



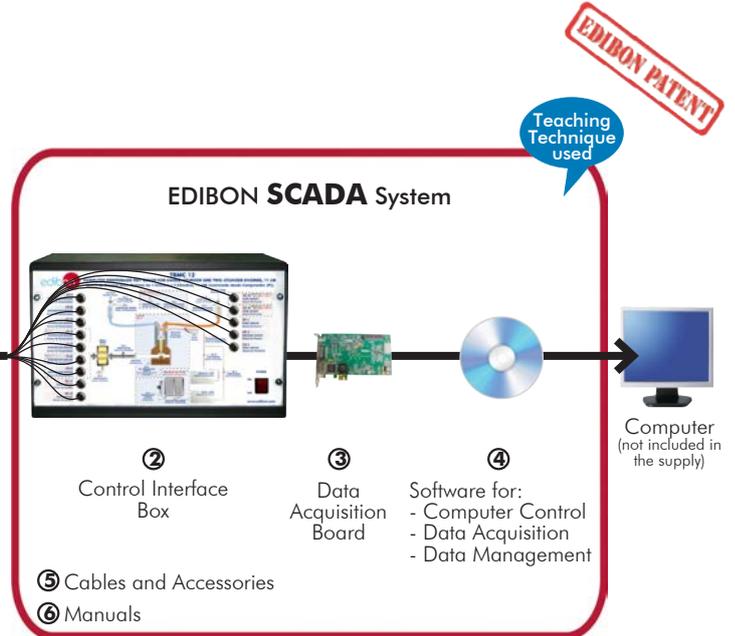
Engineering and Technical Teaching Equipment

# Computer Controlled Test Bench for Single-Cylinder and Two-Cylinders Engines, 11 kW, with SCADA

## TBMC12



① Unit: TBMC12. Computer Controlled Test Bench for Single-Cylinder and Two-Cylinders Engines, 11 kW



\* 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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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

An internal combustion engine is a machine that transforms, after a combustion process, the chemical energy of a fuel-air mix into mechanical energy. In the combustion, the energy contained in the fuel is released by its ignition and later oxidation into the engine.

The importance of this type of engine is due to a series of advantages facing other types of propellers:

- Operation autonomy, due to the high calorific power of the fuels.
- Wide range of powers.
- Great quantity of constructive possibilities.

The engines test bench is a machine to which the internal combustion engine is coupled and, from this set up, we can understand its operation and obtain its features.

There are different standards relevant to the tests execution procedure and to the calculations to obtain different characteristics. The main objective of the engine test is obtaining its characteristic curves, where the torque and power versus the revolutions are measured.

## GENERAL DESCRIPTION

The Computer Controlled Test Bench for Single-Cylinder and Two-Cylinders Engines, 11 kW, "TBM12", designed by EDIBON, is a teaching unit to test internal combustion engines of up to 11 kW.

The element of the unit that offers load torque is an eddy current electromagnetic brake. It is supplied by a variator that allows to control the supply voltage and to vary its torque characteristics. The brake is jointly coupled to the shaft of the combustion engine by a double Cardan joint that transfers torque and power.

The unit also includes:

**Instrumentation:** there are several sensors that provide us measurements of the variables under study.

**Start system:** the engine includes its own electric starter motor that facilitates its operation.

**Fuel supply system:** it carries the required fuel to the internal combustion engine.

**Cooling system:** it carries out the cooling required for the correct operation of the engine. A forced water current removes the heat generated in the engine and transfers it to the atmosphere with a radiator.

**Air intake system:** it allows the intake of fresh air in the engine. It contains the oxygen required to generate the combustion.

**System to remove the exhaust gases:** it removes from the engine the substances generated during the combustion and reduces the noise inherent to the gases flow.

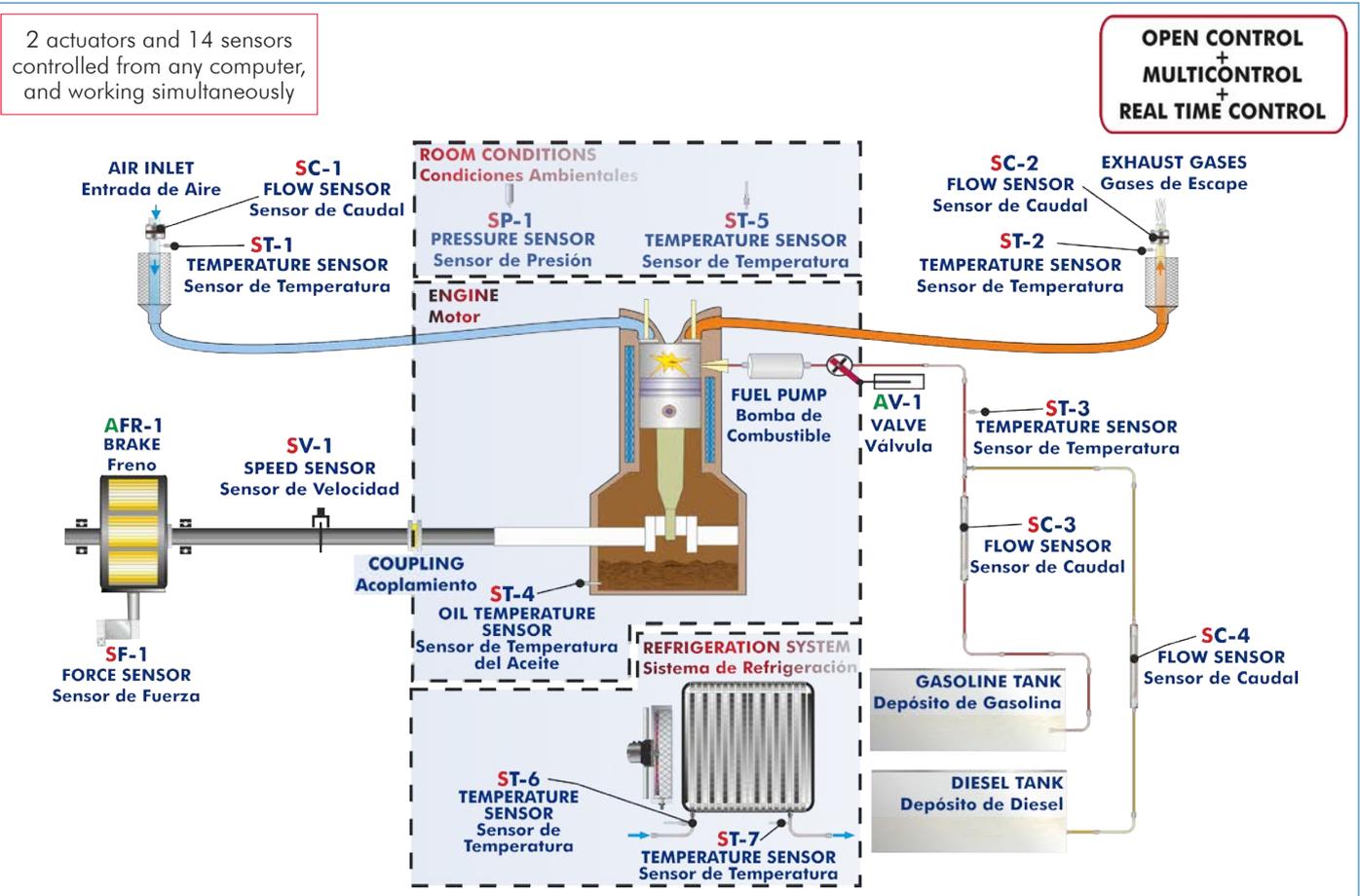
The engine test bench "TBM12" allows to study combustion engines, obtaining their characteristic curves by setting the accelerator of the engine to a specific position and varying the braking torque. Thus, different points of the torque or power versus velocity characteristic curve are obtained. Such curve will be at full load if the accelerator is at its maximum position.

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.



TBMC12 detail

## PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



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 TBM C12. Unit:**

**Test bench for four cylinders and four-stroke combustion engines up to 11 kW, with wheels to facilitate its mobility:**

- Frame and panels made of painted steel.
- Main metallic elements made of stainless steel.
- Mounting base with vibration dampening device to instal the testing engine.
- Diagram in the front panel with distribution of the elements similar to the real one.
- Transparent panels that allow to visualize the operation of the unit.
- Computer controlled electric eddy current brake to generate the load:
  - Maximum power: 11 kW.
- Transmission between the combustion engine and the brake through a double Cardan joint.
- Acceleration of the combustion engine through the computer controlled fuel valve (acceleration/deceleration).
- 5 l capacity fuel tank: either for petrol or for diesel-oil (depending on the purchased test engine).

**Inlet Air Circuit:**

- Air filter.
- Easy and quick connection hose of  $D_{ext}$ : 40 m.

**Exhaust Gases Circuit:**

- Easy and quick connection hose of  $D_{ext}$ : 40 m.

**Instrumentation:**

- Speed sensor to measure the speed (rpm) of the engine, range: 0 – 6000 rpm.
- Force sensor to measure the braking torque, range: 0 – 350 N·m.
- Six "J" type temperature sensors at different points of the process:
  - Inlet air temperature.
  - Exhaust gases temperature.
  - Fuel temperature.
  - Engine oil temperature.
  - Cooling system inlet and outlet water temperature.
- Flow sensor to measure the fuel consumption, (depending on the purchased test engine):
  - Petrol, range: 20 – 160 ml/min.
  - Diesel-oil, range: 5 – 45 ml/min.
- Two flow sensors to measure:
  - Inlet air flow to the combustion engine, range: 0 – 600 m<sup>3</sup>/h.
  - Exhaust gases outlet flow, range: 0 – 600 m<sup>3</sup>/h.
- To obtain the correct power of an engine it is necessary to measure ambient conditions with:
  - "J" type temperature sensor.
  - Pressure sensor, range: 0 – 1 Bar.

**The unit includes all the safety measures required for a safe operation:**

- Temperature limit.
- Limit switch to control if the brake and the engine are correctly connected.
- Limit switch to control if any of the protection panels is open.
- Safety pushbuttons.
- Safety individual hearing protectors to be used during the practical exercises are included.

**The Data Acquisition and Control Software of the "TBM C12" unit allows:**

- The calculation of representative magnitudes: power of the combustion engine and specific consumption of fuel.
- The representation of the characteristic curves of the combustion engines: torque, power or specific consumption versus velocity of the combustion engine.
- The representation of the measured and calculated magnitudes curves, in signal versus signal charts. Free configuration of the axes of these charts.
- The representation in real time of all the measured and calculated magnitudes.
- The recording of the test measurements versus time and generation of a file compatible with spreadsheet applications.



Unit: TBM C12

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.**

**Required elements.** The complete test bench requires to work with at least one of the combustion engines:

- TM12-01. **Water-cooled single-cylinder engine, with variable compression.**

<b>TM12-01.</b> <b>Water-cooled single-cylinder engine, with variable compression</b>
<b>Type of engine:</b> Spark ignition/Compression ignition.
<b>Fuel:</b> Petrol/Diesel oil.
<b>No. of cylinders:</b> 1.
<b>No. of strokes:</b> 4.
<b>Type of air intake:</b> Naturally aspirated.
<b>Type of cooling:</b> Water.
<b>Start:</b> Electric.
<b>Compression ratio:</b> Variable.
<b>Maximum torque:</b> ~30 N·m.
<b>Maximum power:</b> 5.8 kW/1800 rpm CR=18:1. 5.7 kW/1860 rpm CR=8:1.
<b>Cylinder bore:</b> 87.5 mm.
<b>Stroke:</b> 110 mm.



**Recommended elements:**

- **TM12-01SP.** Engine indicator to measure combustion chamber pressure of a water-cooled single-cylinder engine, with variable compression (only to be used with the TM12-01).
- **TM12-01ESTR.** Stroboscopic Lamp for a water-cooled single-cylinder engine, with variable compression (only to be used with the TM12-01).

- TM12-02. Air cooled two-cylinders petrol engine.

TM12-02. Air cooled two-cylinders petrol engine
<b>Type of engine:</b> Spark ignition.
<b>Fuel:</b> Petrol.
<b>No. of cylinders:</b> 2.
<b>No. of strokes:</b> 4.
<b>Type of air intake:</b> Naturally aspirated.
<b>Type of cooling:</b> Air.
<b>Start:</b> Electric.
<b>Compression ratio:</b> 8.5:1.
<b>Maximum torque:</b> 49.9 N·m/2400 rpm.
<b>Maximum power:</b> 16.8 kW/3600 rpm.
<b>Cylinder bore:</b> 80 mm.
<b>Stroke:</b> 67 mm.



Recommended elements:

- TM12-02SP. Engine indicator to measure combustion chamber pressure of an air-cooled two- cylinders petrol engine (only to be used with the TM12-02).
- TM12-02ESTR. Stroboscopic Lamp for an air-cooled two-cylinders petrol engine (only to be used with the TM12-02).

- TM12-03. Air cooled two-cylinders diesel engine.

TM12-03. Air cooled two-cylinders diesel engine
<b>Type of engine:</b> Compression ignition.
<b>Fuel:</b> Diesel oil.
<b>No. of cylinders:</b> 2.
<b>No. of strokes:</b> 4.
<b>Type of air intake:</b> Naturally aspirated.
<b>Type of cooling:</b> Air.
<b>Start:</b> Electric.
<b>Compression ratio:</b> 19:1.
<b>Maximum torque:</b> 42 N·m.
<b>Maximum power:</b> 14 kW.
<b>Cylinder bore:</b> 85 mm.
<b>Stroke:</b> 75 mm.



Recommended elements:

- TM12-03SP. Engine indicator to measure combustion chamber pressure of an air-cooled two- cylinders diesel engine (only to be used with the TM12-03).

**Recommended elements.** The complete test bench has the following recommended elements:

- TBMC-CG. **Computer Controlled Exhaust Gas Calorimeter.**
- TBMC-AGE. **Exhaust Gas Analyzer.**

**② TBMC12/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.



TBMC12/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 TBMC12/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).

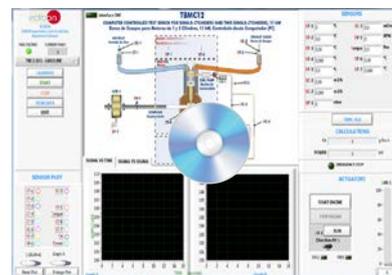
Calibration system for the sensors involved in the process.

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.



TBMC12/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: TBMC12 + TBMC12/CIB + DAB + TBMC12/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

- |  |  |
|--|--|
| <p>1.- Determination of the characteristic curves of an internal combustion engine at different speed regimes:</p> <ul style="list-style-type: none"> <li>Torque.</li> <li>Power.</li> <li>Specific consumption of fuel.</li> </ul> <p>2.- Determination of the efficiency, fuel specific consumption and air-fuel ratio of an internal combustion engine.</p> <p>3.- Determination of the volumetric efficiency and the average effective pressure of an internal combustion engine.</p> <p>Additional practical possibilities:</p> <p>4.- Familiarization with four strokes petrol and diesel engines.</p> <p>5.- Comparison of the characteristics of diesel oil and petrol engines.</p> <p>6.- Study of cooling in alternative internal combustion engines.</p> <p>7.- Pressure measurement in the combustion chamber of an engine (it requires the accessory TM12-01SP or TM12-02SP or TM12-03SP).</p> <p>8.- Graphical representation of the combustion chamber pressure versus time and versus the position of the crankshaft (it requires the accessory TM12-01SP or TM12-02SP or TM12-03SP).</p> <p>9.- Familiarization with the concept of supercharging for engines supercharged by a set of turbo and intercooler (it requires the TM12-02 engine).</p> <p>10.- Analysis of an internal combustion engine exhaust gases (it requires the TBMC-AGE accessory). Recommended for petrol engines.</p> <p>11.- Calculation of the heat contained in the exhaust gases of an internal combustion engine (it requires the TBMC-CG accessory).</p> | <p>12.- Study of the ignition of a petrol combustion engine (it requires the accessory TM12-01ESTR or TM12-02ESTR).</p> <p>13.- Sensors calibration.</p> <p>Other possibilities to be done with this Unit:</p> <p>14.- Many students view results simultaneously.</p> <p style="padding-left: 20px;">To view all results in real time in the classroom by means of a projector or an electronic whiteboard.</p> <p>15.- Open Control, Multicontrol and Real Time Control.</p> <p style="padding-left: 20px;">This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.</p> <p>16.- The Computer Control System with SCADA allows a real industrial simulation.</p> <p>17.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.</p> <p>18.- This unit can be used for doing applied research.</p> <p>19.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.</p> <p>20.- Control of the TBMC12 unit process through the control interface box without the computer.</p> <p>21.- Visualization of all the sensors values used in the TBMC12 unit process.</p> <p>- Several other exercises can be done and designed by the user.</p> |
|--|--|

### REQUIRED SERVICES

- Electrical supply: three-phase, 380 V/50 Hz or 220 V/60 Hz.
- Water supply.
- The unit must be operated in a ventilated space with fume extraction system.
- Computer.

