

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

① Unit: TBMC8. Computer Controlled Test Bench for 7.5 kW Engines.

### 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  
↳ 7.- MECHANICS  
AND  
9.- THERMODYNAMICS  
& THERMOTECHNICS

For more information about key features, click here



Certificate of Approval of the  
Quality Management System



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to current UL and CSA regulations)



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## 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 7.5 kW Engines, "TBM8", designed by EDIBON, is a teaching unit to test internal combustion engines of up to 7.5 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. In case of air-cooling, the refrigeration is obtained by the passing of ambient air through the fins of the engine.

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 Computer Controlled Test Bench for 7.5 kW Engines, "TBM8", 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.

To ensure the optimal performance of the Computer Controlled Test Bench for 7.5 kW Engines, "TBM8", it is essential to carefully select a specific motor to be integrated into the test bench. This will allow a series of experiments to be carried out with a real motor in a completely safe environment, allowing us to collect accurate data on its various parts and functions.

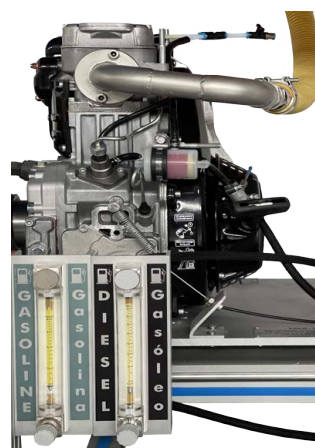
Below are various motor options available for your selection, at least one of which is required to work with the Computer Controlled Test Bench for 7.5 kW Engines, "TBM8":

### • TM8-01. Air-Cooled 4-Stroke 1-Cylinder Gasoline Engine for TBM8.

The Air-Cooled 4-Stroke 1-Cylinder Gasoline Engine are commonly found in a variety of applications, from small unit to recreational vehicles and motorcycles. They are characterized by their compact and efficient design, making them suitable for applications where space is limited.

Additionally, their 4-stroke operation provides more efficient combustion and smoother performance compared to 2-stroke engines. This makes them popular in a wide range of applications, from lawnmowers and motorcycles to portable generators and garden unit.

Additionally, being gasoline powered, they are convenient and easy to fuel, making them ideal for applications where a reliable and easy-to-use power source is required.



TBM8 detail

- **TM8-02. Air-Cooled 2-Stroke 1-Cylinder Gasoline Engine for TBMC8.**

The Air-Cooled 2-Stroke 1-Cylinder Gasoline Engine features a compact and lightweight design, making it ideal for applications where space and weight are critical. It is commonly found in garden unit, portable tools, small boats and motorcycles.

Since they do not require a liquid cooling system, their design is simpler and cheaper, making maintenance and repair easier. In addition, 2-stroke engines usually offer greater power in relation to their size, although at the cost of slightly higher fuel consumption.

- **TM8-03. Air-Cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8.**

This diesel engine is known for its robustness and fuel efficiency, making it ideal for applications in demanding environments such as agricultural unit, small industrial machines and portable generators. Air cooling eliminates the need for a liquid cooling system, simplifying its design and increasing its durability.

4-stroke diesel engines also stand out for their ability to operate at low revs with high torque, providing reliable operation even under extreme conditions.

- **TM8-04. Water-Cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8.**

This model combines the efficiency and durability of a 4-stroke diesel engine with a water-cooling system, which allows for more precise thermal control. It is ideal for industrial applications that require continuous and stable operation, such as construction machinery or heavy unit.

Although the water cooling system adds some complexity to the design, it offers greater heat dissipation capacity, allowing the engine to remain in optimal condition for long periods of operation.

- **TM8-05. Air-Cooled 4-Stroke 1-Cylinder Gasoline and LPG Engine for TBMC8.**

This engine stands out for its versatility, as it can operate on both gasoline and liquefied petroleum gas (LPG), making it suitable for a wide range of applications, from portable generators to small industrial machines. The ability to use LPG not only reduces polluting emissions, but also provides an economical and sustainable alternative to traditional fuel.

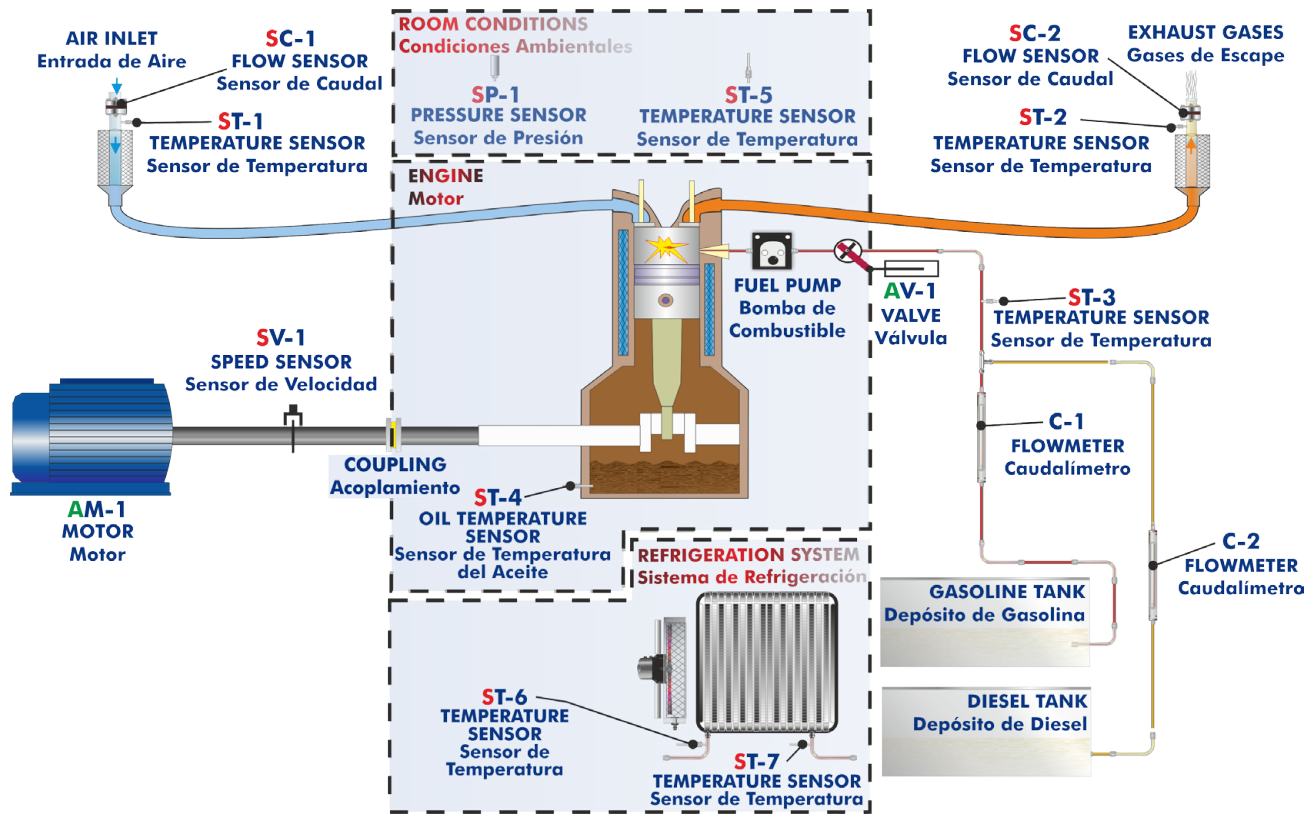
Additionally, being air-cooled, this engine is simpler to maintain, making it a reliable and affordable option for environments where simplicity and versatility are essential.

