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Technical Teaching Equipment

Photovoltaic Solar Energy Unit

EESFB

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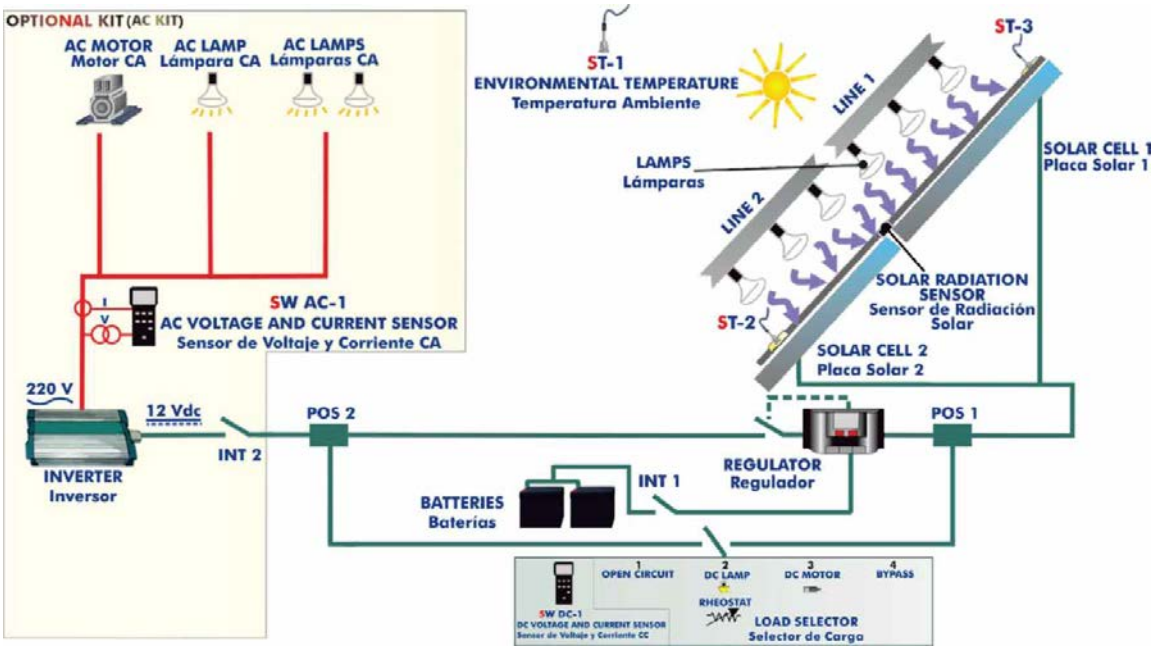
Products
Products range
Units
5.-Energy

Electronic console

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



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)

INTRODUCTION

The sun provides a wide spectrum of solar power. With the exception of the light we see around us every day, the rest of the solar power is invisible. Other parts of the spectrum consist of cosmic beams, gamma rays, x-rays, ultraviolet light, infrared light, radio waves and heat.

Solar radiation is a form of energy that can be transformed into other types of usable energy: electric, calorific, etc. The systems that carry out this transformation belong to a set of new clean technologies, which do not harm the environment. The direct conversion of light energy into electrical energy is known as photovoltaic effect.

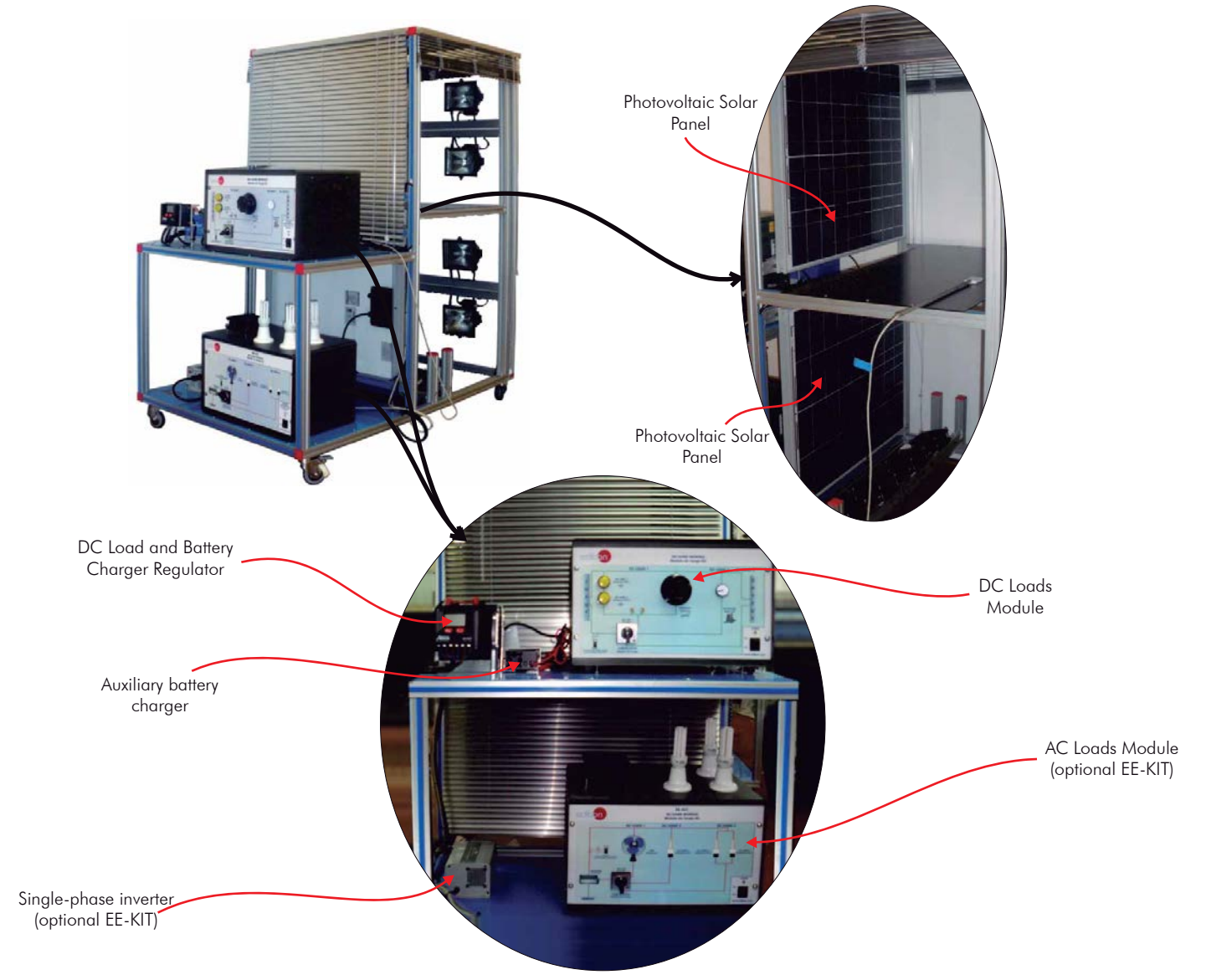
GENERAL DESCRIPTION

The Photovoltaic Solar Energy Unit (EESFB) includes equipment that uses the photo-conversion law for the direct conversion of solar radiation into electricity. The absorbed energy is provided by simulated solar radiation, which in our case is supplied by a panel with powerful light sources (solar lamps).
The unit contains:

- Photovoltaic solar panels.
- Solar simulator composed of solar lamps.
- Ventilation system.
- DC load and battery charger regulator.
- Auxiliary battery charger.
- Battery.
- DC loads module.
- Sensors (temperature, light radiation, DC current and DC voltage).
- Electronic console.

Optional (NOT included in the standard supply):

- EE-KIT. Kit of Conversion and Consumption Simulation (AC):
  - Single-phase inverter.
  - AC Loads Module:
    - 3 Lamps, 1 axial compact fan with plastic guards and 4 positions selector.
  - AC Voltage and current sensors.
- EE-KIT2. Grid Connection Inverter Kit:
  - Grid Connection Inverter.
  - Grid simulator (ESR).



SPECIFICATIONS

The "EESFB" is an unit for the study of the conversion of solar energy into electric energy.

Anodized aluminum structure and panels in painted steel.

Diagram on the front panel with similar distribution to the elements in the real unit.

This unit includes wheels for its mobility.