### REQUIRED CONSUMABLES (Not included)

- Unleaded petrol or diesel-oil, depending on the engine.
- High quality oil (10W40 for Diesel-oil engine and 5W30 for petrol engine).

### DIMENSIONS AND WEIGHTS

- TBMC12:
- Unit:
- Dimensions: 1100 x 900 x 1700 mm approx.  
(43.30 x 35.43 x 66.92 inches approx.)
  - Weight: 260 Kg approx.  
(573.20 pounds approx.)
- Control-Interface Box:
- Dimensions: 490 x 330 x 310 mm approx.  
(19.29 x 12.99 x 12.2 inches approx.)
  - Weight: 10 Kg approx.  
(22 pounds approx.)

## REQUIRED AND RECOMMENDED ELEMENTS

**Required elements.** The complete test bench requires to work with at least one of the combustion engines:

- TM12-01. **Water-cooled single-cylinder engine, with variable compression.**

Recommended elements:

- TM12-01SP. Engine indicator to measure combustion chamber pressure of a water-cooled single-cylinder engine, with variable compression (only to be used with the TM12-01).
- TM12-01ESTR. Stroboscopic Lamp for a water-cooled single-cylinder engine, with variable compression (only to be used with the TM12-01).

- TM12-02. **Air cooled two-cylinders petrol engine.**

Recommended elements:

- TM12-02SP. Engine indicator to measure combustion chamber pressure of an air-cooled two- cylinders petrol engine (only to be used with the TM12-02).
- TM12-02ESTR. Stroboscopic Lamp for an air-cooled two-cylinders petrol engine (only to be used with the TM12-02).

- TM12-03. **Air cooled two-cylinders diesel engine.**

Recommended elements:

- TM12-03SP. Engine indicator to measure combustion chamber pressure of an air-cooled two- cylinders diesel engine (only to be used with the TM12-03).

**Recommended elements.** The complete test bench has the following recommended elements:

- TBMC-CG. **Computer Controlled Exhaust Gas Calorimeter.**
- TBMC-AGE. **Exhaust Gas Analyzer.**

## AVAILABLE VERSIONS

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Offered in this catalog:

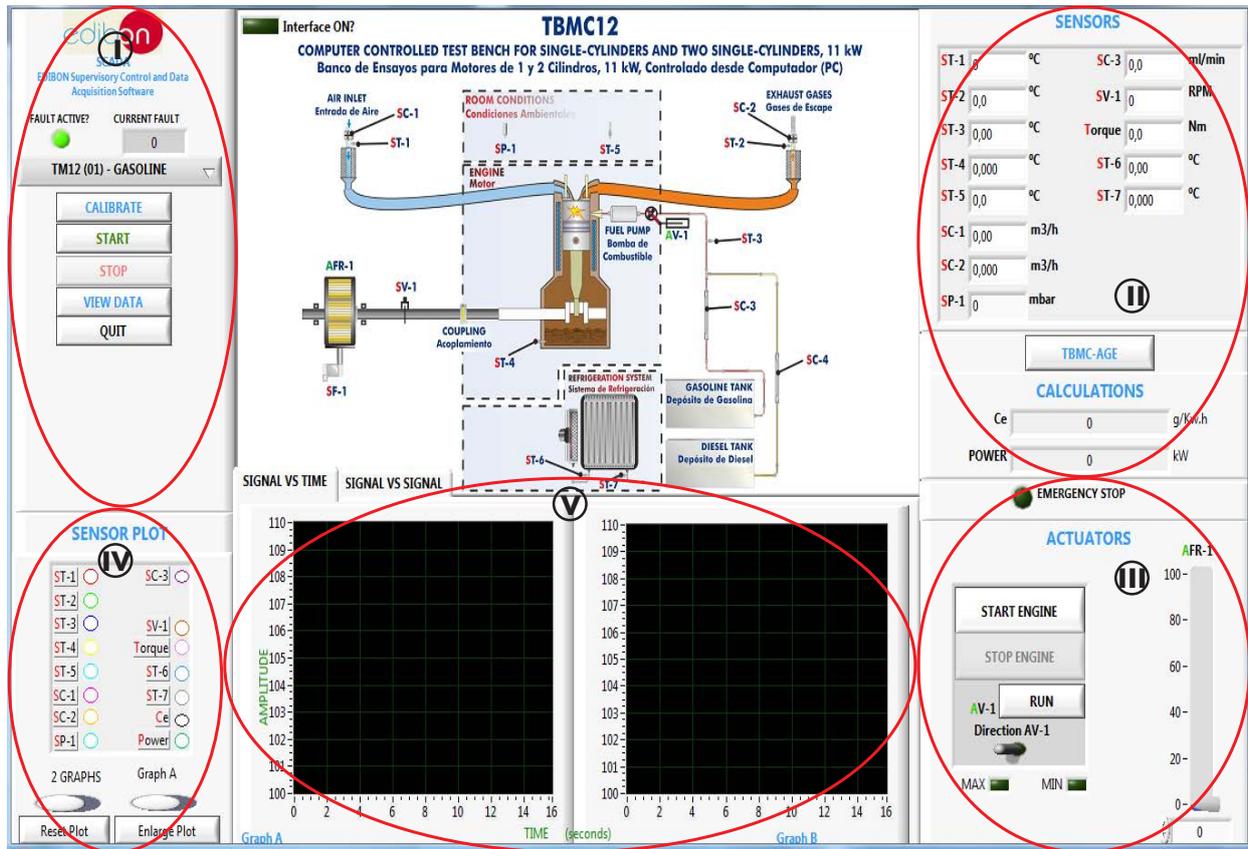
- TBMC12. Computer Controlled Test Bench for Single-Cylinder and Two-Cylinders Engines, 11 kW.

Offered in other catalogs:

- TBMC3. Computer Controlled Test Bench for Single-Cylinder Engines, 2.2 kW.
- TBMC8. Computer Controlled Test Bench for Single-Cylinder Engines, 7.5 kW.
- TBMC75. Computer Controlled Test Bench for Four-Cylinders Engines, 75 kW.

## SOFTWARE MAIN SCREENS

### SCADA Main screen



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. SV=Speed sensor. SF=Force sensor. Torque measurement. Power measurement.

❸ Actuators controls. Actuators: AV=Fuel valve. AFR=Brake.

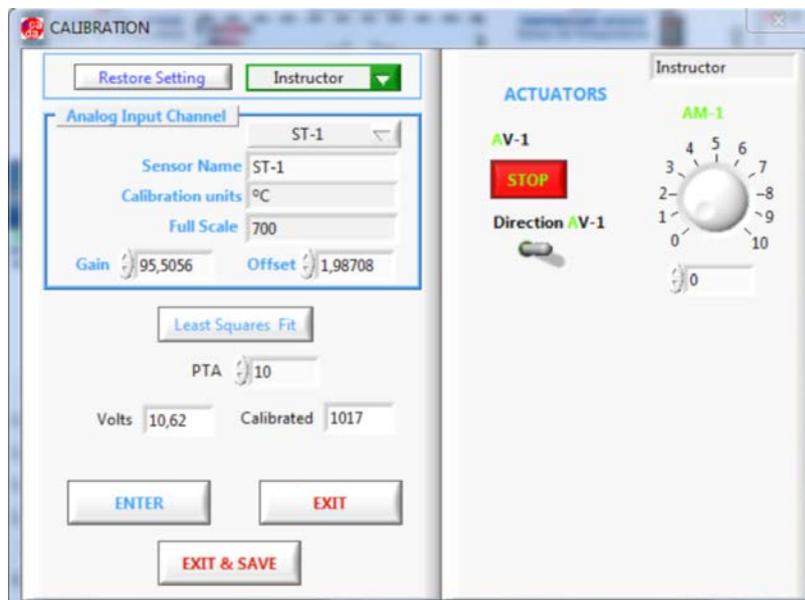
❹ Channel selection and other plot parameters.

❺ Real time graphics displays.

\*It also includes direct access to the TBMC-AGE Exhaust Gas Analyzer unit software.

### Software for Sensors Calibration

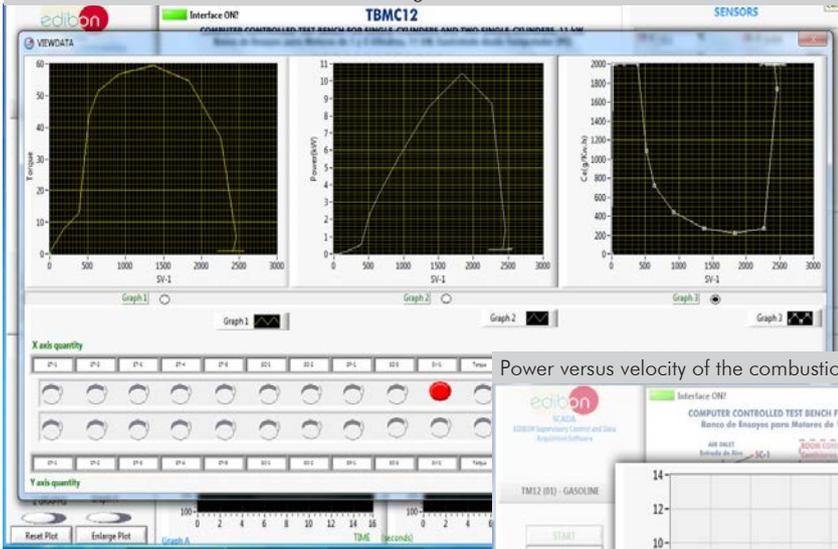
Example of screen



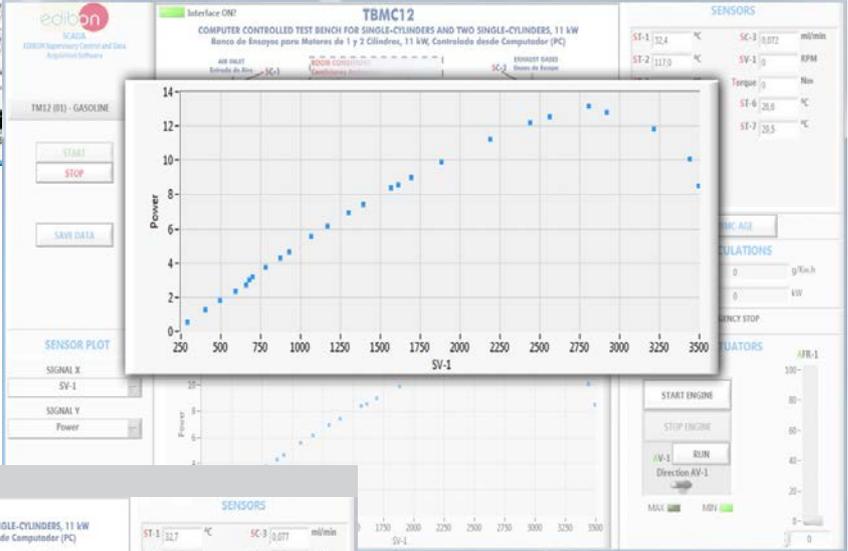
The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