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

2 actuators and 11 sensors  
controlled from any computer,  
and working simultaneously

OPEN CONTROL  
+  
MULTICONTROL  
+  
REAL TIME CONTROL



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 TBMC8. Unit:**

**Test bench for combustion engines up to 7.5 kW, with wheels to facilitate its mobility:**

- Anodized aluminum frame and panels made of painted steel.
- Main metallic elements made of stainless steel.
- Diagram in the front panel with distribution of the elements similar to the real one.
- Mounting base with vibration dampening device to instal the testing engine.
- Transparent panels that allow to visualize the operation of the unit.
- Computer controlled electric eddy current brake to generate the load.
- This motor also works as the engine starter.
- Transmission between the combustion engine and the brake through an elastic coupling.
- 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:**

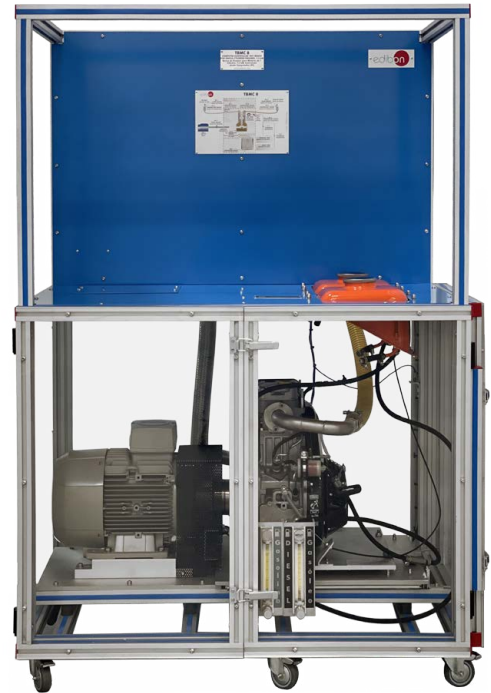
- Speed sensor to measure the speed (rpm) of the engine, range: 0 – 6000 rpm.
- Measurement of the electric motor braking torque.
- Six "J" type temperature sensors at different points of the process:
  - Inlet air temperature.
  - Exhaust gases temperature.
  - Fuel temperature.
  - Engine oil temperature.
  - Cooling system inlet and outlet water temperature.
- Flow meter to measure the fuel consumption, (depending on the purchased test engine), range: 2 – 40 ml/min.
- Two flow sensors to measure:
  - Inlet air flow to the combustion engine, range: 0 – 400 m<sup>3</sup>/h.
  - Exhaust gases outlet flow, range: 0 – 400 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 any of the protection panels is open.
- Safety individual hearing protectors to be used during the practical exercises are included.

**The Data Acquisition and Control Software of the "TBMC8" unit allows:**

- The calculation of representative magnitudes: power of the combustion engine.
- The representation of the characteristic curves of the combustion engines: torque or power 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: TBMC8

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 (at least one) (Not included):

- TM8-01. Air-Cooled 4-Stroke 1-Cylinder Gasoline Engine for TBMC8.
- TM8-02. Air-Cooled 2-Stroke 1-Cylinder Gasoline Engine for TBMC8.
- TM8-03. Air-cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8.
- TM8-04. Water-cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8.
- TM8-05. Air-Cooled 4-Stroke 1-Cylinder Gasoline and LPG Engine for TBMC8.

Additional recommended elements (Not included):

- TBMC-AGE. Exhaust Gas Analyzer.
- TBMC-CG. Computer Controlled Exhaust Gas Calorimeter.
- TBMC-AGE/NOx. Exhaust Gas Analyzer (NOx).

## ② TBMC8/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.**

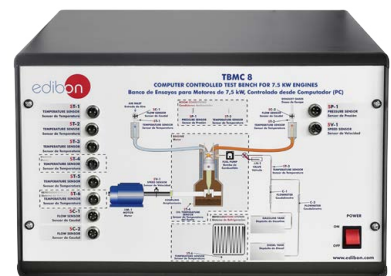
**Real time computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.**

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.**



TBMC8/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)= $\pm 10$  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)= $\pm 10$  V. Data transfers=DMA, interrupts, programmed I/O.

#### Digital Input/Output:

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

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

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



DAB

### ④ TBM8/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).**

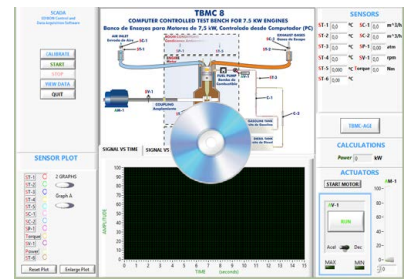
**Calibration system for the sensors involved in the process.**

**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.



TBM8/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: TBM8 + TBM8/CIB + DAB + TBM8/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

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

**TM8-01. Air-Cooled 4-Stroke 1-Cylinder Gasoline Engine for TBMC8**

**Type of engine:** Spark ignition.

**Fuel:** Petrol.

**N° of cylinders:** 1.

**N° of strokes:** 4.

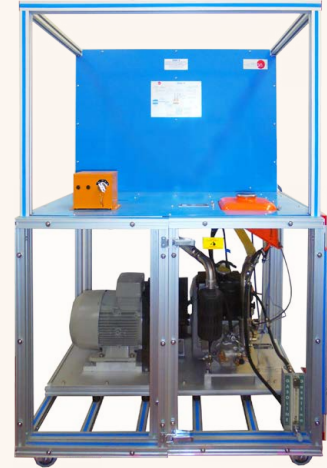
**Type of air intake:** Naturally aspirated.

**Type of cooling:** Air.

**Start:** Electric.

Additional recommended elements (Not included):

- TM8-01SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-01.



**TM8-02. Air-Cooled 2-Stroke 1-Cylinder Gasoline Engine for TBMC8**

**Type of engine:** Spark ignition.

**Fuel:** Petrol.

**N° of cylinders:** 1.

**N° of strokes:** 2.

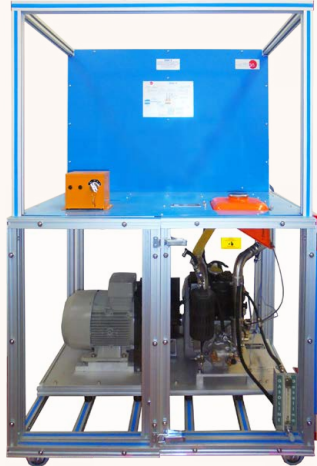
**Type of air intake:** Naturally aspirated.

**Type of cooling:** Air.

**Start:** Electric.

Additional recommended elements (Not included):

- TM8-02SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-02.



**TM8-03. Air-cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8**

**Type of engine:** Compression ignition.

**Fuel:** Diesel oil.

**N° of cylinders:** 1.

**N° of strokes:** 4.

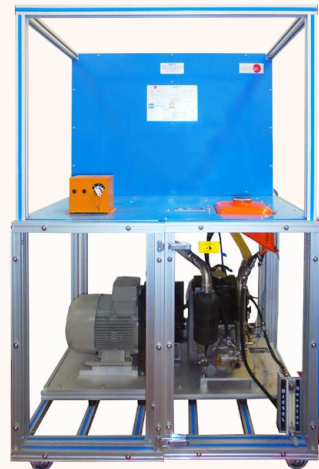
**Type of air intake:** Naturally aspirated.

