

# **SOLENER Sinewave Inverter**

## **User Manual**

**Version 1.6  
February 2010**



### **Soluciones Energéticas S.A.**

**AV Real de Pinto, 146  
28021 Madrid  
Tel: 91-5050062  
Fax: 91-5050079**

**[www.solener.com](http://www.solener.com)  
[solener@solener.com](mailto:solener@solener.com)**



# INDEX

<b>1.- DESCRIPTION OF THE INVERTER</b>	<b>2</b>
<b>2.- FRONT PANEL DESCRIPTION.</b>	<b>3</b>
<b>3.- INVERTER OPERATION.</b>	<b>4</b>
<b>4.- SIGNALS AND INDICATORS.</b>	<b>5</b>
<b>5.- INVERTER PROTECTIONS.</b>	<b>6</b>
<b>5.1.- Overload Protection.</b>	<b>6</b>
<b>5.2.- Overheating Protection.</b>	<b>6</b>
<b>5.3.- Protection against low and high battery voltage.</b>	<b>6</b>
<b>6.- INSTALLING THE INVERTER.</b>	<b>7</b>
<b>6.1.- Fitting the SOLENER.</b>	<b>7</b>
<b>6.2.- Electrical Connection.</b>	<b>7</b>
<b>7.- STARTING PROCEDURE.</b>	<b>8</b>
<b>8.- SHUT-OFF PROCEDURE.</b>	<b>8</b>
<b>9.- PRECAUTIONS</b>	<b>8</b>
<b>10.- MAINTENANCE.</b>	<b>8</b>
<b>11.- SAFETY.</b>	<b>8</b>
<b>12.- TECHNICAL CHARACTERISTICS.</b>	<b>9</b>



## 1.- INVERTER DESCRIPTION.

The SOLENER inverter is a pure sine wave, microprocessor controlled DC/AC converter designed for photovoltaics applications. It has been designed to provide a sinusoidal alternating current output voltage of 230V, 50Hz (there are also 120V, 60Hz versions available) from a 12, 24 or 48 volt input provided by power stored in electro-chemical accumulators. To do so it uses state-of-the-art components such as MOSFETs, 32 bit micro-controllers and LCD modules. As well as its basic inverter function, it also allows the installation to be monitored by providing information about power, energy and other operating parameters. It is built in complete bridge configuration and uses PWM control.

The inverter is able to cover the start-up power peak of television sets, projectors, videos, personal computers, refrigerators, washing machines, submersible pumps, etc. without any problems.

The SOLENER inverter is protected against shortcircuit, overload, overheating, excessive voltage and reverse polarity connection. Reverse polarity connection does not break the input fuse (as occurs with other commercial inverters), the inverter simply ceases to function.

Start-up and shut-down of the inverter by any PROFESSIONAL SOLENER load regulator is possible using an optional control line.

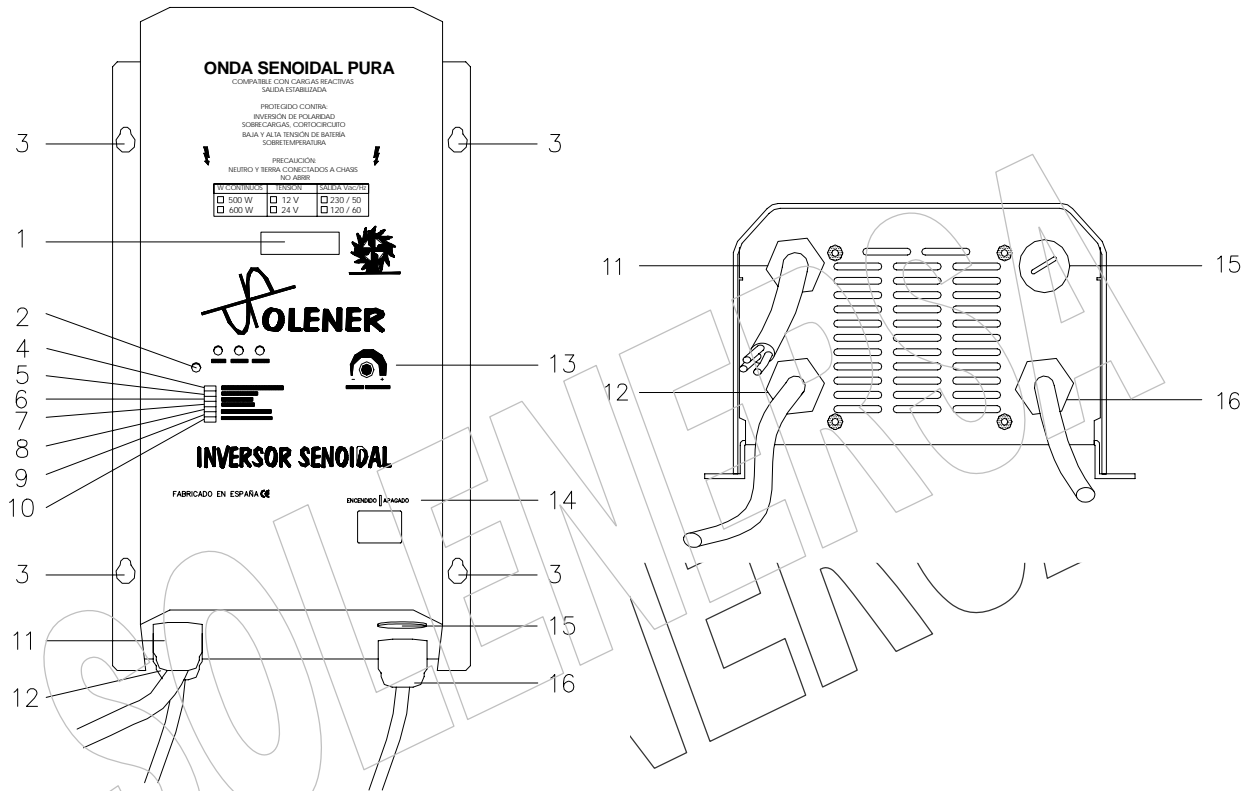
This inverter re-starts automatically when the circumstances which caused shut-down disappear (low or high battery voltage, overheating or an external control signal sent by the regulator). If an overload or a shortcircuit is detected, a manual reset of the system will be necessary once the problem has been eliminated (in some versions this reset is automatic).

