

freesun[®]
SOLAR INVERTER



Solar Inverter
Service Manual


POWER ELECTRONICS[®]



Solar Inverter – LVT
Service Manual

Edition: October 2012

FSMS04AI Rev. A

SAFETY SYMBOLS

Always follow safety instructions to prevent accidents and potential hazards from occurring.

**WARNING**

This symbol means improper operation may result in serious personal injury or death.

**CAUTION**

Identifies shock hazards under certain conditions. Particular attention should be given because dangerous voltage may be present. Maintenance operation should be done by qualified personnel



Identifies potential hazards under certain conditions. Read the message and follow the instructions carefully.



Identifies shock hazards under certain conditions. Particular attention should be given because dangerous voltage may be present.

Edition of October 2012

This publication could present technical imprecision or misprints. The information here included will be periodically modified and updated, and all those modifications will be incorporated in later editions. To consult the most updated information of this product you might access through our website www.power-electronics.com where the latest version of this manual can be downloaded.

Revisions

| Date | Revision | Description |
|----------------|----------|---------------|
| 10 / 10 / 2012 | A | First Edition |

The equipment and technical documentation are periodically updated. Power Electronics reserves the right to modify all or part of the contents of this manual without previous notice.

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SAFETY INSTRUCTIONS

IMPORTANT!

- Read this manual carefully to maximise the performance of this product and to ensure its safe use.
- In order to use appropriately the FREESUN, please, follow all instructions described in the installation manual referred to transport, installation, electrical connection, and commissioning of the equipment.
- Power Electronics accepts no responsibility or liability for any and all damage resulting from inappropriate use of the equipment.
- The information contained in the installation guide must be observed when installing the inverter.

PRIOR TO CONNECTION

In the rear side of the solar inverter are located the **SECURITY FIXATIONS FOR TRANSPORT** in both the transformer and the inductance of the inverter. Before making any connections to the inverter is necessary to consider:

If the inverters are going to be installed side by side, it is **NECESSARY** to **REMOVE** these **SECURITY FIXATIONS BEFORE** placing them in their final location.

It is **ESSENTIAL** to **REMOVE** them **BEFORE CONNECTING**. Make sure that all fixations are properly removed and put back the rear covers of the inverter.

The inverter can now be placed in its final location and the connection procedure can be done as described in the installation manual attached to the inverter.

WARNINGS AND RECOMMENDATIONS



If your device has the positive or negative pole of the photovoltaic system earth connected, the following instructions must be considered:

The only point in the installation where the positive or the negative pole should be grounded is in the proper inverter (through the 4-pole circuit breaker that is added to that effect). It is important to note that if there was another grounded connection elsewhere in the installation (in the panels themselves, in the String Supervisor, etc..) the protection provided by the additional circuit breaker would have NO effect.

Therefore, it is recommended to revise periodically the insulation between the pole that is going to be grounded and the earth. Like this, it will be possible to detect a ground fault unwanted in other points of the installation. This will prevent the circuit breaker from providing inappropriate protection due to eventual uncontrolled ground leakages.

In this manual, safety messages are classified as follows:



WARNING

If possible do not remove the solar inverter cover while the power is applied or the unit is in operation. Otherwise electric shock could occur.

If possible do not run the solar inverter with any of the covers removed. Otherwise you may get an electric shock due to the high voltage terminals inside the inverter.

Do not open the inverter doors except when necessary for installation or maintenance, even in such cases, remove the input power if possible. Otherwise you may access the charged circuits and get an electric shock.

Operate the switches with dry hands.
Otherwise you may get an electric shock.

Do not use cables with damaged insulation.
Otherwise you may get an electric shock.

Do not subject the cables to abrasions, excessive stress, heavy loads or pinching.
Otherwise, you may get an electric shock.



CAUTION

Install the inverter on a non-flammable surface. Do not place flammable material nearby.
Otherwise fire could occur.

Disconnect the input power if the solar inverter gets damaged.
Otherwise it could result in a secondary accident or fire.

After the input power is applied or removed, the inverter will remain hot for a couple of minutes.
Touching hot parts may result in skin burns.

Do not apply power to a damaged inverter or to an inverter with parts missing even if the installation is complete.
Otherwise you may get an electric shock.

