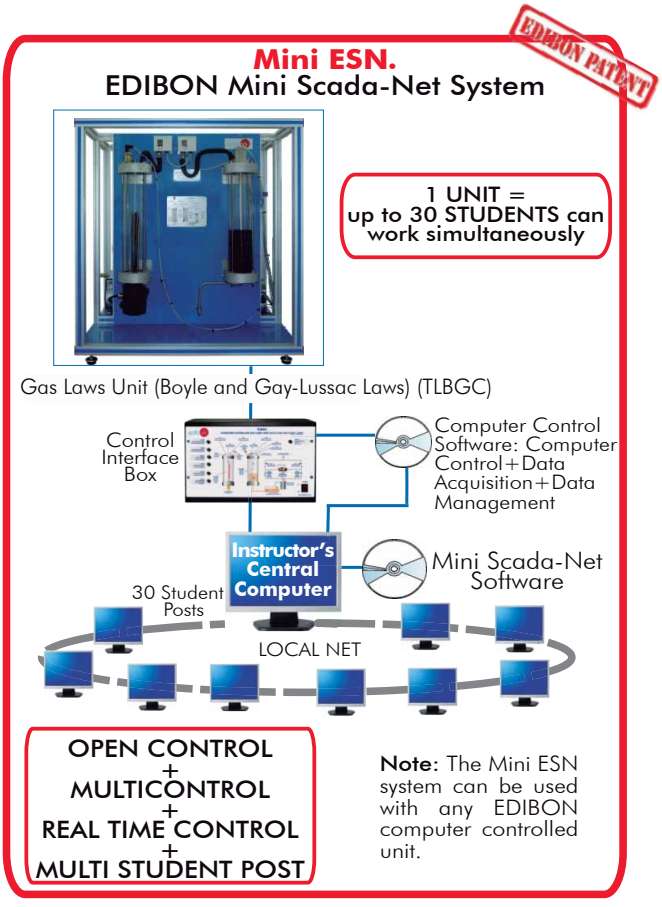
Main characteristics:

- **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/products/catalogues/en/Mini-ESN.pdf



⑫ ESN. EDIBON Scada-Net System.

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

For more information see **ESN** catalogue. Click on the following link:
www.edibon.com/products/catalogues/en/units/thermodynamicsthermotechnics/esn-thermodynamics/ESN-THERMODYNAMICS.pdf

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: TLBGC. Gas Laws Unit (Boyle and Gay-Lussac Laws).**

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

③ **DAB. Data Acquisition Board.**

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

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

⑥ **Manuals.**

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

Optional items (supplied under specific order)

a) Industrial configuration

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

- PCL-PI. PLC Module.
- TLBGC/PLC-SOF. PLC Control Software.

b) Technical and Vocational configuration

⑧ TLBGC/CAI. Computer Aided Instruction Software System.

⑨ TLBGC/FSS. Faults Simulation System.

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

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

d) Multipost Expansions options

⑪ Mini ESN. EDIBON Mini Scada-Net System.

⑫ ESN. EDIBON Scada-Net System.

① TLBGC. 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 layout of the elements similar to the real unit.
A transparent measuring vessel for investigation of isochoric change of state (dimensions: diameter = 100mm, height = 450 mm). It includes:
- A computer controlled electrical heating element, 300W, with PID temperature control, limited to 80°C.
- One "J type" temperature sensor to measure the temperature of the air in the vessel.
- One pressure sensor to measure the pressure of the heated air in the vessel, range: 0-6 bar.
- A hand-operated regulation valve to normalize the air in the vessel to room conditions.
- One relief valve, working pressure: 0-2.5 bar.