**Type of cooling:** Air.

**Start:** Electric.

Additional recommended elements (Not included):

- TM8-03SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-03.





#### TM8-04. Water-cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8

**Type of engine:** Compression ignition.

**Fuel:** Diesel oil.

**N° of cylinders:** 1.

**N° of strokes:** 4.

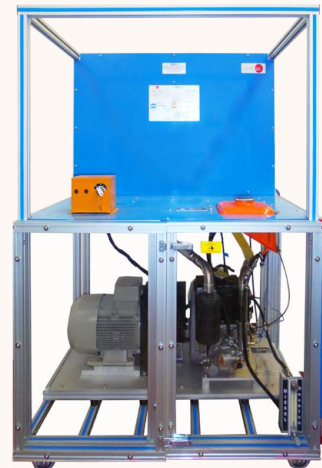
**Type of air intake:** Naturally aspirated.

**Type of cooling:** Water.

**Start:** Electric.

Additional recommended elements (Not included):

- TM8-04SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-04.



#### TM8-05. Air-Cooled 4-Stroke 1-Cylinder Gasoline and LPG Engine for TBMC8

**Type of engine:** Spark ignition.

**Fuel:** Petrol or GLP.

**N° of cylinders:** 1.

**N° of strokes:** 4.

**Type of air intake:** Naturally aspirated.

**Type of cooling:** Air.

**Start:** Electric.

Additional recommended elements (Not included):

- TM8-05SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-05.



### Additional recommended elements (Not included)

#### TBMC-AGE. Exhaust Gas Analyzer

##### Measurements:

Carbon monoxide, CO (%).  
Carbon dioxide, CO<sub>2</sub> (%).  
HC gasoline, propane, methane (ppm).  
Oxygen, O<sub>2</sub> (%).  
Carbon monoxide adjusted (%).  
Lambda factor.  
Oil temperature.

##### Technical data:

Power supply: 115/230 VAC – 50/60 Hz – 68 W.  
Measure time: 12 seconds (max.).  
Warm-up time: 6 minutes (from 25 °C).  
Working temperature: from +2 °C to +40 °C.  
Humidity: 95 % max. (non-condensing).  
Pressure: 800 – 1060 mbar.  
CO (+/- 0.02 % abs +/- 3 % rel): from 0 to 15 %.  
CO<sub>2</sub> (+/- 0.3 % abs +/- 3 % rel): from 0 to 20 %.  
HCg (+/- 4 ppm abs +/- 3 % rel): from 0 to 15000 ppm vol.  
HCp (+/- 8 ppm abs +/- 3 % rel): from 0 to 30000 ppm vol.  
O<sub>2</sub> (+/- 0.1 % abs +/- 5 % rel): from 0 to 25 %.  
COc (+/- 1 % abs +/- 3 % rel): from 0 to 20 %.  
Lambda: from 0 to 9.999 rpm.  
Oil temperature: 0 – 200 °C.  
Sample gas tube length: 6 m approx.  
Sample gas tube diameter: 5 mm approx.  
USB wire to computer.  
Control software.



#### TBMC-CG. Computer Controlled Exhaust Gas Calorimeter

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.  
Double-wall tank, made in stainless steel, with a finned steel pipe heat exchanger inside.  
Exchange volume: 13 l.  
Heat exchange area on exhaust gas side: 1.2 m<sup>2</sup>.  
Heat exchange area on water side: 0.17 m<sup>2</sup>.  
Exhaust gas inlet at the bottom of the unit.  
Exhaust gas outlet at the upper part of the unit.  
Water inlet and outlet connections and hoses are supplied.  
Connection between engine and calorimeter using an exhaust gas a heatresistant hose.  
Regulation valve for the cooling water flow rate.  
Four temperature sensors, "J" type, at different process stages, for measurement of:  
Exhaust gases temperature at the input.  
Gases temperature at the calorimeter output.  
Water temperature at the calorimeter input.  
Water temperature at the calorimeter output.  
Flow sensor to measure the cooling water flow.  
Pressure sensor for gases under analysis, range: 0 – 1 bar.  
Measuring ranges:  
Exhaust gas temperature: 0 – 600 °C.  
Water temperature: 0 – 600 °C.  
Flow rate: 0 – 600 l/hour.



### TBMC-AGE/NOx. Exhaust Gas Analyzer (NOx)

#### Measurements:

Carbon monoxide, CO (%).  
Carbon dioxide, CO<sub>2</sub> (%).  
HC gasoline, propane, methane (ppm).  
Oxygen, O<sub>2</sub> (%).  
Carbon monoxide adjusted (%).  
Lambda factor.  
Oil temperature.

#### Technical data:

Power supply: 115/230 VAC – 50/60 Hz – 68 W.  
Measure time: 12 seconds (max.).  
Warm-up time: 6 minutes (from 25 °C).  
Working temperature: from +2 °C to +40 °C.  
Humidity: 95 % max. (non-condensing).  
Pressure: 800 – 1060 mbar.  
CO (+/- 0.02 % abs +/- 3 % rel): from 0 to 15 %.  
CO<sub>2</sub> (+/- 0.3 % abs +/- 3 % rel): from 0 to 20 %.  
HCg (+/- 4 ppm abs +/- 3 % rel): from 0 to 15000 ppm vol.  
HCp (+/- 8 ppm abs +/- 3 % rel): from 0 to 30000 ppm vol.  
O<sub>2</sub> (+/- 0.1 % abs +/- 5 % rel): from 0 to 25 %.  
COc (+/- 1 % abs +/- 3 % rel): from 0 to 20 %.  
Lambda: from 0 to 9.999 rpm.  
Oil temperature: 0 – 200 °C.  
Sample gas tube length: 6 m approx.  
Sample gas tube diameter: 5 mm approx.  
USB wire to computer.  
Control software.



## 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.- Analysis of an internal combustion engine exhaust gases (it requires the additional recommended element TBMC-AGE). Recommended for petrol engines.
- 8.- Calculation of the heat contained in the exhaust gases of an internal combustion engine (it requires the additional recommended element TBMC-CG).
- 9.- Sensors calibration.

Other possibilities to be done with this unit:

- 10.- Many students view results simultaneously.
    - To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
  - 11.- 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.
  - 12.- The Computer Control System with SCADA allows a real industrial simulation.
  - 13.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
  - 14.- This unit can be used for doing applied research.
  - 15.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
  - 16.- Control of the TBMC8 unit process through the control interface box without the computer.
  - 17.- Visualization of all the sensors values used in the TBMC8 unit process.
- Several other exercises can be done and designed by the user.

### REQUIRED SERVICES

- Electrical supply: three-phase, 380 VAC – 400 VAC/50 Hz or 190 VAC – 240 VAC/60 Hz, 7.6 kW.
- 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).
- Propane (for TM8-05).

### DIMENSIONS AND WEIGHTS

TBMC8:

Unit:

- Dimensions: 1600 x 1000 x 1500 mm approx.  
(62.99 x 39.36 x 59.09 inches approx.)
- Weight: 200 Kg approx.  
(441 pounds approx.)

Control-Interface Box:

- Dimensions: 490 x 330 x 310 mm approx.  
(19.29 x 12.99 x 12.20 inches approx.)
- Weight: 10 Kg approx.  
(22 pounds approx.)