The unit includes:

- Two photovoltaic solar panels (polycrystalline):
  - Tempered glass modules with high level of transmissivity.
  - Encapsulating material: modified ethylene-vinyl acetate.
  - Output nominal power: 66W.
  - Area of the panel: 0.51 m^2.
  - Max. current: 3.76 A. Max. voltage: 17.53 V.
  - 36 cells, 156 x156 mm each.
- Solar simulator composed of:
  - Aluminum frame.
  - 8 Halogen lamps of 400W each one, distributed into two independent voltage regulated circuits.
  - Electrically safe.
- Ventilation system that allows to analyze the temperature influence on the unit operation, formed by:
  - 4 Axial compact fans with plastic guards.
- DC load and battery charger regulator:
  - It regulates how power generated in the photovoltaic solar panels is distributed to and from the auxiliary battery and to the load. A display informs about the state of the charge, operating parameters and fault messages. The functions of the electronic protection are:
    - Overvoltage disconnection, short circuit protection of load and module, overvoltage protection at module input, over-temperature and overload protection, and battery overvoltage shutdown.
- Auxiliary battery charger:
  - It carefully assesses the battery and then delivers the optimum charge required.
- Battery:
  - Nominal voltage: 12V. Rated capacity (20 hours rate): 24A/H.
- DC loads module:
  - Metallic box with diagram on the front panel.
  - 2 Lamps of 24V.
  - One DC motor: voltage: 36V, power: 5W.
  - Rheostat of 500W.
  - Independent connection for every load with the help of the 4 positions selector:
    - Solar panels work at open-circuit.
    - Rheostat and lamps are connected directly to the solar panels. These loads can be connected individually or in parallel with the aid of manual switches.
    - The DC motor is directly connected to the solar panels.
    - The DC load is disconnected and the solar panels are directly connected to the charge regulator.
- Sensors:
  - Solar radiation sensor to study the behaviour of solar photovoltaic panels.
  - 3 "J" type temperature sensors to measure the environmental temperature, the temperature in the solar panel no. 1 and the temperature in the solar panel no. 2.
  - DC current sensor and DC voltage sensor.
- The unit includes four blinds to reduce a direct visual contact with the halogen lamps and to reduce the direct contact with the photovoltaic solar panels when the unit is working.

Electronic console:

- Metallic box.
- Connector for the solar radiation sensor. Digital display for the solar radiation sensor.
- Connectors for the temperature sensors. Digital display for the temperature sensors. Selector for temperature sensors.
- Connectors for the DC current and voltage sensor. Digital display for the current (DC). Digital display for the voltage (DC).
- 2 Switches for the lamps of the two independent circuits.
- 2 Regulators for the light intensity of lamps of the two independent circuits.
- Switch for the ventilation system.
- Switch to connect the solar panels in parallel or series.

Cables and Accessories, for normal operation.

Manuals:

- This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance, & Practices Manuals.

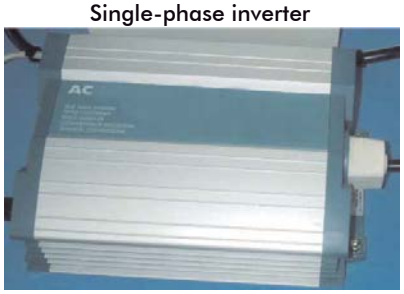
Optional (NOT included in the standard supply): See section "Optional" in page 4.

- -EE-KIT. Kit of Conversion and Consumption Simulation (AC).
- -EE-KIT2. Grid Connection Inverter Kit.

Optional

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

Single-phase inverter

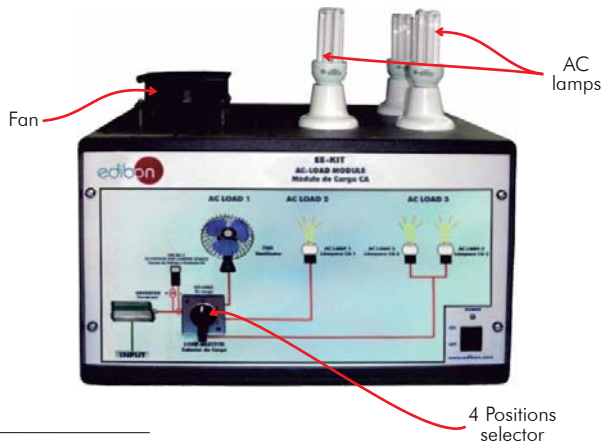


- Single-phase inverter:
  - Single-phase.
  - 25 kHz switch mode technology.
  - Start-up power of 200%.
  - Short-circuit protection.
  - High temperature protection.
  - Overcharge protection.
  - Operation state indicating LED.
  - Rear connection/disconnection switch.

- AC Loads Module:
  - Metallic box.
  - Diagram in the front panel.
  - Axial compact fan of 230V with plastic guards.
  - 3 Lamps of 220V - 240V., power: 11W.
  - Independent connection for every load with the help of the 4 positions selector:
    - Inverter operation with no load.
    - Fan motor connected.
    - One AC lamp connected.
    - Two AC lamps connected in parallel.

- AC voltage and current sensor.

AC Loads Module



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 an indicating LED at the front side of the housing.

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

The inverter can be connected to a computer (PC) through a 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: 150 W.
    - Maximum power @ 25°C: 220 W.
    - MPP voltage: 45-125V DC.
    - Maximum voltage: 155V DC.
    - Nominal current: 3A.
  - Output (AC):
    - Voltage: 230V (207 - 253 V).
    - Maximum power, fuse: 2.25 A.
    - Frequency: 50 Hz (49.8 ~ 50.2 Hz).

This unit is supplied with the Grid Simulator (ESR), which simulates a low power grid to inject the power generated by the inverter.

- Grid Simulator (ESR):

ESR is designed to create an isolated low power grid. The unit uses a battery as voltage source and generates a sine signal of 220V/50Hz.

The main features of the ESR are:
- Inlet voltage source: battery of 12Vdc.
- Output: 220V/50Hz.
- Isolation transformer.
- Battery charger included.
- Protection fuses.

The user can work with this module safely. The devices included in the EE-KIT2 can be used worldwide.

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Identification and familiarization with all components of the unit and how they are associated with its operation.

2.- Determination of the solar panel characteristic parameters.

3.- Study of the materials that make up the solar cell.

4.- Study of the p and n sides of a solar cell.

5.- Study of the I-V and P-V curves.

6.- Study of the inverse current or the saturation current.

7.- Study of V, I and W according to different loads.

8.- Measurement of the open-circuit voltage and the short-circuit current for a solar panel with load.

9.- Measurement of the maximum power for a solar panel with load.

10.- Study of the relationship between power generated and solar radiation power.

11.- Study of the solar panel maximum power.

12.- Study of the influence of temperature on the solar panel open-circuit voltage.

13.- Determination of the photo-conversion efficiency.

14.- Study of the efficiency of the solar panels connected in parallel.

15.- Study of the efficiency of the solar panels connected in series.

16.- Study of the efficiency, depending on the temperature, of the photovoltaic system connected in parallel.

17.- Study of the operation of the photovoltaic generation system supplying power to different DC loads without an auxiliary battery.

18.- Study of the photovoltaic power generation system operation with an auxiliary battery and supplying different DC/AC loads.

19.- Study of the operation of the photovoltaic system in series/parallel with connection of different loads and without the support of the storage battery.

20.- Study of the operation of the photovoltaic system in series/parallel with connection of different loads DC and with the support of the storage battery.

Additional practical possibilities:

21.- Lamps illumination profile study.

22.- Determination of the resistance of a solar cell connected in series and in parallel.

23.- Study of the parameters that define the quality of a solar cell.

24.- Study of the dependence of the voltage of open circuit (V∞) on the lumens.

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

25.- Study of the operation of the photovoltaic system in series/parallel with connection of different loads and without the support of the storage battery.

26.- Study of the operation of the photovoltaic system in series/parallel with connection of different AC loads and with the support of the storage battery.

27.- Study of the connection of loads to an alternating voltage of 220V.

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

28.- Study of the inverter connected to the grid simulator.

REQUIRED SERVICES

- Electrical supply: three phase, 380V/50Hz, 220V/60Hz, and minimum power 5 kVA.

DIMENSIONS & WEIGHTS

EESFB:

Unit:	-Dimensions:	2200 x 1200 x 2005mm. approx. (86.61 x 47.24 x 78.93 inches approx.)
	-Weight:	300 Kg. approx. (661 pounds approx.)
Electronic console:	-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.).

OPTIONAL

- EE-KIT. Kit of Conversion and Consumption Simulation (AC):
  - Single-phase inverter.
  - AC Loads Module:
    - 3 Lamps, 1 axial compact fan with plastic guards and 4 positions selector.
  - AC voltage and current sensors.

- EE-KIT2. Grid Connection Inverter Kit:
  - Grid Connection Inverter.
  - Grid Simulator (ESR).

- 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:

-EESFB. Photovoltaic Solar Energy Unit.

Offered in other catalogues:

-EESFC. Computer Controlled Photovoltaic Solar Energy Unit.

-MINI-EESF. Photovoltaic Solar Energy Modular Trainer.

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

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