Load detection is a standby state whereby the inverter reduces its power consumption whilst waiting for a load equal or to or greater than that specified to be attached. When it detects this load the inverter becomes active and goes into normal mode. When power consumption drops back to below the set limit, the inverter goes back into detection mode. It is also possible to adjust the load detection threshold using a potentiometer placed on the front panel (from 0W - always working - to 60W). If the power of the connected load is lower than the specified threshold power then the inverter will start and stop once per second until the load surpasses this set point. This will produce a characteristic blinking which is especially notable in light bulbs.



## 2.- FRONT PANEL DESCRIPTION

The figure below shows a front view of the SOLENER unit, showing all the elements of the user interface. These element references will be used throughout the rest of this manual.



- |                                    |                                       |
|------------------------------------|---------------------------------------|
| 1. Alphanumeric screen             | 9. Load detection indicator           |
| 2. Acoustic alarm                  | 10. Power ON indicator                |
| 3. Fixing holes                    | 11. AC output tri-conductor cable     |
| 4. Load disconnection indicator    | 12. Negative battery cable            |
| 5. Shortcircuit/Overload indicator | 13. Load detection potentiometer      |
| 6. High battery voltage indicator  | 14. ON/OFF switch                     |
| 7. Low battery voltage indicator   | 15. External control cable (optional) |
| 8. Overheating indicator           | 16. Positive battery cable            |



### 3.- INVERTER OPERATION

After switching on the inverter the unit carries out system checking sequences. If an error is detected the cause of the failure will be shown on the LCD display and the "output disconnected" LED will be ON along with another LED (depending on the failure) which will flash. This failure does not allow the inverter to function correctly therefore it will not supply an output. As apart of this autotest process the internal fan of the inverter runs for 1 second.

After the autotest process the AC output voltage increases gradually from 0 to its nominal value (soft start). If the load detection circuit does not find loads greater than that determined by the potentiometer then the inverter will go into stand-by mode to reduce its consumption, trying to restart once per second.

When the battery voltage is lower than the "low battery voltage" setting, the acoustic alarm is activated and the "low battery" LED begins to flash once per second. After 10 seconds this LED remains lit and the "output disconnected" LED also lights up, indicating that the inverter has been shut-off. If the battery voltage rises above the restart voltage then the inverter starts automatically and both LEDs are turned off.

If the battery voltage reaches 16V (32/64V) then the "High battery voltage" LED comes on immediately together with the "Output disconnected" LED. If the DC voltage then drops below the restart voltage setting then the inverter re-starts automatically.

When the power MOSFETs reach a certain programmed temperature (50°), the internal fan is activated, it then stops when the temperature drops below a lower limit (40°C). However, if the temperature keeps on increasing (because the connected load is too high) and reaches 60°C, the output voltage decreases by 10% in order to reduce the load; if, despite this the temperature keeps rising then the unit will shut off when the temperature reaches 80°C, restarting again at 60°C. Shut down of the system due to overheating will be indicated by the corresponding LED along with the red load disconnection LED (the screen also indicates the cause of the load disconnection). Whilst the system is disconnected due to overheating the fan will continue functioning.

If 12V (24V/48V) are not present in the control line then the inverter will stop and switch on the "Output disconnected" LED. When the nominal tension is again supplied the alarm LED turns off and the inverter restarts (this input is optional and is not present in all models).

If a shortcircuit is produced at the inverter output then the unit automatically limits the output power to protect the installation, and the shortcircuit LED lights up. If the shortcircuit lasts more than 10 seconds then the "Output disconnected" LED will light up and the inverter will stop. Once the cause of the shortcircuit has been eradicated it is necessary to reset the unit (using the ON/OFF switch) in order to recouperate the AC output.

When an AC overload is detected, the inverter limits the time that power is supplied to the load (the time that this power will be supplied decreases as the overload increases). Once this time has passed, the inverter output shuts off and the "Output disconnected" LED lights up. In order to recouperate full operation of the unit it will be necessary to switch it off and on again.



#### 4.- SIGNALS AND INDICATORS

The inverter is equipped with an alphanumeric LCD screen with 2 lines and 16 columns which displays information regarding the status of the inverter and the installation. On the front panel there are also 7 LEDs which indicate (from bottom to top):

- **power ON** (green): The unit has the battery connected and it is working.
- **load detected** (green): Flashes when the inverter is in load detection mode and remains lit when the load is detected and 230Vac are present at the output.
- **overheating** (yellow): When the internal temperature is too high.
- **low battery voltage** (yellow): Flashes when the battery voltage is low (disconnection prealarm) and remains lit when the inverter stops due to low battery voltage.
- **high battery voltage** (yellow): Remains lit if battery voltage is higher than 16V (32V/64V).
- **overload** (red): Flashes when output power is higher than the inverter nominal power and remains lit after a prefixed time that depends on the overload level.
- **load disconnected** (red): ON if the inverter has disconnected in order to protect the installation or itself.

The LED that remains lit together with the "Output disconnected" LED shows the cause of the disconnection. If only the "Output disconnected" LED is lit then the disconnection was caused by a signal from the external control line or by a continuous overload. Information regarding the cause of the disconnection can be found on the screen.

An intermittent acoustic alarm (one 50 millisecond beep per second) will be activated before disconnection when the "Low battery voltage" or "Shortcircuit" LEDs are flashing.

Information about the unit is shown in a cycle on the screen (input and output current and voltage, output power, peak power, energy consumption, internal temperature, time working,...), as well as the cause of any disconnection.

The load detection circuit is set to detect a load of 1% of the nominal power. If a load is connected whose power consumption is lower than this threshold, it may be necessary to include an additional load to ensure that the inverter comes out of standby.

The keyboard permits the adjustment of some parameters, as well as the resetting of the counters and maximum/minimum levels of the variables. It also permits the screen to be changed manually and for an individual screen to remain activated (always visible) if required. Pushing the central button twice activates the screen which provides readings of input voltage and current.



## **5.- INVERTER PROTECTIONS**

The inverter is protected against polarity inversion, overload, shortcircuit, overheating and out-of-range battery voltage.

Each of these protections is described in detail below.

Contact SOLENERSA for automatic restarting after overload or shortcircuit.

### **5.1.- Overload Protection**

See the attached table.

After disconnection of the unit due to an overload it must be reset manually once the problem has been solved.

### **5.2.- Overheating Protection**

As the inverter is logically not 100% efficient, heat losses are generated, particularly when the unit is operating at full load. When the inverter is subjected to a heavy load for a prolonged period of time, the overheating protection will be triggered, first activating its internal fan and stopping the inverter if the temperature keeps increasing.

When the temperature drops down to a certain value, the unit starts automatically.

### **5.3.- Protection against high and low battery voltages**

The inverter can operate within the range of battery voltages between 10 and 16 V (12V model). This range is adjusted in factory depending on the battery used.

Shutdown of the inverter when the level of charge of the battery is low prevents the battery block from fully discharging as this would cause irreversible damage. A delay time is envisaged in the control circuit allowing the battery voltage to drop momentarily below these limits. This makes it possible to start induction motors with this inverter. The "Low Battery Voltage" LED alarm will blink for ten seconds and will remain lit after this time period has passed, indicating that the output has been disconnected.

Disconnection of the load when the battery level is too high is intended to protect the inverter against excessive input voltages.



## 6.- INSTALLING THE INVERTER

### 6.1.- Fitting

The inverter must be fixed on a vertical surface, with its connection wires at the bottom of the unit and with at least 5cm free at the top and the bottom for ventilation. It should be placed high enough so as to be out of the reach of children and animals.

The inverter should be fitted using screws placed through the four holes provided.

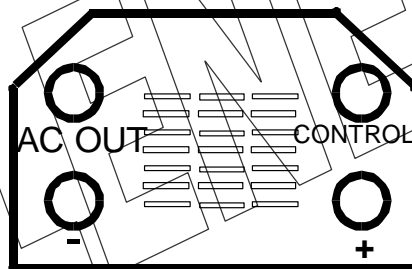
### 6.2.- Electrical Connection

The inverter has four cable holders on its underside along with the cables.

These four cables are:

- A red wire (or black with a red terminal) for connection to the positive terminal of the battery.
- A black or blue wire for connection to the negative terminal of the battery.
- A 3 X 2.5 mm conductor cable for connection of the AC loads.
- An optional double conductor cable for connection of the remote control.

The figure below shows the connection terminals.



Before connecting the unit ensure that the ON/OFF switch on the front panel is in the OFF position, then:

- Connect the AC wires to the external output breaker (the earth and negative cables are connected to the casing of the unit).
- Connect the negative battery cable to the battery.
- Connect the positive battery cable to the battery.

#### NOTES:

- **AC output voltage is very dangerous. You must always install a circuit breaker at the inverter output for protection.**
- **Switch the inverter off before manipulating the installation, it could start automatically without prior warning.**



## 7.- STARTING PROCEDURE

- Check all the connections.
- Turn the inverter on using the switch on the front panel.
- Close the AC output breaker of the installation.
- If the load connected to the inverter is higher than that adjusted with the “load detection” potentiometer, the inverter will start and the output voltage will increase rapidly to 230Vac.

## 8.- STOPPING PROCEDURE

Turn the inverter off using the ON/OFF switch.

## 9.- PRECAUTIONS

- Do not manipulate the interior of the unit.
- Do not connect any power supply to the inverter AC output.
- Do not cover the ventilation slots.
- Protect the unit against exposure to direct sunlight and water.
- Do not drop objects (especially metallic) through the ventilation slots.

## 10.- MAINTENANCE

The inverter does not require any specific maintenance. Only periodical cleaning of the casing with a dry cloth is recommended. If necessary soapy water can be used (never alcohols or disolvents) but never in excess.

## 11.- SAFETY

The inverter is electronically protected (hardware and software protections) against most of the possible causes of damage. The following table shows the possible causes of disconnection and their solutions.

FAILURE	RESULT	SOLUTION
Overheating	Inverter will stop and “Output disconnected” and “Overheating” LED will light.	Inverter automatically restarts when temperature reaches the normal value.
Inversion of the battery polarity	Inverter ceases to function.	Connect the battery correctly.
Overload/Shortcircuit	Inverter will stop and “Output disconnected” and “Shortcircuit” LED will light (the latter only in case of shortcircuit).	Eliminate the cause of the shortcircuit or the overload. Reset the unit using ON/OFF switch.
High battery voltage	Inverter stops and “Battery high” and “Output disconnected” LEDs will light.	Inverter restarts when battery voltage drops to reconnection voltage.
Low Battery voltage	Inverter stops and “Battery low” and “Output disconnected” indicators light.	Inverter restarts when battery voltage rises to reconnection voltage.



## 12.- TECHNICAL CHARACTERISTICS

### ELECTRICAL

#### *PURE SINE WAVE*

Waveform	<i>PURE SINE WAVE</i>
Nominal output voltage .....	230 Vac
Nominal output frequency .....	50 Hz
Variations in output frequency .....	<0,1%
Variations in output voltage .....	<5%
Minimum operating input voltage .....	5/6 $V_{nom}$
Maximum operating input voltage .....	4/3 $V_{nom}$
Efficiency .....	85-97 %
Efficiency with nominal load .....	> 85 %
Power consumption .....	<70 mA
Aluminium casing treated with epoxy paint.	

Nominal power (W)	1000	1200	1500	2000	2200	3300	4000	7000
Nominal voltage (V)	12	24/36	12	24/36/48	12	24	36/48	48
Overload 3" (W)	1500	2000	2800	4000	3600	6500	7000	12000
Overload 50" (W)	1200	1500	2250	2700	3000	5400	6000	10500
Overload 6" (W)	960	1200	1800	2160	2400	4320	4320	8400
Length (mm)	315	315	460	460	535	535	535	647
Height (mm)	118	118	157	157	178	178	178	210
Width (mm)	192	192	255	255	285	285	285	344
Net weight (kg)	9	12	20	22	24	36	36	68

### PROTECTIONS

- Polarity inversion (using low-loss intelligent diode)
- Overvoltage shutdown at 4/3  $V_{nom}$
- Shortcircuit and overload
- Overheating

INFORMATION SUBJECT TO MODIFICATION WITHOUT PREVIOUS WARNING