## SOME REAL RESULTS OBTAINED FROM THIS UNIT

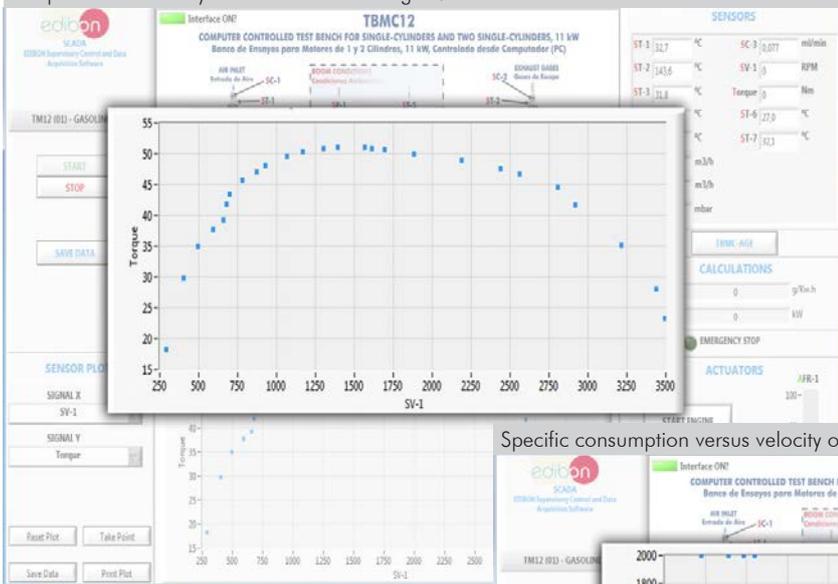
The data acquisition and control software of the "TBM12" unit allows the representation of the characteristic curves of the combustion engine.



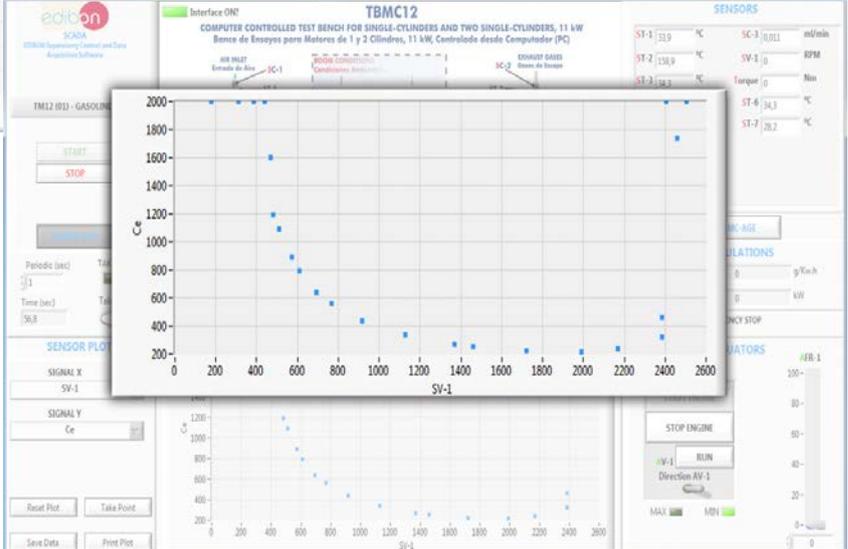
Power versus velocity of the combustion engine.



Torque versus velocity of the combustion engine.



Specific consumption versus velocity of the combustion engine.



## 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) **TBMC12/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:

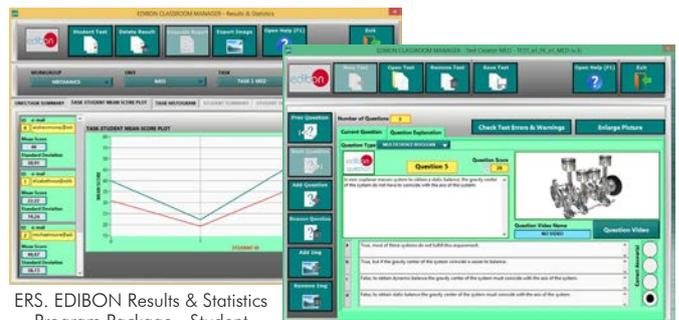
[www.edibon.com/en/files/expansion/ICAI/catalog](http://www.edibon.com/en/files/expansion/ICAI/catalog)

### Instructor Software



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

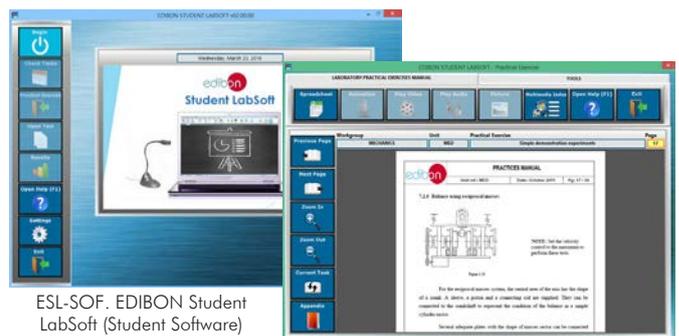
ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

