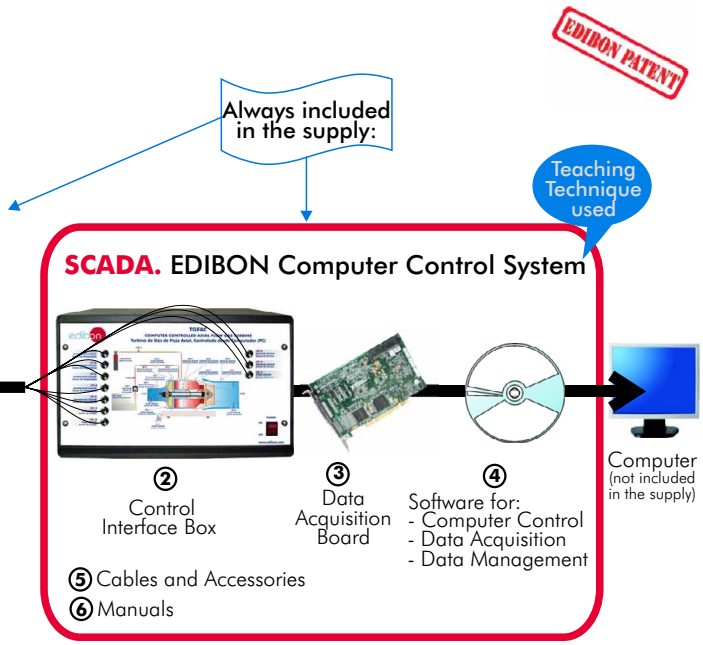
edibon

Technical Teaching Equipment

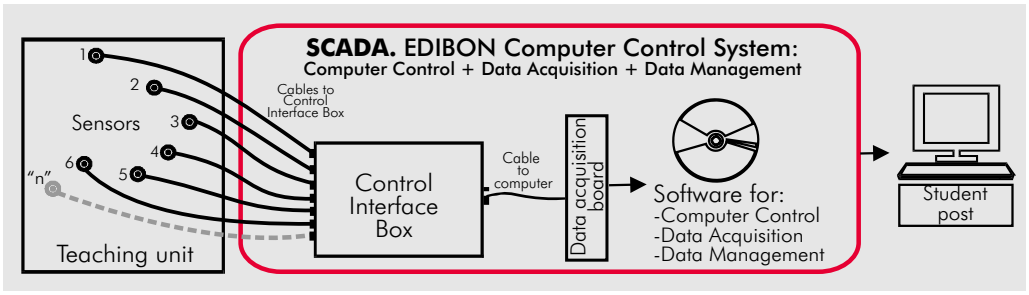
# Computer Controlled **Axial Flow Gas Turbine/ Jet Engine**

## TGFAC




**OPEN CONTROL**
+
**MULTICONTROL**
+
**REAL TIME CONTROL**

① Unit: TGFAC. Axial Flow Gas Turbine/Jet Engine

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

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(total safety)

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

**Worlddidac Quality Charter Certificate**
(Worlddidac Member)

## DESCRIPTION

The "TGFAC" Axial Flow Gas Turbine/Jet Engine developed by EDIBON is a demonstrating teaching equipment of a Gas Turbine as jet engine.

The main element of the TGFAC unit is the Reaction Turbine which consist of:

- Radial compressor, which is supplied by atmospheric air to compress it.
- Annular combustion chamber. In every combustion, there is a fuel (propane gas, kerosene, paraffin), a comburent (in this case, compressed air received from the compressor) and the activation energy, which will cause the mix ignition.
- Expansion axial turbine: The inflamed gases of the combustion chamber transfer a part of the energy that they have in the turbine paddles.

Compressor and turbine are coupled on the same shaft, so, when we have the system auto-sustained, part of the combustion gases caloric energy is used to move the compressor.

TGFAC unit includes a series of annex installations:

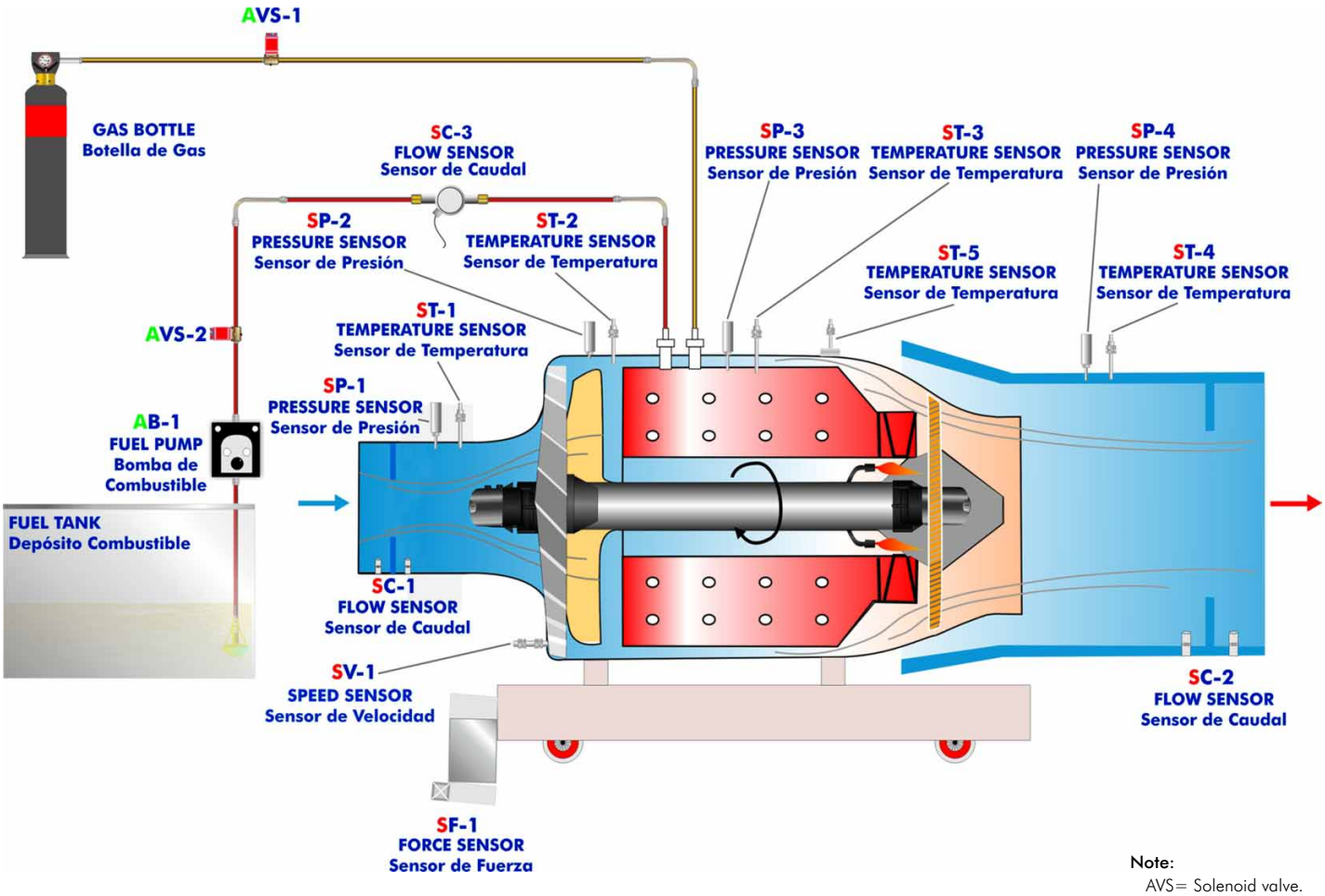
- Start installation: The starter accessory consists of an electric engine which, joint to compressor shaft, causes the shaft rotation.
- Gas ignition installation: The system is automatic and it will make the gas to enter into the combustion chamber by an electrovalve. The gas propane ignition is produced by means of a spark plug automatically.
- Fuel installation: The used fuel is kerosene (paraffin). The fuel line consists of an electrovalve to supply, a fuel pump and a tank. A tank load accessory is also provided.
- Turbine lubrication: The lubrication is carried out by means of the oil which has the fuel mixed (with 5% of oil (special turbine)).

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), including: Control interface Box + Data Acquisition Board + Computer Control and Data Acquisition Software, for controlling the process and the parameters involved.

## PROCESS DIAGRAM AND ELEMENTS ALLOCATION

3 actuators and 12 sensors controlled from any computer, and working simultaneously

**OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL**




Note:
AVS= Solenoid valve.

## Items supplied as standard

### ① TGFAC. Unit:

Bench top unit, computer controlled.
Anodized aluminium structure and painted steel panels (epoxy paint).
Main metallic elements in stainless steel and aluminium.
Diagram in the front panel with similar distribution to the element in the real unit.
Axial flow gas turbine (jet turbine) of 200 N thrust at 110.000 rpm. It consists of a radial compressor, combustion chamber and expansion axial turbine.
Jet engine with speed regulation, computer controlled. Fast response of the unit to speed changes.
Ignition System, computer controlled. It is formed by electrical motor, propane gas system for ignition, electrovalve (solenoid valve) and spark plug for ignition.
Fuel feeding system, computer controlled. It consist of:
- Fuel pump.
- 4 l. "explosafe" fuel tank.
- Electrovalve (solenoid valve).
- Fuel: Kerosene, with 5% oil approx. (not included).

Collector of inlet and exhaust duct, of 225 mm, with sensors to measure the gases flow rates.
Typical exhaust gases temperature: 800º C.
The unit incorporates transparent protection screens for a safety operation and the best experiment visibility.
3 temperature sensors, "J" type, in different stages of the process, for measurement of:
- Inlet air temperature.
- Inlet air temperature in the compressor.
- Fuselage temperature.
- Range of the sensors: 0-600º C.

2 temperature sensors, "K" type, for measurement of:
- Combustion chamber temperature.
- Exhaust gases temperature.
- Range of the sensors: 0-1050º C.

Speed sensor to measure the speed (rpm) of the turbine shaft, range: 0-120000 rpm.
Load Cell-Force sensor for measurement of the turbine trust, range: 0-300 N.
4 Pressure sensors, for measurement of:
- Pressure at the gas inlet.
- Pressure in the compressor.
- Pressure in the combustion chamber.
- Pressure at the gas outlet.
- Range of the pressure sensors: 0-2.5 bar.

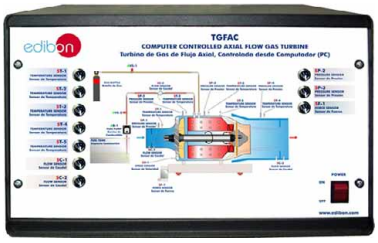
2 Flow sensors for:
- Air inlet.
- Gas outlet.

Flow sensor for the fuel consumption measurement, range: 0-1000 ml./min.
Safety-devices.
Possibility to do the turbine local control by means a electronic box installed in the unit.
Emergency stop, located in the unit.
Included hearing protectors.


TGFAC. Unit

### ② TGFAC/CIB. Control Interface Box :

**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 for -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.
**Simultaneously 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 placed in only one computer screen.
**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, resistances, control valves, etc.
**Open control** allowing modifications, at any time and in a real time, of parameters involved in the process simultaneously.
**Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.**




TGFAC/CIB

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**Items supplied as standard** (continuation)

**③ DAB. Data Acquisition Board:**

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

Bus PCI.

**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)=±10V.
Data transfers=DMA, interrupts, programmed I/0.
DMA channels=6.

**Analog output:** Number of **channels=2**.
**Resolution=16 bits**, 1 in 65536.
Max. output rate up to: 833 KS/s.
Output range(V)=±10V.
Data transfers=DMA, interrupts, programmed I/0.

**Digital Input/Output:**
Number of **channels=24 inputs/outputs**.
D0 or DI Sample Clock frequency: 0 to 1 MHz.

Timing: **Counter/timers=2**.
Resolution: Counter/timers: 32 bits.

DAB

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

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 simultaneously 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 250,000 data per second guaranteed.**

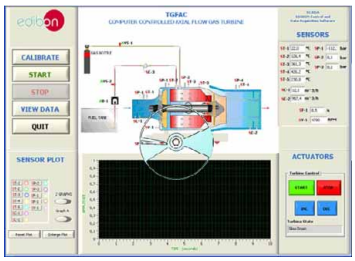
**Calibration system for the sensors involved in the process.**

**It allows the registration of the alarms state and the graphic representation in real time.**

Comparative analysis of the obtained data, after to the process and modification of the conditions during the process.

**Open software, allowing to 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 at different work levels.

**This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.**




TGFAC/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: TGFAC + TGFAC/CIB + DAB + TGFAC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply, enabling a normal operation.**

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## Complementary items to the standard supply

PLC. Industrial Control using PLC (7 and 8):

**⑦ PLC-PI. PLC Module:**

Circuit diagram in the front panel.

Front panel:

**Digital inputs(X) and Digital outputs (Y) block:**

**16 Digital inputs,** activated by switches and 16 LEDs for confirmation (red).

**14 Digital outputs** (through SCSI connector) with 14 LEDs for message (green).

**Analog inputs block:**

**16 Analog inputs** (-10V. to + 10V.) (through SCSI connector).

**Analog outputs block:**

**4 Analog outputs** (-10V. to + 10V.) (through SCSI connector).

**Touch screen**:

High visibility and multiple functions.
Display of a highly visible status.
Recipe function.
Bar graph function.
Flow display function.
Alarm list.
Multi language function.
True type fonts.

