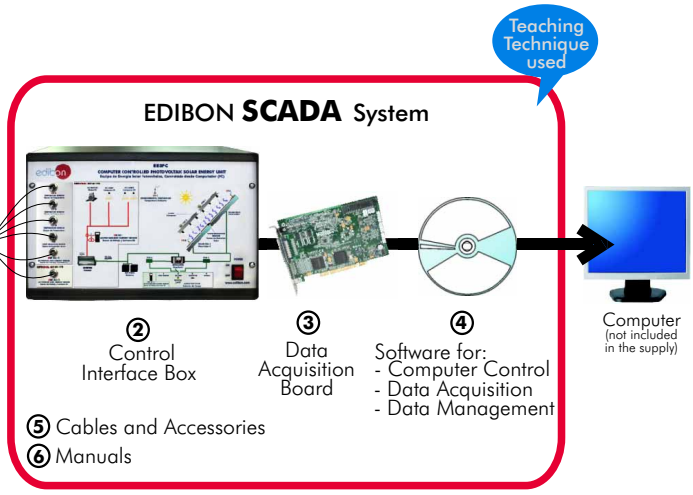
edibon
Technical Teaching Equipment

Computer Controlled **Photovoltaic Solar Energy Unit,** with SCADA

EESFC

EDIBON PATENT



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

① Unit: EESFC. Photovoltaic Solar Energy Unit

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

Key features:

- **Advanced Real Time SCADA.**
- **Open Control + Multicontrol + Real Time Control.**
- **Own Control Software based on Labview.**
- **National Instruments Data Acquisition board (250 KS/s (kilo samples per second)).**
- **Calibration exercises included.**
- **Students multipost (an entire class) by using a projector.**
- **Ready for doing applied research, real industrial simulation, training courses possibilities, etc.**
- **Unit is totally safe (Mechanical, Electronic/Electrical and Software safety devices included).**
- **Results calculation and analysis software (CAL).**
- **Several future expansions, as ESN. EDIBON Scada-Net System (many students working simultaneously), and more.**
- **Designed and manufactured under several quality standards.**

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Products
Products range
Units
5.-Energy

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

European Union Certificate
(total safety)

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

Worlddidac Quality Charter Certificate
(Worlddidac Member)

GENERAL DESCRIPTION

"EESFC" is a computer controlled unit for the study of the transformation of solar energy in electric energy.

This unit uses the photoconversion solar system for the direct conversion of solar radiation into electricity. The absorbed energy is provided by simulated solar radiation; in our case, this is done by means of a panel with powerful light sources.

Basically it is formed by:

- Photovoltaic Solar Panels.
- Solar Simulator formed by solar lamps.
- DC Load and Battery Charger Regulator.
- Auxiliary battery charger.
- Battery.
- DC Loads Module.
- Sensors (temperature, light radiation, DC current and DC voltage).
- EDIBON Computer Control System (SCADA).

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 and Data Acquisition Software Packages, for controlling the process and all parameters involved in the process.

Optional (NOT included in the minimum supply):

- EE-KIT. Kit of Conversion and Consumption Simulation (AC):

  Single-phase inverter.

  AC Loads Module:

  Lamps of 220V-240V, 50-60Hz, 15W; Fan of 230V; and 4 Positions selector.

  AC voltage and current sensors.

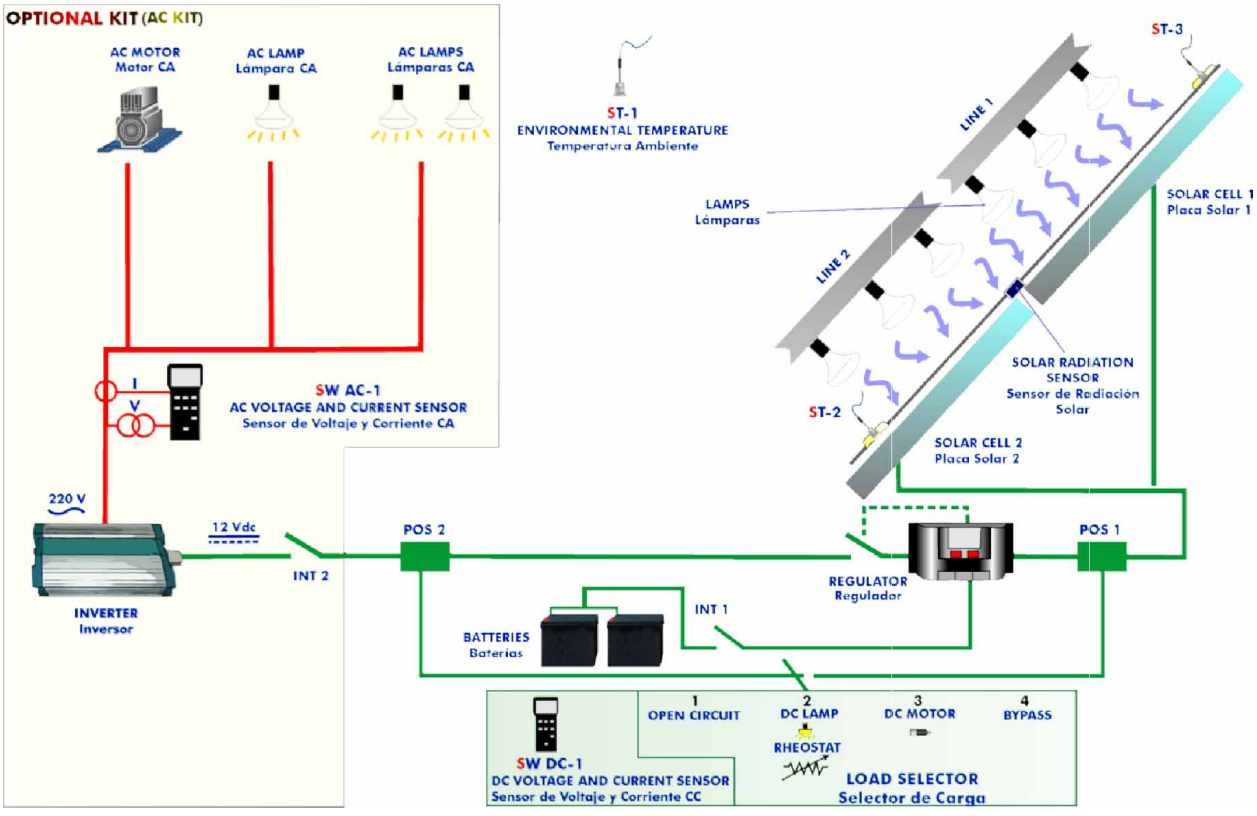
- EE-KIT2. Grid Connection Inverter Kit:

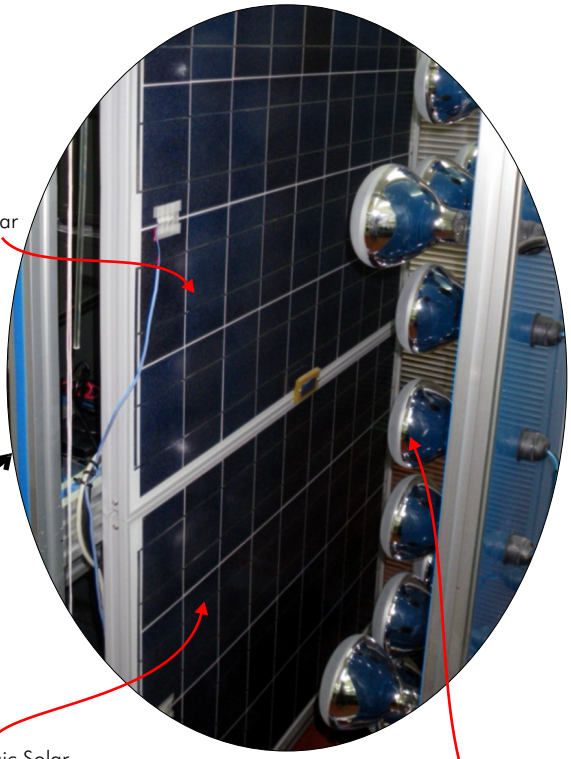
  Grid Connection Inverter.

  Energy Generation Simulator.

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL





Photovoltaic Solar Panel

Photovoltaic Solar Panel

Solar Lamps Panel

DC Load and Battery Charger Regulator

DC Loads Module

Auxiliary battery charger

AC Loads Module (optional EE-KIT)

Inverter (optional EE-KIT)

With this unit there are several options and possibilities:
- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8, 9, 10, 11 and 12.

Let us describe first the main items (1 to 6):

① EESFC. Unit:

Anodized aluminium structure and panels in painted steel.
Diagram in the front panel with similar distribution to the elements in the real unit.
2 Photovoltaic solar panels (polycrystallines):
Crystal modules with high level of transmissivity.
Encapsulater etil-viniloacetatum modified.
Frame made of aluminium.
Solar simulator:
Aluminium structure adjustable in horizontal position.
11 Solar spectrum lamps of 300W each one, distributed in two independent voltage regulated circuits.
Electrical safety, constituted by three-phase magneto thermal protection.
Supply cables.
Ventilation system that allows us to analyze the temperature influence on the system performance operation.
DC Load and Battery Charger Regulator:
DC Load regulation. PWM regulation. Staggered charge. Quick charge.
Floating charge. Under-voltage disconnection and warning messages.
Reconnection. Over-voltage disconnection. High temperature protection.
Batteries high voltage protection. Load and module over-current protection.
Solar panels, batteries and load inverse polarity protection.
Inverse current flow protection. Solar panels open-circuit over-voltage protection.
Auxiliary battery charger.
Battery: Deep cycle charge battery. Plates with active materials of high density. 24 Amp/hour.
DC Loads Module:
Metallic box. Diagram on the front panel.
DC lamps of 12Vdc. DC motor of 24-36Vdc. Rheostat of 300W.
Variable measurement point controlled from the computer.
Independent connection for every load with the help of the 4 Positions selector:
With the load selector in position 1, solar panels operate at open-circuit voltage.
With the load selector in position 2, the rheostat and the lamps are directly connected to the solar panels, depending on the selection made in the computer. These loads can connect independently or in parallel with the help of manual switches.
With the load selector in position 3, the DC motor is directly connected to the solar panels.
With the load selector in position 4, no DC load is connected and the solar panels connect directly to the batteries charge regulator.
Sensors:
3 Temperature sensors (one in the solar panel 1, other in the solar panel 2 and another of room temperature).
Light radiation sensor. DC current sensor and DC voltage sensor.
This unit incorporates wheels for its mobility.
The complete unit includes as well:

Advanced Real Time SCADA.
Open Control + Multicontrol + Real Time Control.
Own Control Software based on Labview.
National Instruments Data Acquisition board (250 KS/s (kilo samples per second)).
Calibration exercises included.
Students multipost (an entire class) by using a projector.
Ready for doing applied research, real industrial simulation, training courses possibilities, etc.
Unit is totally safe (Mechanical, Electronic/Electrical and Software safety devices included).
Results calculation and analysis software (CAL).
Several future expansions, as ESN. EDIBON Scada-Net System (many students working simultaneously), and more.
Designed and manufactured under several quality standards.

EESFC. Unit

Optional (NOT included in the minimum supply):
-EE-KIT. Kit of Conversion and Consumption Simulation (AC):
Single-phase inverter.
AC Loads Module:
Lamps of 220V-240V, 50-60Hz, 15W; Fan of 230V; and 4 Positions selector.
AC voltage and current sensors.
-EE-KIT2. Grid Connection Inverter Kit:
Grid Connection Inverter.
Energy Generation Simulator.
See section "Optional" in page 7.

② EESFC/CIB. Control Interface Box:

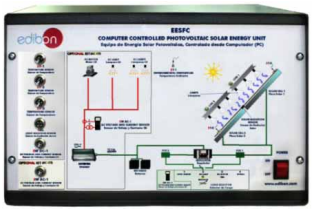
The Control Interface Box is part of the SCADA system.

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.



EESFC/CIB

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, resistances, 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.

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

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

DAB

Analog output:

Number of **channels=2. Resolution=16 bits**, 1 in 65536. Maximum output rate up to: 833 KS/s.

Output range(V)=±10 V. 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.

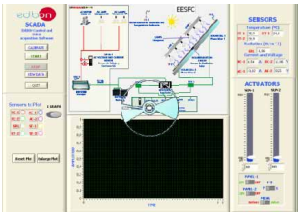
Timing: Number of **Counter/timers=2**. Resolution: Counter/timers: 32 bits.

④ EESFC/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.



EESFC/CCSOF

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 blackboard.

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

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH MAIN ITEMS

1.- Determination of the typical parameters of the solar panels.
2.- Study of the existing relation between generated power and power of solar radiation.
3.- Study of the solar panels maximum performance.
4.- Study of the influence of the temperature on the tension of circuit opened of the solar panels.
5.- Study of the behaviour of the solar panels connected in parallel.
6.- Study of the behaviour of the solar panels connected in series.
7.- Study of the behaviour of the system connected in parallel depending on temperature.
8.- Lamps illumination profile study.
9.- Efficiency experimental determination.
10.- Influence of the angle of incidence on the temperature.
11.- Determination of the material that makes up the solar cell.
12.- Determination of the p and n side of a solar cell.
13.- Determination of the first quadrant of the I-V curve, without illumination of the solar cell.
14.- Determination of the inverse current or the saturation current with regard to a solar cell without illumination.
15.- Determination of the resistance in series and in parallel of a solar cell without illumination.
16.- Dependence of the voltage of open circuit (V_{oc}) with the lumens.
17.- Determination the characteristic parameters of a solar cell with illumination.
18.- Relation of the maximum power with the power input.
19.- Determination of the parameters that define the quality of a solar cell.
20.- Solar energy measurement.
21.- Measurement of the solar panel voltage in vacuum.
22.- Determination of the cells disposition in a solar panel.
23.- Measurement of the maximum power for a solar panel with load.
24.- Measurement of the solar panel voltage in vacuum with constant illumination and different temperature.
25.- Study of V,I,W according to different loads.
26.- Familiarization with the regulator parameters.
27.- Study of functionality of the photovoltaic system series/parallel with connection of different loads and without the support of the storage battery.
28.- Study of functionality of the photovoltaic system series/paralell with connection of different loads DC and with the support of the storage battery.
29.- Connection of loads to direct voltage.

Other possible practices:

30.- Sensors calibration.

Practices to be done with the OPTIONAL KIT "EE-KIT":

31.- Study of functionality of the photovoltaic system series/parallel with connection of different loads and without the support of the storage battery.
32.- Study of functionality of the photovoltaic system series/paralell with connection of different loads AC and with the support of the storage battery.
33.- Connection of loads to alternating voltage of 220 V.

Practices to be done with the OPTIONAL KIT "EE-KIT2":

34.- Study of the grid utility inverter.

Other possibilities to be done with this Unit:

35.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic blackboard.
36.- Open Control, Multicontrol and Real Time Control.
This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivate parameters; etc in real time.
37.- The Computer Control System with SCADA allows a real industrial simulation.
38.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
39.- This unit can be used for doing applied research.
40.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
41.- Control of the EESFC unit process through the control interface box without the computer.
42.- Visualization of all the sensors values used in the EESFC unit process.

- By using PLC-PI additional 19 more exercises can be done.
- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: three phase, 400V/50-60Hz, and minimum power 5 kVA.
- Computer (PC).

DIMENSIONS & WEIGHTS

EESFC. Unit: -Dimensions: 2200 x 1200 x 2005 mm. approx.
-Weight: 300 Kg. approx.
Control Interface Box: -Dimensions: 490 x 330 x 310 mm. approx.
-Weight: 10 Kg. approx.

OPTIONAL

- EE-KIT. Kit of Conversion and Consumption Simulation (AC):
  Single-phase inverter.
  AC Loads Module:
  Lamps of 220V-240V, 50-60Hz,15W; Fan of 230V; and 4 Positions selector.
  AC voltage and current sensors.

- EE-KIT2. Grid Connection Inverter Kit:
  Grid Connection Inverter.
  Energy Generation Simulator.

- PSA/PC. Polycrystalline photovoltaic solar panel. (2 units)

- PSA/MC. Monocrystalline photovoltaic solar panel. (2 units)

- PSA/AM. Amorphous photovoltaic solar panel. (2 units)

AVAILABLE VERSIONS

Offered in this catalogue:

-EESFC. Computer Controlled Photovoltaic Solar Energy Unit.

Offered in other catalogues:

-EESFB. Photovoltaic Solar Energy Unit.
-MINI-EESF. Photovoltaic Solar Energy Modular Trainer.

EE-KIT. Kit of Conversion and Consumption Simulation (AC):

- Single-phase inverter:

  Single-phase.

  25 kHz switch mode technology.

  Start-up power of 200%.

  Short-circuits protection.

  High temperature protection.

  Overcharge protection.

  Operation state LED indicator.

  Rear connection/disconnection switch.

Inverter

- AC Loads Module:

  Metallic box.

  Diagram in the front panel.

  Fan of 230V.

  Lamps of 220V - 240V., 50-60 Hz., 15W.

  Independent connection for every load with the help of the 4 Positions selector:

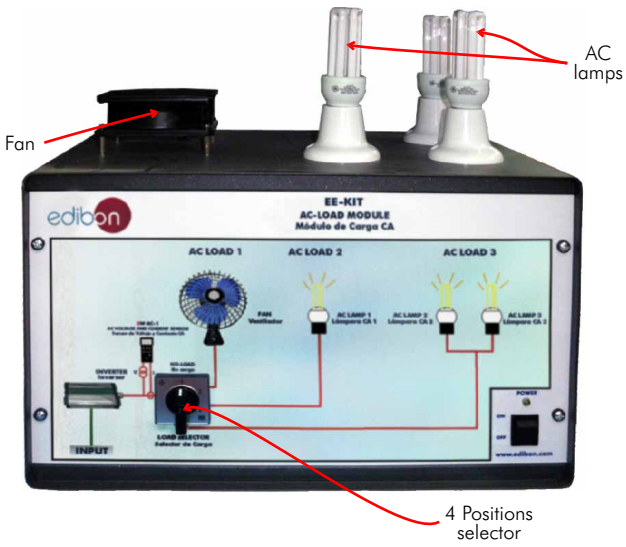
  -With the load selector in position 1, the inverter operates without load.

  -With the load selector in position 2, the fan motor is connected.

  -With the load selector in position 3, one AC lamp is connected.

  -With the load selector in position 4, two AC lamps are connected in parallel.

AC Loads Module



- AC voltage and current sensors.

EE-KIT2. Grid Connection Inverter Kit:

Inverter used for the conversion and injection to the grid of the power generated by a simulated source of renewable energy. The simulated source is a simulator used to obtain a variable power to be injected to the grid.

The operation mode is displayed by means of a LED indicator at the front side of the housing.

It is equipped with extensive safety measures to ensure that it switches off immediately as soon as the AC plug is removed from the wall socket or the public grid fails in operation.

The inverter can be connected to a PC through RS232 communication to display some parameters such as voltage and current inputs, mains voltage and frequency, maximum AC power, Kwh, etc.

- Grid Connection Inverter:

  Input (DC):

  Nominal power @ 25°C: 200 W.

  Maximum power @ 25°C: 250 W.

  PV power: 160-300 Wp.

  MPP voltage: 40-75V DC.

  Maximum voltage: 155V DC.

  Nom. rated current: 4A.

  Output (AC):

  Voltage: 85% ~ 110% Un (195-253 V).

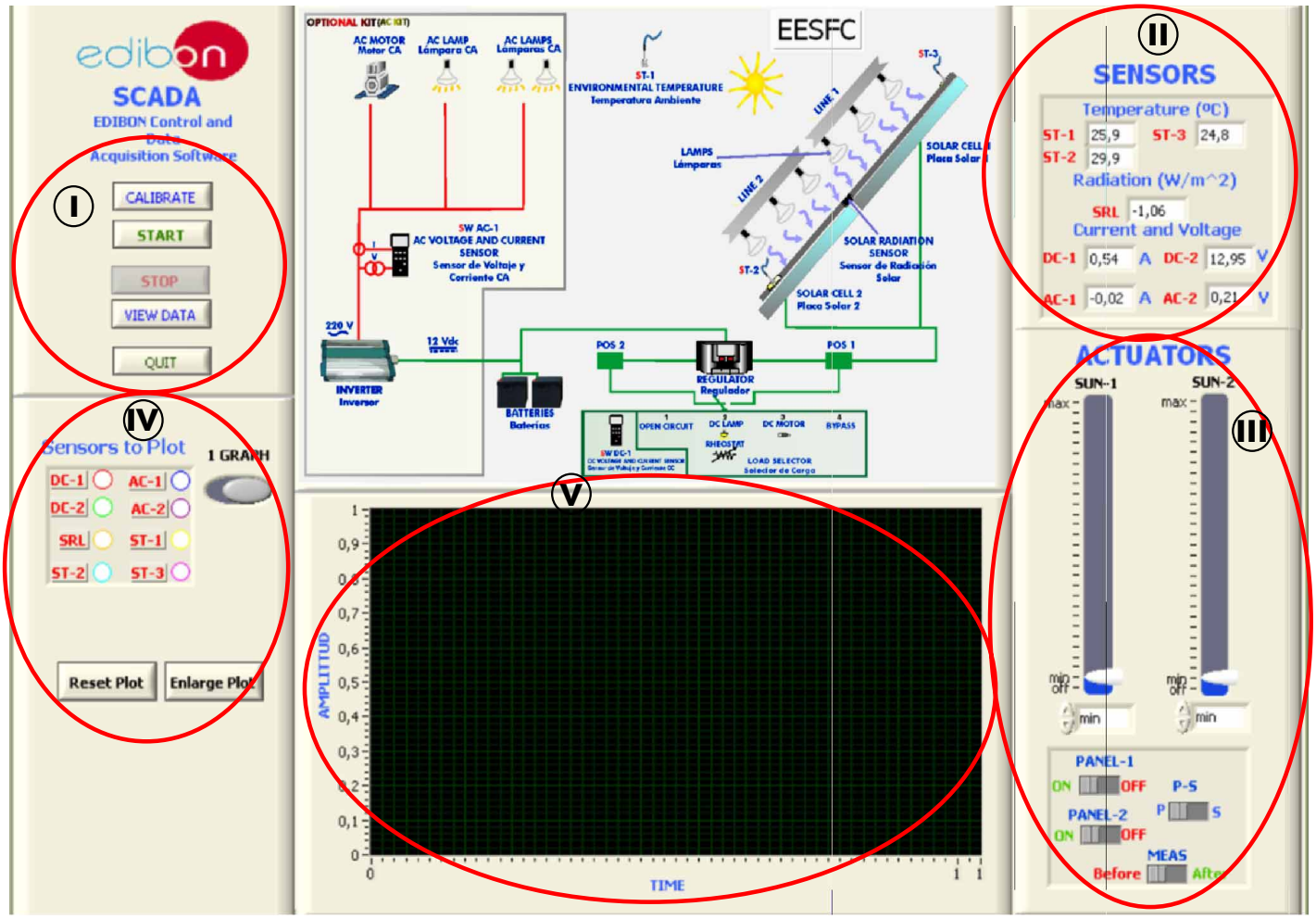
  Nominal power: 140 W.

  Maximum power/fuse: 2.25 A / 3.15 A.

  Frequency: 49.5 ~ 50.5 Hz.

- Energy Generation Simulator.

SCADA
Main screen



Ⓘ Main Controls.

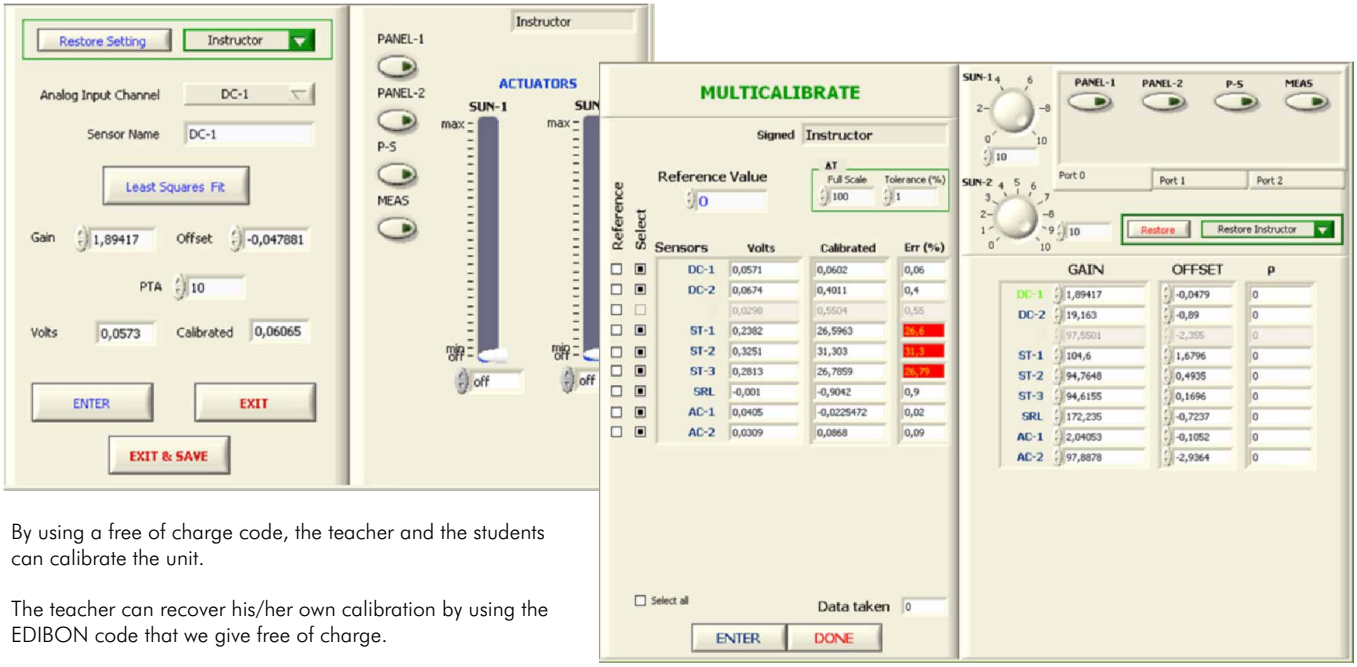
Ⓘⓘ Sensors displays and extra output parameters. Sensors: ST= Temperature sensor. SRL= Radiation sensor. DC-1= DC current sensor. DC-2= DC voltage sensor. AC-1= AC current sensor. AC-2= AC voltage sensor.

Ⓘⓘⓘ Actuators controls.

Ⓘⓥ Channel selection and other plot parameters.

Ⓥ Graphical Display.

Software for Sensors Calibration



By using a free of charge code, the teacher and the students can calibrate the unit.

The teacher can recover his/her own calibration by using the EDIBON code that we give free of charge.

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 12.
All these items try to give more possibilities for:

a) Industrial configuration. (PLC)
b) Technical and Vocational Education configuration. (CAI and FSS)
c) Higher Education and/or Technical and Vocational Education configuration. (CAL)
d) Multipost Expansions options. (Mini ESN and ESN)

a) Industrial configuration

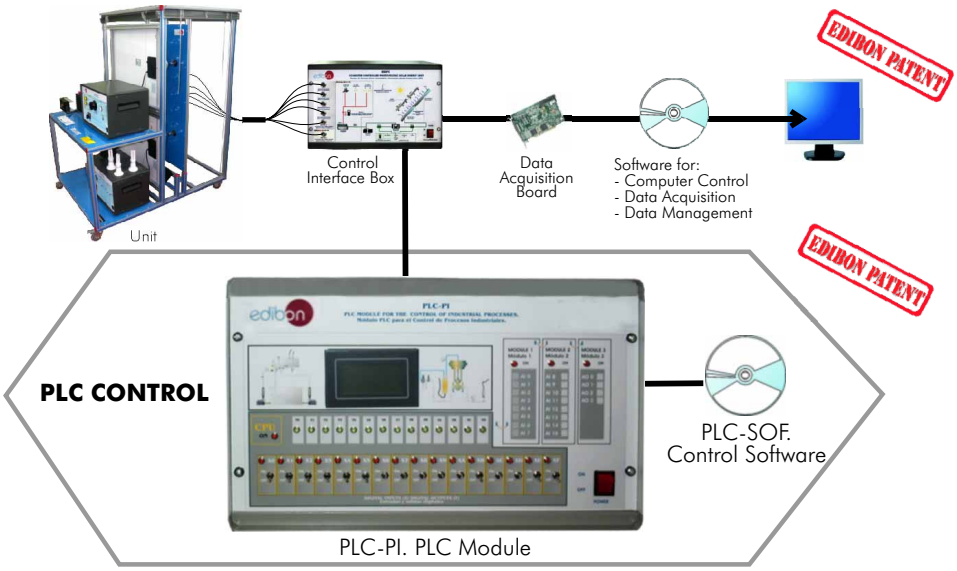
⑦ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

-**PLC-PI. PLC Module:**

Metallic box.
Circuit diagram in the module 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 (-10 V. to + 10 V.) (through SCSI connector).
Analog outputs block:
4 Analog outputs (-10 V. to + 10 V.) (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.
Power supply input (100 to 240 V AC).
DC input: 16 (24 V DC).
Relay output: 14.
High-speed counter.
Multi-point PID control.
Digital inputs/outputs and analog inputs/outputs Panasonic modules.
Communication RS232 wire to computer (PC).
Dimensions: 490 x 330 x 310 mm. approx. Weight: 30 Kg. approx.

-**EESFC/PLC-SOF. PLC Control Software:**

For this particular unit, always included with PLC supply.
The software has been designed using Labview and it follows the unit operation procedure and linked with the Control Interface Box used in the Computer Controlled Photovoltaic Solar Energy Unit (EESFC).



Practices to be done with PLC-PI:

1.- Control of the EESFC unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the EESFC unit process.
3.- Calibration of all sensors included in the EESFC unit process.
4.- Hand on of all the actuators involved in the EESFC unit process.
5.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
6.- Simulation of outside actions, in the cases hardware elements do not exist. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
7.- PLC hardware general use and manipulation.
8.- PLC process application for EESFC unit.
9.- PLC structure.
10.- PLC inputs and outputs configuration.
11.- PLC configuration possibilities.
12.- PLC programming languages.
13.- PLC different programming standard languages.
14.- New configuration and development of new process.
15.- Hand on an established process.
16.- To visualize and see the results and to make comparisons with the EESFC unit process.
17.- Possibility of creating new process in relation with the EESFC unit.
18.- PLC Programming exercises.
19.- Own PLC applications in accordance with teacher and student requirements.

⑧ EESFC/CAI. Computer Aided Instruction Software System.

This complete package included two Softwares: the INS/SOF. Classroom Management Software (Instructor Software) and the EESFC/SOF. Computer Aided Instruction Software (Student Software).

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

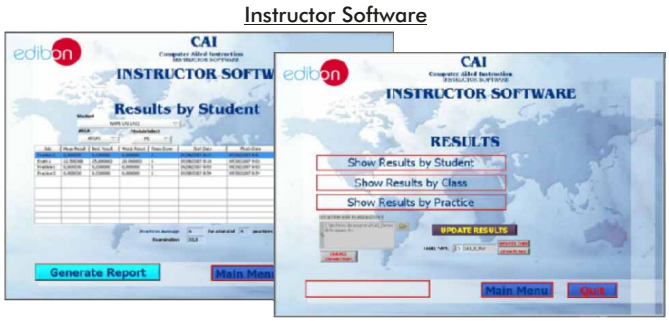
This complete package consists on an Instructor Software (INS/SOF) totally integrated with the Student Software (EESFC/SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students. These, on the other hand, get a virtual instructor who helps them to deal with all the information on the subject of study.

- INS/SOF. Classroom Management Software (Instructor Software):

The Instructor can:

Organize Students by Classes and Groups.
Create easily new entries or delete them.
Create data bases with student information.
Analyze results and make statistical comparisons.
Print reports.
Develop own examinations.
Detect student's progress and difficulties.
...and many other facilities.

Instructor Software



- EESFC/SOF. Computer Aided Instruction Software (Student Software):

It explains how to use the unit, run the experiments and what to do at any moment.

This Software contains:

Theory.
Exercises.
Guided Practices.
Exams.

Student Software

For more information see **CAI** catalogue. Click on the following link:
www.edibon.com/products/catalogues/en/CAI.pdf

⑨ EESFC/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 on 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 canals interchange at any time during the program execution.
- Response reduction of an actuator.

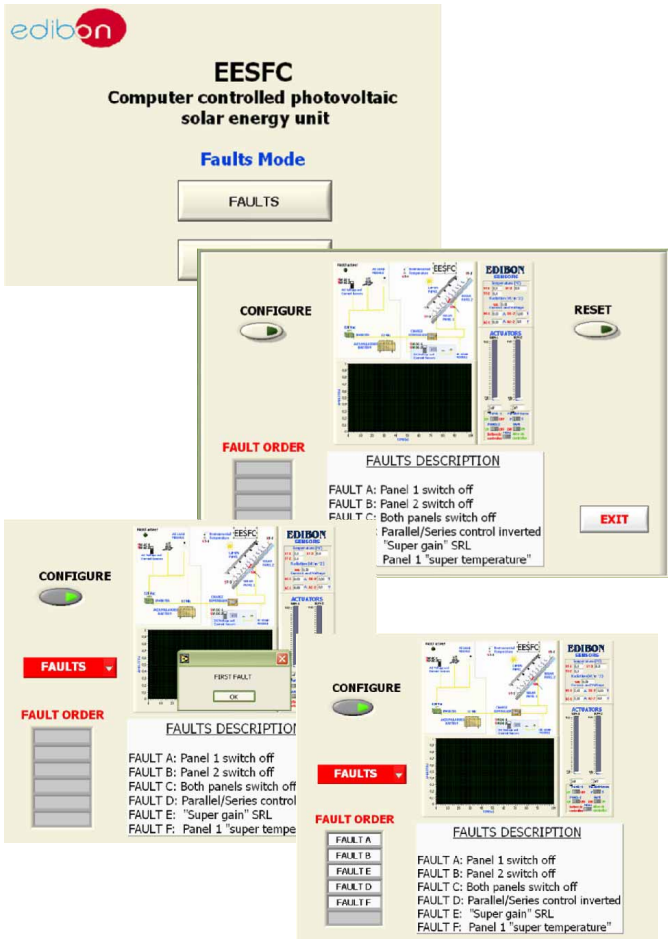
Faults in the controls execution:

- 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/products/catalogues/en/FSS.pdf

c) Higher Education and/or Technical and Vocational Education configuration

⑩ EESFC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

This Computer Aided Learning Software (CAL) is a Windows based software, simple and very easy to use, specifically developed by EDIBON. It is very useful for Higher Education level.

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.

CAL computes the value of all the variables involved.

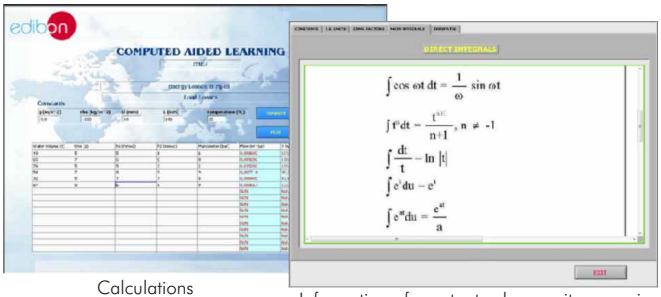
It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

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

www.edibon.com/products/catalogues/en/CAL.pdf



Calculations

Information of constant values, unit conversion factors and integral and derivative tables

Plotting options

d) Multipost Expansions options

⑪ Mini ESN. EDIBON Mini Scada-Net System.

Mini ESN. EDIBON Mini Scada-Net System allows 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 on 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:

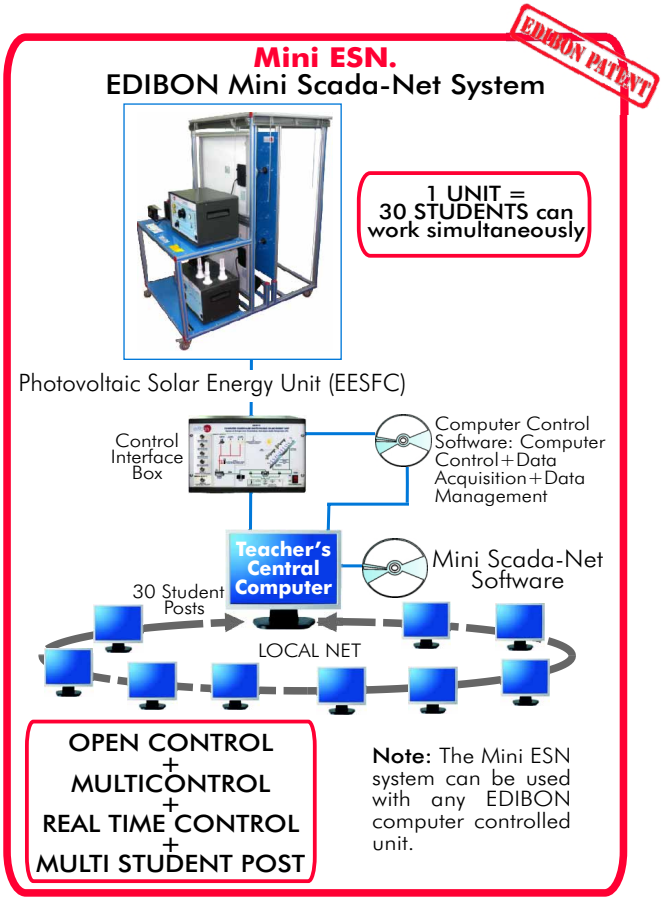
- **It allows 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.**
- **Open Control + Multicontrol + Real Time Control + Multi Student Post.**
- **Teacher controls and explains to all students at the same time.**
- **Any user/student can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

Main advantages:

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

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

www.edibon.com/products/catalogues/en/Mini-ESN.pdf



⑫ ESN. EDIBON Scada-Net System.

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

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

www.edibon.com/products/catalogues/en/units/energy/esn-alternativeenergies/ESN-ALTERNATIVE_ENERGIES.pdf

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: EESFC. Photovoltaic Solar Energy Unit.**

② **EESFC/CIB. Control Interface Box.**

③ **DAB. Data Acquisition Board.**

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

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

⑥ **Manuals.**

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

Optional items (supplied under specific order)

a) Industrial configuration

⑦ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

- PCL-PI. PLC Module.
- EESFC/PLC-SOF. PLC Control Software.

b) Technical and Vocational configuration

⑧ EESFC/CAI. Computer Aided Instruction Software System.

⑨ EESFC/FSS. Faults Simulation System.

c) Higher Education and/or Technical and Vocational Education configuration

⑩ EESFC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

d) Multipost Expansions options

⑪ Mini ESN. EDIBON Mini Scada-Net System.

⑫ ESN. EDIBON Scada-Net System.

① EESFC. Unit:

Anodized aluminium structure and panels in painted steel.
Diagram in the front panel with similar distribution to the elements in the real unit.
2 Photovoltaic solar panels (polycrystallines):
Crystal modules with high level of transmissivity.
Encapsulater etil-viniloacetatum modified.
Frame made of aluminium.
Solar simulator:
Aluminium structure adjustable in horizontal position.
11 Solar spectrum lamps of 300W each one, distributed in two independent voltage regulated circuits.
Electrical safety, constituted by three-phase magneto thermal protection.
Supply cables.
Ventilation system that allows us to analyze the temperature influence on the system performance operation.
DC Load and Battery Charger Regulator:
DC Load regulation. PWM regulation. Staggered charge. Quick charge.
Floating charge. Under-voltage disconnection and warning messages.
Reconnection. Over-voltage disconnection. High temperature protection.
Batteries high voltage protection. Load and module over-current protection.
Solar panels, batteries and load inverse polarity protection.
Inverse current flow protection. Solar panels open-circuit over-voltage protection.
Auxiliary battery charger.
Battery: Deep cycle charge battery. Plates with active materials of high density. 24 Amp/hour.
DC Loads Module:
Metallic box. Diagram on the front panel.
DC lamps of 12Vdc. DC motor of 24-36Vdc. Rheostat of 300W.
Variable measurement point controlled from the computer.
Independent connection for every load with the help of the 4 Positions selector:
With the load selector in position 1, solar panels operate at open-circuit voltage.
With the load selector in position 2, the rheostat and the lamps are directly connected to the solar panels, depending on the selection made in the computer. These loads can connect independently or in parallel with the help of manual switches.
With the load selector in position 3, the DC motor is directly connected to the solar panels.
With the load selector in position 4, no DC load is connected and the solar panels connect directly to the batteries charge regulator.
Sensors:
3 Temperature sensors (one in the solar panel 1, other in the solar panel 2 and another of room temperature).
Light radiation sensor. DC current sensor and DC voltage sensor.
This unit incorporates wheels for its mobility.
The complete unit includes as well:
Advanced Real Time SCADA.
Open Control + Multicontrol + Real Time Control.
Own Control Software based on Labview.
National Instruments Data Acquisition board (250 KS/s (kilo samples per second)).
Calibration exercises included.
Students multipost (an entire class) by using a projector.
Ready for doing applied research, real industrial simulation, training courses possibilities, etc.
Unit is totally safe (Mechanical, Electronic/Electrical and Software safety devices included).
Results calculation and analysis software (CAL).
Several future expansions, as ESN. EDIBON Scada-Net System (many students working simultaneously), and more.
Designed and manufactured under several quality standards.

Optional (NOT included in the minimum supply):
-EE-KIT. Kit of Conversion and Consumption Simulation (AC):
Single-phase inverter.
AC Loads Module:
Lamps of 220V-240V, 50-60Hz, 15W; Fan of 230V; and 4 Positions selector.
AC voltage and current sensors.
-EE-KIT2. Grid Connection Inverter Kit:
Grid Connection Inverter.
Energy Generation Simulator.

② EESFC/CIB. Control Interface Box:

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

③ DAB. Data Acquisition Board:

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

④ EESFC/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 blackboard.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals: This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Exercises and Practical Possibilities to be done with Main Items

1.- Determination of the typical parameters of the solar panels.
2.- Study of the existing relation between generated power and power of solar radiation.
3.- Study of the solar panels maximum performance.
4.- Study of the influence of the temperature on the tension of circuit opened of the solar panels.
5.- Study of the behaviour of the solar panels connected in parallel.
6.- Study of the behaviour of the solar panels connected in series.
7.- Study of the behaviour of the system connected in parallel depending on temperature.
8.- Lamps illumination profile study.
9.- Efficiency experimental determination.
10.- Influence of the angle of incidence on the temperature.
11.- Determination of the material that makes up the solar cell.
12.- Determination of the p and n side of a solar cell.
13.- Determination of the first quadrant of the I-V curve, without illumination of the solar cell.
14.- Determination of the inverse current or the saturation current with regard to a solar cell without illumination.
15.- Determination of the resistance in series and in parallel of a solar cell without illumination.
16.- Dependence of the voltage of open circuit (V_{oc}) with the lumens.
17.- Determination the characteristic parameters of a solar cell with illumination.
18.- Relation of the maximum power with the power input.
19.- Determination of the parameters that define the quality of a solar cell.
20.- Solar energy measurement.
21.- Measurement of the solar panel voltage in vacuum.
22.- Determination of the cells disposition in a solar panel.
23.- Measurement of the maximum power for a solar panel with load.
24.- Measurement of the solar panel voltage in vacuum with constant illumination and different temperature.
25.- Study of V,I,W according to different loads.
26.- Familiarization with the regulator parameters.
27.- Study of functionality of the photovoltaic system series/parallel with connection of different loads and without the support of the storage battery.
28.- Study of functionality of the photovoltaic system series/paralell
with connection of different loads DC and with the support of the storage battery.
29.- Connection of loads to direct voltage.

Other possible practices:

30.- Sensors calibration.

Practices to be done with the OPTIONAL KIT "EE-KIT":

31.- Study of functionality of the photovoltaic system series/parallel with connection of different loads and without the support of the storage battery.
32.- Study of functionality of the photovoltaic system series/paralell with connection of different loads AC and with the support of the storage battery.
33.- Connection of loads to alternating voltage of 220 V.

Practices to be done with the OPTIONAL KIT "EE-KIT2":

34.- Study of the grid utility inverter.

Other possibilities to be done with this Unit:

35.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic blackboard.
36.- Open Control, Multicontrol and Real Time Control.
This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivate parameters; etc in real time.
37.- The Computer Control System with SCADA allows a real industrial simulation.
38.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
39.- This unit can be used for doing applied research.
40.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
41.- Control of the EESFC unit process through the control interface box without the computer.
42.- Visualization of all the sensors values used in the EESFC unit process.

- By using PLC-PI additional 19 more exercises can be done.
- Several other exercises can be done and designed by the user.

a) Industrial configuration

⑦ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

-**PLC-PI. PLC Module:**

Metallic box.
Circuit diagram in the module front panel.
Digital inputs(X) and Digital outputs (Y) block: 16 Digital inputs. 14 Digital outputs.
Analog inputs block: 16 Analog inputs.
Analog outputs block: 4 Analog outputs.
Touch screen.
Panasonic PLC:
High-speed scan of 0.32 µsec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.
Digital inputs/outputs and analog inputs/outputs Panasonic modules.

-**EESFC/PLC-SOF. PLC Control Software:**

For this particular unit, always included with PLC supply.

Practices to be done with PLC-PI:

1.- Control of the EESFC unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the EESFC unit process.
3.- Calibration of all sensors included in the EESFC unit process.
4.- Hand on of all the actuators involved in the EESFC unit process.
5.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
6.- Simulation of outside actions, in the cases hardware elements do not exist. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
7.- PLC hardware general use and manipulation.
8.- PLC process application for EESFC unit.
9.- PLC structure.
10.- PLC inputs and outputs configuration.
11.- PLC configuration possibilities.
12.- PLC programming languages.
13.- PLC different programming standard languages.
14.- New configuration and development of new process.
15.- Hand on an established process.
16.- To visualize and see the results and to make comparisons with the EESFC unit process.
17.- Possibility of creating new process in relation with the EESFC unit.
18.- PLC Programming exercises.
19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ EESFC/CAI. Computer Aided Instruction Software System.

This complete package consists on an Instructor Software (INS/ SOF) totally integrated with the Student Software (EESFC/SOF).
-INS/SOF. Classroom Management Software (Instructor Software):
The Instructor can:
Organize Students by Classes and Groups.
Create easily new entries or delete them.
Create data bases with student information.
Analyze results and make statistical comparisons.
Print reports.
Develop own examinations.
Detect student's progress and difficulties.
-EESFC/SOF. Computer Aided Instruction Software (Student Software):
It explains how to use the unit, run the experiments and what to do at any moment.
This Software contains:
Theory.
Exercises.
Guided Practices.
Exams.

⑨ EESFC/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 on 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 canals 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.

c) Higher Education and/or Technical and Vocational Education configuration

⑩ EESFC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

This Computer Aided Learning Software (CAL) is a Windows based software, simple and very easy to use.
CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.
CAL will perform the calculations.
CAL computes the value of all the variables involved.
It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.
Different plotting displays.
It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

d) Multipost Expansions options

⑪ Mini ESN. EDIBON Mini Scada-Net System.

EDIBON Mini Scada-Net System allows 30 students to work with a Teaching Unit in any laboratory, simultaneously.
The Mini ESN system consists on 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 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.
-Teacher controls and explains to all students at the same time.
-Any user/student can work doing "real time" control/multicontrol and visualisation.
-The manager/teacher can see in his/her computer what any user/student is doing in the unit.
-Continuous communication between the manager and all the users/students connected.

Main advantages:

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

The system basically will consist of:
This system can be used with Computer Controlled Unit.

-Manager/Teacher computer.
-Computers in a local net.
-Mini SCADA-NET system (Manager/Instructor Software + User/Student Software + Unit Software adaptation + Unit-Control Interface adaptation + Webcam + cables and accessories required for a normal operation).

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

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