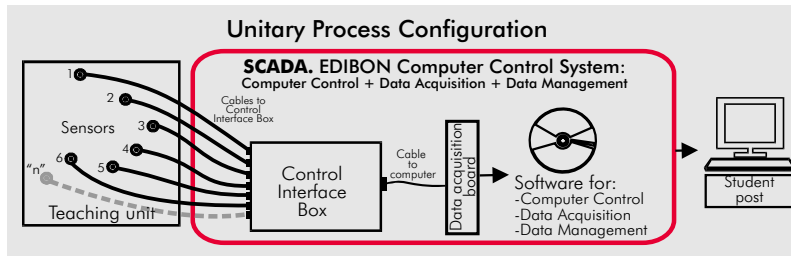
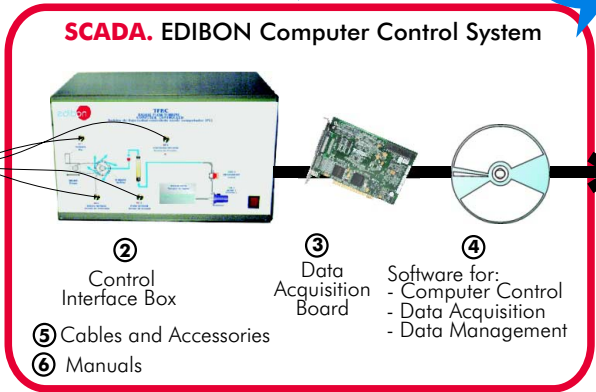


① Unit: TFRC. Radial Flow Turbine

Always included in the supply:

Teaching Technique used



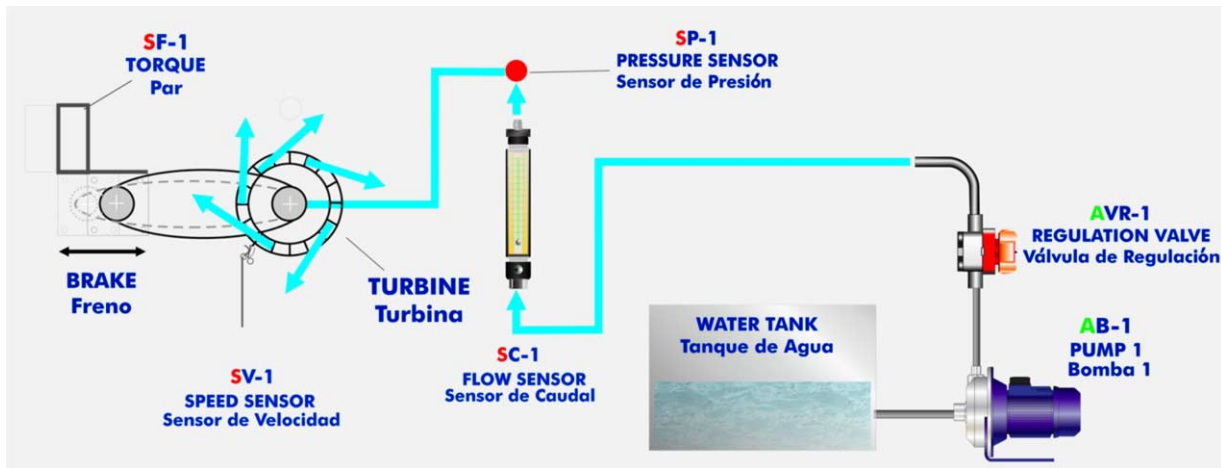
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- 8.-Fluid Mechanics & Aerodynamics

## PROCESS DIAGRAM AND ELEMENTS ALLOCATION

1 actuator and 4 sensors controlled from any computer, and working simultaneously

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



ISO:9001-2000 Certificate of Approval. Reg. No. E204034



European Union Certificate



Certificates ISO 14001: 2004 and ECO-Management and Audit Scheme (environmental management)



Worlddidac Quality Charter Certificate Worlddidac Member

## DESCRIPTION

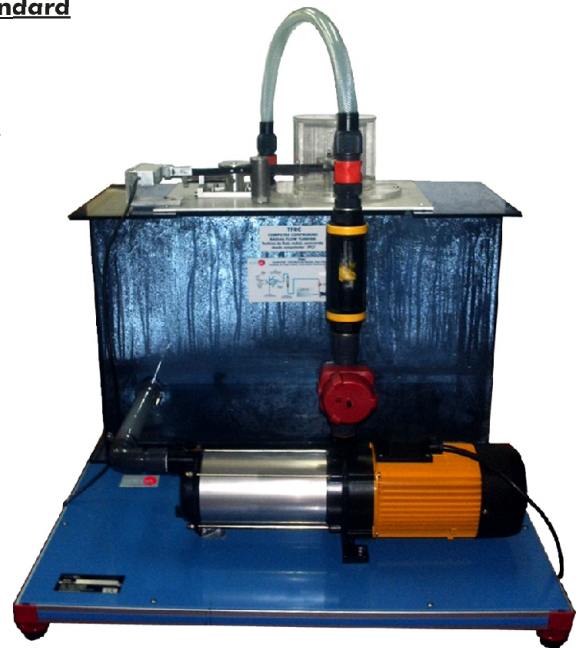
This unit consists of a Radial Turbine, with two nozzles at 90° degrees with respect to the perpendicular direction of the rotating axis. There is a pressure sensor placed at the water inlet of the turbine to measure the admission pressure. A band brake connected to a load cell allows varying the load given to the turbine by means of a connection device. A sensor determines the turbine velocity. 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 different parameters involved.

## SPECIFICATIONS

### Items supplied as standard

① **TFRC. Unit:**

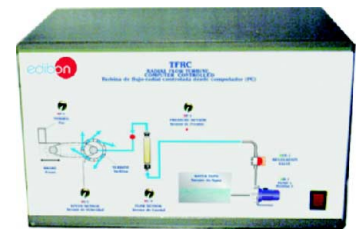
- Bench-top unit.
- Anodized aluminium structure and panels in painted steel.
- Main metallic elements in stainless steel.
- Diagram in the front panel with similar distribution that the elements in the real unit.
- Nozzle:
  - Inlet diameter: 21mm.
  - Outlet diameter: 4 mm.
  - Discharge angle: 180°.
- Turbine rotor:
  - External diameter: 69mm.
  - Internal diameter: 40mm.
  - Number of nozzle: 2.
  - Inlet angle of the nozzle: 180°.
  - Outlet angle of the nozzle: 180°.
  - Used material: Aluminium.
- Brake:
  - Pulley diameter: 60mm.
  - Effective radio: 50mm.
- Load cell: 0-2 Kg. Force sensor: 0-20N (maximum).
- Water pump, computer controlled:
  - Maximum Pressure: 7 bar.
  - Maximum Water Flow: 116 l/min at 2.4 bar.
  - Electrical Power: single-phase, 220 V.
  - Pressure sensor: 0 to 100 psi (0 to 6.7 bar).
  - Flow sensor: 0 to 150 l/min.
  - Speed sensor: 0 to 20000 rpm.
- Water transparent tank, capacity: 100 l. approx.



TFRC. Unit

② **TFRC/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 from -10V. to +10V computer output.
- Sensors connectors in the interface have different pins 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.



TFRC/CIB

③ **DAB. Data Acquisition Board:**

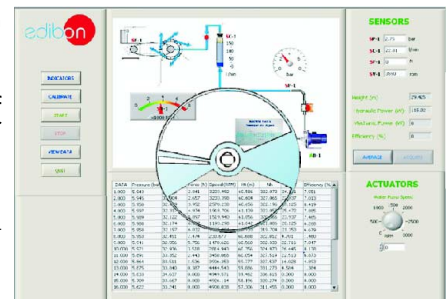
- PCI Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI.
- Analog input:
  - Number of channels = 16 single-ended or 8 differential. Resolution = 16 bits, 1 in 65536.
  - Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V) = ±10V.
  - Data transfers = DMA, interrupts, programmed I/O. Number of DMA channels = 6.
- Analog output:
  - Number of channels = 2. Resolution = 16 bits, 1 in 65536. Maximum output rate up to: 833 KS/s.
  - Output range (V) = ±10V. Data transfers = DMA, interrupts, programmed I/O.
- Digital Input/Output: Channels = 24 inputs/outputs. D0 or D1 Sample Clock frequency: 0 to 1 MHz.
- Timing: Counter/timers = 2. Resolution: Counter/timers: 32 bits.



DAB

④ **TFRC/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. Student calibration system for all 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.



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

Continue...

**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.

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 VAC).

DC input: 16 (24 VDC).

Relay output: 14 (250 VA 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).

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

For this particular unit, always included with PLC supply.



PLC-PI

**Items available on request**

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

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

Software Main Screens

Main screen

The main screen displays a hydraulic system diagram with components SF-1, SC-1, SP-1, and AB-1. It includes a control panel with buttons for INDICATORS, CALIBRATE, START, STOP, VIEW DATA, and QUIT. A data table is shown below the diagram, and a 'SENSORS' panel on the right displays real-time values for SP-1, SC-1, SF-1, and SV-1. An 'ACTUATORS' panel on the right shows a 'Water Pump Speed' control knob.

DATA	Pressure (bar)	Flow (l/min)	Force (N)	Speed (RPM)	Ht (m)	Nh	Nm	Efficiency (%) ▲
1.000	5.943	32.522	2.841	3203.992	60.586	322.073	24.321	7.551
2.000	5.945	33.004	2.657	3233.398	60.604	327.065	22.937	7.013
3.000	5.950	32.489	3.952	2570.238	60.656	322.196	27.125	8.419
4.000	5.997	32.317	4.974	1918.706	61.139	323.057	25.472	7.885
5.000	5.989	32.122	5.897	1519.940	61.056	320.666	23.937	7.465
6.000	5.988	32.174	6.317	1193.298	61.042	321.086	20.125	6.268
7.000	5.958	32.197	6.032	1325.984	60.733	319.704	21.353	6.679
8.000	5.953	32.451	7.474	233.677	60.688	322.012	4.701	1.460
9.000	5.941	32.556	5.756	1478.626	60.560	322.333	22.716	7.047
10.000	5.921	32.936	3.518	2814.943	60.356	324.970	26.445	8.138
11.000	5.891	33.352	2.443	3450.068	60.054	327.519	22.510	6.873
12.000	5.864	33.511	1.536	3906.353	59.777	327.537	16.028	4.893
13.000	5.875	33.840	0.387	4444.543	59.886	331.273	4.584	1.384
14.000	5.833	34.637	0.000	4949.571	59.462	336.815	0.000	0.000
15.000	5.709	33.667	0.000	4926.114	58.196	320.274	0.000	0.000
16.000	5.622	33.241	0.000	4900.038	57.306	311.455	0.000	0.000

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

Example of Sensors Calibration screen

The calibration screen for sensor SC-1 shows the following settings:

- Analog Input Channel: SC-1
- Sensor Name: SC-1
- Least Squares Fit: [Button]
- Gain: 7.35436
- Offset: -0.5593
- PTA: 10
- Volts: 4.948
- Calibrated: 35.83

On the right, the 'ACTUATORS' section shows a control knob for AB-1 (Water Pump Speed) with a scale from 0 to 10 and a current value of 5.

Continue...

Some typical exercises results

**SENSORS**

SP-1 4.44 bar  
 SC-1 66.45 l/min  
 SF-1 0.079 N  
 SV-1 6475.7 RPM

Height (m) 45.225  
 Hydraulic Power (W) 491.35  
 Mechanic Power (W) 1.39  
 Efficiency (%) 0.3

AVERAGING ACQUIRE

DATA	Pressure (bar)	Flow (l/min)	Force (N)	Speed (RPM)	Ht (m)	Nh	Nm	Eff
1.000	4.571	67.706	0.251	6395.616	46.595	515.820	4.262	0
2.000	4.534	67.277	0.539	6253.783	46.222	508.436	3.906	1
3.000	4.562	66.985	1.112	6019.030	46.503	509.242	17.851	3
4.000	4.556	67.167	1.138	5986.151	46.448	510.089	18.222	3
5.000	4.556	66.511	1.366	5786.428	46.449	505.059	21.096	4
6.000	4.726	63.383	8.252	1822.118	48.175	499.245	40.173	8
7.000	4.643	63.957	6.164	3160.941	47.327	494.894	52.021	11

**SENSORS**

SP-1 5.58 bar  
 SC-1 33.5 l/min  
 SF-1 0.644 N  
 SV-1 4447.6 rpm

Height (m) 56.05  
 Hydraulic Power (W) 315.05  
 Mechanic Power (W) 6.51  
 Efficiency (%) 2.1

AVERAGE ACQUIRE

DATA	Pressure (bar)	Flow (l/min)	Force (N)	Speed (RPM)	Ht (m)	Nh	Nm	Efficiency (%)
1.000	5.943	32.522	2.841	3203.992	60.586	322.073	24.321	7.561
2.000	5.945	33.004	2.657	3233.398	60.604	327.065	22.937	7.013
3.000	5.950	32.489	3.952	2570.238	60.656	322.196	27.125	8.419
4.000	5.997	32.317	4.974	1918.706	61.139	323.057	25.472	7.885
5.000	5.989	32.122	6.897	1519.940	61.056	320.666	23.937	7.465
6.000	5.988	32.174	6.317	1193.298	61.042	321.086	20.125	6.268
7.000	5.958	32.197	6.032	1325.984	60.733	319.704	21.353	6.679
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12.000	5.864	33.511	1.536	3906.353	59.777	327.537	16.028	4.893
13.000	5.875	33.840	0.387	4444.543	59.886	331.273	4.594	1.384
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15.000	5.709	33.667	0.000	4926.114	58.196	320.274	0.000	0.000
16.000	5.622	33.241	0.000	4900.038	57.306	311.455	0.000	0.000

**m.w.c.**

63.866210

X axis quantity: SP-1 SC-1 SF-1 SV-1 Ht Nh Nm Eff(%)

Y axis quantity: SP-1 SC-1 SF-1 SV-1 Ht Nh Nm Eff(%)

Enlarge Active Plot

**m.w.c.**

40.611621  
33.673123  
27.875081  
14.263311

X axis quantity: SP-1 SC-1 SF-1 SV-1 Ht Nh Nm Eff(%)

Y axis quantity: SP-1 SC-1 SF-1 SV-1 Ht Nh Nm Eff(%)

Enlarge Active Plot

**m.w.c.**

40.611621  
33.673123  
27.875081  
14.263311

X axis quantity: SP-1 SC-1 SF-1 SV-1 Ht Nh Nm Eff(%)

Y axis quantity: SP-1 SC-1 SF-1 SV-1 Ht Nh Nm Eff(%)

Enlarge Active Plot

## EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

- 1.- Determination of the curves  $M(n, H_0)$ ,  $N(n, H_0)$ ,  $\eta(n, H_0)$ .
- 2.- Determination of the curves  $M(n, Q)$ ,  $N_m(n, Q)$ ,  $\eta(n, Q)$ .
- 3.- Adimensional analysis.
- 4.- Sensors calibration.

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

- 5.- Control of the TFRC unit process through the control interface box without the computer.
- 6.- Visualization of all the sensors values used in the TFRC unit process.
- 7.- Calibration of all sensors included in the TFRC unit process.
- 8.- Hand on of all the actuators involved in the TFRC unit process.
- 9.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
- 10.- 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).
- 11.- PLC hardware general use and manipulation.
- 12.- PLC process application for TFRC unit.
- 13.- PLC structure.
- 14.- PLC inputs and outputs configuration.

15.- PLC configuration possibilities.

16.- PLC program languages.

17.- PLC different programming standard languages (literal structured, graphic, etc.).

18.- New configuration and development of new process.

19.- Hand on an established process.

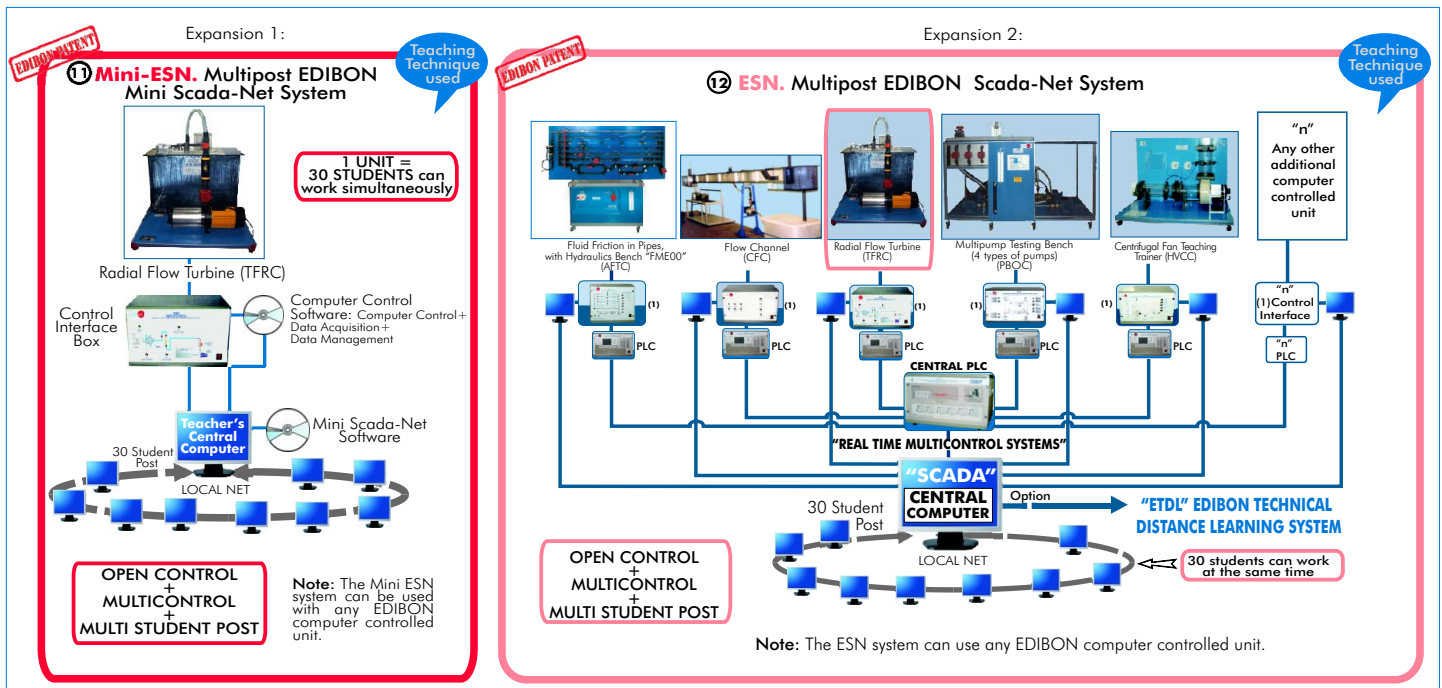
20.- To visualize and see the results and to make comparisons with the TFRC unit process.

21.- Possibility of creating new process in relation with the TFRC unit.

22.- PLC Programming Exercises.

23.- Own PLC applications in accordance with teacher and student requirements.

## POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS



## ORDER INFORMATION

### Items supplied as standard

Minimum configuration for normal operation includes:

- ① Unit: TFRC. Radial Flow Turbine.
- ② TFRC/CIB. Control Interface Box.
- ③ DAB. Data Acquisition Board.
- ④ TFRC/CSOF. Computer Control + Data Acquisition + Data Management Software.
- ⑤ Cables and Accessories, for normal operation.
- ⑥ Manuals.

**\* IMPORTANT: Under TFRC 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 TFRC/PLC-SOF. PLC Control Software.
  - ⑨ TFRC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).
  - ⑩ TFRC/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, 220 V/50Hz or 110 V/60 Hz.
- Water supply and drainage.
- Computer (PC).

## DIMENSIONS & WEIGHTS

- TFRC Unit: -Dimensions: 800x900x800 mm. approx.  
-Weight :80 Kg. approx.
- Control Interface Box: -Dimensions: 490x330x310 mm. approx.  
-Weight: 10 Kg. approx.
- PLC Module (PLC-PI): -Dimensions: 490x330x310 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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Issue: ED01/09  
Date: March/2009

REPRESENTATIVE: