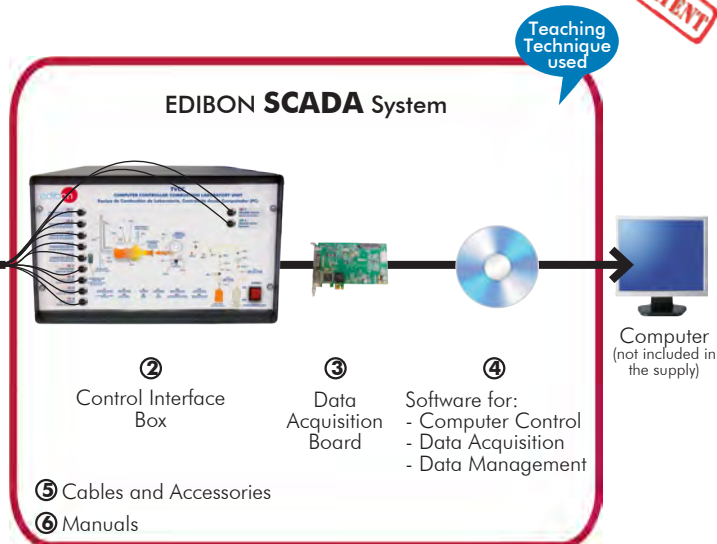


① Unit: TVCC. Computer Controlled Combustion Laboratory Unit



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

## Key features:

- **Advanced Real-Time SCADA.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON Control Software based on LabVIEW.**
- **National Instruments Data Acquisition board (250 KS/s, kilo samples per second).**
- **Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.**
- **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**
- **Capable of doing applied research, real industrial simulation, training courses, etc.**
- **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**
- **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**
- **Designed and manufactured under several quality standards.**
- **Optional 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



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PRODUCTS  
↳ 9 - 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

Despite the development of renewable sources and the importance given to use of such clean energies, almost half of the electricity and energy generated comes from hydrocarbon combustion.

Nowadays, these fuels have two problems. On one hand, they are finite resources. Their exhaustion is predicted to happen in a closer or further term, according to different published studies. On the other hand, the burning of these fuels release to the atmosphere big quantities of CO<sub>2</sub>, which has been accused of being the main cause of global heating.

For these reasons, a sound knowledge of the factors that affect the efficiency of these fuels combustion is essential for everyone involved in the study and use of energies.

The "TVCC" unit enables the students the study and understanding of many aspects related to combustion, using a small scale unit based on an industrial dual burner.

## GENERAL DESCRIPTION

The Computer Controlled Combustion Laboratory Unit, "TVCC", unit is mounted on a metallic frame that enables safe access to the equipment and an easy handling and access to the burner, combustion chamber and all the accessories and control panels.

The burner starts the combustion with fuel oil (diesel or gas oil) or with gas (natural gas or LPG). The gas (either from an LPG cylinder or from the premises' supply) and fuel oil stored in two tanks provided with the unit are fed to the burner through suitable ducts and valves.

Both lines include their corresponding filter and the appropriate safety measures.

Prior to the combustion start, the burner begins with an air purge, later on it burns the corresponding fuel and, automatically, it is set to a safe working conditions.

The burner has an integrated fan that provides the air required for the combustion, a flame detection sensor and an ignition controller. This fan has a differential pressure sensor to measure the air flow provided, a thermocouple to determine its temperature and a regulator for the air flow to be introduced in the burner.

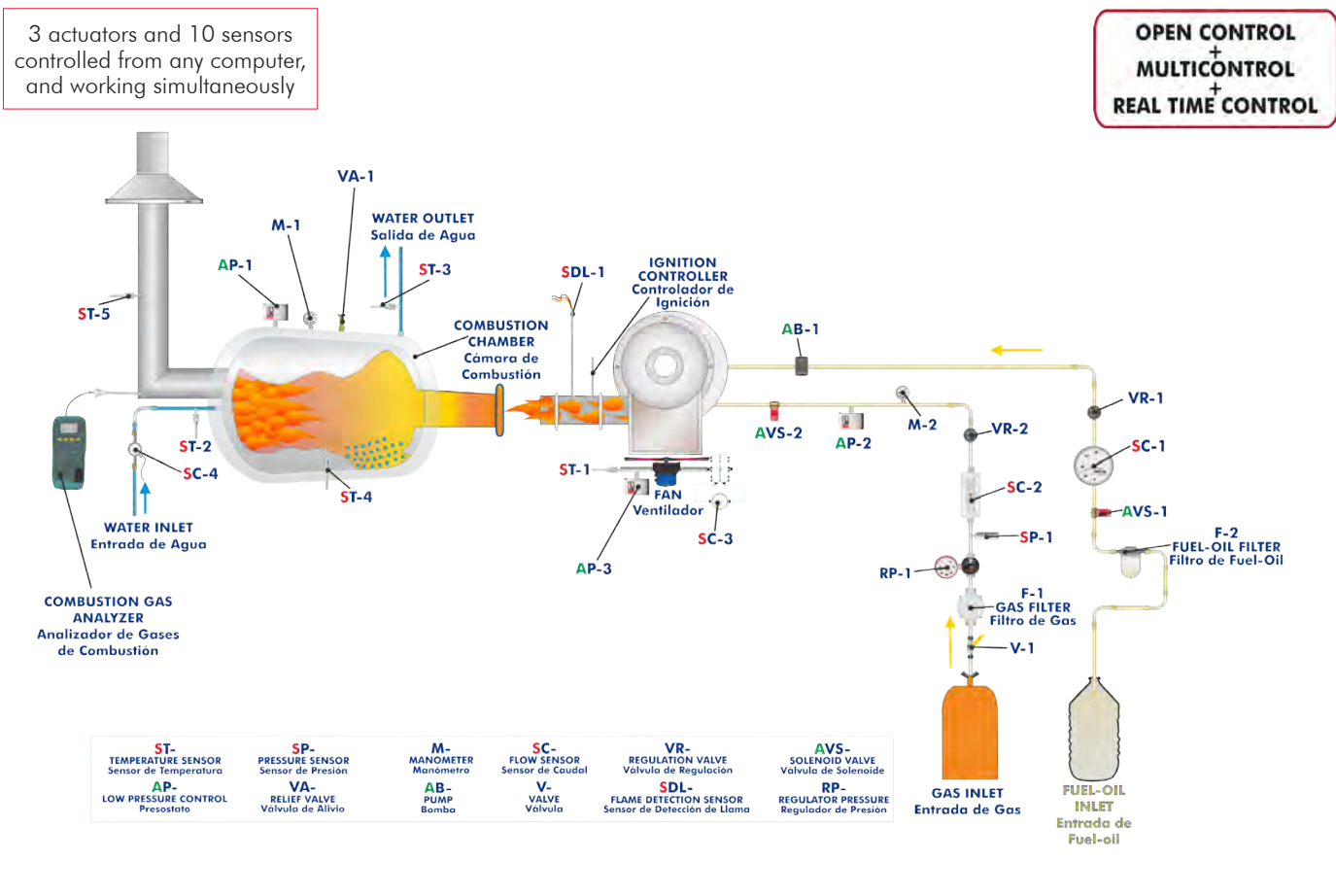
The flame burns inside a stainless steel combustion chamber cooled with water. Such chamber has five observation points (of 100 mm) at their sides which allow to observe the flame.

The unit also includes a manual digital analyzer for the combustion fumes. It allows to determine the composition of such gases, the air excess, content in O<sub>2</sub>, CO, CO<sub>2</sub> and CO/CO<sub>2</sub> ratio.

This way, students can study the effect of the fuel/air ratio in the characteristics of the flame, in the efficiency of the combustion, in the constituents of the combustion fumes, etc., as well as the influence of all these aspects in the use of different fuels.

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 TVCC. Unit:

Anodized aluminum frame and panels made of painted steel.

The unit includes wheels to facilitate its mobility.

Main metallic elements made of stainless steel.

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

Stainless steel combustion chamber (700 mm x 1100 mm) with five pieces of 100 mm diameter for the observation points.

Cooling jacket with thermometer, manometer and pressure switch to avoid overpressure in the jacket.

Dual burner of 150 kW to work both with natural gas (or other LPG) and fuel oil.

Fan integrated in the burner with a regulating lever for the air flow.

The natural gas line includes:

- Manual valve.
- Gas filter.
- Pressure sensor, range: 0 - 1 bar.
- Pressure regulator, range: 0 - 3 bar.
- Manometer, range: 0 - 400 mbar.
- Electronic solenoid valve and safety pressure switch.
- Flow sensor, range: 3 - 21 m<sup>3</sup>/h.
- Needle valve to regulate the gas inlet flow.

The fuel oil line includes:

- Manual valve.
- Electronic solenoid valve.
- Flow sensor, range: 4 - 38 kg/h.
- Needle valve to regulate the liquid fuel inlet flow.
- Two Storage and supply tanks for the fuel oil.
- Suction pump of the fuel into the burner.

Air ventilation, safety and drain valves.

Five temperature sensors: combustion chamber, cooling water inlet and outlet, combustion fumes outlet and air inlet to the burner.

Four Flow sensors: natural gas inlet, fuel oil inlet, cooling water flow inlet (range: 1.5 - 30 l/min) and air inlet (by means of a differential pressure sensor, range: 0 - 1 PSI).

Combustion gases analyzer: measurement of the content in O<sub>2</sub>, CO and CO<sub>2</sub>, efficiency of the combustion, air excess and CO/CO<sub>2</sub> ratio.

Two solenoid valves, one for each working flow: gas or fuel oil.

Flame detection sensor and ignition controller.

Safety measures. The feeding to the burner is cut off when:

- The outlet water temperature exceeds 80°C.
- The pressure of the cooling jacket exceeds 1 bar.
- A water flow higher than 5 l/min is not detected.

The complete unit includes as well:

**Advanced Real-Time SCADA.**

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

**Specialized EDIBON Control Software based on LabVIEW.**

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

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

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

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

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

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

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

**Optional 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 Scaqa-Nef (ESN) System which enables multiple students to simultaneously operate many units in a network.**



Unit: TVCC

**② TVCC/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 computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.**

Real time computer control for pumps, compressors, heating elements, control valves, etc.

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

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

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



TVCC/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**. D0 or DI Sample Clock frequency: 0 to 100 MHz.

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



DAB

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

The three softwares are part of the SCADA system.

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.**

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

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

**Management, processing, comparison and storage of data.**

**Sampling velocity up to 250 KS/s (kilo samples per second).**

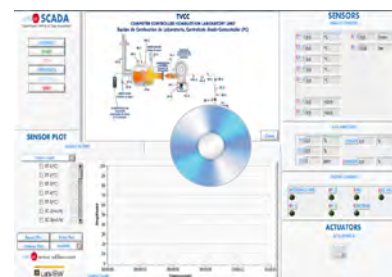
**Calibration system for the sensors involved in the process.**

**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.**



TVCC/CCSOF

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

**⑥ Manuals:**

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

\*References 1 to 6 are the main items: TVCC + TVCC/CIB + DAB + TVCC/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 THE MAIN ITEMS

- 1.- Study of the combustion process and the burner operation.
  - 2.- Familiarisation of the adjustment and operation of an fuel oil or gas burner.
  - 3.- Effect of the air/fuel ratio both in the efficiency of the combustion and in the measuring of the combustion gases components and in the temperature.
  - 4.- Effect of the air/fuel ratio on energy balance.
  - 5.- Effect of the air/fuel ratio on heat transfer.
  - 6.- Effect of the flame radiation on heat transfer and observed temperature.
  - 7.- Comparison of flue gas analysis with theoretical predictions.
  - 8.- Comparison of the performance of different fuels.
  - 9.- Assessment of a burner, including:
    - Flame stability.
    - Flame shape.
    - Flame radiation.
    - Firing rate.
    - Turndown range.
    - Smoke emission.
  - 10.- Comparison between a gas burner and a fuel oil burner.
- Additional practical possibilities:
- 11.- Sensors calibration.

Other possibilities to be done with this Unit:

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

### REQUIRED SERVICES

- Electrical supply: single-phase, 220 V/50 Hz or 110 V/60 Hz.
- Water supply.
- The unit must be operated in a ventilated space with fume extraction system.
- Computer.

### DIMENSIONS AND WEIGHTS

TVCC:

Unit:

- Dimensions: 2200 x 1000 x 1900 mm approx.  
(86.61 x 39.37 x 74.80 inches approx.).
- Weight: 400 Kg approx.  
(881.8 pounds approx.).

Control Interface Box:

- Dimensions: 490 x 330 x 310 mm approx.  
(19.29 x 13 x 12.20 inches approx.).
- Weight: 10 Kg approx.  
(22 pounds approx.).

### REQUIRED CONSUMABLES (Not included)

- Gas: natural gas or LPG. Minimum flow of 7 m<sup>3</sup>/h at a pressure of 2 bar.
- Fuel oil: kerosene, diesel or other light fuel (approximate density between 790 - 840 kg/m<sup>3</sup> and viscosity between 0.011 - 0.055 cm<sup>2</sup>/s at 40°C). Minimum flow: 10 kg/h.

# SOFTWARE MAIN SCREENS

## SCADA Main screen

The SCADA Main screen is divided into several functional areas:

- Top Left:** A control panel with buttons for CALIBRATE, START, STOP, VIEW DATA, SAVE DATA, and QUIT.
- Top Center:** A schematic diagram of the TVCC (COMPUTER CONTROLLED COMBUSTION LABORATORY UNIT) with various components labeled like VA-1, M-1, AP-1, etc.
- Top Right:** A panel for ANALOG SENSORS showing real-time values for ST-1 to ST-5 (Temperature) and SC-2 to SC-3 (Flow).
- Bottom Left:** A SENSOR PLOT area with a list of sensors to monitor and a graph showing Amplitude vs. Time(seconds).
- Bottom Center:** A large empty graph area for real-time data visualization.
- Bottom Right:** A panel for ACTUATORS showing digital sensors and control buttons for AP-1 to AP-3, FAN, and GAS VALVE.

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

## Software for Sensors Calibration Example of screen

The Simple Calibrate software interface is designed for sensor calibration and includes the following sections:


- Analog Input Channel:** Configuration for a specific sensor (e.g., ST-1), including calibration units, current gain, full scale, and current offset.
- Gain & Offset Setting:** Fields for setting new gain and new offset, with buttons to restore factory values or set new ones.
- Scaling Parameters:** A section for selecting the Least Square Fit method.
- Actuators:** A panel for controlling the burner, with a visual indicator and a 'Muticalibrate' button.
- Sensors Table:** A comprehensive table listing calibration data for all sensors.

Sensors	Volts	Calibrated	Err(%)	Current Gain	Current Offset	Test	Print
ST-1	0,283196	27,6086	27,6086	97,481	0,0024		
ST-2	0,312116	30,9823	30,9823	96,563	0,8434		
ST-3	0,282696	28,5008	28,5008	96,803	1,135		
ST-4	0,326112	34,0049	34,0049	126,4	-7,2157		
ST-5	0,258064	26,5578	26,5578	126,87	-6,1827		
SC-1	0,311012	0,93955	0,93955	2,48897	0,165452		
SC-3	0,277541	-588,469	-588,469	161,17	-633,2		

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

## SOME REAL RESULTS OBTAINED FROM THIS UNIT

Reminder of checks before starting the unit.



Supervisory Control & Data Acquisition

CALIBRATE

START

STOP

VIEW DATA

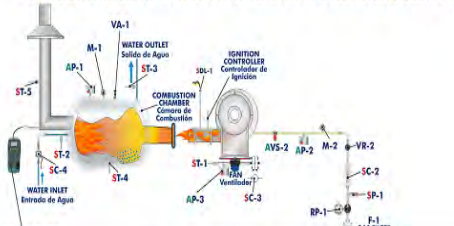
SAVE DATA

QUIT

### TVCC

#### COMPUTER CONTROLLED COMBUSTION LABORATORY UNIT

Equipo de Combustión de Laboratorio, Controlado desde Computador (PC)



### SENSORS

ANALOG SENSORS

ST-1	0,0	°C	SC-4	0,0	l/min
ST-2	0,0	°C	SP-1	0,00	bar
ST-3	0,0	°C			
ST-4	0,0	°C			
ST-5	0,0	°C			
SC-2	0,0	m3/h			
SC-3	0,0	m3/h			

### SENSOR PLOT

SIGNAL VS TIME

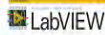
Single Graph

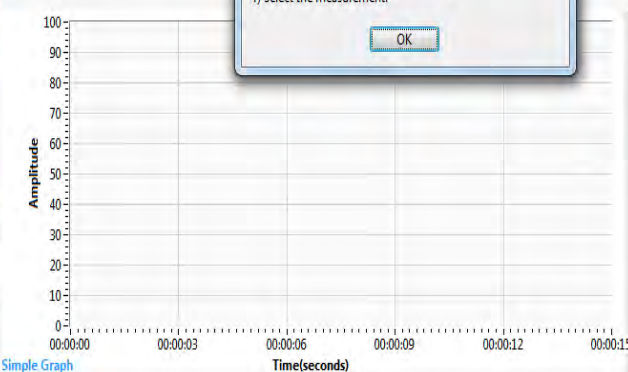
- ST-1(°C)
- ST-2(°C)
- ST-3(°C)
- ST-4(°C)
- ST-5(°C)
- SC-2(m3/h)
- SC-3(m3/h)

Reset Plot
Print Plot

Enlarge Plot
seconds

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Please, do the following checks before start running the unit:

- 1) Make sure the refrigeration water circuit is open.
- 2) Turn on the gas meter.
- 3) Wait while the gas meter is initializing.
- 4) Select the measurement.

OK

Zoom

### SENSORS

ANALOG SENSORS

ST-1	0,0	°C	SC-4	0,0	l/min
ST-2	0,0	°C	SP-1	0,00	bar
ST-3	0,0	°C			
ST-4	0,0	°C			
ST-5	0,0	°C			
SC-2	0,0	m3/h			
SC-3	0,0	m3/h			

### GAS ANALYZER


O2	0,0	%	LOSSES	0,0	%
CO2	0,0	%			
CO	0	ppm	LAMBDA	0,0	%

### DIGITAL SENSORS


INTERFACE ON?	AP-2	FAN	GAS VALVE
AP-1	AP-3	IGNITION	

### ACTUATORS

ACTUATORS A



Representation in real time of the measured magnitudes. Chart with visualization of the temperature measurements working with diesel.



Supervisory Control & Data Acquisition

CALIBRATE

START

STOP

VIEW DATA

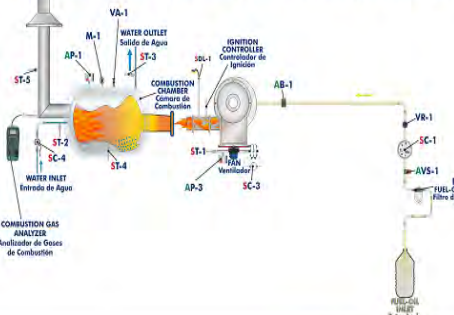
SAVE DATA

QUIT

### TVCC

#### COMPUTER CONTROLLED COMBUSTION LABORATORY UNIT

Equipo de Combustión de Laboratorio, Controlado desde Computador (PC)



### SENSORS

ANALOG SENSORS

ST-1	37,8	°C	SC-4	18,5	l/min
ST-2	33,3	°C			
ST-3	48,6	°C			
ST-4	435,0	°C			
ST-5	536,2	°C			
SC-1	10,3	kg/h			
SC-3	334,6	m3/h			

### SENSOR PLOT

SIGNAL VS TIME


Single Graph

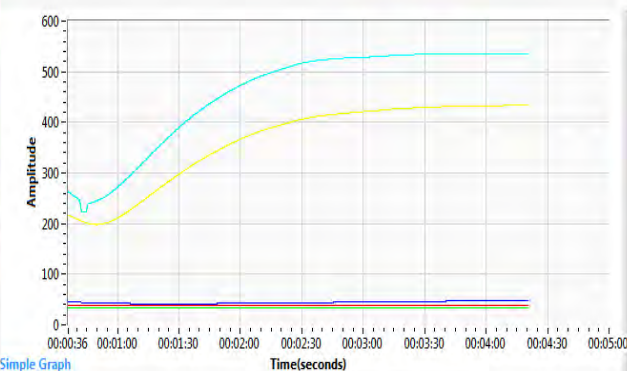
- ST-1(°C)
- ST-2(°C)
- ST-3(°C)
- ST-4(°C)
- ST-5(°C)
- SC-1(kg/h)
- SC-3(m3/h)

Reset Plot
Print Plot

Enlarge Plot
minutes

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Zoom

### GAS ANALYZER


O2	14,3	%	LOSSES	15,4	%
CO2	4,7	%			
CO	4500	ppm	LAMBDA	3	%

### DIGITAL SENSORS

INTERFACE ON?	AP-3	FAN	OIL VALVE
AP-1		IGNITION	PUMP

### ACTUATORS

ACTUATORS A



7

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Representation in real time of the measured magnitudes. Chart with visualization of the temperature measurements working with propane.

**edibon SCADA**  
Supervisory Control & Data Acquisition

CALIBRATE  
START  
STOP  
VIEW DATA  
SAVE DATA

Periodic (sec): 1 | 416,4 sec

Take Data | Taken Data

STOP SAVING

**TVCC**  
**COMPUTER CONTROLLED COMBUSTION LABORATORY UNIT**  
Equipo de Combustión de Laboratorio, Controlado desde Computador (PC)

Zoom

**SENSORS**  
ANALOG SENSORS

ST-1	36,8	°C	SC-4	18,5	l/min
ST-2	33,1	°C	SP-1	0,31	bar
ST-3	48,7	°C			
ST-4	428,4	°C			
ST-5	543,8	°C			
SC-2	4,7	m <sup>3</sup> /h			
SC-3	285,7	m <sup>3</sup> /h			

**GAS ANALYZER**

O <sub>2</sub>	14,1	%	LOSSES	10,4	%
CO <sub>2</sub>	4,2	%			
CO	2030	ppm	LAMBDA	3,1	%

**DIGITAL SENSORS**

INTERFACE ON:  AP-2:  FAN:  GAS VALVE:

AP-1:  AP-3:  IGNITION:

**ACTUATORS**  
ACTUATORS A

BURNER:

**SENSOR PLOT**

SIGNAL VS TIME

Single Graph

- ST-1(°C)
- ST-2(°C)
- ST-3(°C)
- ST-4(°C)
- ST-5(°C)
- SC-2(m<sup>3</sup>/h)
- SC-3(m<sup>3</sup>/h)

Reset Plot | Print Plot | Enlarge Plot | minutes

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LabVIEW

SIGNAL VS TIME

Amplitude

Time(seconds)

Simple Graph

Representation in real time of the measured magnitudes. Chart with visualization of the gas analyzer measurements working with diesel.

**edibon SCADA**  
Supervisory Control & Data Acquisition

CALIBRATE  
START  
STOP  
VIEW DATA  
SAVE DATA  
QUIT

**TVCC**  
**COMPUTER CONTROLLED COMBUSTION LABORATORY UNIT**  
Equipo de Combustión de Laboratorio, Controlado desde Computador (PC)

Zoom

**SENSORS**  
ANALOG SENSORS

ST-1	37,8	°C	SC-4	18,5	l/min
ST-2	33,3	°C			
ST-3	50,3	°C			
ST-4	442,0	°C			
ST-5	544,3	°C			
SC-1	10,3	kg/h			
SC-3	357,9	m <sup>3</sup> /h			

**GAS ANALYZER**

O <sub>2</sub>	14,2	%	LOSSES	16,2	%
CO <sub>2</sub>	4,8	%			
CO	4500	ppm	LAMBDA	3	%

**DIGITAL SENSORS**

INTERFACE ON:  FAN:  OIL VALVE:

AP-1:  AP-3:  IGNITION:  PUMP:

**ACTUATORS**  
ACTUATORS A

BURNER:

**SENSOR PLOT**

SIGNAL VS TIME

Single Graph

- SC-3(m<sup>3</sup>/h)
- SC-4(l/min)
- O<sub>2</sub>(%)
- CO<sub>2</sub>(%)
- CO(ppm)
- LOSSES(%)
- LAMBDA(%)

Reset Plot | Print Plot | Enlarge Plot | minutes

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LabVIEW

SIGNAL VS SIGNAL

Amplitude

Time(seconds)

Simple Graph



Representation in real time of the measured magnitudes. Chart with visualization of the gas analyzer measurements working with diesel.

**edibon SCADA**  
Supervisory Control & Data Acquisition

CALIBRATE  
START  
STOP  
VIEW DATA  
SAVE DATA

Periodic (sec)  
1      331 sec

Take Data      Taken Data

STOP RUNNING

**TVCC**  
**COMPUTER CONTROLLED COMBUSTION LABORATORY UNIT**  
Equipo de Combustión de Laboratorio, Controlado desde Computador (PC)

**SENSORS**  
ANALOG SENSORS

ST-1	36,5 °C	SC-4	18,5 l/min
ST-2	33,2 °C	SP-1	0,31 bar
ST-3	46,9 °C		
ST-4	419,2 °C		
ST-5	538,2 °C		
SC-2	4,7 m3/h		
SC-3	300,5 m3/h		

**SENSOR PLOT**

SIGNAL VS TIME      SIGNAL VS SIGNAL

Single Graph

- SC-4(l/min)
- SP-1(bar)
- O2(%)
- CO2(%)
- CO(ppm)
- LOSSES(%)
- LAMBDA(%)

Reset Plot      Print Plot  
Enlarge Plot      minutes

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LabVIEW

**GAS ANALYZER**

O2	14,2 %	LOSSES	8,5 %
CO2	4,2 %		
CO	2097 ppm	LAMBDA	3,1 %

**DIGITAL SENSORS**

INTERFACE ON?      AP-2      FAN      GAS VALVE  
AP-1      AP-3      IGNITION

**ACTUATORS**  
ACTUATORS A

BURNER

Signal versus signal chart where any of the measured variables can be represented.

**edibon SCADA**  
Supervisory Control & Data Acquisition

CALIBRATE  
START  
STOP  
VIEW DATA  
SAVE DATA  
QUIT

**TVCC**  
**COMPUTER CONTROLLED COMBUSTION LABORATORY UNIT**  
Equipo de Combustión de Laboratorio, Controlado desde Computador (PC)

**SENSORS**  
ANALOG SENSORS

ST-1	37,0 °C	SC-4	18,5 l/min
ST-2	32,9 °C		
ST-3	60,5 °C		
ST-4	645,5 °C		
ST-5	773,4 °C		
SC-1	10,3 kg/h		
SC-3	304,1 m3/h		

**SENSOR PLOT**

SIGNAL VS TIME      SIGNAL VS SIGNAL

Signal (y)  
LOSSES

Signal (x)  
SC-3

Acquire Point      Save Acquired Points

Reset Plot      Print Plot  
Enlarge Plot      minutes

edibon www.edibon.com  
LabVIEW

**GAS ANALYZER**

O2	3,7 %	LOSSES	7,6 %
CO2	12,8 %		
CO	52 ppm	LAMBDA	1 %

**DIGITAL SENSORS**

INTERFACE ON?      FAN      OIL VALVE  
AP-1      AP-3      IGNITION      PUMP

**ACTUATORS**  
ACTUATORS A

BURNER

## 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 **TVCC/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.

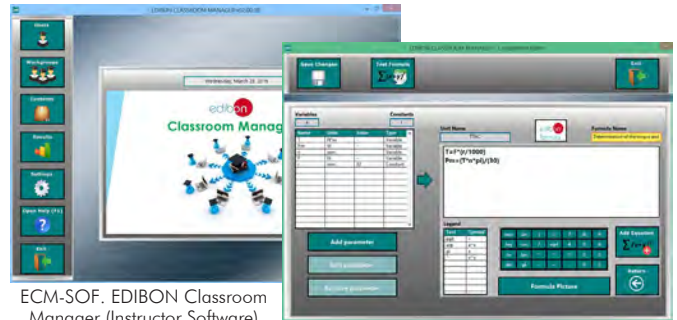
Innovative features:

- **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](http://www.edibon.com/en/files/expansion/ICAI/catalog)

### Instructor Software



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

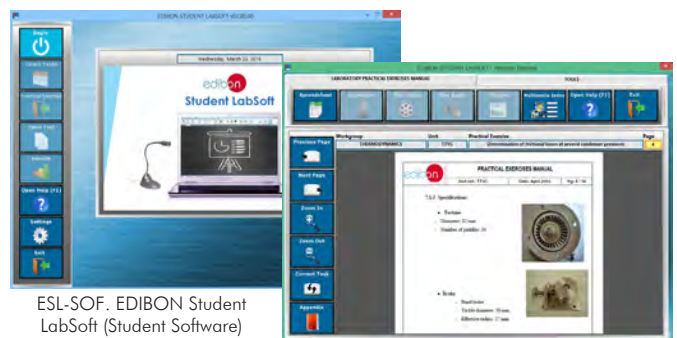
ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

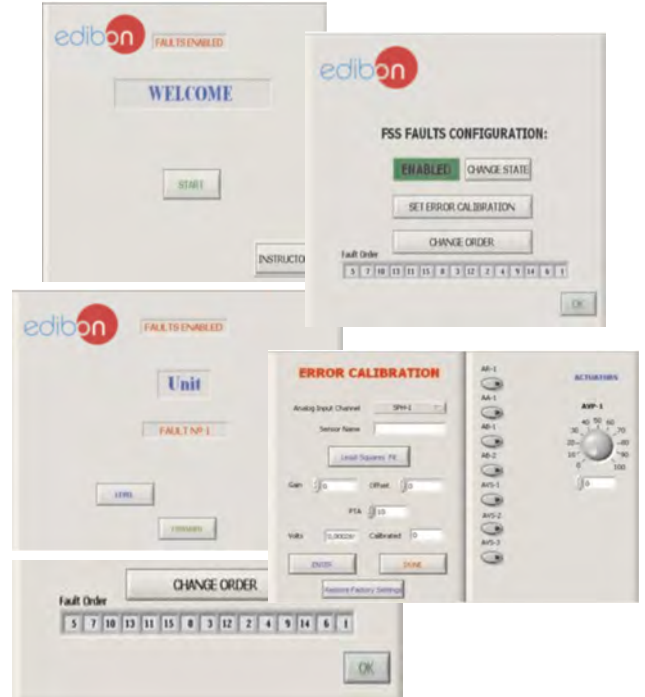
**⑧ TVCC/FSS. Faults Simulation System.**

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](http://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 integrated in a local network.

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

Main characteristics:

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

Main advantages:

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

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

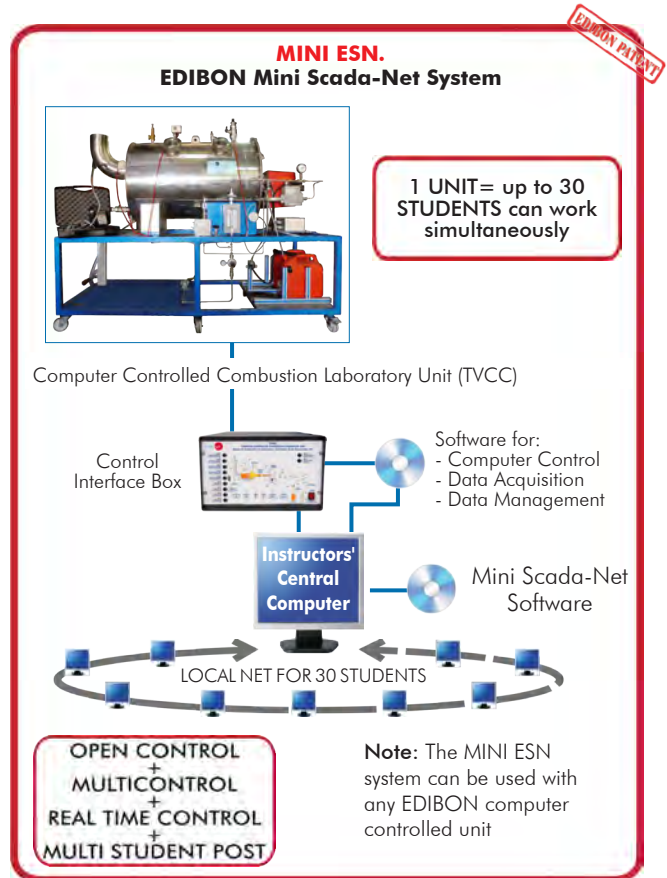
[www.edibon.com/en/files/expansion/MINI-ESN/catalog](http://www.edibon.com/en/files/expansion/MINI-ESN/catalog)

**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](http://www.edibon.com/en/files/expansion/ESN/catalog)



## ORDER INFORMATION

### **Main items** (always included in the supply)

Minimum supply always includes:

- ① **Unit: TVCC. Computer Controlled Combustion Laboratory Unit.**
- ② **TVCC/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **TVCC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
- ⑤ **Cables and Accessories**, for normal operation.
- ⑥ **Manuals.**

\***IMPORTANT:** Under TVCC 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 TVCC/ICAL. Interactive Computer Aided Instruction Software System.
- ⑧ TVCC/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.

**① TVCC. Unit:**

Anodized aluminum frame and panels made of painted steel.  
 The unit includes wheels to facilitate its mobility.  
 Main metallic elements made of stainless steel.  
 Diagram in the front panel with distribution of the elements similar to the real one.  
 Stainless steel combustion chamber (700 mm x 1100 mm) with five pieces of 100 mm diameter for the observation points.  
 Cooling jacket with thermometer, manometer and pressure switch to avoid overpressure in the jacket.  
 Dual burner of 150 kW to work both with natural gas (or other LPG) and fuel oil.  
 Fan integrated in the burner with a regulating lever for the air flow.  
 The natural gas line includes:  
 Manual valve.  
 Gas filter.  
 Pressure sensor, range: 0 - 1 bar.  
 Pressure regulator, range: 0 - 3 bar.  
 Manometer, range: 0 - 400 mbar.  
 Electronic solenoid valve and safety pressure switch.  
 Flow sensor, range: 3 - 21 m<sup>3</sup>/h.  
 Needle valve to regulate the gas inlet flow.  
 The fuel oil line includes:  
 Manual valve.  
 Electronic solenoid valve.  
 Flow sensor, range: 4 - 38 kg/h.  
 Needle valve to regulate the liquid fuel inlet flow.  
 Two Storage and supply tanks for the fuel oil.  
 Suction pump of the fuel into the burner.  
 Air ventilation, safety and drain valves.  
 Five temperature sensors: combustion chamber, cooling water inlet and outlet, combustion fumes outlet and air inlet to the burner.  
 Four Flow sensors: natural gas inlet, fuel oil inlet, cooling water flow inlet (range: 1.5 - 30 l/min) and air inlet (by means of a differential pressure sensor, range: 0 - 1 PSI).  
 A pressure sensor: natural gas inlet, range: 0 - 1 bar.  
 Combustion gases analyzer: measurement of the content in O<sub>2</sub>, CO and CO<sub>2</sub>, efficiency of the combustion, air excess and CO/CO<sub>2</sub> ratio.  
 Two solenoid valves, one for each working flow: gas or fuel oil.  
 Flame detection sensor and ignition controller.  
 Safety measures. The feeding to the burner is cut off when:  
 The outlet water temperature exceeds 80°C.  
 The pressure of the cooling jacket exceeds 1 bar.  
 A water flow higher than 5 l/min is not detected.  
 The complete unit includes as well:  
 Advanced Real-Time SCADA.  
 Open Control + Multicontrol + Real-Time Control.  
 Specialized EDIBON Control Software based on LabVIEW.  
 National Instruments Data Acquisition board (250 KS/s, kilo samples per second).  
 Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.  
 Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.  
 Capable of doing applied research, real industrial simulation, training courses, etc.  
 Remote operation and control by the user and remote control for EDIBON technical support, are always included.  
 Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).  
 Designed and manufactured under several quality standards.  
 Optional 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.

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

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

**③ DAB. Data Acquisition Board:**

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

**④ TVCC/CSOF. Computer Control +Data Acquisition+Data Management Software:**

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

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

**⑥ Manuals:**

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

### Exercises and Practical Possibilities to be done with the Main Items

- 1.- Study of the combustion process and the burner operation.
  - 2.- Familiarisation of the adjustment and operation of an oil or gas burner.
  - 3.- Effect of the air/fuel ratio both in the efficiency of the combustion and in the measuring of the combustion gases components and in the temperature.
  - 4.- Effect of the air/fuel ratio on energy balance.
  - 5.- Effect of the air/fuel ratio on heat transfer.
  - 6.- Effect of the flame radiation on heat transfer and observed temperature.
  - 7.- Comparison of flue gas analysis with theoretical predictions.
  - 8.- Comparison of the performance of different fuels.
  - 9.- Assessment of a burner, including:
    - Flame stability.
    - Flame shape.
    - Flame radiation.
    - Firing rate.
    - Turndown range.
    - Smoke emission.
  - 10.- Comparison between a gas burner and a gas oil burner.
- Additional practical possibilities:
- 11.- Sensors calibration.
- Other possibilities to be done with this Unit:
- 12.- Many students view results simultaneously.
    - To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
  - 13.- 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.
  - 14.- The Computer Control System with SCADA allows a real industrial simulation.
  - 15.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
  - 16.- This unit can be used for doing applied research.
  - 17.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
  - 18.- Control of the TVCC unit process through the control interface box without the computer.
  - 19.- Visualization of all the sensors values used in the TVCC unit process.
- Several other exercises can be done and designed by the user.

### a) Technical and Vocational Education configuration

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

Main advantages:

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

The system basically will consist of:

This system is used with a Computer Controlled Unit.

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

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



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