### REQUIRED ELEMENTS (Not included)

Required (at least one):

- TM8-01. Air-Cooled 4-Stroke 1-Cylinder Gasoline Engine for TBMC8.
- TM8-02. Air-Cooled 2-Stroke 1-Cylinder Gasoline Engine for TBMC8.
- TM8-03. Air-cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8.
- TM8-04. Water-cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8.
- TM8-05. Air-Cooled 4-Stroke 1-Cylinder Gasoline and LPG Engine for TBMC8.

### ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- TBMC-AGE. Exhaust Gas Analyzer.
- TBMC-CG. Computer Controlled Exhaust Gas Calorimeter.
- TBMC-AGE/NOx. Exhaust Gas Analyzer (NOx).

### SIMILAR UNITS AVAILABLE

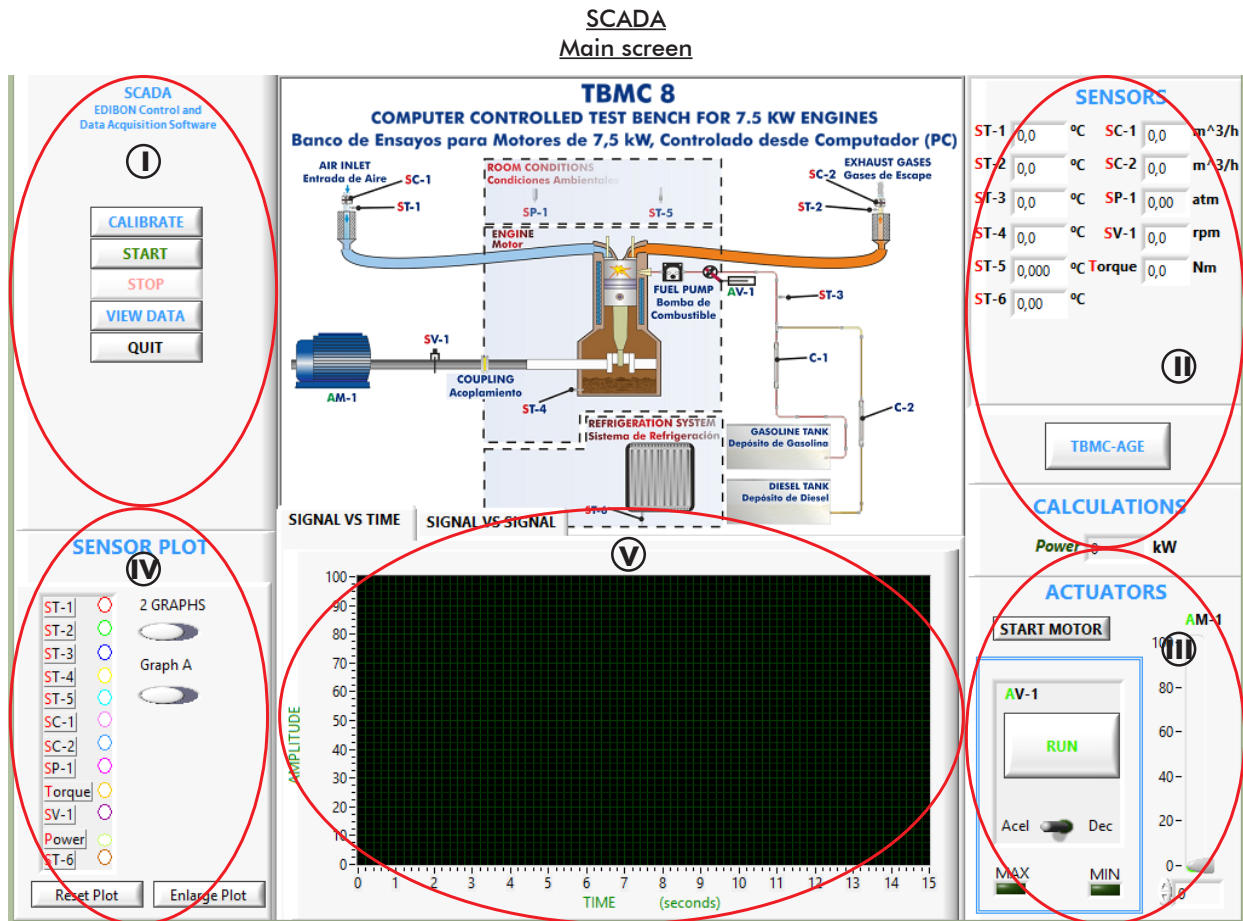
Offered in this catalog:

- TBMC8. Computer Controlled Test Bench for 7.5 kW Engines.

Offered in other catalogs:

- TBMC3. Computer Controlled Test Bench for 2.2 kW Engines.
- TBMC12. Computer Controlled Test Bench for 11 kW Engines.
- TBMC75. Computer Controlled Test Bench for 75 kW Engines.

## SOFTWARE MAIN SCREENS



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. Torque measurement. Power calculation.

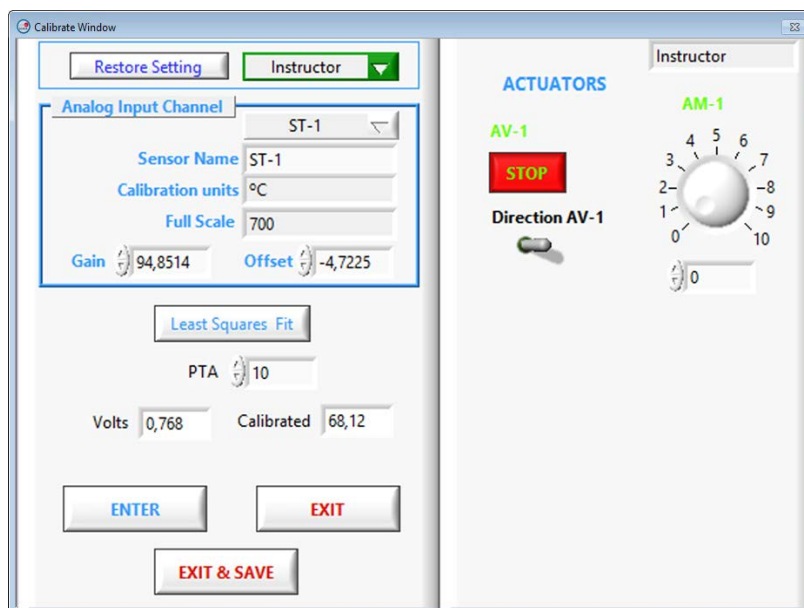
❸ Actuators controls. Actuators: AV=Fuel valve (for accelerate and decelerate). AM=Electric motor control.

❹ Channel selection and other plot parameters.

❺ Real time graphics displays.

### Software for Sensors Calibration

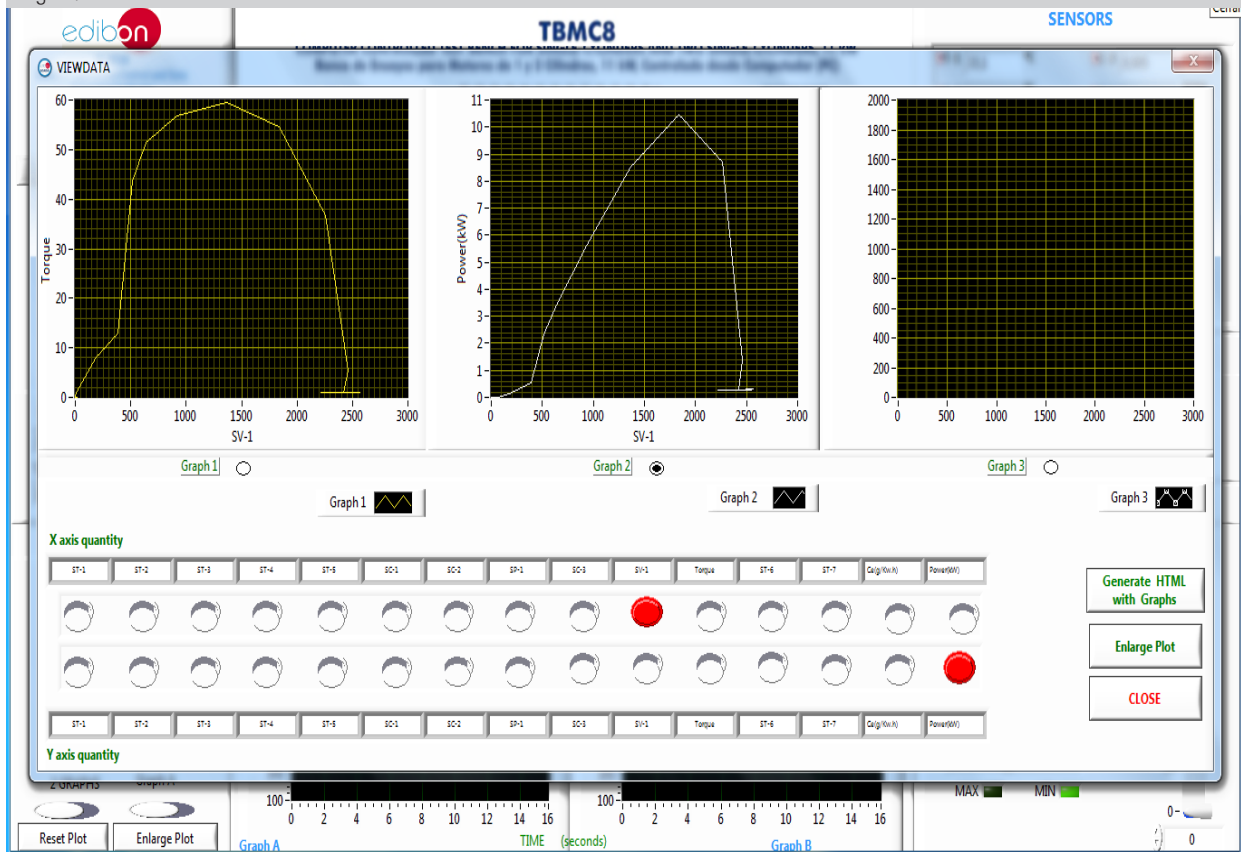
Example of screen



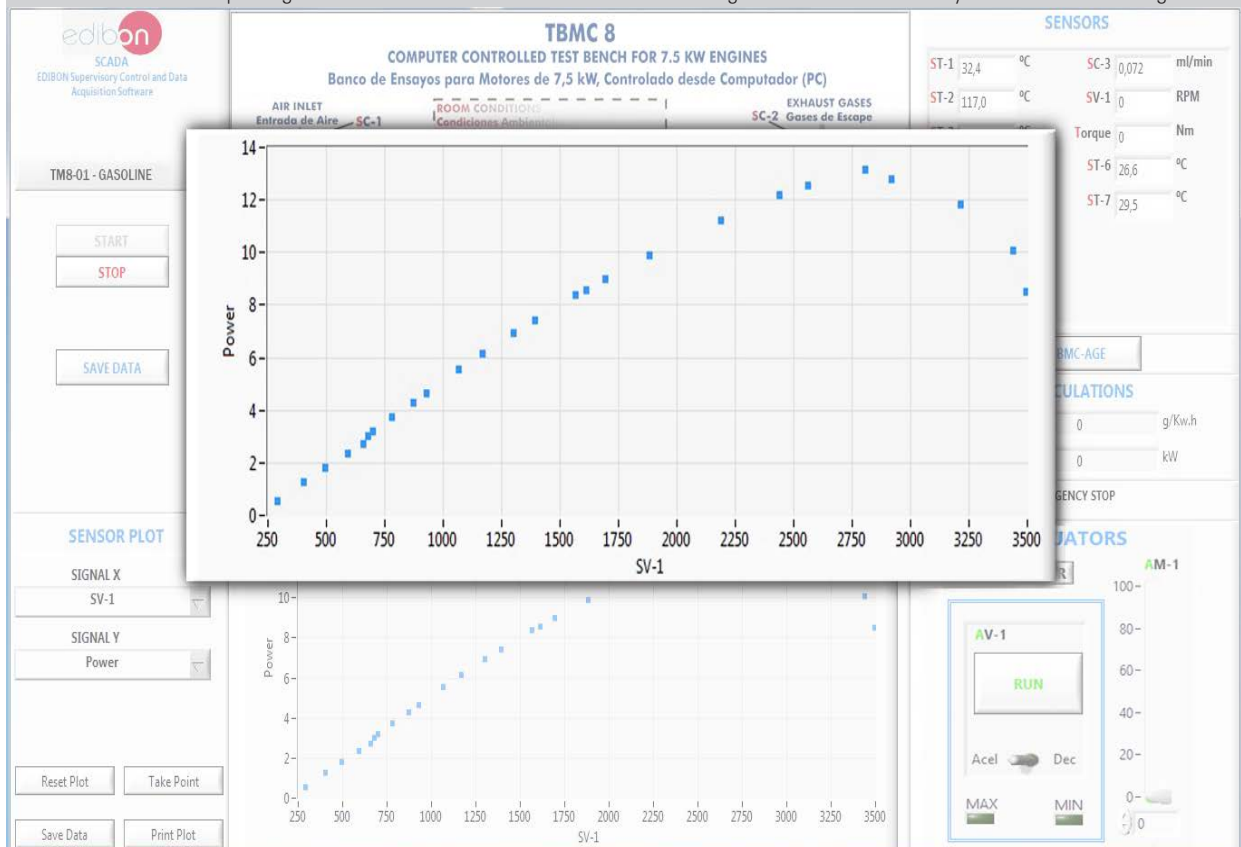
The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

## SOME REAL RESULTS OBTAINED FROM THIS UNIT

The data acquisition and control software of the "TBM8" unit allows the representation of the characteristic curves of the combustion engine.