Do not allow lint, paper, wood chips, dust, metallic chips or other foreign matter into the inverter.
Otherwise fire or accident could occur.



WARNINGS

RECEPTION

- The Freesun is carefully tested and perfectly packed before leaving the factory.
 - In the even of transport damage, please ensure that you notify the transport agency and POWER ELECTRONICS: 902 40 20 70 (International +34 96 136 65 57) or your nearest agent, within 24hrs from receipt of the goods.
-

UNPACKING

- Make sure model and serial number of the solar inverter are the same on the box, delivery note and unit.
 - Each solar inverter is supplied with a technical manual.
-

RECYCLING

- Packing of the equipments should be recycled. For this, it is necessary to separate different materials included (plastic, paper, cardboard, wood, ...) and deposit them on proper banks.
 - Waste products of electric and electronic devices should be selectively collected for their correct environmental management.
-

SAFETY

- Before operating the solar inverter, read this manual thoroughly to gain an understanding of the unit. If any doubt exists then please contact POWER ELECTRONICS, (902 40 20 70 / +34 96 136 65 57) or your nearest agent.
 - Wear safety glasses when operating the inverter with power applied and the front cover is removed.
 - Handle the solar inverter with care according to its weight.
 - Install the inverter according to the instructions within this manual.
 - Do not place heavy objects on the inverter.
 - Ensure that the mounting orientation is correct.
 - Do not drop the inverter or subject it to impact.
 - The Freesun inverters contain static sensitive printed circuits boards. Use static safety procedures when handling these boards.
 - Avoid installing the inverter in conditions that differ from those described in the *Technical Characteristics* section.
-

TRIAL RUN

- Verify all parameters before operating the inverter.
 - Always apply voltage and current signals to each terminal that are within levels indicated within this manual. Otherwise, damage to the inverter may result.
-

OPERATION PRECAUTIONS

- Do not modify or alter anything within the inverter.
 - Before programming or operating the Freesun Series, initialise all parameters back to factory default values.
-

WHO'S ABLE TO APPLY THE FOLLOWING INSTRUCTIONS?

- Only trained electricians approved by the responsible energy supply company may install and commission the inverters. The instructions assume that you, the installer, are familiar with electrical installations and know the corresponding rules and regulations.
-

SPECIAL HAZARDS OF PHOTOVOLTAIC SYSTEMS

Photovoltaic systems have special characteristics that can represent special hazards:

- An active power source is connected. This means that, regardless to the operating mode of the inverter, there may be voltage present, either from the photovoltaic generator and/or the FREESUN. This is especially important to consider when disconnecting particular parts of the system.
 - Very high DC voltages are present (no zero-crossing) which, in case of a fault or inappropriate use of fuses or plugs, may lead to arcing.
 - The short-circuit current of the photovoltaic generator is only slightly more than the maximum operating current and is also dependent on the level of a solar irradiation. This means that, if a short circuit occurs in the system, the existing circuit breakers are not guaranteed to switch off.
 - A highly branched generator array may be difficult to disconnect if a fault develops (e. g. short circuit). We recommend the extra use of external DC circuit breakers for disconnecting the inverter and/or the DC main cables / String supervisors (DC circuit breakers are built-in). One circuit breaker should be allocated to each input, and these should be located near to de FREESUN as described in the standard VDE0100 part 7-712 and the VDI 6012 regulations.
 - Power Electronics must be informed of the required AC grid connection type
 - The device contains capacitors on the AC and DC sides. The discharge time of the capacitors is longer than 10 minutes. For this reason, it is required to wait longer than this time before making any operation or maintenance actions in the unit.
-

1. INTRODUCTION

The Freesun, the string supervisor units and the communication units must be maintained at regular intervals. Maintenance includes the following activities:

- Inspection of wearing parts, and replacement if necessary
- Functional test of components
- Inspection of contact joints
- Cleaning of cabinet interior, if necessary
- Ambient conditions

The maintenance interval depends on the location and the ambient conditions. A device installed in a dusty environment requires more frequent maintenance than recommended. The maintenance interval is to be adapted accordingly.



Figure 1.1 Freesun LVT frame 3 (General view)

Maintenance Task in Freesun Inverter

| MAINTENANCE TASK | MAINTENANCE INTERVAL (RECOMMENDED) |
|---|--|
| Reading of historical data and errors | 1 month * (depending on inverter size) |
| Cleaning the protective grids at the air inlets and outlets. | 12 months [*] |
| Checking of dust, dirt, humidity and water leaks inside the inverter. Clean the Freesun if necessary. | 12 months [*] |
| Check all power cable connections for looseness and tighten them if necessary. Check the connectors and insulation for discoloration or degradation. If necessary, replace any damaged connectors or corroded contacts. | 12 months [*] |
| Check the safety notices and stickers on and in the switch cabinet and replace missing or damaged labels. | 12 months |
| Check all cooling fans for functionality and operating noise. | 12 months |
| Checking the heating and the hygrostat | 12 months |
| Checking protective devices: <ul style="list-style-type: none"> • Line circuit breaker • Power switch | 12 months |
| Checking the fuses and disconnectors. | 12 months |
| Checking the overvoltage arrester. | 12 months [*] |
| Checking of main AC voltage and auxiliary 230 V and 24 V voltages. | 12 months |
| Checking of over temperature function. | 12 months |
| Checking of grounding operation (GFDI) | 12 months |
| Changing intervals of heating and ventilation parts. | 12 months |

[*] Maintenance interval could be shorter if required by location or ambient conditions.

1.1. Maintenance Task in Freesun String Supervisor

| MAINTENANCE TASK | MAINTENANCE INTERVAL (RECOMMENDED) |
|--|------------------------------------|
| Check all power and string cable connections for looseness and tighten them if necessary. Check the connectors and insulation for discoloration or degradation. If necessary, replace any damaged connectors or corroded contacts. | 12 months |
| Check the String Supervisor fixation. | 12 months |
| Check whether the enclosure is damaged and properly sealed. | 12 months |
| Make sure that the cover locks are correctly closed. They are closed under light pressure by means of a screwdriver until they lock into position (1/4 turning). | 12 months |
| Check whether there is condensation water in the device. | 12 months |
| Check the pressure adjusting screw for dirt or damage and replace it, if necessary. | 12 months |
| Check the plexiglass covers above the string fuses. | 12 months |
| Check the safety notices on and in the device and replace them if they are damaged or no longer legible. | 12 months |
| Visually check the existing fuses and tension springs on the fuse holders. | 12 months |
| Check the ground connection and the contact resistance to the ground potential. | 12 months |
| Check the overvoltage protector, the visual display must be green | 12 months |

2. MAINTENANCE OF THE FREESUN

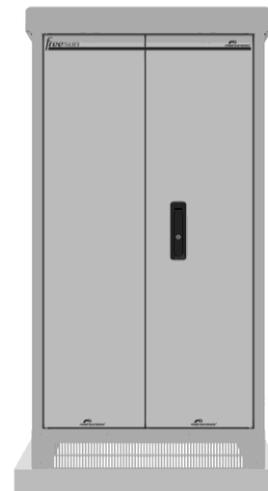
2.1. Topology

The next figure show an example of the Freesun for frame 3, frame 1 and indoor, outdoor .



FSITG0003A

Figure 2.1 FREESUN Frame 3 indoor front view



FSITG0002A

Figure 2.2 FREESUN Frame 1 outdoor front view

2.2. Reading out Historical Data and Errors

A regular check of the plant operation is necessary to recognize possible failures which have no alarm function. Furthermore, plant operation might be improved by analyzing the plant data. Deviations from the optimum operation can result in yield losses and thus in a reduction of the plant's profitability.

Depending on the plant size, the error memory of the inverter as well as the long-term data of the data logger must be analyzed at least once a month. Proceed as described in the Programming and Software Manual.

2.3. Cleaning the Electronics Parts

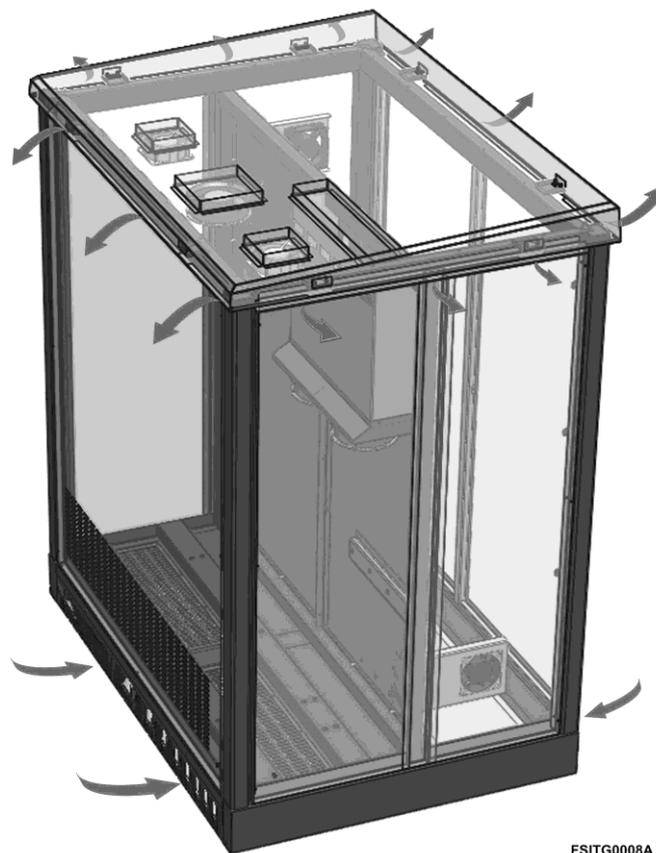
The electronic parts of the Freesun inverters are considerably well-protected and thus require almost no maintenance work. Only carry out a visual inspection and clean the circuit boards with a soft brush or a vacuum cleaner with a soft top part if there are dust deposits. The cleaning equipment must be anti-static and ESD-compliant. Do not use any hard or coarse brushes. Do not use pressurized air.

2.4. Protective Grids at the Air Inlets and Outlets

This section describes how to clean the protective grids at the air inlets and outlets. Exchanging the protective grids is only necessary in case of damage.

2.4.1. Freesun Ventilation

In order to cool the inverter, the ventilation system must be free of any obstructions to ensure the required inlet ventilation and heat dissipation. The specified minimum clearances must be maintained to ensure the proper ventilation and heat dissipation as described in the previous sections. The permissible ambient temperature in order to ensure the correct operation and maximum feed-in performance is between -20°C and $+50^{\circ}\text{C}$. The exhaust air (waste heat) is blown out through the rear part of the inverter.



FSITG0008A

Figure 2.3 Ventilation for the FREESUN

2.5. Checking the Power Cable Connections

1. Check all power cable connections and tighten them if necessary.
2. Check the connectors and insulation for discoloration or degradation.
3. If necessary, replace any damaged connectors or corroded contacts.

2.6. Checking the Fans

The device is equipped with several fans for cooling. To perform any work on the fans is recommended that the equipment is switched off. This procedure should be taken into account for commissioning, maintenance and repair work.

Check all cooling fans for functionality and operating noise, while the Freesun is stopped and the doors are opened. You can use the test fan mode in order to check the interior Freesun fans.

2.7. Checking the Heating and the Hygrostat

Immediately after isolating the device, depending on the operating conditions, certain components can be very hot (e. g. fuses, transformer core, sine wave filter, heatsinks, etc.). Safety gloves should always be worn when working near components that can be expected to be very hot. We recommend that safety gloves be worn during all work on the inverter.

Depending on the version, one or several heating models are installed.

1. Switch the Freesun to "Stop" and open the doors.
2. Ensure that the Freesun is connected to a control voltage (supply voltage).
3. Tape door contact switch to the "On" position.
4. Turn the hygrostat down as far down as possible. If the value is smaller than the current air humidity, the heater is activated.

If the air humidity is too low, a functional test of the heater cannot be carried out. In this case, the hygrostat does not switch on, even if it is set to the minimum value.

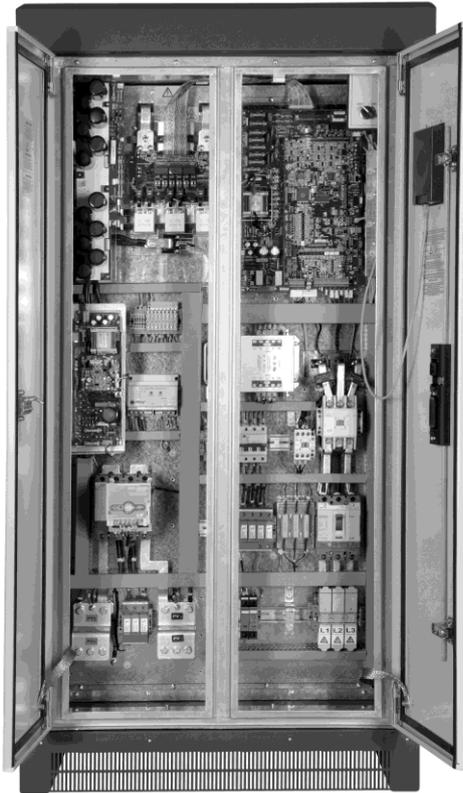
If the hygrostat has been switched through, the heating fans must start and the air blown through the heat sink must heat up.

1. Once the functional test of the heating has been conducted, adjust the hygrostat back to the initial setting. The value is specified with an adhesive label on the thumb wheel and in the circuit diagram.
2. Release door contact switches (remove the adhesive tape).
3. Close the cabinet doors.

2.8. Checking protective devices

All work on the FREESUN may only be performed when:

- 1- The device is safely disconnected from de PV voltage (DC), the grid voltage (AC), and the auxiliary power supply (internal or external),
- 2- Power sources are secured against being switched on, and the device is voltage-free. Only qualified technical personnel may undertake any such task.



FSITG0009A

Figure 2.4 FREESUN Frame 1 internal view



FSITG0010A

Figure 2.5 FREESUN Frame 3 internal view

2.8.1. Electrical Connections to the AC Grid Power

The AC grid connection is made at the TN-C, TN-S, TT grid connection type, which must be provided by the customer, using a 3-phase system equipped for 400V.

In addition, it is also necessary to verify that existing rotary field on L1, L2 and L3 is the same than inverter phase sequence; on the contrary a trip will be generated.

The grid connection must be installed in a way such that a right-hand rotary field lies at the input of the cabinet. In case of a left-hand rotary field is present, the inverter will generate a trip.

Cehck that the grid connection cable is fused at the nominal current indicated on the name plate. If the specified nominal current differs from the nominal current of the fuse plug, the fuse plug having the next highest nominal current may be used.

The cables for AC connection will be fixed using M8 cable lugs.



Figure 2.6 View of the base plates for cable routing and the FREESUN electrical connections

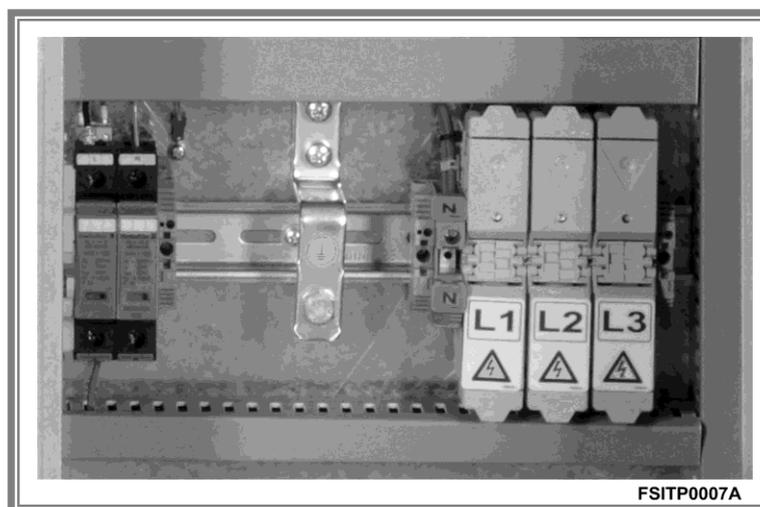


Figure 2.7 AC connection terminals

2.8.2. PV Generator Power Connection (DC Connection)

A busbar that allows string distribution boxes to be connected is located in the left lower area of the inverter sidewall. Cables rated for a minimum of 900V // 1000V are required for connecting the DC cables to the fuse inputs of the inverter.

Suitable cable screw connections must be installed in the busbar plates to provide strain relief for the cable. The DC cables are connected directly to the busbar using M10 cable lugs.

The DC voltage of the PV generator must never exceed the maximum permissible inverter input voltage. Otherwise the inverter is in acute danger when connected: $U_{PV} < 900 // 1000 \text{ V}$.

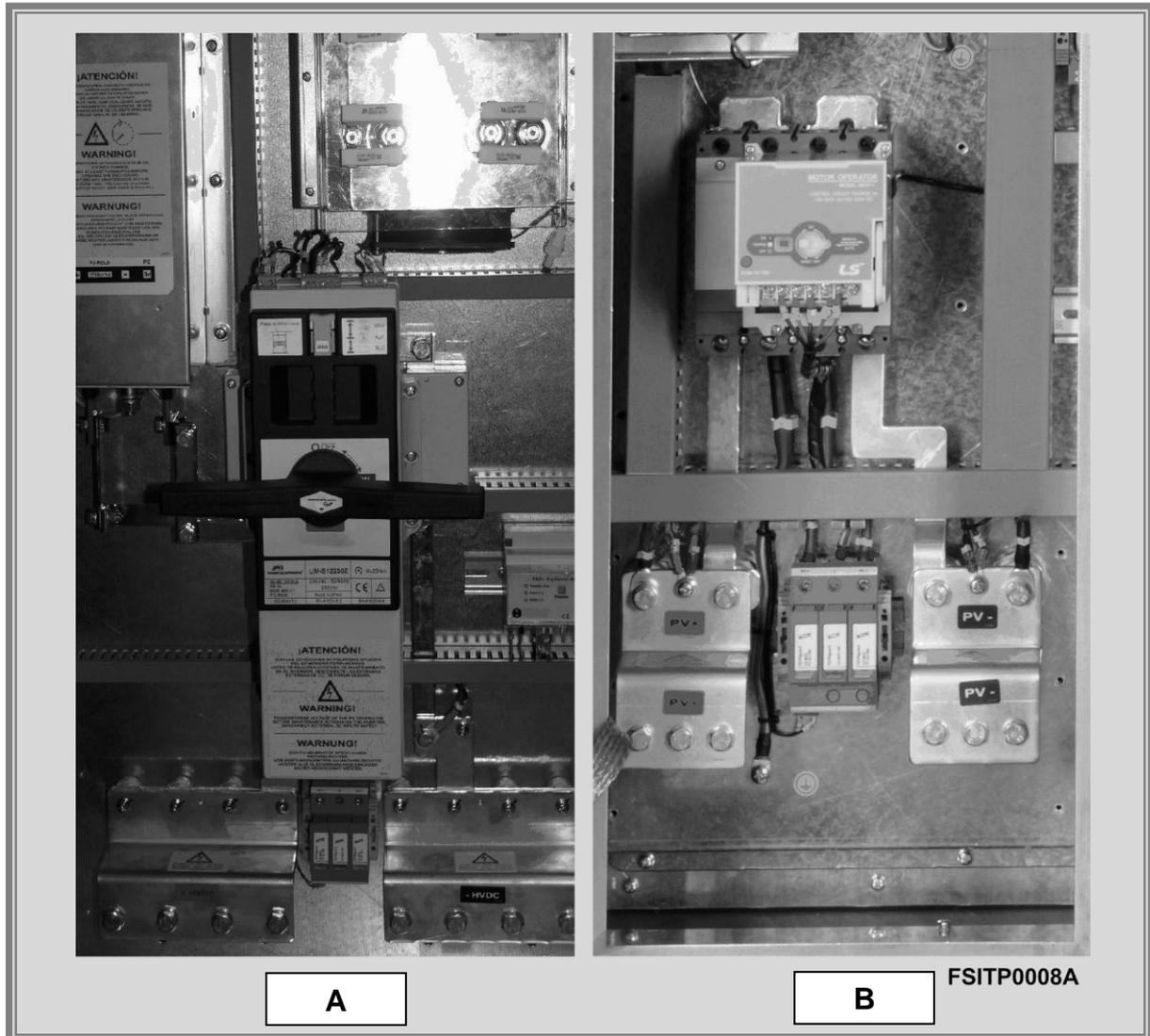


Figure 2.8 View of DC connection area with on-load disconnector (A) and circuit breaker (B)

2.8.3. Checking the DC Main Switch

Each module in the Freesun inverter has a motor-driven circuit breaker on the DC side.

This switch is equipped with a circuit breaker, a springpower storage device, an off key, and a position display.

1. Switch the Freesun to "Stop" and open the doors.
2. Ensure that the Freesun is connected to a control voltage (supply voltage) and is supplied with power.
3. Tape door contact switch to the "On" position.
4. Switch the Freesun to "Start". The DC switch is switched on and shifts to "On" position.
5. Switch the Freesun to "Stop". The DC switch trips and shifts to "Off" position.
6. Release door contact switches (remove the adhesive tape).
7. Close the cabinet doors.

2.8.4. Checking the Fuses and Disconnectors

1. Visually check the existing fuses and tension springs on the fuse holders.
2. Check all power cable connections for looseness and tighten them if necessary. Check the connectors and insulation for discoloration or degradation. Replace any damaged connectors or corroded contacts.
3. Check all string cable connections for looseness and tighten them if necessary. Check the insulation, and the terminals on the assembly as well on the busbar for discoloration or degradation. If necessary, lubricate the contacts.

2.8.5. Checking the Overvoltage Protector

The inverters have several overvoltage protectors which need to be regularly checked for correct function. You can locate the exact position and number of overvoltage protectors using the reference designation of the components in the provided circuit diagram (Installation Manual). The overvoltage protectors are inspected visually and by means of measurements.

1. Visual inspection of the arrester for optical signs of wear.
2. Check the operating readiness of the protector via the function and fault signaling (A) of the protection path which is free of operating current.

| | |
|----------------------|--|
| Visual display green | Overvoltage protector is ready for operation |
| Visual display red | Overvoltage protector defective |

2.8.6. Maintaining the Insulator Monitor

The GFDI is subject to aging caused by wear of the contacts every time they are tripped. Due to aging, sensitivity is reduced. Check the insulation of the PV generator in regular maintenance intervals in order to ensure the functionality of the insulator monitor.

1. Visual inspection of the insulator monitor. Remove possible dirt or dust deposits by using a vacuum cleaner or with compressed air.
2. Pulse test mode in order to verify the correct performance of the insulator monitor.

The plant operator determines the insulation test of the entire plant. In case the mechanical or optical check is not fulfilled or in accordance with the maintenance protocol, the insulator monitor must be replaced. Replacement is also necessary after at least after 100 ground faults which led to the tripping of the insulator monitor.

Maintenance work of the soft grounding is carried out after checking the insulator monitor. Once tripped, manually reset the failure via the button.

3. MAINTENANCE OF THE FREESUN STRING SUPERVISOR

The environmental conditions that should be considered for the correct installation and operation of the string supervisor are:

- **TEMPERATURE RANGE** -20°C to +50°C
- **RELATIVE HUMIDITY** 15 to 95%
- **ALTITUDE** 1000m over sea level
- **POLLUTION DEGREE** Type II

The String Supervisors are usually installed near the modules at the open air. Depending on the system size, an increased number of String Supervisors is required which must be taken into account during maintenance work. In the following, some steps are listed which serve as maintenance instruction.

