

Solar International Botswana (PTY) LTD.

Solar PV Hybrid System

1800Wp - 5kVA

USER MANUAL

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1. Introduction¹

The Solar PV System is a hybrid system that operates in conjunction with an electric generator (not supplied by Solar International (Pty). Ltd.). The system also has the capability to operate as a stand-alone system. There is a manual change-over from generator to solar operation. Under no circumstances should the generator and solar system power any load simultaneously since this will lead to the destruction of the solar system and/or generator.

Under normal operation the solar panels supply DC electric power to charge the batteries that in turn is converted to AC electric power by the inverter. To ensure that the power from the solar panels does not over-charge the batteries when they are fully charged, a charge controller is used.

This user manual describes the system components, maintenance requirements and warranty issues.

2. System Components

2.1 Solar Panels

2.1.1 Description

The Shell Solar RSM90 solar panel contains semi-crystalline silicon solar cells, generating a nominal peak power of 88 Watt at 33.5 Volt under standard test conditions (1000W/m^2 and 1.5 AM). Open circuit voltage and short circuit current under these conditions are 43V and 2.9A respectively. The nominal operating voltage of the solar panel is 24V. The panels are connected in series strings of two panels to obtain a nominal operating voltage of 48V. Maximum permitted series voltage is 600V.

The front of the solar panel is a high impact resistant, highly transparent tempered glass plate offering the solar module adequate protection against environmental hazards such as hail and high wind loads. The back of the solar panel consists of a tedlar-aluminium-polyester foil, offering a reliable barrier against penetration of moisture and dirt. The solar cells are embedded in ultraviolet stabilized Ethyl Vinyl Acetate (EVA). The highly corrosion resistant aluminium alloy frame provides structural support for the solar panel.

¹ This User Manual is supplied with the 1800Wp – 5kVa Solar PV system and should not be reproduced or distributed in any form without written consent of the director of Solar International Botswana (Pty.) Ltd.

2.1.2 Layout of Solar Panels on the Roof

The 20 solar panels are positioned on the roof in two rows of 9 panels and 12 panels as is indicated in the figure below.

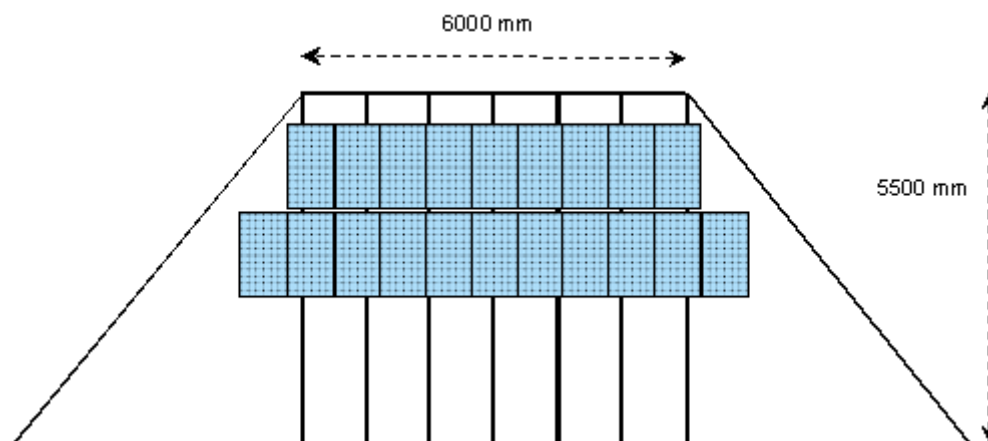


Figure 1 Layout of the solar panels on the roof

2.1.3 Solar Panel Brackets

The solar panel brackets are made of 38x38x3 mm angle iron with the angle facing upward to accommodate the solar panels (not supplied by Solar International (Pty). Ltd.). The dimensions of the solar brackets are as indicated in the diagrams below.

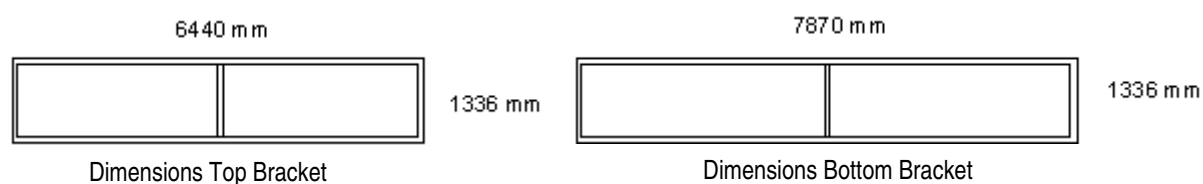


Figure 2 Dimensions of the solar panel brackets

2.1.4 Serial Numbers of Solar Panels

The serial numbers of the solar panels and their position (birds eye view) are indicated in the diagram below.

