Solar panels with battery – network injection

SOLBAT is a solar unit which complies with standards, consisting of an electrical cabinet (with its metering and protective components), a domestic unit and a photovoltaic panel with a power of 400Wc. (Indicative power may vary by 10% depending on the series.)

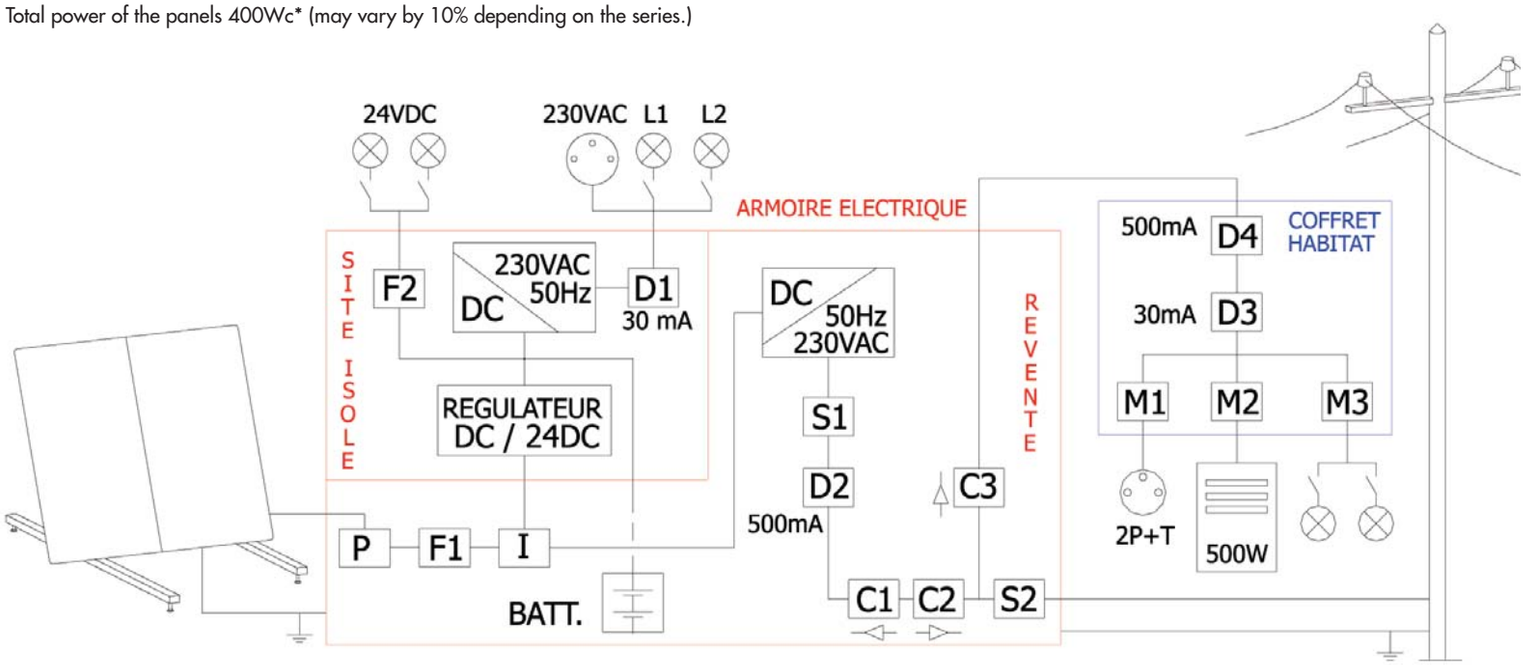
ref. SOLBAT

A solar panel has a significant wind resistance area. If the panel overturns, it may be unsafe for people walking near the panel and the expensive panel may be damaged. To limit these risks, an instantly removable stand is fixed to a wheeled frame. At the leg ends, four actuators raise the SOLBAT to a stable and horizontal position, even if the ground slopes or is uneven.

Tiltable from the vertical to the horizontal position in 5° increments, this panel swivel about a wheeled frame; sufficiently compact to be rolled through a doorway.

PHOTOVOLTAIC FEATURES

- Unfolded stand wheelbase: 225 x 260cm
- Overall folded stand dimensions: 227 x 75cm high 195cm
- Effective surface area of cells: 3.1m²
- Total power of the panels 400Wc* (may vary by 10% depending on the series.)



ELECTRICAL CABINET/LIVING AREA FRAME

A double-sided wheeled frame, with a door on the front for a domestic electrical installation and on the rear a technical cabinet for a standard solar unit.

Partial or total resale operation.

In the cabinet, a DC/AC inverter transforms the DC photovoltaic current into alternating 220VAC 50Hz and in synchronism, injects it into the network.

Operation in isolated mode

The photovoltaic current charges a sealed 24V battery through a regulator. This DC voltage is used directly by the low energy consumption lamps and/or transformed into 250VAC 50Hz voltage by a 200W converter.

COMPOSITION DE L'ARMOIRE ÉLECTRIQUE

2 disconnectors	2 500mA 30A differentials	2 30mA differentials
1 lightening conductor + fuses	3 100Wh resolution meters	1 punch-type emergency stop
1 source inverter	magnetothermal circuit breakers	2 converters

INVERTER ON THE N ETWORK	Voltage	Max current	Power	cosφ
ENTREE	65~125 VDC	8A	550W	
SORTIE	230VAC 50Hz	2.25A	525VA	0.99

INVERTER ON ISOLATED MODE	Voltage	Max current	Power
ENTREE	20~32 VDC	11A	210W
SORTIE	230VAC 50Hz	1A	200VA

Efficiency at full load: 94%
Load consumption: 330mA
Ripple: THD <3%

COMPONENTS OF THE DOMESTIC UNIT

The other side of the wheeled frame consists of a standard domestic electrical control box with two areas: A standard living area, when the unit is connected to the public network and a living area for an isolated site.

Standard living area

This part is made of a standard control box, with standardised protective devices, as described below, and loads consisting of light fittings and a radiator.

- 1 500mA differential
- 1 30mA differential circuit breaker
- 3 magnetothermal circuit breakers
- 1 radiator 500W
- 2 light fittings 100W with switches
- 1 230VAC 50Hz 2P+E socket

Isolated site living area

This area is characterised by low energy consumption light fittings used directly in 24V. If the inverter fails on an isolated site, the user can still use the voltage from the battery for lighting purposes.

- A second specific inverter for this area produces 220V 50Hz from the battery.
- The isolated area's own loads
- 2 24VDC low energy consumption light fittings with switches
- One 2P +E socket and two 100 W 230V AC light fittings with switches

Living area side

TUTORIALS

The CD supplied with SOLBAT proposes 14 comprehensive tutorials: Tilting of panels depending on the azimuth and latitude, isolated site wiring, the total resale or resale of the consumption surplus, efficiency (panels and inverters), wiring diagrams, the role of solar unit components, safety instructions, etc.

Example of a tutorial

Problem

In this tutorial, the cabinet is used in an isolated site. The panel can be used in clear and cloudy weather conditions.

How should solar panels be wired? What is the impact of wiring errors on panels? By considering the panel's features, is the DC voltage dangerous? What safety instructions should be implemented to connect the panels to the cabinet and position the solar unit in isolated site mode? What is the role of inverter I? By applying these safety instructions, connect and quickly check the operation of the cabinet in isolated mode.

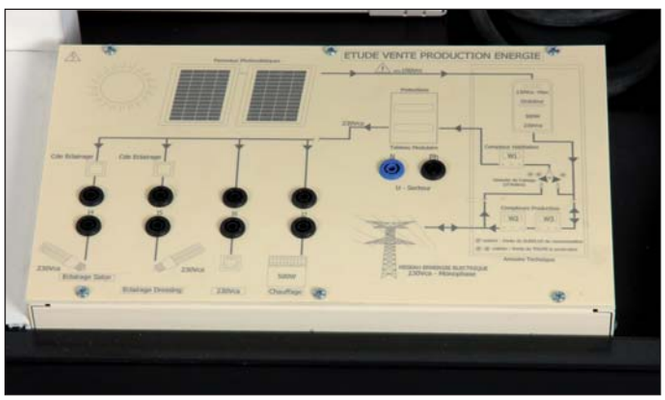
With no receiver connected, measure the continuous power coming from the panels. Explain where the electrical energy produced is stored. Measure the voltage and current at the battery input Determine the regulator's efficiency Using the pyranometer supplied, determine the efficiency of the chain: panels + regulator

With no receiver connected, adjust the panel's tilt so that the continuous power is around 150W. Place a hook-on ammeter measuring the DC, onto the conductor wire connected to the + pole of the battery and read the Ib current. Successively switch on the light fitting L1 then L2. Note how the battery current Ib changes and its sign. Direct the solar panel to increase its electricity production. How does the current Ib change? What would happen if an additional load was connected to the isolated site 230V AC socket?

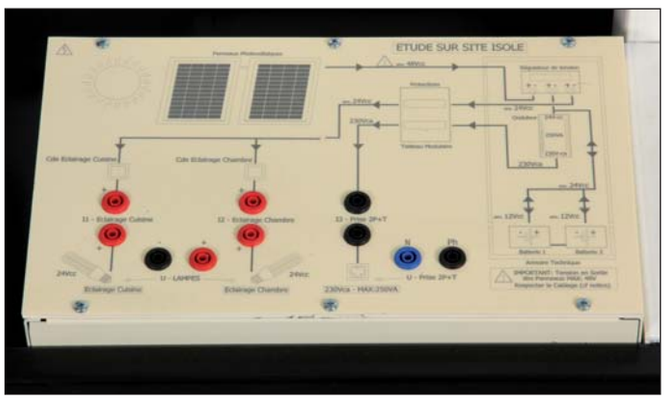
SUPPLIED ACCESSORIES

- A portable pyranometer Rated 200.0 and 2000 W/m². (see page 181)
- A cable to connect the panels/electrical cabinet 30m – 3x6mm².

2 MIMIC UNITS TO MEASURE THE CURRENT AND THE VOLTAGE



Production resale unit



Isolated site unit

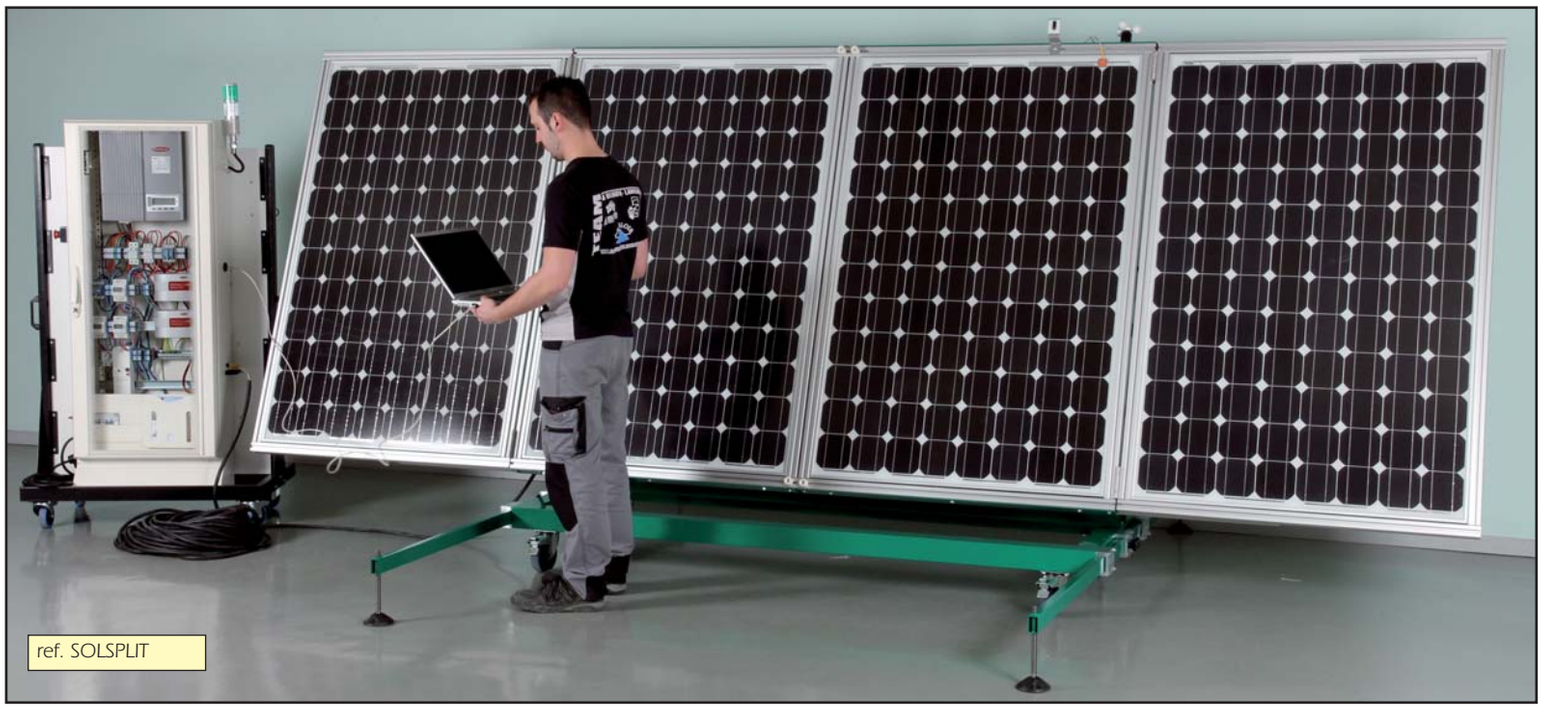
Optional artificial solar source

Given that photovoltaic panels do not produce significant power in cloudy conditions, it is not possible to complete the related tutorials. DC10 is a source which, by replacing the solar panels, overcomes unpredictable sunshine

• Mains input	230V single-phase
• Stop/start switching	Push-button + LED indicator lights
• Emergency stop	Key operated
• DC output	Adjustable from 0 to 230V DC
• Maximum current	10A
• Filtering	5% of residual ripple at 10A.
• Adjustment method	Button on the top
• Display of outputs	1 voltmeter and 1 ammeter
• Output terminals in parallel	2 photovoltaic type connectors 2 4mm safety terminals
• Upstream protection	By fuse
• Output protection	By circuit breaker
• Protection of individuals	By safety isolation transformer
• Dimensions/Weight	330 x 280mm height 510mm/40kg
• Castors	4 including 2 with brakes

ref. DC10

Wheeled folding solar unit (data acquisition)



ref. SOLSPLIT

COMPLETE RANGE ENERGY

SOLSPLIT is a solar unit which complies with standards, consisting of an electrical cabinet (with its metering and protective components) and four photovoltaic panels including two outer panels which fold over the central panels. In the unfolded position, the cells generate an electrical power of 800Wc, enough to inject significant current into the network through an inverter and provide measurements comparable with that of a real domestic installation. The data acquisition system (temperature, irradiation, wind speed and all electrical quantities) allows tutorials to be completed even when there is no sunlight.

Tiltable from the vertical to the horizontal position in 5° increments, the panels swivel about a wheeled frame; sufficiently compact to be rolled through a doorway when the panels are folded.

With the panels in the unfolded position, 4 actuators on a removable stand with a wide wheelbase provide excellent stability for the panel. When windy, the ground coverage is a safety factor for people walking near the panel, and prevents costly material damage in the event of overturning. The triptych is lockable in the closed position.

Safety position: 4 actuators and the wide wheelbase prevent the panels from overturning in the event of strong winds.

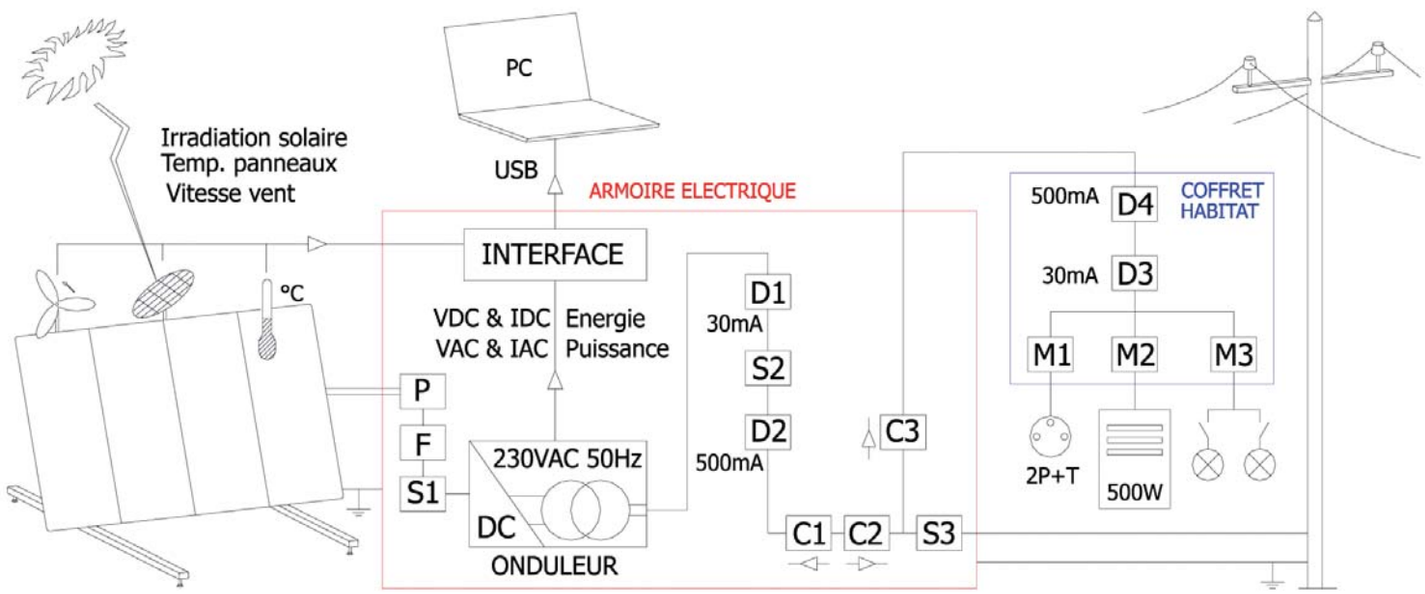
Transport position on wheels. Once the outer panels are folded back and the stabilisers removed, the dimensions are: width 75cm, height 195cm

PHOTOVOLTAIC FEATURES

- Unfolded stand wheelbase: 225 x 260cm
- Overall folded stand dimensions: 227 x 75cm high 195cm
- Effective surface area of cells: 6.3m
- Total power of the panels 800Wc (variation of ± 10% depending on the series)
- Triptych tiltable in 5° increments.
- A protractor measures the panel tilt.

FEATURES OF EACH PANEL

- Open circuit voltage: 57VDC
- Short-circuit current: 4.8A
- Optimum operating voltage: 46VDC
- Optimum operating current: 4.3A
- Maximum power: 200Wc (variation of ± 10% depending on the series)
- Sealed connections IP65 – 1000V on the rear of the panel.
- Type of cells: Monocrystalline silicon



ELECTRICAL CABINET/LIVING AREA FRAME

A double-sided wheeled frame, with a door on the front for a domestic electrical installation and on the rear a technical cabinet for a standard solar unit. In the cabinet a DC/AC inverter converts the photovoltaic DC current to AC current 220VAC 50Hz, and in synchronism, injects it into the network through an isolation transformer. This inverter is protected against any polarity reversal and any overload on the DC or AC side. Inverter warranty: 5 years. The cabinet is supplied wired for the total resale of energy to the public network. The other side of the wheeled frame includes a standard domestic electrical control box, 2P+E socket, 2 light fittings and a radiator. A mimic unit measures the current and voltage.

INVERTER FEATURES

INPUT			OUTPUT				
Voltage	Current max	Power	Voltage	Power	Distorsion	Efficiency	cosφ
150~450 VDC	10,8A	2 kW	230VAC-50Hz	1,5 kW	≤ 3,5%	91%	1

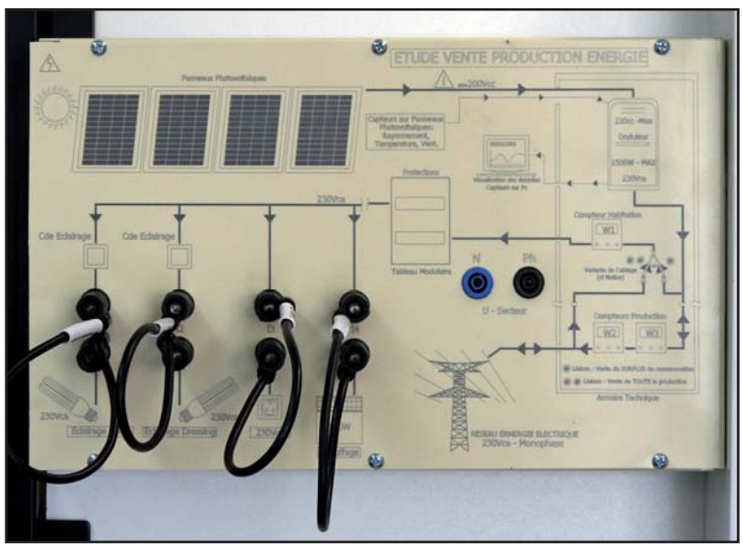
COMPONENTS OF THE CABINET

- 3 disconnectors
- 1 500mA differential
- 3 10Wh resolution meters
- 1 30mA differential circuit breaker
- 1 lightning conductor and fuses
- Punch-type emergency stop

The other side of the wheeled frame includes a standard domestic electrical control box.
Components of the domestic unit

- 1 500mA differential.
- 1 30mA differential circuit breaker
- 3 magnetothermal circuit breakers
- 1 radiator 500W
- 2 light fittings 100W with switches
- 1 230VAC 50Hz 2P+E socket

On the domestic side, a mimic unit fitted with safety leads, to take voltage and current measurements simply. The cabinet is supplied wired for the total resale of energy to the public network.



mimic unit fitted with safety leads, to take voltage and current measurements

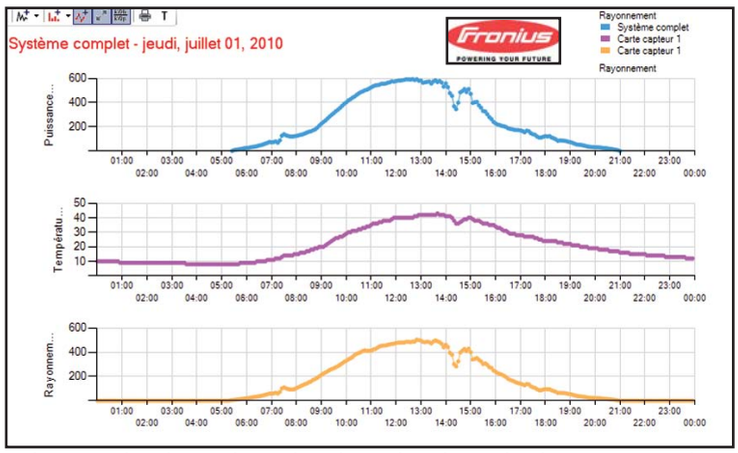
Electrical side

Domestic side

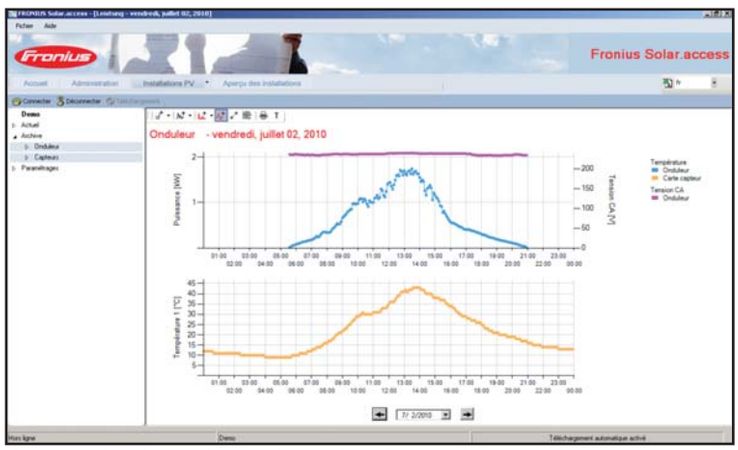
3 SENSORS SUPPLIED WITH SOLSPLIT

- Irradiation measurement
- temperature of panels
- wind speed

These physical parameters as well as the AC and DC currents and voltages, power and energy are recorded by an interface and used on a PC. The software menus are used to display one or several curves by screen, bar charts, etc. All data can be exported to Excel



In the screenshot shown above, three logs taken during the day are presented one above the other: AC instantaneous power, temperature of panels, solar radiation intensity (irradiation).



The screenshot shown above indicates the voltage and power at the inverter output as well as the temperature of panels. The scales are specified with the units.

The screenshot shown above indicates the amount of energy produced over the first 21 days of the month.

TUTORIALS

In addition to tutorials on the acquisition of curves and their, the CD supplied with SOLSPLIT also presents 12 comprehensive tutorials: Tilting of panels depending on the azimuth and latitude, wiring for the total resale or the resale of the consumption surplus, efficiency (panels and inverter), wiring diagrams, the role of components, safety instructions, etc.

Example of a tutorial

Work to be completed

- *Modify the internal wiring of the cabinet to resell the surplus electrical energy production.*
- *Produce the new schematic diagram. Explain the role of each component downstream of the S2 disconnector.*
- *Produce a wire diagram listing the input and output numbers for components.*
- *Implement the safety rules with a view to modifying the electrical wiring.*
- *Modify the wiring.*
- *Implement the safety rules with a view to powering up.*
- *Measure the current between D2 and C1 for different loads: successively start up one, then two light fittings, where each light fitting is 100W. Switch off the light fittings and connect the 500W radiator. With the radiator connected, switch on one then two light fittings. Note and provide an explanation*
- *For each of these operations, note the changes on the input and output meters.*
- *For what power will the C1 input meter increment?*

WARRANTY

Inverter factory warranty: 5 years. The Fronius website provides free software updates and proposes the most frequently asked questions/answers.
In accordance with C15100 supplied with Socotec certificate of compliance.

SUPPLIED ACCESSORIES

- *A portable pyranometer Rated 200.0 and 2000 W/m².*
- *A cable to connect the panels/electrical cabinet 30m – 3x6mm².*
- *A cable to connect the sensors/interface for 4-20mA signals, length 30m.*
- *A CD with all tutorials*
- *Acquisition operating software*

Optional artificial solar source

Given that photovoltaic panels do not produce significant power in cloudy conditions, it is not possible to complete the related tutorials. DC10 is a source which, by replacing the solar panels, overcomes unpredictable sunshine

• Mains input	230V single-phase
• Stop/start switching	Push-button + LED indicator lights
• Emergency stop	Key operated
• DC output	Adjustable from 0 to 230V DC
• Maximum current	10A
• Filtering	5% of residual ripple at 10A.
• Adjustment method	Button on the top
• Display of outputs	1 voltmeter and 1 ammeter
• Output terminals in parallel	2 photovoltaic type connectors 2 4mm safety terminals
• Upstream protection	By fuse
• Output protection	By circuit breaker
• Protection of individuals	By safety isolation transformer
• Dimensions/Weight	330 x 280mm height 510mm/40kg
• Castors	4 including 2 with brakes

ref. DC10

Solar kit

NEW

REF. VALSOL

VALSOL is a kit for studying the principles of solar energy, its storage and conversion. The kit consists of two solar panels which are connected in parallel and can be seen immediately the kit is opened. When closed, the panels are protected against impact and scratches. These industrial panels are identical to those found in stand-alone weather stations.

The following can be found underneath the solar panel:
- a standard 15V DC 15 Ah Li-ion battery
- a 12V DC/220V AC, 50Hz, 150W converter
- safety and monitoring electronics

CONTROL PANEL
- On/Off button
- a circuit breaker to protect against over-currents
- 4mm safety terminals for voltage and electric current inputs, with jumpers
- the converter's On/Off button
- a 220V AC 50Hz socket with on and defect lamps
- a two-line LCD display delivering messages about the battery: temperature, % charge, charging current and voltage, usage current and voltage, undercharged battery, overcharged battery and overheating, etc., as well as the power output.

NB: these are indications, rather than highly accurate measurements.

PROTECTION OF COMPONENTS IN THE CASE OF
- battery overcharge: when its voltage reaches 16.5V the charging current is automatically cut, in order to preserve the battery's service life.
- excessive battery discharge: When its voltage reaches 11.5V, an audible alarm will be triggered. When it falls below 10.5 V the output will be disconnected automatically.
- abnormal increase in the battery temperature
- overload or short-circuit on the converter's output

SUGGESTED TUTORIALS

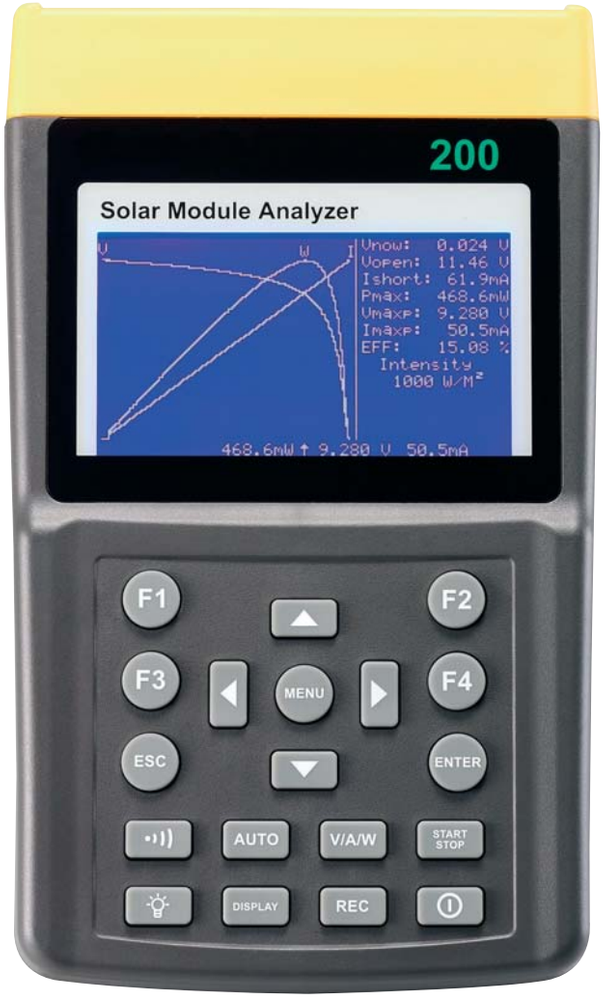
One of the jumpers isolates the photo-voltaic panels from the rest of the electronics. In this way, students can measure
- the voltage in the no-load circuit (approximately 21V)
- The short-circuit current (approximately 1.9A)
- the current and the voltage according to the lighting, by covering one of the two panels or by varying the tilt of the kit's lid in relation to the sun by an angle α; and check that the power output is a function of cos α
- Using a rheostat, students can look for the charge which corresponds to a maximum power supplied by the panel

The control panel's second jumper measures the DC level at the converter's input. Students can:
- measure the no-load voltage and current at the converter's input, and calculate the no-load power input
- measure currents and voltages upstream and downstream of the converter and calculate the converter's efficiency and losses by loading the 220V AC output.
- check that the converter can supply up to 150W. Compare this power with the power supplied instantly by the panels. Draw conclusions about the role of the battery.

PROPERTIES OF THE SOLAR PANEL
- Total surface area: 420 x 680mm
- Total power: 30W
- Typical voltage: 17.5V
- Typical current: 1.7A
- Short-circuit current: 1.9A
- No-load circuit: 21.5V

OTHERS FEATURES
- Dimensions: 570 x 380 x 160mm. Weight 14kg.

Solar analyser



- Current/voltage graph drawing (characteristic of the solar panel)
- Autoscan search of the solar panel maximum power – Pmax (60V – 6A)
- Maximal voltage Vmaxp at Pmax power
- Maximal voltage Imaxp at Pmax power
- Opened circuit voltage Vopen
- Short-circuit opened Ishort
- I = f(V) graph with a cursor
- Efficiency calculation in %
- Power by area unit (in W/m2)
- Manual test for a particular point
- Range 10V / accuracy 0.001V
  Range 60V / accuracy 0.01V
  Range 1A / accuracy 0.1mA
  Range 6A / accuracy 1mA
  Accuracy 1% + 18dgt

ref. *VA200*

COMPLETE RANGE ENERGY

FEATURES:
-I-V Curve Test for Solar Cell
-Single Point I-V Test
-Max. Solar Power (Pmax) search by auto-scan for PROVA 200A: 60V, 6A
-Max. Solar Power (Pmax) search by auto-scan for PROVA 200A-24: 24V, 600mA
-Best Resolution for PROVA 200A: 1mV, 0.1mA
-Best Resolution for PROVA 200A-24: 1mV, 10µA
-Maximum Voltage (Vmaxp) at Pmax
-Maximum Current (Imaxp) at Pmax
-Voltage at open circuit (Vopen).
-Current at short circuit (Ishort).
-I-V curve with cursor
-Efficiency (%) calculation of solar panel
-Scan delay (parameter) setting. (0 ~ 9999 mS)
-Solar panel dimension (parameter) setting.(0.001 ~ 9999 Cm^2)
-Standard light source (parameter) setting.(250、500、750、1000 W/m^2)
-Min. power (parameter) setting and alarm. (1 mW ~ 100 W)
-Real time data logging
-Rechargeable batteries; LCD displays low battery
-RS232C (to USB Bridge) cable for PC
-Option: portable thermal printer (model: 300XP) to print (hardcopy) the LCD displays of Solar Module Analyzer.