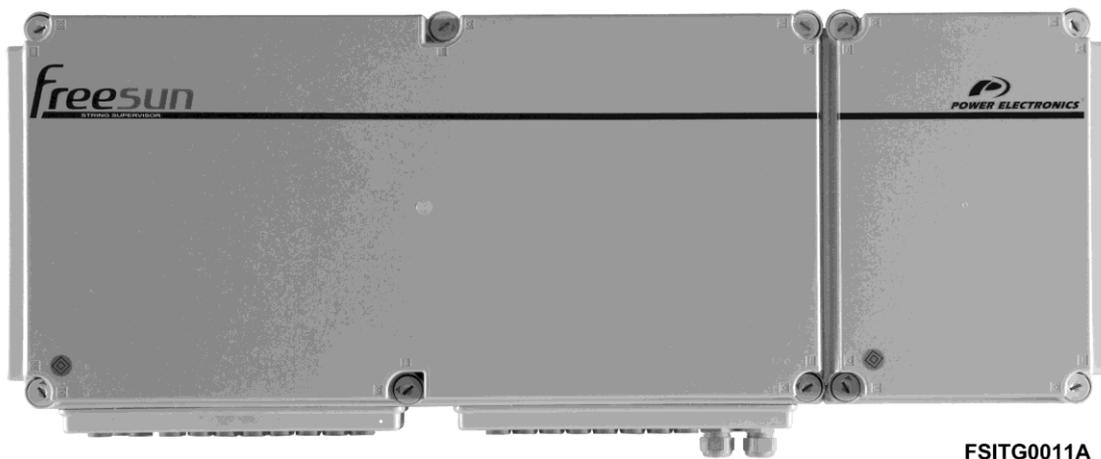


Figure 3.1 String Supervisor external view

First, check the installation site for accessibility, inflammable materials and safe positioning and then make sure that the String Supervisor is attached to a horizontal installation and that a sufficient sun shading system is available.

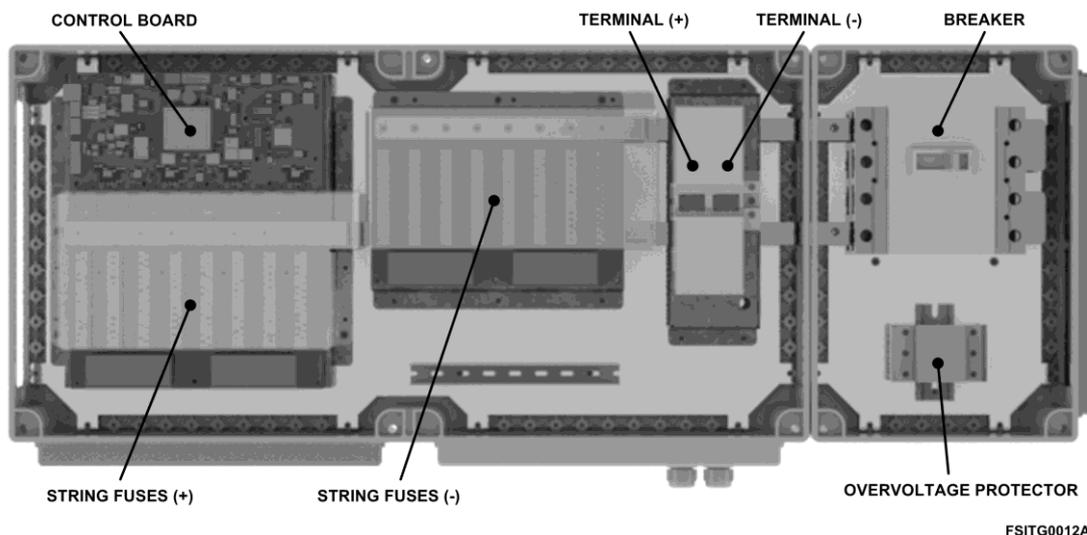


Figure 4.2 String Supervisor internal view

1. Check whether the enclosure is damaged and properly sealed.
2. Make sure that the lid is securely in place and properly sealed. Make sure that the cover locks are correctly closed; they are closed under light pressure by means of a screwdriver until they lock into position (1/4 turning).
3. Check whether there is condensation water in the device. Wipe out the String Supervisor, check from where the water intruded the device and take corrective measures.
4. Check the pressure adjusting screw for dirt or damage and replace it, if necessary.
5. Check the Plexiglass covers above the string fuses.
6. Check the safety notices on and in the device and replace them if they are damaged or no longer legible. You can order new labels from Power Electronics.
7. Visually check the existing fuses and tension springs on the fuse holders.
8. In addition, check the auxiliary voltage of +24 V at the connection terminals and the plug connectors; it must be at least +21 V.
9. Check all power cable connections for looseness and tighten them if necessary. Check the connectors and insulation for discoloration or degradation. Replace any damaged connectors or corroded contacts.
10. Check all string cable connections for looseness and tighten them if necessary. Check the insulation, and the terminals on the assembly as well on the busbar for discoloration or degradation.
11. Check all cable connections of the optional DC main switch for looseness and tighten them if necessary. Check the insulation and the switch for discoloration or degradation.
12. Check the shield connection of the communication link. It must be hand-tightened; therefore, a screwdriver is not suitable.
13. Check the ground connection and the contact resistance to the ground potential.
14. Check the overvoltage protector, the visual display must be green. Maintenance of the String Supervisor is completed.

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