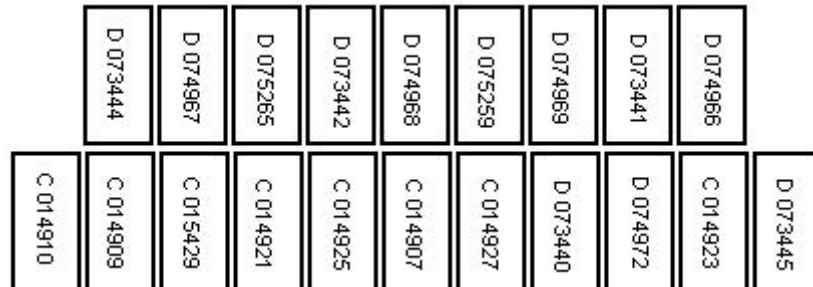


Figure 3 Layout of the solar panels on the roof with serial numbers

The photo below shows the layout of the solar panels on the roof. There is a provision of adding an additional row of panels under the existing layout. There is an air gap between the panels and the roof to allow for ventilation so that the thatch does not rot.



Figure 4 Layout of the solar panels on the roof before thatching

2.1.5 Solar Panel Wiring

The solar panels are divided in five sub-arrays that are wired 2 panels in series and 2 series strings (indicated with an “S”) in parallel, resulting in a nominal voltage of 48V. These units are then wired in individual junction boxes numbered 1 to 5 as indicated in the figure below. The individual cables from the terminal boxes 1 - 5 of the sub-arrays are fed into the charge regulator.

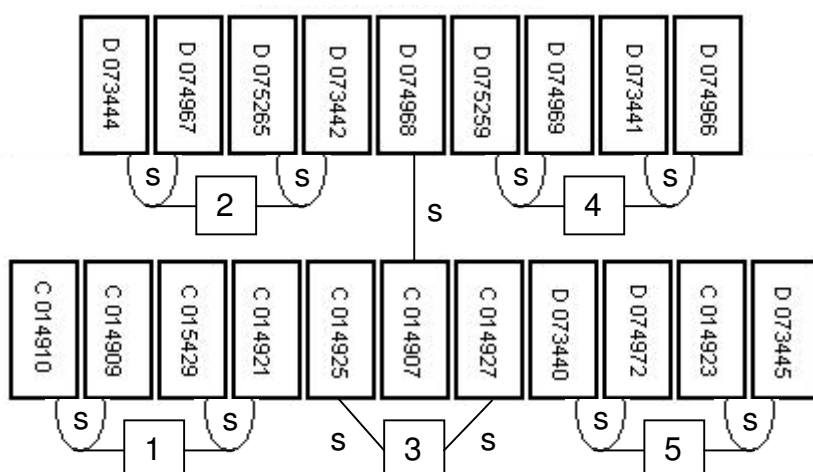


Figure 5 Layout of the wiring and terminal boxes

2.2 Batteries

2.2.1 Battery Frame

The battery frame is a welded construction made of 50x50x 5mm angle iron. Dimensions of the frame are as indicated in the figure on the right.

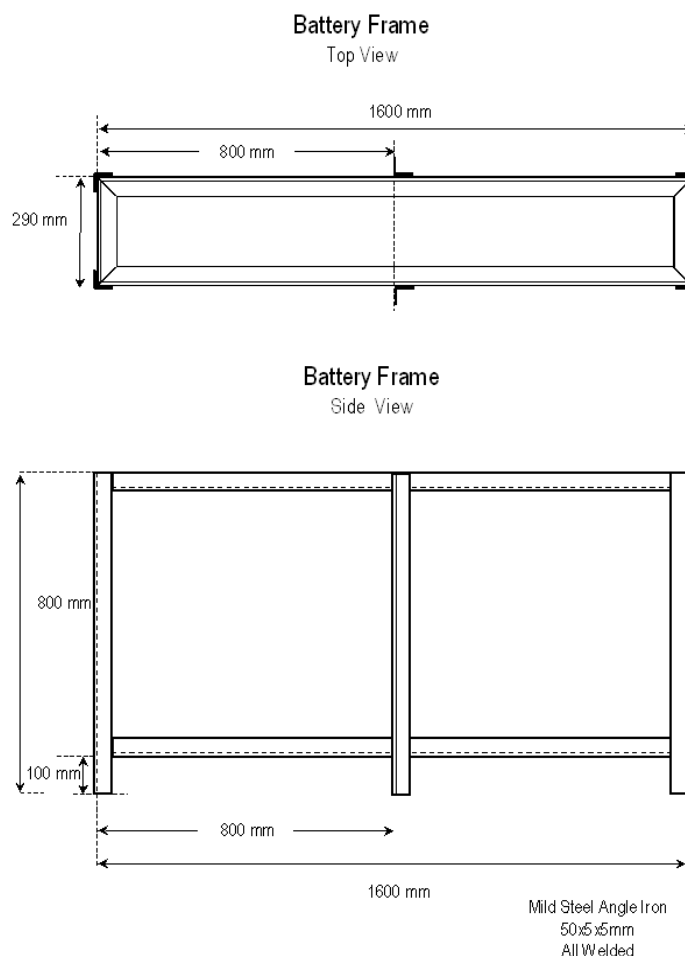


Figure 6 Top view and side view of the battery frame

2.2.2 Battery Wiring

The battery wiring is indicated in the diagram on the right. The nominal voltage of the battery bank is 48V. Six batteries are wired in series and five series groups are wired in parallel. The diagram shows top and bottom level of Rack A and Rack B respectively.

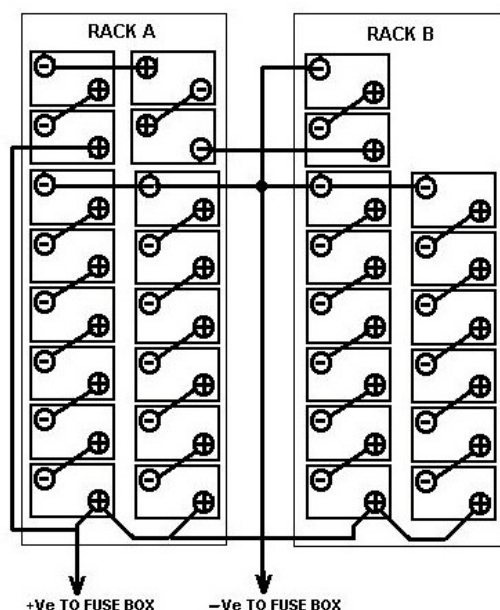


Figure 7 Battery wiring diagram

2.2.3 Battery Specifications

The batteries installed are 30 off 8DC150 Taurus deep cycle batteries with a nominal voltage of 8V and a capacity of 210Ah at a 20 hour discharge rate. This battery has a weight of 27.5 kg and dimensions 264x181x284mm (LxWxH). The deep cycle range of Taurus batteries incorporates the latest technology to ensure optimum performance, life and reliability and are particularly designed for applications where regular charge and discharge is required.

Features of the batteries are the following:

- Strong durable polypropylene container with heat sealed lid.
- Low resistance welded inter-cell connectors to minimise voltage drop for continues discharge.
- Plates and elements constructed to give durability, resistance to corrosion and high performance.
- Long life polyethylene separators with glass matt.
- Low antimony grid alloy, resulting in a low rate of self discharge and longer period between topping up.

2.2.4 Battery and Control Room

The layout of the battery room is shown in the photo below. The inset shows a birds-eye view. The charge regulator is mounted on the wall and the inverter is located between the two rows of batteries. Note the air bricks at the top and bottom of the walls to allow for ventilation.

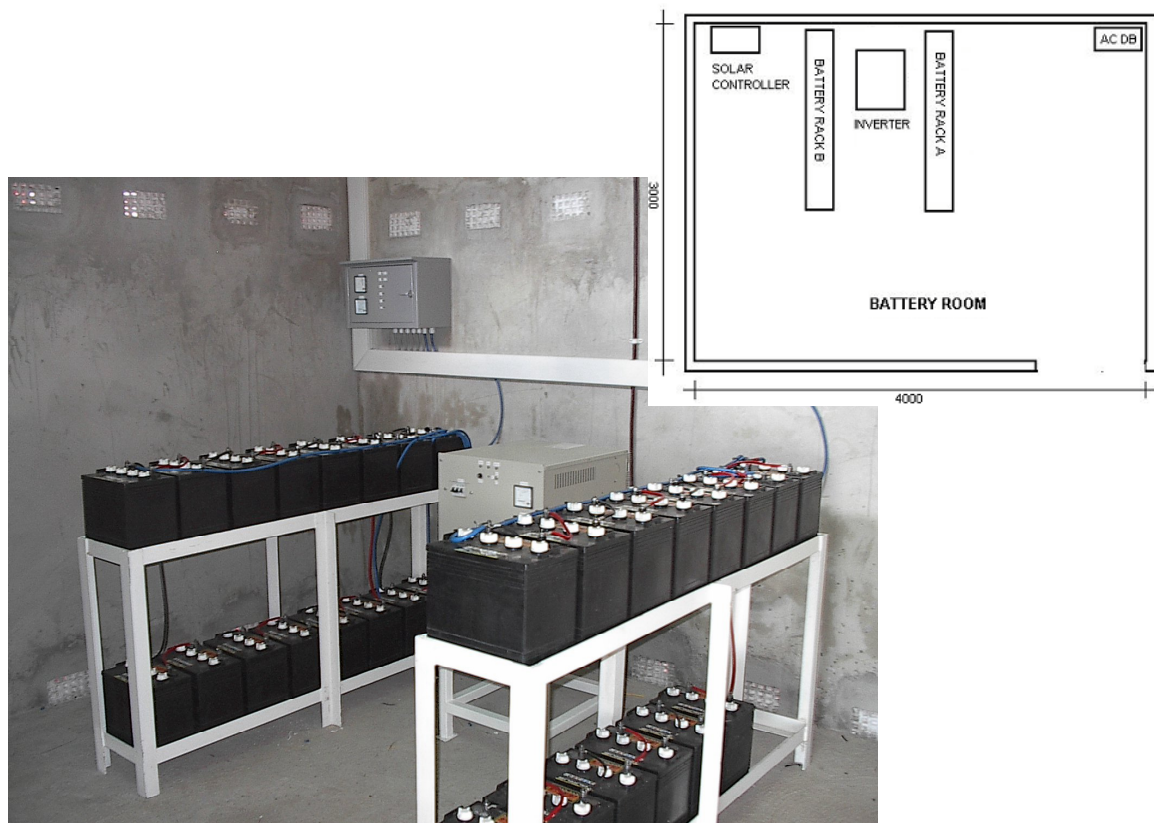


Figure 8 Layout of the battery and control room

2.3 Charge Regulator and Inverter

2.3.1 Charge Regulator

The function of the charge regulator is to prevent the batteries from being overcharged by the solar panels. There is a constant monitoring of the battery status by the charge regulator, and during the daytime charging cycle, the right amount of charge current is automatically fed to the batteries, whilst the solar will also be supplying power directly to the inverters.



Figure 9 Front of the charge regulator

On the charge regulator there is an indication of which sub-array is charging. When the batteries approach full charge, the sub-arrays are switched off subsequently, starting with sub-array 5.

The batteries are being monitored for low voltage and should the voltage fall below a pre-set level, the inverter will switch off to save the batteries from damage from over-discharge. The figure on the right gives a schematic diagram of the charge regulator.

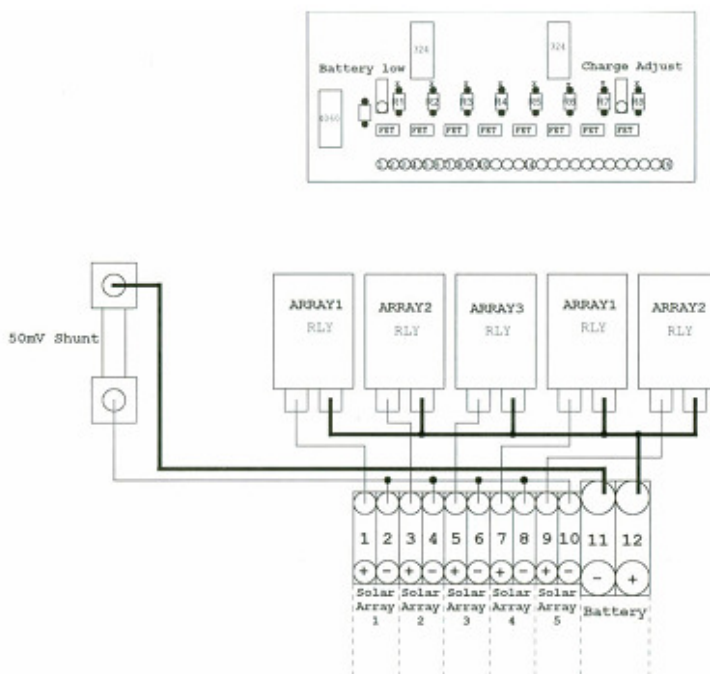


Figure 10 Schematic diagram of the charge regulator

2.3.2 Inverter

The sine wave inverter is used to generate 220 VAC from DC batteries. The sine wave so generated is of the same form as that of grid electricity and at the standard frequency of 50 Hz. It enables the user to operate the most sophisticated appliances and equipment from this power source.

The inverter has low power consumption in a no-load condition, which affords a saving on solar modules or other generating sources.



Figure 11 Front panel of the inverter

The inverter is equipped with an under-voltage lockout facility, which protects the batteries from over-discharge. The output voltage is regulated at 220 Volts AC. The inverter operating efficiency is of around 90%. The inverter is rugged, and reliable. It has been tried and tested in many different locations and applications.

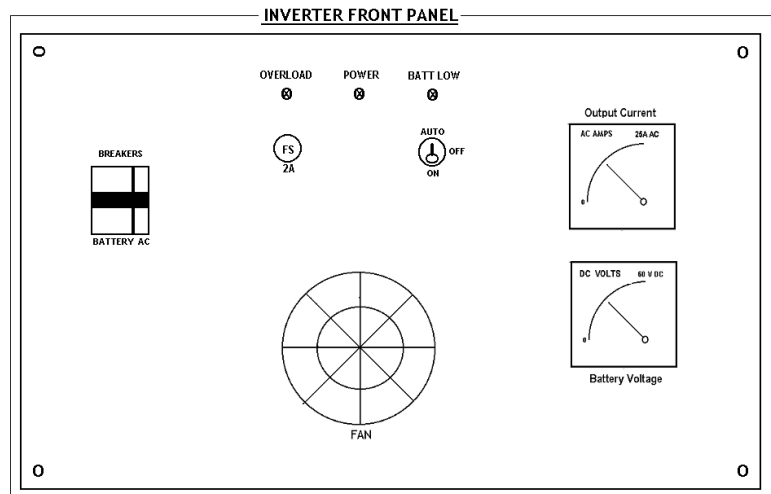


Figure 12 Schematic diagram of the front panel of the inverter

The specifications of the inverter are the following:

- Nominal power rating 5000W
- Nominal input voltage rating 48V DC
- DC Input Variation +/- 10%
- Output Voltage Regulation 220V AC +/- 3%
- Output Frequency 50 Hz
- Output Waveform Sine Wave
- Frequency Stability +/- 1%
- Overload Rating (10 sec.) 130%
- Load Power Factor 0.8 leading or lagging
- AC Output current meter Standard (0 – 15 Amps)
- Electronics Protection 2 Amps fuse
- Reverse Battery Protection MCB
- AC Power Indication LED
- Ambient Temperature range 0 to +40 deg C
- Humidity 90% Standard
- Finish Textured Epoxy

An additional feature is its ability to absorb substantial surge currents for short spells of time.

Inverter Operating Instructions

- The user should prevent rodents or insects from entering the cabinet and damaging the wiring or circuitry.
- The user should ensure the inverter is operating correctly before connecting to a load.
- Although the inverter is capable of absorbing a certain amount of overload current for a short period, it is recommended that the load do not exceed 80% of the rated capacity, to allow for start up in-rush currents, as the inverter has an over-current protection circuit which may trip if the load exceeds the maximum value allowed.