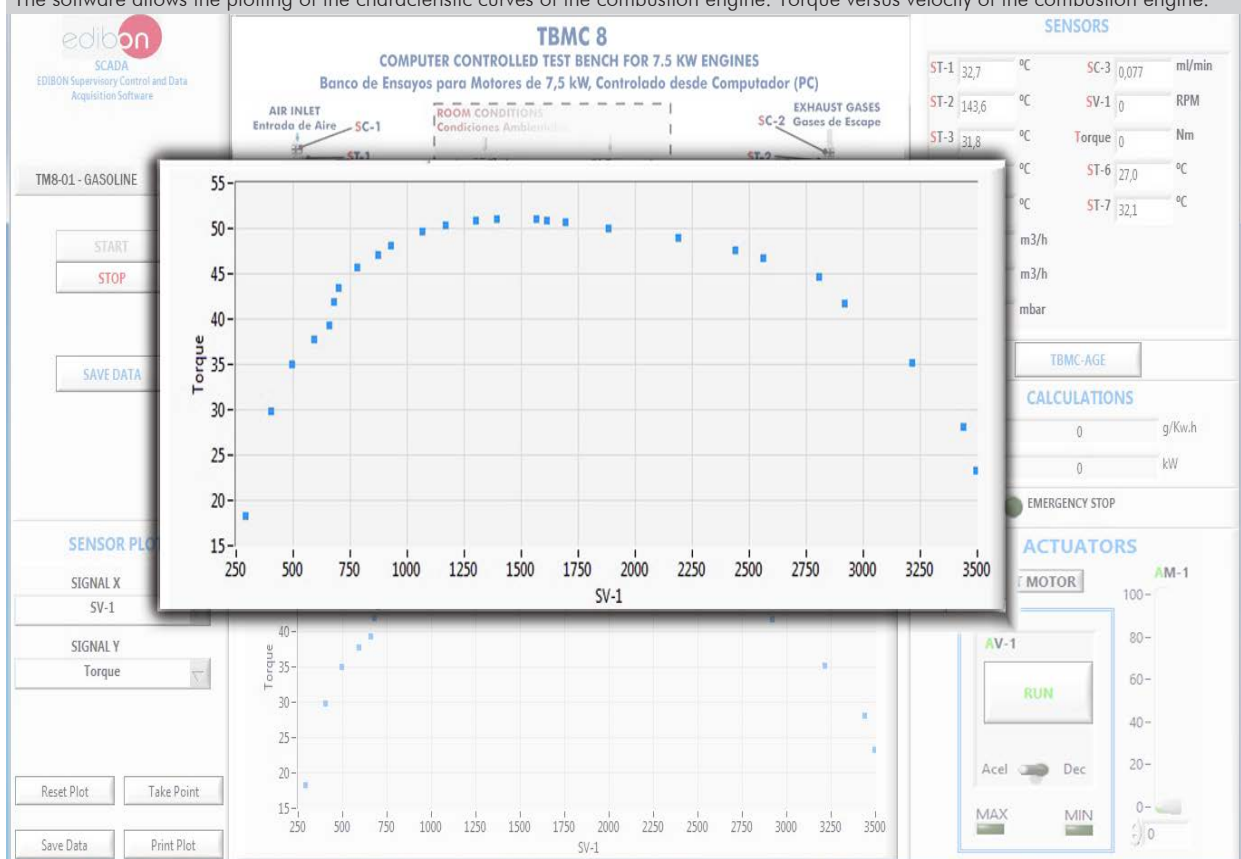
The software allows the plotting of the characteristic curves of the combustion engine. Power versus velocity of the combustion engine.



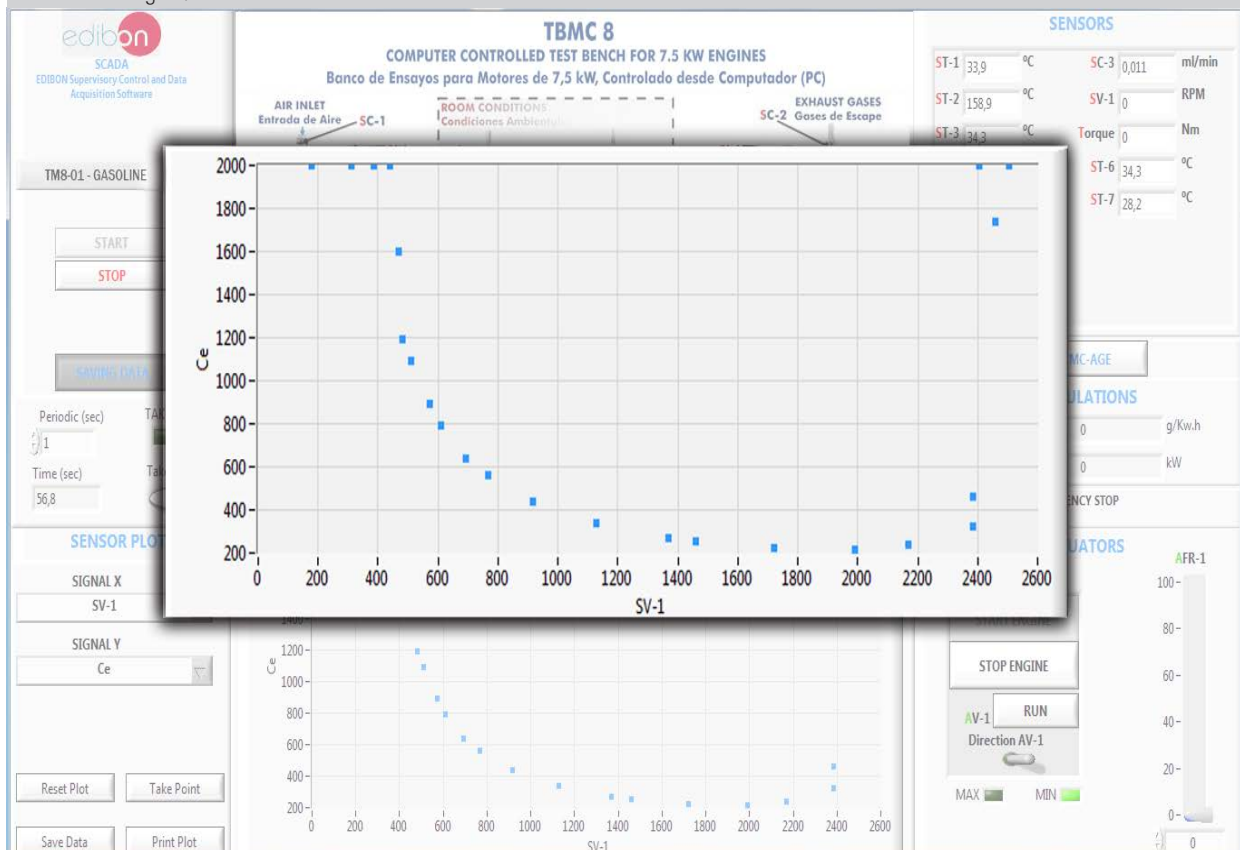


Some **real** results obtained from this unit

The software allows the plotting of the characteristic curves of the combustion engine. Torque versus velocity of the combustion engine.



The software allows the representation of the characteristic curves of the combustion engine. Specific consumption versus speed 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 TBMCS/ICAI. Interactive Computer Aided Instruction Software.

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

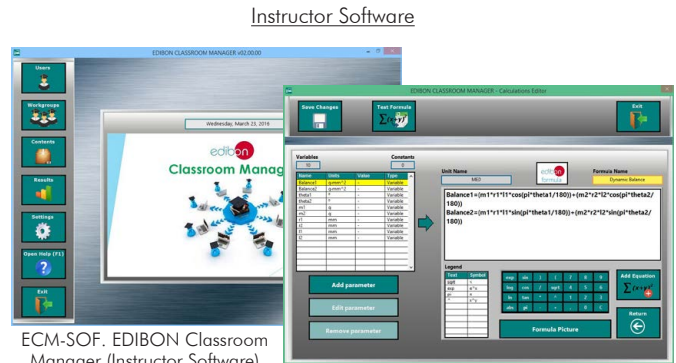
This software is optional and can be used additionally to items (1 to 6).

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

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

Innovative features:

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



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

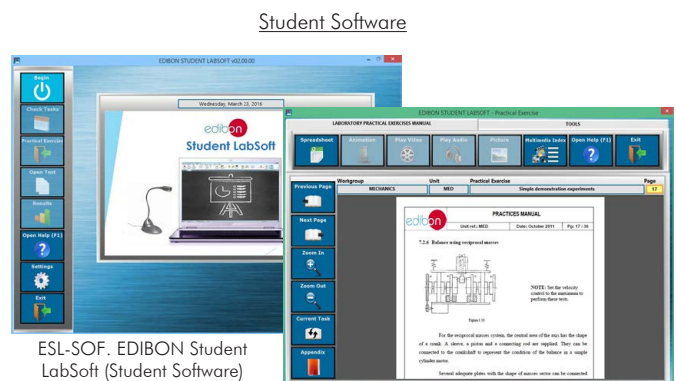
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

#### - 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.

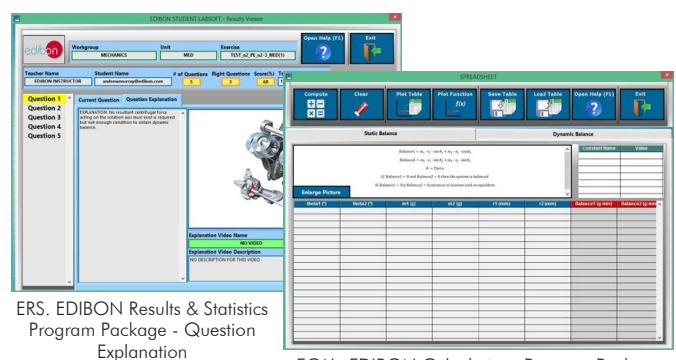
Innovative features:

- 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.



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

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

[www.edibon.com/en/interactive-computer-aided-instruction-software](http://www.edibon.com/en/interactive-computer-aided-instruction-software)

### ⑧ TBMCS/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.

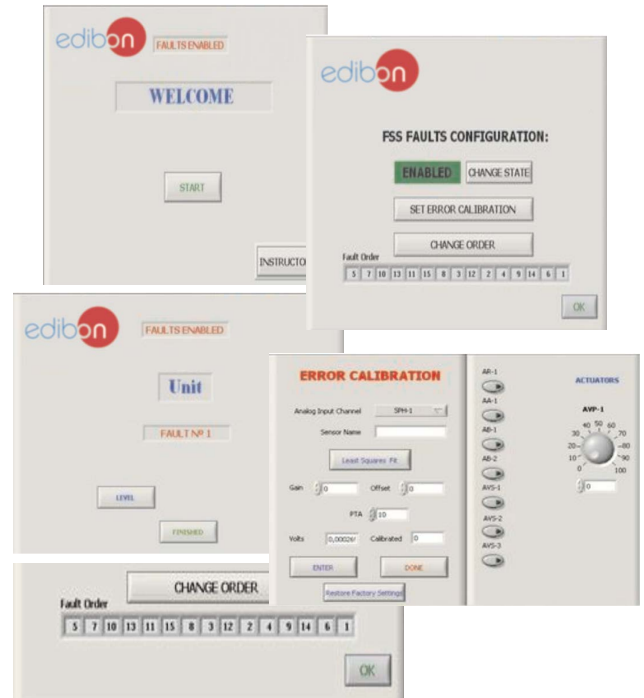
Faults in the controls execution:

- 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/fault-simulation-system](http://www.edibon.com/en/fault-simulation-system)

### 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:

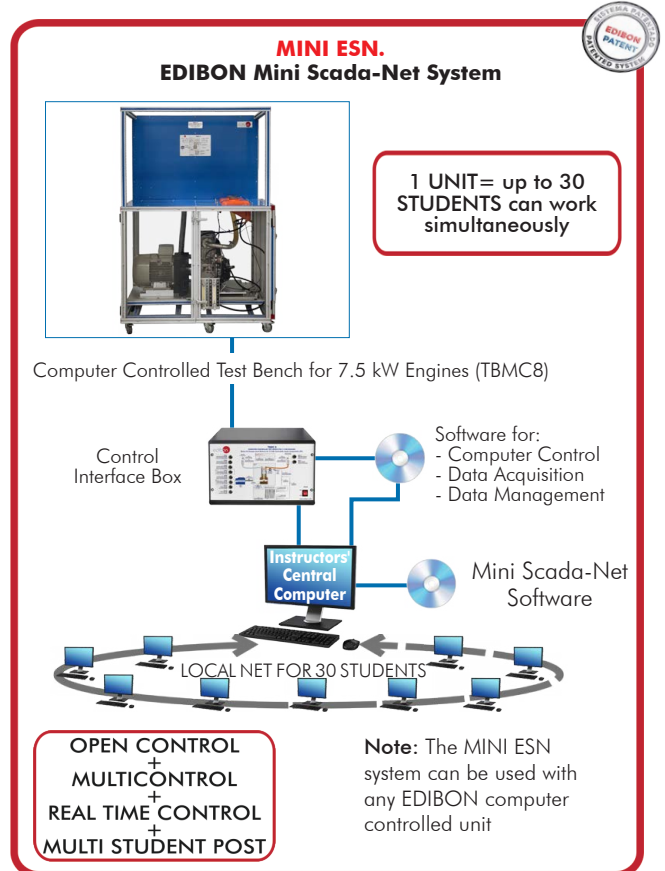
[www.edibon.com/en/edibon-scada-net](http://www.edibon.com/en/edibon-scada-net)

### ⑩ ESN. EDIBON Scada-Net Systems.

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

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

[www.edibon.com/en/edibon-scada-net](http://www.edibon.com/en/edibon-scada-net)



## ORDER INFORMATION

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

Minimum supply always includes:

- ① **Unit: TBMC8. Computer Controlled Test Bench for 7.5 kW Engines.**
- ② **TBMC8/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **TBMC8/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
- ⑤ **Cables and Accessories**, for normal operation.
- ⑥ **Manuals.**

**\*IMPORTANT:** Under TBMC8 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 TBMC8/ICAL. Interactive Computer Aided Instruction Software.
- ⑧ TBMC8/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.

### ①TBMC8. Unit:

Test bench for combustion engines up to 7.5 kW, with wheels to facilitate its mobility:

- Anodized aluminum frame and panels made of painted steel.
- Main metallic elements made of stainless steel.
- Diagram in the front panel with distribution of the elements similar to the real one.
- Mounting base with vibration dampening device to instal the testing engine.
- Transparent panels that allow to visualize the operation of the unit.
- Computer controlled electric eddy current brake to generate the load.
- This motor also works as the engine starter.
- Transmission between the combustion engine and the brake through an elastic coupling.
- 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.
- Measurement of the electric motor braking torque.
- 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 meter to measure the fuel consumption, (depending on the purchased test engine), range: 2 – 40 ml/min.
- Two flow sensors to measure:
  - Inlet air flow to the combustion engine, range: 0 – 400 m<sup>3</sup>/h.
  - Exhaust gases outlet flow, range: 0 – 400 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 any of the protection panels is open.
- Safety individual hearing protectors to be used during the practical exercises are included.

The Data Acquisition and Control Software of the “TBMC8” unit allows:

- The calculation of representative magnitudes: power of the combustion engine.
- The representation of the characteristic curves of the combustion engines: torque or power 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 (at least one) (Not included):

- TM8-01. Air-Cooled 4-Stroke 1-Cylinder Gasoline Engine for TBMC8.
  - Type of engine: Spark ignition.
  - Fuel: Petrol.
  - N° of cylinders: 1.
  - N° of strokes: 4.
  - Type of air intake: Naturally aspirated.
  - Type of cooling: Air.
  - Start: Electric.

Additional recommended elements (Not included):

- TM8-01 SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-01.
- TM8-02. Air-Cooled 2-Stroke 1-Cylinder Gasoline Engine for TBMC8.
  - Type of engine: Spark ignition.
  - Fuel: Petrol.
  - N° of cylinders: 1.
  - N° of strokes: 2.



Type of air intake: Naturally aspirated.

Type of cooling: Air.

Start: Electric.

Additional recommended elements (Not included):

- TM8-02SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-02

- TM8-03. Air-cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8.

Type of engine: Compression ignition.

Fuel: Diesel oil.

N° of cylinders: 1.

N° of strokes: 4.

Type of air intake: Naturally aspirated.

Type of cooling: Air.

Start: Electric.

Additional recommended elements (Not included):

- TM8-03SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-03.

- TM8-04. Water-cooled 4-Stroke 1-Cylinder Diesel Engine for TBMC8.

Type of engine: Compression ignition.

Fuel: Diesel oil.

N° of cylinders: 1.

N° of strokes: 4.

Type of air intake: Naturally aspirated.

Type of cooling: Water.

Start: Electric.

Additional recommended elements (Not included):

- TM8-04SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-04.

- TM8-05. Air-Cooled 4-Stroke 1-Cylinder Gasoline and LPG Engine for TBMC8.

Type of engine: Spark ignition.

Fuel: Petrol or GLP.

N° of cylinders: 1.

N° of strokes: 4.

Type of air intake: Naturally aspirated.

Type of cooling: Air.

Start: Electric.

Additional recommended elements (Not included):

- TM8-05SP. Indicator for Pressure Measurement in the Combustion Chamber of TM8-05.

Additional recommended elements (Not included):

- TBMC-AGE. Exhaust Gas Analyzer.

Measurements:

Carbon monoxide, CO (%).

Carbon dioxide, CO<sub>2</sub> (%).

HC gasoline, propane, methane (ppm).

Oxygen, O<sub>2</sub> (%).

Carbon monoxide adjusted (%).

Lambda factor.

Oil temperature.

Technical data:

Power supply: 115/230 VAC – 50/60 Hz – 68 W.

Measure time: 12 seconds (max.).

Warm-up time: 6 minutes (from 25 °C).

Working temperature: from +2 °C to +40 °C.

Humidity: 95 % max. (non-condensing).

Pressure: 800 – 1060 mbar.

CO (+/- 0.02 % abs +/- 3 % rel): from 0 to 15 %.

CO<sub>2</sub> (+/- 0.3 % abs +/- 3 % rel): from 0 to 20 %.

HCG (+/- 4 ppm abs +/- 3 % rel): from 0 to 15000 ppm vol.

HCp (+/- 8 ppm abs +/- 3 % rel): from 0 to 30000 ppm vol.

O<sub>2</sub> (+/- 0.1 % abs +/- 5 % rel): from 0 to 25 %.

COc (+/- 1 % abs +/- 3 % rel): from 0 to 20 %.

Lambda: from 0 to 9.999 rpm.

Oil temperature: 0 – 200 °C.

Sample gas tube length: 6 m approx.

Sample gas tube diameter: 5 mm approx.

USB wire to computer.

Control software.

- TBMC-CG. Computer Controlled Exhaust Gas Calorimeter.

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.

Double-wall tank, made in stainless steel, with a finned steel pipe heat exchanger inside.

Exchange volume: 13 l.

Heat exchange area on exhaust gas side: 1.2 m<sup>2</sup>.

Heat exchange area on water side: 0.17 m<sup>2</sup>.

Exhaust gas inlet at the bottom of the unit.

Exhaust gas outlet at the upper part of the unit.

Water inlet and outlet connections and hoses are supplied.

Connection between engine and calorimeter using an exhaust gas a heatresistant hose.

Regulation valve for the cooling water flow rate.



Four temperature sensors, "J" type, at different process stages, for measurement of:

- Exhaust gases temperature at the input.
- Gases temperature at the calorimeter output.
- Water temperature at the calorimeter input.
- Water temperature at the calorimeter output.
- Flow sensor to measure the cooling water flow.

Pressure sensor for gases under analysis, range: 0 – 1 bar.

Measuring ranges:

- Exhaust gas temperature: 0 – 600 °C.
- Water temperature: 0 – 600 °C.
- Flow rate: 0 – 600 l/hour.

- TBMC-AGE/NOx. Exhaust Gas Analyzer (NOx).

Measurements:

- Carbon monoxide, CO (%).
- Carbon dioxide, CO<sub>2</sub> (%).
- HC gasoline, propane, methane (ppm).
- Oxygen, O<sub>2</sub> (%).
- Carbon monoxide adjusted (%).
- Lambda factor.
- Oil temperature.

Technical data:

- Power supply: 115/230 VAC – 50/60 Hz – 68 W.
- Measure time: 12 seconds (max.).
- Warm-up time: 6 minutes (from 25 °C).
- Working temperature: from +2 °C to +40 °C.
- Humidity: 95 % max. (non-condensing).
- Pressure: 800 – 1060 mbar.
- CO (+/- 0.02 % abs +/- 3 % rel): from 0 to 15 %.
- CO<sub>2</sub> (+/- 0.3 % abs +/- 3 % rel): from 0 to 20 %.
- HCg (+/- 4 ppm abs +/- 3 % rel): from 0 to 15000 ppm vol.
- HCp (+/- 8 ppm abs +/- 3 % rel): from 0 to 30000 ppm vol.
- O<sub>2</sub> (+/- 0.1 % abs +/- 5 % rel): from 0 to 25 %.
- COc (+/- 1 % abs +/- 3 % rel): from 0 to 20 %.
- Lambda: from 0 to 9.999 rpm.
- Oil temperature: 0 – 200 °C.
- Sample gas tube length: 6 m approx.
- Sample gas tube diameter: 5 mm approx.
- USB wire to computer.
- Control software.

## ②TBMC8/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.

## ③DAB. 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.

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

## ④TBMC8/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.

## ⑤Cables and Accessories, for normal operation.

## ⑥Manuals:

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.- Analysis of an internal combustion engine exhaust gases (it requires the additional recommended element TBMC-AGE). Recommended for petrol engines.
- 8.- Calculation of the heat contained in the exhaust gases of an internal combustion engine (it requires the additional recommended element TBMC-CG).
- 9.- Sensors calibration.

Other possibilities to be done with this unit:

- 10.- Many students view results simultaneously.
    - To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
  - 11.- 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.
  - 12.- The Computer Control System with SCADA allows a real industrial simulation.
  - 13.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
  - 14.- This unit can be used for doing applied research.
  - 15.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
  - 16.- Control of the TBMC8 unit process through the control interface box without the computer.
  - 17.- Visualization of all the sensors values used in the TBMC8 unit process.
- Several other exercises can be done and designed by the user.

### a) Technical and Vocational Education configuration

#### ⑦ **TBMC8/ICAI. Interactive Computer Aided Instruction Software.**

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

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

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

Innovative features:

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

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

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

Innovative features:

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

#### ⑧ **TBMC8/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.



C/ Julio Cervera, 10. Móstoles Tecnológico.  
28935 MÓSTOLES. (Madrid). ESPAÑA - SPAIN.  
Tel.: 34-91-6199363 Fax: 34-91-6198647

E-mail: [edibon@edibon.com](mailto:edibon@edibon.com) Web: [www.edibon.com](http://www.edibon.com)

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