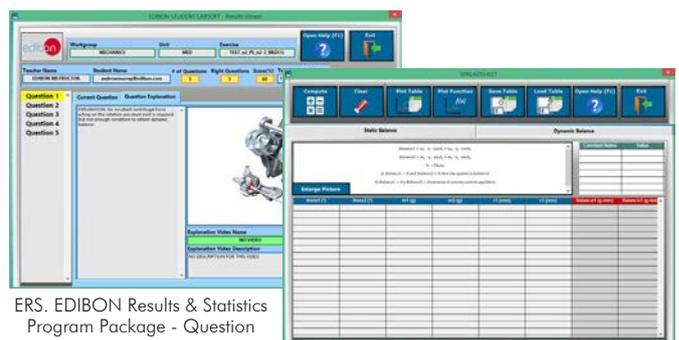
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

### 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

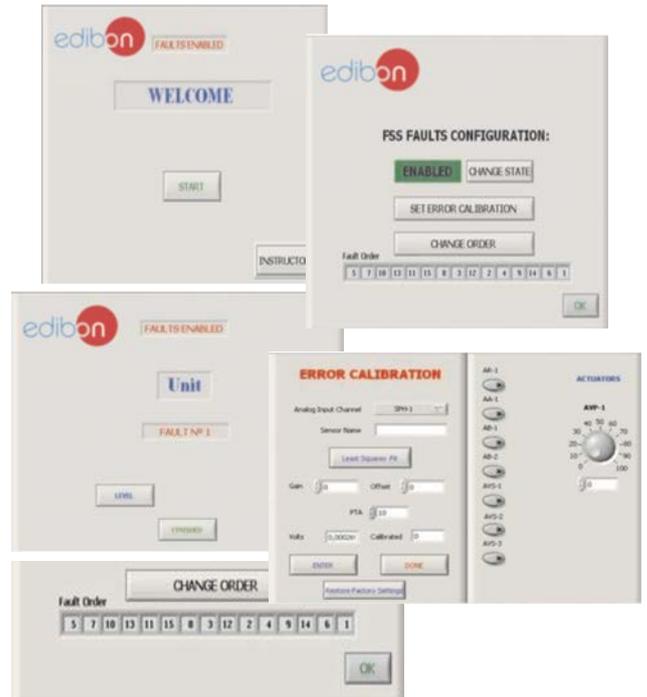
**⑧ TBMCI2/FSS. Faults Simulation System.**

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:

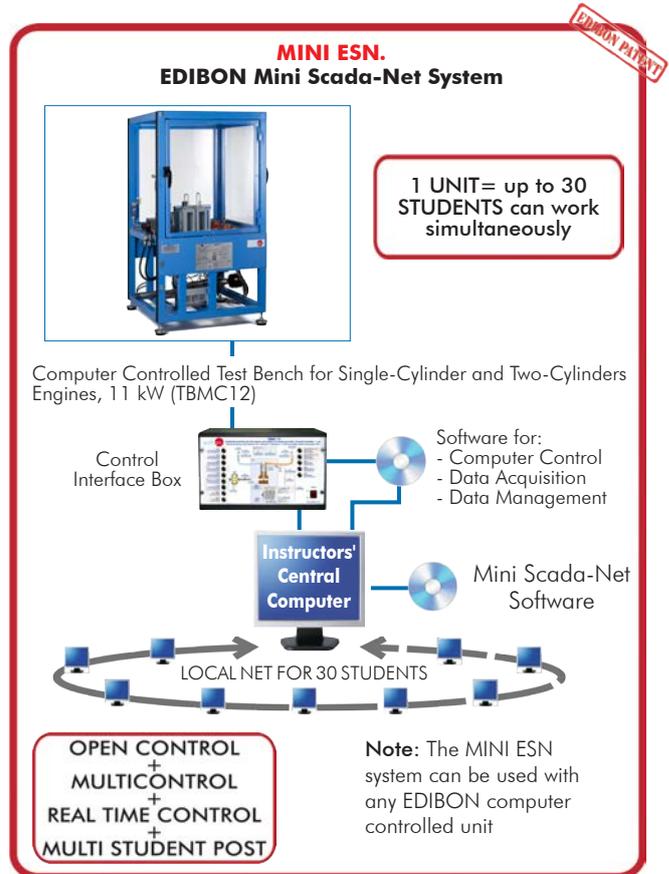
[www.edibon.com/en/files/expansion/MINI-ESN/catalog](http://www.edibon.com/en/files/expansion/MINI-ESN/catalog)

**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: TBMC12. Computer Controlled Test Bench for Single-Cylinder and Two-Cylinders Engines, 11 kW.**
- ② **TBMC12/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **TBMC12/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
- ⑤ **Cables and Accessories**, for normal operation.
- ⑥ **Manuals.**

\***IMPORTANT:** Under TBMC12 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 TBMC12/ICAL. Interactive Computer Aided Instruction Software System.
- ⑧ TBMC12/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 **TBMC12. Unit:**

**Test bench for four cylinders and four-stroke combustion engines up to 11 kW, with wheels to facilitate its mobility:**

- Frame and panels made of painted steel.
- Main metallic elements made of stainless steel.
- Mounting base with vibration dampening device to instal the testing engine.
- Diagram in the front panel with distribution of the elements similar to the real one.
- Transparent panels that allow to visualize the operation of the unit.
- Computer controlled electric eddy current brake to generate the load:
  - Maximum power: 11 kW.
- Transmission between the combustion engine and the brake through a double Cardan joint.
- Acceleration of the combustion engine through the computer controlled fuel valve (acceleration/deceleration).
- 5 l capacity fuel tank: either for petrol or for diesel-oil (depending on the purchased test engine).

**Inlet Air Circuit:**

- Air filter.
- Easy and quick connection hose of  $D_{ext}$ : 40 m.

**Exhaust Gases Circuit:**

- Easy and quick connection hose of  $D_{ext}$ : 40 m.

**Instrumentation:**

- Speed sensor to measure the speed (rpm) of the engine, range: 0 – 6000 rpm.
- Force sensor to measure the braking torque, range: 0 – 350 N·m.
- Six "J" type temperature sensors at different points of the process:
  - Inlet air temperature.
  - Exhaust gases temperature.
  - Fuel temperature.
  - Engine oil temperature.
  - Cooling system inlet and outlet water temperature.
- Flow sensor to measure the fuel consumption, (depending on the purchased test engine):
  - Petrol, range: 20 – 160 ml/min.
  - Diesel-oil, range: 5 – 45 ml/min.
- Two flow sensors to measure:
  - Inlet air flow to the combustion engine, range: 0 – 600 m<sup>3</sup>/h.
  - Exhaust gases outlet flow, range: 0 – 600 m<sup>3</sup>/h.
- To obtain the correct power of an engine it is necessary to measure ambient conditions with:
  - "J" type temperature sensor.
  - Pressure sensor, range: 0 – 1 Bar.

**The unit includes all the safety measures required for a safe operation:**

- Temperature limit.
- Limit switch to control if the brake and the engine are correctly connected.
- Limit switch to control if any of the protection panels is open.
- Safety pushbuttons.
- Safety individual hearing protectors to be used during the practical exercises are included.

**The Data Acquisition and Control Software of the "TBMC12" unit allows:**

- The calculation of representative magnitudes: power of the combustion engine and specific consumption of fuel.
- The representation of the characteristic curves of the combustion engines: torque, power or specific consumption versus velocity of the combustion engine.
- The representation of the measured and calculated magnitudes curves, in signal versus signal charts. Free configuration of the axes of these charts.
- The representation in real time of all the measured and calculated magnitudes.
- The recording of the test measurements versus time and generation of a file compatible with spreadsheet applications.

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.

**Required elements.** The complete test bench requires to work with at least one of the combustion engines:

- TM12-01. **Water-cooled single-cylinder engine, with variable compression.**

**Recommended elements:**

- TM12-01SP. Engine indicator to measure combustion chamber pressure of a water-cooled single-cylinder engine, with variable compression (only to be used with the TM12-01).
- TM12-01ESTR. Stroboscopic Lamp for a water-cooled single-cylinder engine, with variable compression (only to be used with the TM12-01).

- TM12-02. **Air cooled two-cylinders petrol engine.**

**Recommended elements:**

- TM12-02SP. Engine indicator to measure combustion chamber pressure of an air-cooled two- cylinders petrol engine (only to be used with the TM12-02).
- TM12-02ESTR. Stroboscopic Lamp for an air-cooled two-cylinders petrol engine (only to be used with the TM12-02).

- TM12-03. **Air cooled two-cylinders diesel engine.**

**Recommended elements:**

- TM12-03SP. Engine indicator to measure combustion chamber pressure of an air-cooled two- cylinders diesel engine (only to be used with the TM12-03).

**Recommended elements.** The complete test bench has the following recommended elements:

- TBMC-CG. **Computer Controlled Exhaust Gas Calorimeter.**
- TBMC-AGE. **Exhaust Gas Analyzer.**

**②TBMC12/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.

**④TBMC12/CCSOF. Computer Control +Data Acquisition+Data Management Software:**

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

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

**⑥ Manuals:**

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

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

- 1.- Determination of the characteristic curves of an internal combustion engine at different speed regimes:
    - Torque.
    - Power.
    - Specific consumption of fuel.
  - 2.- Determination of the efficiency, fuel specific consumption and air-fuel ratio of an internal combustion engine.
  - 3.- Determination of the volumetric efficiency and the average effective pressure of an internal combustion engine.
- Additional practical possibilities:
- 4.- Familiarization with four strokes petrol and diesel engines.
  - 5.- Comparison of the characteristics of diesel oil and petrol engines.
  - 6.- Study of cooling in alternative internal combustion engines.
  - 7.- Pressure measurement in the combustion chamber of an engine (it requires the accessory TM12-01SP or TM12-02SP or TM12-03SP).
  - 8.- Graphical representation of the combustion chamber pressure versus time and versus the position of the crankshaft (it requires the accessory TM12-01SP or TM12-02SP or TM12-03SP).
  - 9.- Familiarization with the concept of supercharging for engines supercharged by a set of turbo and intercooler (it requires the TM12-02 engine).
  - 10.-Analysis of an internal combustion engine exhaust gases (it requires the TBMC-AGE accessory). Recommended for petrol engines.
  - 11.-Calculation of the heat contained in the exhaust gases of an internal combustion engine (it requires the TBMC-CG accessory).
  - 12.-Study of the ignition of a petrol combustion engine (it requires the accessory TM12-01ESTR or TM12-02ESTR).
  - 13.-Sensors calibration.
- Other possibilities to be done with this Unit:
- 14.-Many students view results simultaneously.
    - To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
  - 15.-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.
  - 16.-The Computer Control System with SCADA allows a real industrial simulation.
  - 17.-This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
  - 18.-This unit can be used for doing applied research.
  - 19.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
  - 20.-Control of the TBMC12 unit process through the control interface box without the computer.
  - 21.-Visualization of all the sensors values used in the TBMC12 unit process.
- Several other exercises can be done and designed by the user.

### a) Technical and Vocational Education configuration

#### ⑦ **TBMC12/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 **TBMC12/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

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

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

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

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

Main characteristics:

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

Main advantages:

- It allows an easier 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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