2.3.3 Switching on the inverter

A qualified person conversant with the solar system and inverter should only carry this out, to prevent inadvertent damage and/or loss of guarantee,. The following should be observed (refer to figures 11 and 12 on the previous page):

1. Inspect the inverter for physical damage. Ensure that all circuit breakers and meter(s) on the front panel are intact.
2. Ensure that the circuit breakers are in the “OFF” position and the toggle switch is in the “AUTO” position.
3. Do not connect any load to the inverter yet.
4. Switch “ON” the battery circuit breaker on the front panel. Switch the toggle switch to “ON”.
5. Confirm that the inverter is working. The green “Power” LED should be on and the red “Overload” LED should be off..
6. Connect the AC load to the inverter and then switch on the “AC” circuit breaker at the front panel. The inverter is now supplying 220 VAC to the load. The meter will indicate the amount of current flowing.

2.3.4 Switching form Solar to Generator Operation

The change-over switch has not been supplied by Solar International Botswana (Pty.) Ltd. and therefore the user should obtain this information from their supplier.

WARNING!

**UNDER NO CIRCUMSTANCES SHOULD THE GENERATOR AND SOLAR SYSTEM
POWER ANY LOAD SIMULTANEOUSLY , SINCE THIS WILL RESULT IN THE
DESTRUCTION OF THE SOLAR SYSTEM AND/OR GENERATOR**

3. Maintenance

3.1 Solar Panels

Electrical maintenance of the solar array is minimal. A visual check of the general tidiness of the wiring to the panels and the conduits can be done from the ground, so there is no need to climb onto the array. The boxes at the back of the panels are not to be opened under any circumstances; there are no user – serviceable components inside.

Because of the size of the array, to clean it is difficult; however, if it is felt that the array is in need of cleaning, then hosing the face of the panels with plain water is quite in order.

3.2 Batteries

The batteries are low maintenance, and will require every three (3) months to be cleaned and the electrolyte level to be checked, and if necessary “topped up” with distilled or de-mineralised water. Avoid over-filling as this will lead to acid spill. Before “topping up”, the electrolyte specific gravity should be checked with a hydrometer, in order to monitor the battery charge status and individual cell conditions with respect to each other.

Further, the only other maintenance required is to lightly grease the terminals and checking the nuts for tightness. Should any terminals show signs of corrosion, they should be cleaned with a mild solution of bicarbonate of soda and then re-greased.

WARNING!

DO NOT SMOKE NOR USE NAKED FLAMES IN THE BATTERY ROOM

If you can't see, use an electric torch.

3.3 Charge Controller and Inverter

The charge controller and inverter do not have any serviceable parts. Lethal voltages are present inside the cabinet when the inverter is active. Opening the cabinets voids the warranty. Do not splash water onto the cabinets. When dusty, use a dry cloth to wipe-off dust. Make sure that the ventilation holes are not blocked.

No attempt should be made to remove any of the units. Should any unit be suspect, it must be reported through the normal channels for action by the appropriate persons trained and experienced in the Inverter and Charge Controller and their workings.

4. Warranty

Equipment supplied by Solar International Botswana (Pty) Ltd. will be warranted for a period of one (1) year from the date of installation to the customer purchaser against defects resulting from faulty workmanship and/or materials, when such equipment is installed by Solar International Botswana (Pty) and is operating under normal design conditions.

4.1 Solar Panels

The Shell Solar panels carry a workmanship of two years. The panels carry a limited peak power warranty of 20 years from the date of sale to the consumer purchaser against degradation in excess of ten (20) per cent of the minimum nameplate power output measured at an optimum voltage under the standard conditions of 1000W/m² at a cell temperature of 25 degrees Celsius.

Shell Solar warrant to replace this lost power provided such degradation is determined to be due to faulty workmanship or materials or repair of the panels or a refund of the purchase price based on a yearly depreciation of 5%. This applies to the RSM90 solar panels provided that the serial or identification number has not been altered, defaced or removed and that the solar panels have not been removed from the original installation by persons or bodies not authorized in writing to do so by Solar International Botswana (Pty) Ltd.

4.2 Batteries

The Batteries are warranted for a period of one (1) year from date of installation, against failure through faulty workmanship or materials. The batteries will be replaced or repaired “free of charge” during this period, provided the installation has not been altered without the written authorization of Solar International Botswana (Pty) Ltd. The warranty does not cover neglect or abuse, or the use of battery dopes will render the warranty null and void.

4.3 Inverter and Charge Controller

The Inverter and Charge Controller, are warranted for a period of one (1) year from date of commissioning, and Solar International Botswana (Pty) Ltd. will repair or replace faulty units, within the warranty period, provided that the installation has not been tampered with, or the units have not been abused in any way.