Back panel:

Power supply connector.
Fuse 2A.
RS-232 connector to PC.
USB 2.0 connector to PC.

Inside:

Power supply outputs: 24 Vdc, 12 Vdc, -12 Vdc, 12 Vdc variable.

**Panasonic PLC**:

**High-speed scan of 0.32 μsec.** for a basic instruction.
**Program capacity of 32 Ksteps**, with a sufficient comment area.
Free input AC voltage(100 to 240 V AC).
DC input: 16 (24 V DC).
Relay output: 14 (250 V A AC/2 A).
**High-speed counter**.
**Multi-point PID control**.

**Digital inputs/outputs and analog inputs/outputs Panasonic modules**.

Communication RS232 wire, to computer (PC).

PLC-PI

**⑧ TGFAC/PLC-SOF. PLC Control Software:**

For this particular unit, always included with PLC supply.

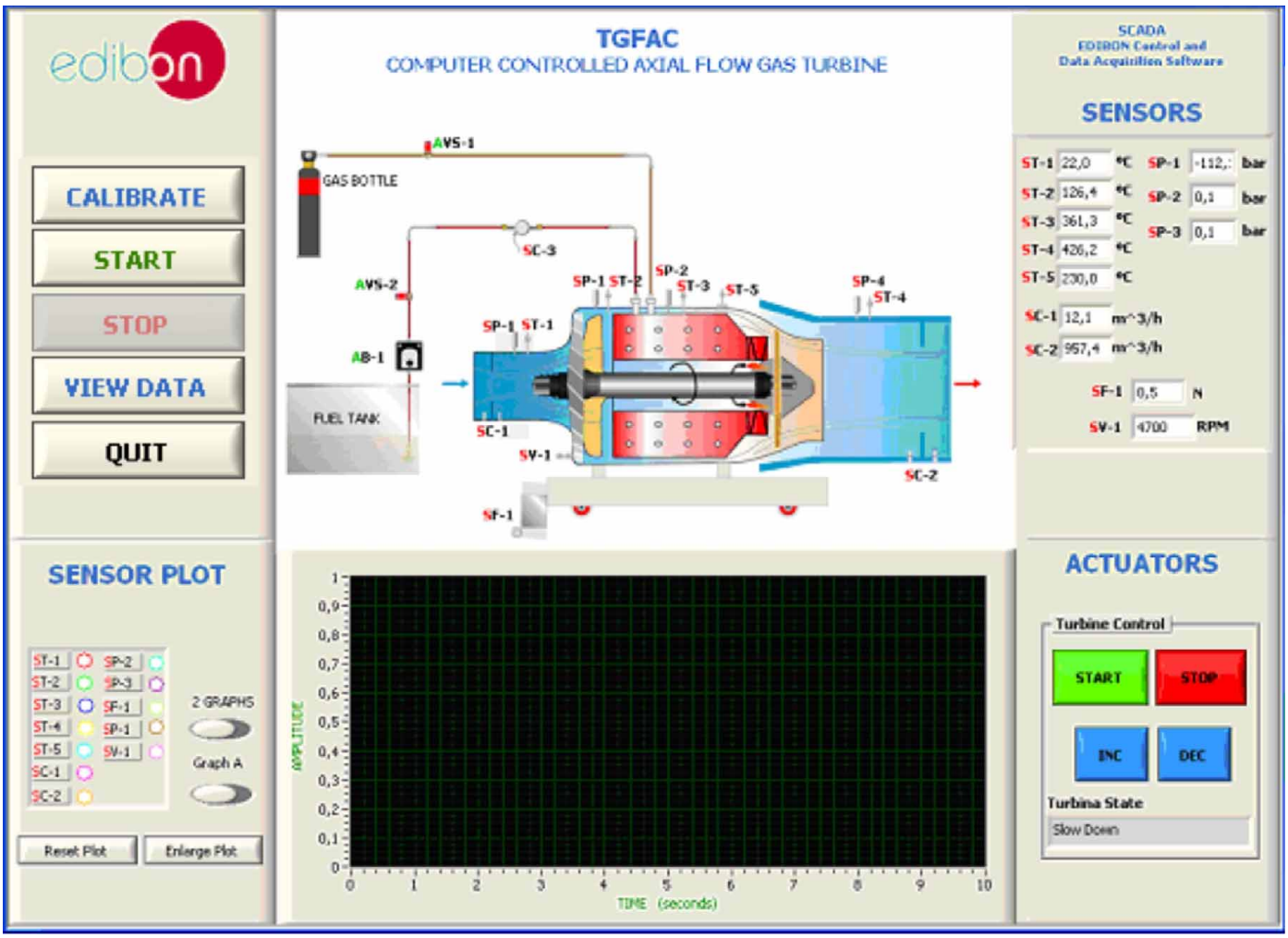
## Items available on request

**⑨ TGFAC/CAL. Computer Aided Learning Software (Results Calculation and Analysis)**.

**⑩ TGFAC/FSS. Faults Simulation System.**

## Software Main Screens

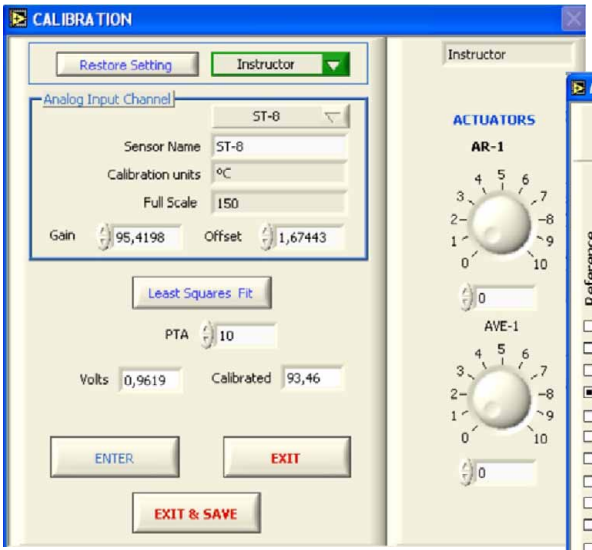
Main screen

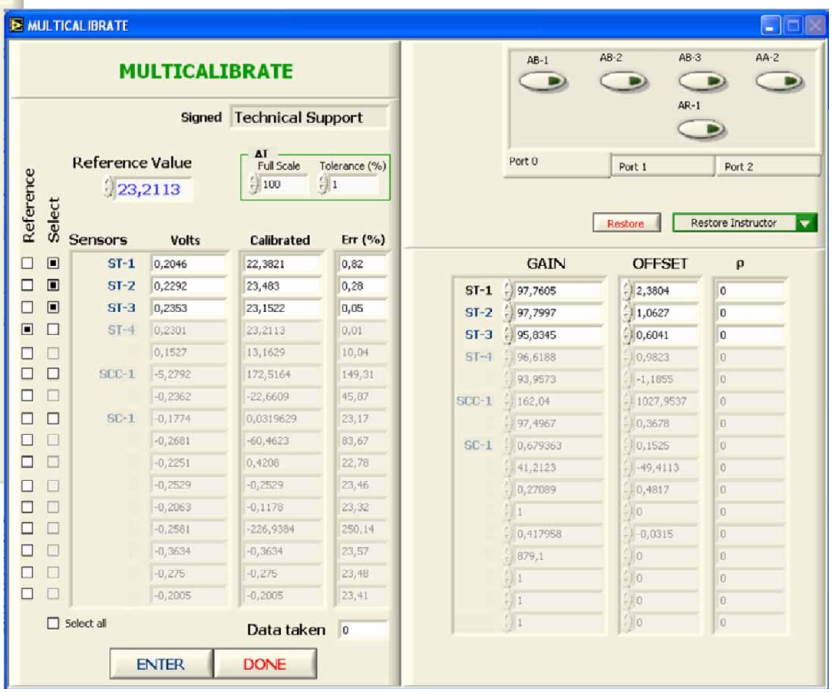



**Note:** ST=Temperature sensor. SC=Flow sensor. SP=Pressure sensor. SF=Force sensor. SV=Speed sensor.

Turbine control=CLICK "INC" for increase the turbine power.
CLICK "DEC" for decelerate the turbine power.

Examples of Sensors Calibration screens

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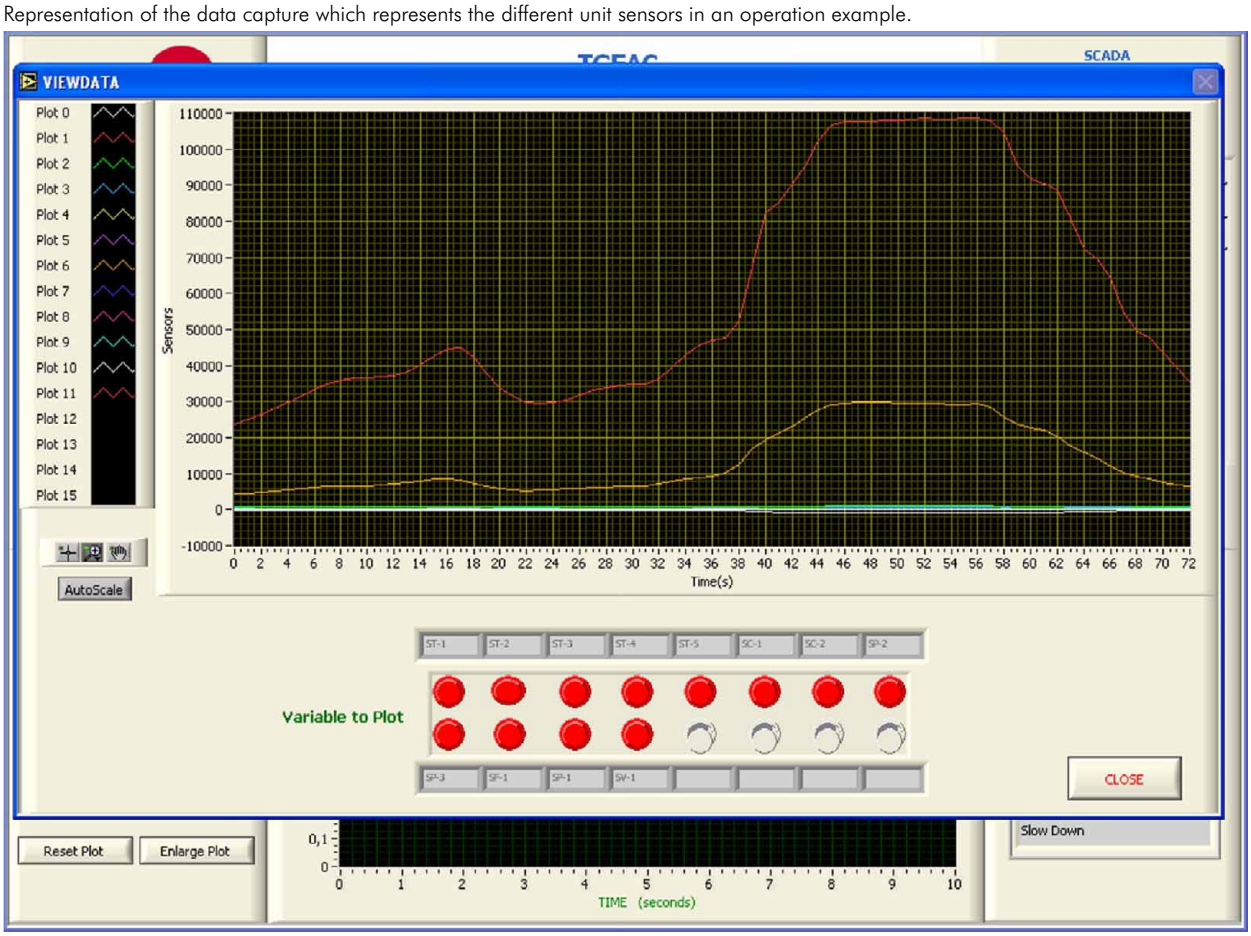
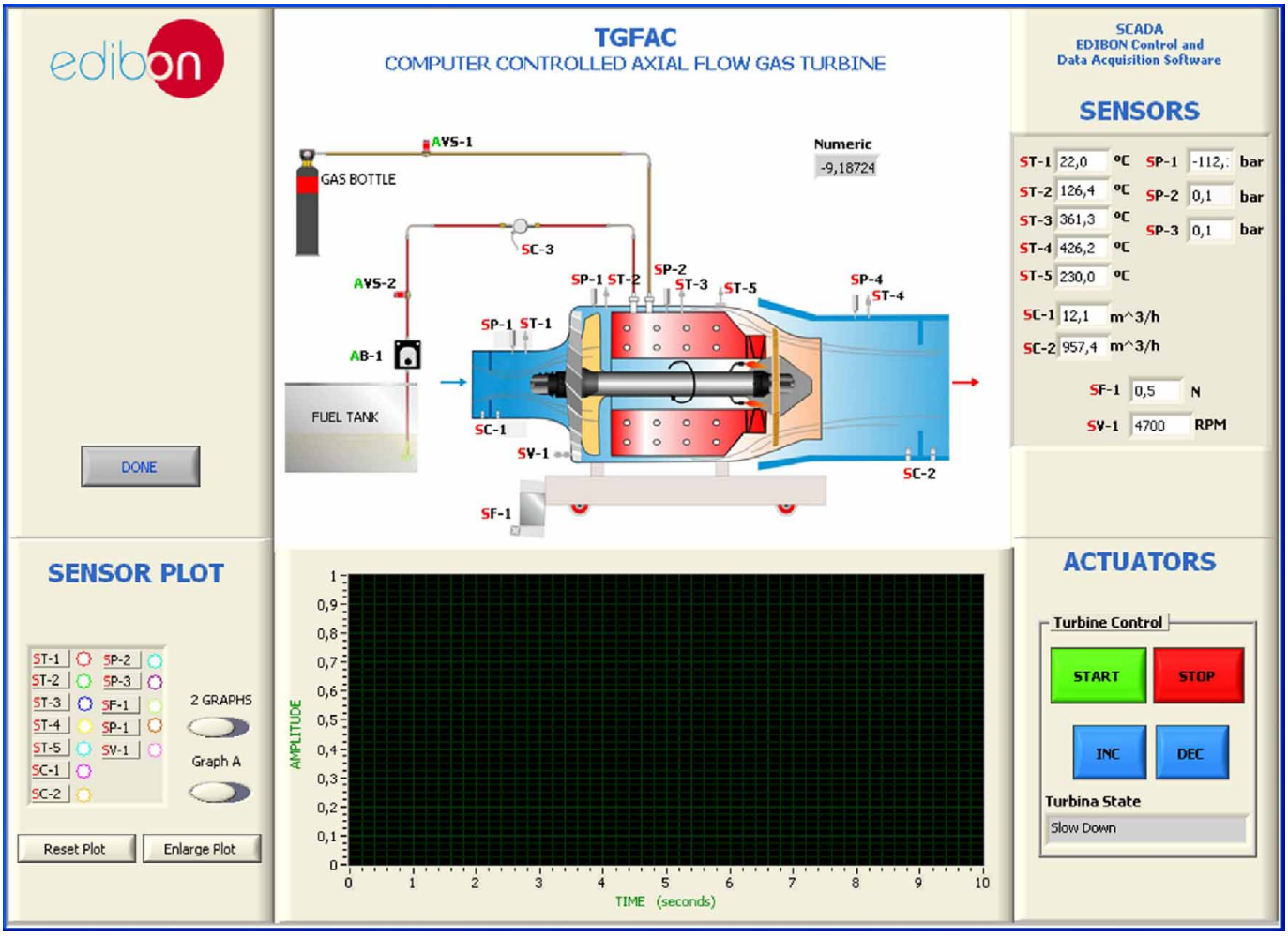
## Some typical exercises results

Representation of the data capture which represents the different unit sensors in an operation example.




The unit shows the sensors values during a setting up of the equipment.



## EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Study of a gas turbine.
2.- Function and operation of a gas turbine as jet engine.
3.- Determination of fuel consumption.
4.- Air and fuel ratio.
5.- Recording the turbine characteristic.
6.- Determination of the efficiency of the compressor.
7.- Determination of the specific thrust.
8.- Determination of the efficiency of the turbine.
9.- Temperature measurements.
10.- Safety systems in the operation of a gas turbine.
11.- Energy global balance.

Other possible practices:

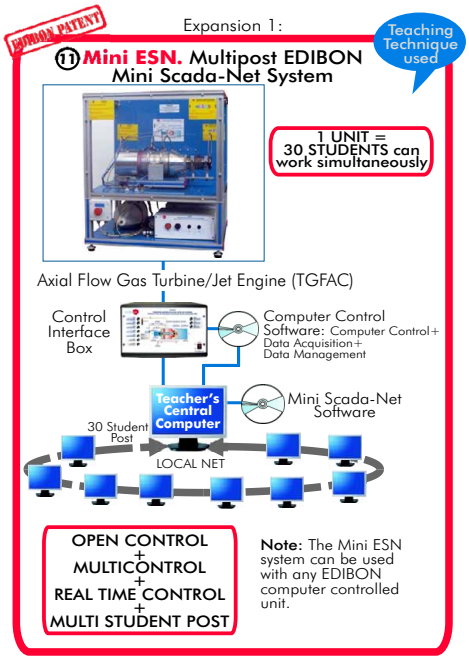
12.- Sensors calibration.

Practices to be done by PLC Module (PLC-PI) + PLC Control Software:

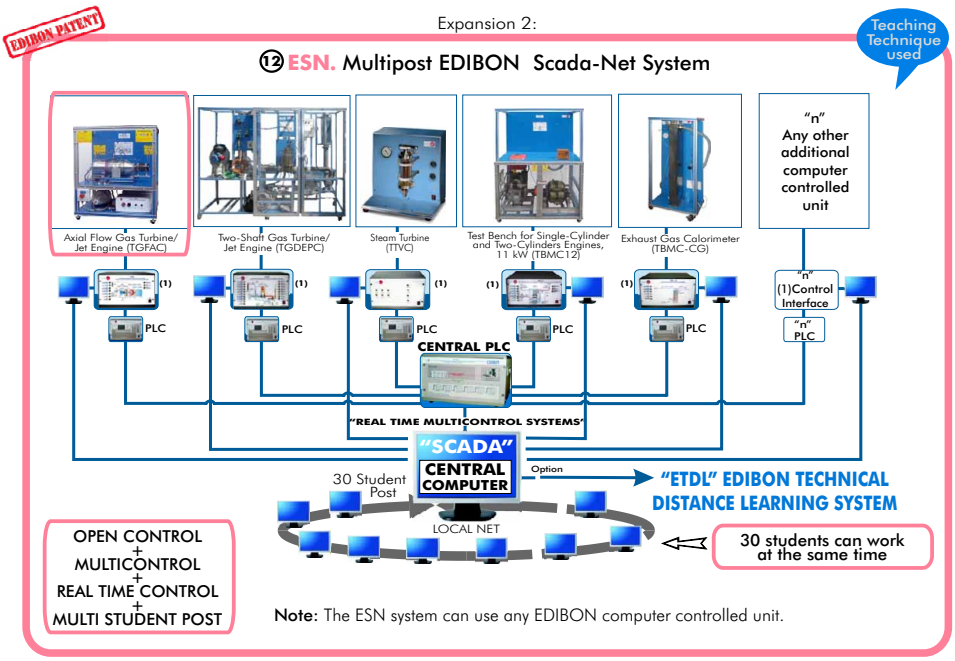
13.- Control of the TGFAC unit process through the control interface box without the computer.
14.- Visualization of all the sensors values used in the TGFAC unit process.
15.- Calibration of all sensors included in the TGFAC unit process.
16.- Hand on of all the actuators involved in the TGFAC unit process.
17.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
18.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
19.- PLC hardware general use and manipulation.
20.- PLC process application for TGFAC unit.
21.- PLC structure.
22.- PLC inputs and outputs configuration.
23.- PLC configuration possibilities.
24.- PLC program languages.
25.- PLC different programming standard languages (literal structured, graphic, etc.).
26.- New configuration and development of new process.
27.- Hand on an established process.
28.- To visualize and see the results and to make comparisons with the TGFAC unit process.
29.- Possibility of creating new process in relation with the TGFAC unit.
30.- PLC Programming Exercises.
31.- Own PLC applications in accordance with teacher and student requirements.

## POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS

Expansion 1:




Expansion 2:




## ORDER INFORMATION

### Items supplied as standard

**Minimum configuration** for normal operation includes:

① **Unit: TGFAC. Axial Flow Gas Turbine/Jet Engine.**
② **TGFAC/CIB. Control Interface Box.**
③ **DAB. Data Acquisition Board.**
④ **TGFAC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
⑤ **Cables and Accessories**, for normal operation.
⑥ **Manuals.**

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

### Complementary items to the standard supply

PLC. Industrial Control using PLC (7 and 8):

⑦ PCL-PI.PLC Module.
⑧ TGFAC/PLC-SOF. PLC Control Software.
⑨ TGFAC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).
⑩ TGFAC/FSS. Faults Simulation System. (Available on request).

Expansions

⑪ Mini ESN. Multipost EDIBON Mini Scada-Net System.
⑫ ESN. Multipost EDIBON Scada-Net System.

## REQUIRED SERVICES

- Electrical supply: single-phase, 220V./50Hz or 110V./60Hz.
- Fuel: kerosene, with 5% oil approx.
- Exhaust gases extractor.
- Computer (PC).

## DIMENSIONS & WEIGHTS

| | |
|---|---|
| TGFAC Unit: | -Dimensions: 700 x 500 x 800 mm. approx. |
| | -Weight: 70 Kg. approx. |
| Control Interface Box: | -Dimensions: 490 x 330 x 310 mm. approx. |
| | -Weight: 10 Kg. approx. |
| PLC Module (PLC-PI): | -Dimensions: 490 x 330 x 310 mm. approx. |
| | -Weight: 30 Kg. approx. |

✱ Specifications subject to change without previous notice, due to the convenience of improvements of the product.

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