A transparent measuring vessel for investigation of isothermal change of state, (dimensions: diameter = 100mm, height = 450 mm). It includes:
- A graduated scale.
- One "J type" temperature sensor to measure the trapped air temperature.
- One pressure sensor to measure the trapped air pressure, range: 0-6 bar.
- One level sensor to measure the change in height of the trapped air column. Length of the level sensor probe: 400 mm.
- A hand-operated regulation valve to normalize the air in the vessel to room conditions.
- One relief valve, working pressure: 0-2.5 bar.
- Compressor/vacuum pump to ensure necessary pressure differences to move the oil volume. Max. pressure = 2 bar, power = 300W.
- Two solenoid valves and two proportional pressure valves to ensure a constant level operation by controlling the opening/closing of the valves.
- A reservoir vessel to store the hydraulic oil.
- A catch tank to collect oil and prevent it to go to the pressure regulator valves.
- Hydraulic oil to change the volume of the testing gas.

Two pressure switches to limit the maximum pressure in the vessels.
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 CAL software helps the user perform calculations and comprehend the results.
- This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② TLBGC/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 TLBGC/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 Main Items

1.- Experimental demonstration of the laws of state changes in gases.

2.- Investigation of the characteristic equation of air $P \cdot V = n \cdot R \cdot T$ at room temperature.

3.- Demonstration of the change of pressure of a fixed volume of air during heating.

4.- Demonstration of Gay-Lussac's Law $V \approx T \cdot$Constant for air.

5.- Demonstration of gas temperature change during compression and decompression.

6.- Demonstration of Boyle's Law $P \cdot V =$ Constant for air.

Additional practical possibilities:

7.- Sensors calibration.

Other possibilities to be done with this Unit:

8.- Many students view results simultaneously.

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

9.- 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.

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

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

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

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

14.- Control of the TLBGC unit process through the control interface box without the computer.

15.- Visualization of all the sensors values used in the TLBGC unit process.

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

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

a) Industrial configuration

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

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

Metallic box.
Circuit diagram in the module front panel.
Digital inputs(X) and Digital outputs (Y) block: 16 Digital inputs. 14 Digital outputs.
Analog inputs block: 16 Analog inputs.
Analog outputs block: 4 Analog outputs.
Touch screen.
Panasonic PLC:
High-speed scan of 0.32 μsec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.
Digital inputs/outputs and analog inputs/outputs Panasonic modules.

-**TLBGC/PLC-SOF. PLC Control Software:**

For this particular unit, always included with PLC supply.

Practices to be done with PLC-PI:

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

b) Technical and Vocational Education configuration

⑧ TLBGC/CAI. Computer Aided Instruction Software System.

This complete software package consists of an Instructor Software (INS/SOF) totally integrated with the Student Software (TLBGC/SOF).
-INS/SOF. Classroom Management Software (Instructor Software):
The Instructor can:
Organize Students by Classes and Groups.
Create easily new entries or delete them.
Create data bases with student information.
Analyze results and make statistical comparisons.
Generate and print reports.
Detect student's progress and difficulties.
-TLBGC/SOF. Computer Aided Instruction Software (Student Software):
It explains how to use the unit, run the experiments and what to do at any moment.
This Software contains:
Theory.
Exercises.
Guided Practices.
Exams.

⑨ TLBGC/FSS. Faults Simulation System.

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit.
The "FAULTS" mode consists on causing several faults in the unit normal operation. The student must find them and solve them.
There are several kinds of faults that can be grouped in the following sections:
Faults affecting the sensors measurement:
- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:
- Actuators canals interchange at any time during the program execution.
- Response reduction of an actuator.

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

On/off faults:
- Several on/off faults can be included.

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

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

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

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

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

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

Different plotting displays.

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

d) Multipost Expansions options

⑪Mini ESN. EDIBON Mini Scada-Net System.

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

The Mini ESN system consists on the adaptation of any EDIBON Computer Controlled Unit with SCADA 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 improvements of the product.

edibon INTERNATIONAL

C/ Del Agua, 14. Polígono Industrial San José de Valderas.
28918 LEGANÉS. (Madrid). SPAIN.
Phone: 34-91-6199363 FAX: 34-91-6198647
E-mail: edibon@edibon.com WEB site: **www.edibon.com**

Issue: ED01/2014
Date: December/2014

REPRESENTATIVE: