ENERTRONICA SANTERNO

SOLAR ENERGY

*USER MANUAL*
*Installation, Use and Maintenance*

# SUNWAY STRING BOX LT 1500V 24 INPUTS

*English*

*15PEN6PB100*
*2020/05/08 R.02*

- This manual is integrant and essential to the product. Carefully read the instructions contained herein as they provide important hints for use and maintenance safety.
- This device is to be used only for the purposes it has been designed for. Other uses should be considered improper and dangerous. The manufacturer is not responsible for possible damages caused by improper, erroneous and irrational uses.
- Enertronica Santerno is responsible for the device in its original setting.
- Any changes to the structure or operating cycle of the device must be performed or authorized by Enertronica Santerno.
- Enertronica Santerno assumes no responsibility for the consequences resulting by the use of non-original spare-parts.
- Enertronica Santerno reserves the right to make any technical changes to this manual and to the device without prior notice. If printing errors or similar are detected, the corrections will be included in the new releases of the manual.
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# 1. GENERAL INFORMATION

## 1.1. Scope of this Manual and for Whom this Manual is Intended

This manual covers the following SUNWAY STRING BOX LT 1500V Class II models:

- SB-24-LT07-1500V – 24 INPUTS 2 OUTPUTS PER POLE
- SB-24-LT08-1500V – 24 INPUTS 1 OUTPUT PER POLE
- SB-24-LT10-1500V – 24 INPUTS 1 OUTPUT PER POLE

This manual must be read by:

- Installers
- Operators
- Plant manager
- Please refer to section 0.

Images included in this manual are for reference only.

## 1.2. Symbols Used

**Danger**

**Indicates an operating procedure which, if not carried out correctly, may lead to injuries or even death caused by electric shock.**

**Warning**

**Indicates an operating procedure which, if not carried out correctly, may cause serious damage to equipment.**

*Note*

*Indicates important information concerning use of the equipment.*

**Prohibition**

**Strictly forbids the execution of operating procedures.**

## 1.3. Definitions

Installer

Technician responsible for setting up, positioning and installing the equipment in compliance with the system diagram and in accordance with first-class, professional criteria.

Operator

Worker who has been suitably trained and informed on the risks and relative safety procedures to be adopted. The operator can carry out routine maintenance on the equipment.

Plant manager

Person who co-ordinates or manages system management activities and is responsible for ensuring health and safety standards are adhered to.

Technical room

Place used for housing the technological systems such as the wiring, plumbing, heating, air-conditioning, lifting and telecommunications systems.

It is equipped with suitable forced-air ventilation and/or air conditioning and is also fitted with appropriate safety devices governing access, maintenance and fire-prevention.

Person in charge of running the electrical system (System Manager)

Person with the highest level of responsibility concerning operation of the electrical system. If required some of his/her tasks may be delegated to others.

Person in charge of working activities (Works Supervisor)

Person with the highest level of responsibility concerning the execution of work. If required some of his/her tasks may be delegated to others.

The Works Supervisor must give all persons involved in the execution of work activities the relative instructions concerning reasonably foreseeable dangers which may not be immediately apparent.

Skilled electrician

Someone who has been trained and has enough technical knowledge or experience to enable him/her to avoid the dangers which may be generated by electricity.

Instructed person

**Someone who has been adequately advised or supervised by a skilled person to enable him/her to avoid the dangers which may be generated by electricity.**

## 1.4. SUNWAY STRING BOX LT 1500V

The SUNWAY STRING BOX LT 1500V products have been designed for maximum reliability and life expectancy, based on numerous years of experience working with large ground and rooftop installations, complies with the most stringent national and European safety directives.

Careful and precise design down to the very last detail and strict quality control guaranteed by standard ISO 9001 are the strong points of a reliable product which is able to maintain its features unaltered over time.

Designed to last in even the most arduous environmental conditions, Enertronica Santerno string boxes guarantee wide safety margins during daily use.

These and other design features are what position SUNWAY STRING BOX LT 1500V at the highest level of reliability and performance for photovoltaic field energy production.

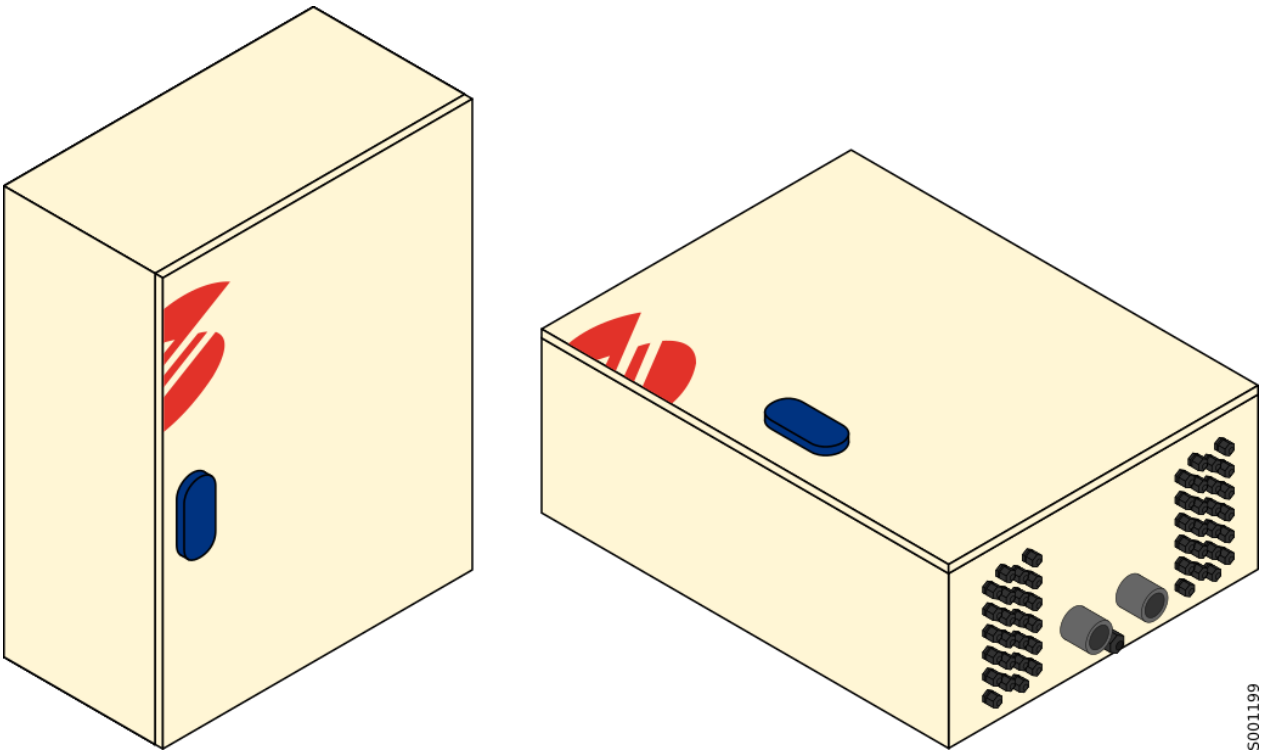



**Figure 1: SUNWAY STRING BOX LT 1500V 24 INPUTS**

## 1.5. Operating Principle

Medium- and large-power PV generator systems are made up of a high number of strings. To optimize the connection topology and enhance the protection and monitoring systems, the parallel connection of the strings is usually carried out on more than one level, usually a first parallel level and a second parallel level.

Enertronica Santerno offers a complete range of products for string parallel connections, SUNWAY STRING BOX LS, SUNWAY STRING BOX LT 1000V and SUNWAY STRING BOX LT 1500V for creating the first parallel level and the Sunway DC-Parallel or inside the inverter for creating the second parallel level.

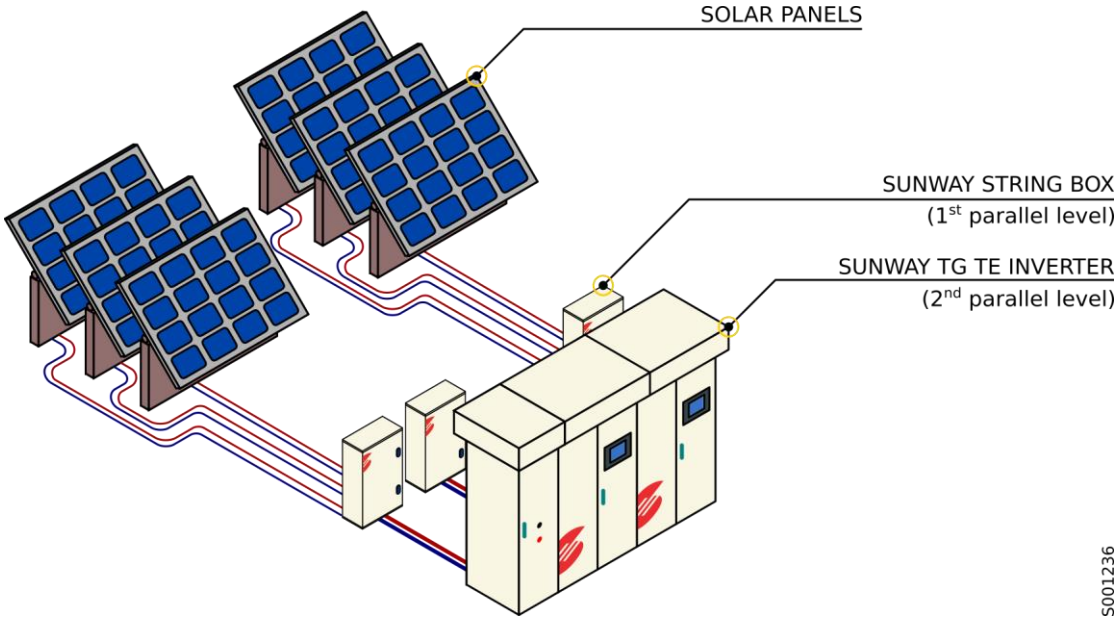



**Figure 2: Block diagram of the first and second parallel levels**

The SUNWAY STRING BOX LT 1500V is made up of the following function blocks:

- String connection section, including:
  - Safety fuses,
  - Parallel connection of the PV generator strings,
  - Surge protection device (SPD,
- Output section, including:
  - switch disconnector.

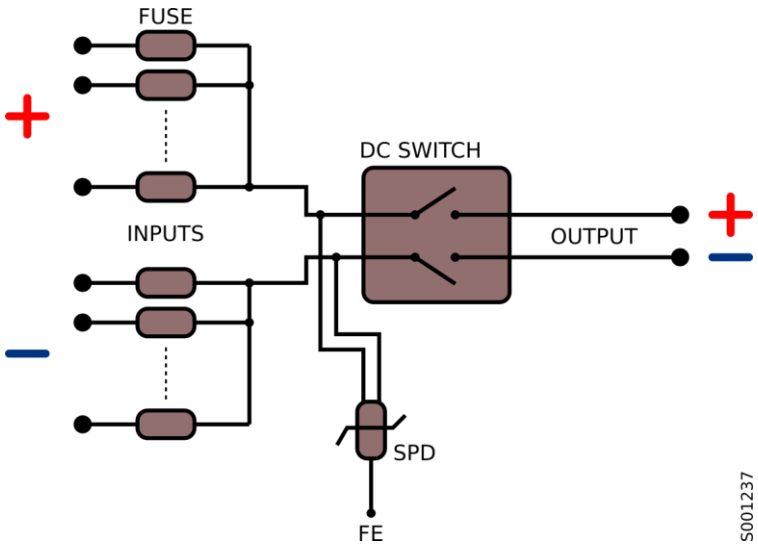



**Figure 3: Single-line diagram of a SUNWAY STRING BOX LT**

### 1.5.1. Integrated Standard Functions

The main integrated standard functions of SUNWAY STRING BOX LT 1500V 24 INPUTS 2 OUTPUTS are listed below:

- Possibility to connect up to 24 strings
- Fuses on both poles (fuses to be ordered separately).
- DC switch disconnector.
- Surge Protection Devices (SPDs).

- Box made of self-extinguishing glass fiber reinforced polyester, UV resistant.
- IP65 degree of protection.
- Complete integration with the Sunway Station.

*Note*

*The fuse kit is supplied separately.*

### 1.5.2. Attached Documentation

Each SUNWAY STRING BOX LT 1500V is supplied with a leaflet including the basic safety instructions.
The following documents are available for download from santerno.com:

| Name of the document | Scope |
|---|---|
| Installation Guide | Contains all the information necessary for the assembly, installation and maintenance of the product |

**Table 1: Documentation available for download from santerno.com**

### 1.5.3. Preservation of the Documentation

All documents must be kept for the entire life span of the equipment together with the system documentation. They must be kept in a place where they are readily available.

# 2. CAUTION STATEMENTS

This section covers safety statements. The non-observance of the safety instructions below may cause serious injury or death and equipment failure. Carefully read the instructions below before installing, starting and operating the equipment.

Only competent personnel must carry out the equipment installation.

## 2.1. Safety recommendations

*Note*

*Always read this instruction manual thoroughly before starting the equipment.*

**Danger**

**ALWAYS PROVIDE FUNCTIONAL EARTH BONDING.**

**OBSERVE THE PRESCRIPTIONS CONCERNING CONDUCTOR SECTION INDICATED IN SECTION 11.6.3.**

**Warning**

**Do not connect supply voltages which exceed the rated voltage. If voltage exceeding the rated value is applied, the internal circuits may be damaged.**

**Do not carry out isolation tests between the power terminals.**

**Make sure that the screws on the fuses have been tightened correctly.**

**Observe the ambient conditions for installation.**

## 2.2. Precautions for Use and Prohibitions

**Danger**

**RISK OF ELECTRIC SHOCK**

**NEVER carry out operations on the equipment when it is powered.**

**EXPLOSION AND FIRE RISKS**

**The risk of explosion or fire may exist if the equipment is installed in a room containing flammable vapours. Do not install the equipment where there is a risk of explosion or fire.**

**Prohibition**

**The product described in this manual has not been designed to operate in potentially explosive atmospheres. Consequently, installation in such an environment is strictly prohibited.**

**Prohibition**

**It is forbidden to make any technical or mechanical modifications to the product even when out of warranty.**

**Enertronica Santerno is not responsible for any risks that may arise due to unauthorised alterations, modifications or tampering. .**

**Prohibition**

**It is strictly prohibited to operate inside the SUNWAY STRING BOX LT 1500V to carry out short circuit tests concerning the strings.**
**Any system testing must be carried out on the individual strings only once that have been disconnected from the product.**

## 2.3. Intended Use

The SUNWAY STRING BOX LT 1500V products constitute a modular system for creating parallel strings for PV modules.
The product envisages an output on-load disconnector which is capable of cutting off the connection of the PV field subsection.
Observe the maximum operating voltage indicated in the product technical characteristics found in section
The product must only be used as prescribed in this manual. The DC power supply must come from the PV field only.
Any use other than that described in this manual is to be considered inappropriate and therefore improper.

## 2.4. Qualified Technical Personnel

All work on SUNWAY STRING BOX LT 1500V products must be carried out by skilled technical personnel only. By skilled personnel it is intended persons who have been suitably trained to carry out the work in question.
To commission and use the SUNWAY STRING BOX LT, personnel must know and understand the instructions for installation and use. In particular, all safety warnings must be strictly observed.

## 2.5. Specific Dangers Linked to Photovoltaic (PV) Systems

PV systems have certain characteristics which are the source of additional hazards and are described below:

- A live current source is connected. Depending on the operating conditions, there may be live voltage from the PV generator or from the electrical grid. This must be taken into consideration, particularly when disconnecting parts from the system.
- Very high DC voltages are involved (with no periodic zero crossings) hence failure or the incorrect use of fuses or plugs may cause electric arcs.
- The short-circuit current of the PV generator is only slightly higher than the maximum operating current and furthermore is linked to radiation. This means that fuses may not always blow in the event of a short-circuit.
- The PV generator grid is usually an IT type, i.e. it is only earthed in the event of a fault or energy leakage. For connection to PV fields with earthing pole, connection is of the TN type, but the earth connection is protected by a fuse which may trip in the event of a single fault.
- In the event of a fault (for example a short-circuit), cutting off a generator with a high number of branches may prove to be somewhat difficult. Take great care to ensure each sub-field disconnect switch has been opened before going near the devices installed in the technical room.

## 2.6. Personal Protective Equipment

Maintenance technicians must be provided with the following personal protective equipment as envisaged by European Directives and relative implementation of the same on national territory.

| SYMBOL | | DESCRIPTION |
|---|---|---|
|  | Safety glasses/face shield | Throughout operations |

| | | |
|---|---|---|
|  | 1000 V high-voltage insulated gloves | Throughout operations |
|  | Dielectric helmet | Throughout operations |
|  | Safety footwear/dielectric boots | Throughout operations |
|  | Insulated tools | Throughout operations |
|  | Operators must also be provided with a suitable means of communication for contacting the emergency services if necessary. | |

*Note*

*It is always advisable to work on the electrical cabinets with THE POWER SUPPLY SWITCHED OFF and the equipment in safety conditions (please refer to section 2.8).*

## 2.7. Execution of Work

Maintenance, configuration modifications and management operations require the involvement of all production and maintenance personnel. These activities **must be carried out in observance of health and safety regulations.**

The Standards and Laws governing this aspect vary depending on the personnel involved, methods of access and/or the tasks which may be carried out on the product and envisage constructive measures aimed at guaranteeing adequate levels of safety.

Standard EN 50110-1, second edition, identifies the people who are granted access to the product:

- Person in charge of running the electrical system (System Manager).
- Person in charge of work activities (Works Supervisor).
- Skilled electrician.
- Instructed person.

Please refer to section 0.

Standard EN 50110-1 governs the way work in a plant is carried out and the relationship between the aforementioned persons who may work on the plant to maintain the electrical safety conditions stipulated by European Directives.

This standard and its national equivalents must therefore be adhered to whenever it is necessary to access a PV system.

## 2.8. Safety Procedure

Always place the equipment in safety conditions before carrying out any kind of operation inside the box involving removing the polycarbonate protective panels providing IP20 degree of protection with respect to live parts, even when the box front cover is open. To do this, follow the instructions provided below:

- Make sure that the inverter connected to the SUNWAY STRING BOX LT 1500V is not running, i.e. that it is STOPPED.
- Open the inverter DC-side switch disconnector.
- Open the disconnector, if present, of all the string boxes connected to the same inverter.
- Open the cover of the SUNWAY STRING BOX LT 1500V and open the switch disconnector (there is NO need to remove the polycarbonate safety panel).
- Open all fuses.
- Remove the polycarbonate protective cover and use a multimeter to check that voltage is not present between the output bars polarities, among the poles and the earth.
- Proceed with the operation in question.

**Danger**

**ELECTRIC SHOCK HAZARD**
**High voltage on string cables and output cables.**

### 2.8.1. Polycarbonate Protective Panels

The SUNWAY STRING BOX LT 1500V is fitted with an internal polycarbonate protective panel. Live parts which are most exposed to possible inadvertent contact are protected by this panel made of polycarbonate, a transparent, break-proof material which is resistant to high temperatures. Once the front door has been opened, the panel makes it possible to carry out the following operations in relative safety:

- visually inspect the box inside in relative safety:
- turning the DC switch ON or OFF;
- replace string fuses;
- measure string voltages.

Only during installation must be removed the cover panel of the output terminals following the instructions given in the paragraph 7.2.

**Prohibition**

**It is not necessary to remove the internal panel when commissioning and maintaining the product. .**

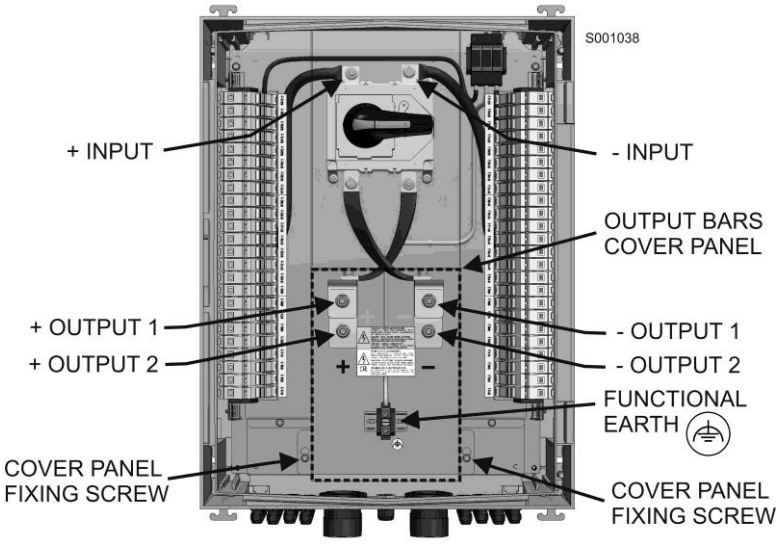



**Figure 4: Position of the measurement points and of the screws to remove the polycarbonate cover panel of output terminals**

# 3. DESCRIPTION OF THE PRODUCT

## 3.1. Composition of the SUNWAY STRING BOX LT

The product comprises:

- fuses on the string inputs of the positive pole
- fuses on the string inputs of the negative pole
- a surge protection device (SPD)
- switch disconnector

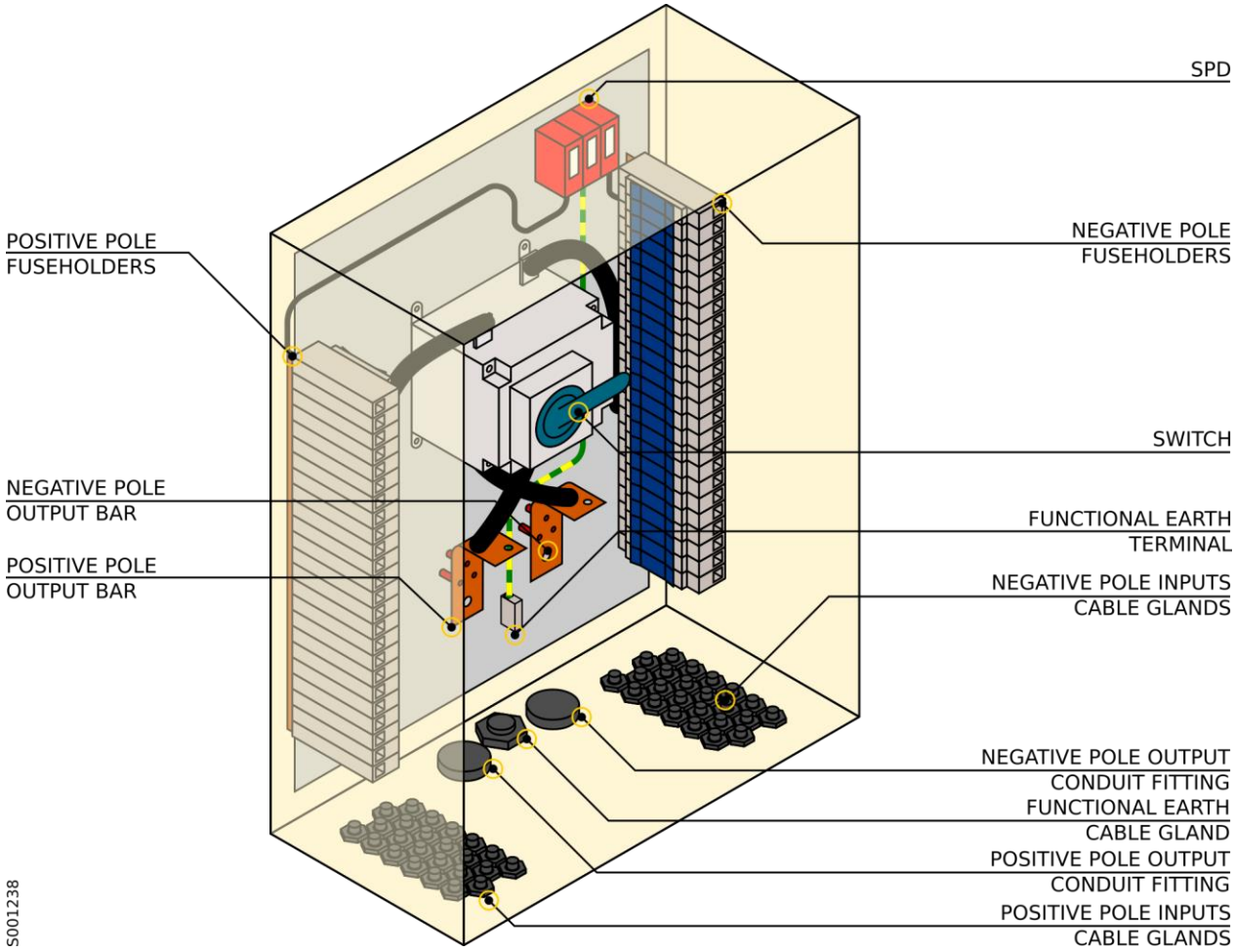



**Figure 5: Internal view of a SUNWAY STRING BOX LT**

# 4. PRODUCT IDENTIFICATION

## 4.1. Product Part Number

The product Part Number identifies the parallel string box and is indicated on the relevant nameplate. The nameplate also holds all the necessary technical data (please refer to section 11.1).
The product Part Number is made up of the following elements:

XX-YY-VVWW-ZZZZV-II

| Field | Name | Description |
|---|---|---|
| XX | Model | SB: for STRING BOX |
| YY | N. of strings | N. of string inputs |
| VV | Version | LT: light |
| WW | Optional field | Identifies product versions |
| ZZZZ | Field voltage | 1500: Class 1500V |
| II | Insulation class | If not present: Insulation class I<br>II: Insulation class II |

**Table 2: Product name**

Example: SB-24-LT07-1500V-II

## 4.2. Product Revision Index

The product revision index is indicated on the nameplate. Please refer to section 11.1.

## 4.3. Serial Number

The serial number of each individual module can be found on the lower section of the module itself (on the label and on the inside).

S000165


**Figure 6: SUNWAY STRING BOX LT 1500V Serial Number**

SN YYXXXXX

Where YY = year of manufacture of the string box

XXXXX = serial number

# 5. STORAGE AND TRANSPORT

The warranty covers manufacturing defects. The manufacturer shall not be held liable for any damage which may have occurred during transport and unpacking. Under no circumstances shall the manufacturer be held liable for damage or faults caused by incorrect use, misuse, incorrect installation or inadequate temperature or humidity conditions or exposure to corrosives nor for faults caused by operation outside the rated values. Nor shall the manufacturer be held liable for consequential or accidental damage.

*Note*

*For the terms of warranty, please refer to the warranty certificate supplied with the product.*

## 5.1. Checking the Product on Delivery

On receiving delivery of the equipment make sure that the packaging shows no signs of damage. Check that it complies with your order by referring to the nameplates described below. In the event of any damage, please contact the relative insurance company or the supplier. If the delivery does not match your order, contact the supplier immediately.

*Note*

*Check that all relative accompanying materials are present.*

## 5.2. Conditions for Transport

The parallel string boxes are delivered packed to extremely high standards.

To avoid damaging the product, move the package using a pallet jack or a forklift with adequate lifting capacity.

## 5.3. Storage

If the equipment is to be stored before installation, make sure that the ambient conditions in the warehouse meet the necessary specifications (please refer to section 11.2).

# 6. HANDLING AND ASSEMBLY

**Prohibition**

**It is strictly forbidden to proceed with product handling and assembly operations in adverse weather conditions, in snow, rain or persistent fog. Always check that there is no water or condensate inside the product.**

**It is strictly prohibited to leave the product outside when its front cover is open, in any kind of weather conditions.**

**Warning**

**The SUNWAY STRING BOX LT 1500V must be installed with the cable input/output side pointing downwards.**

**Avoid installing the product where it may be exposed to direct sunlight.**

**Do not install the SUNWAY STRING BOX LT 1500V upside down or with its front cover turned upwards. Make sure that air can circulate freely around the box.**

**Warning**

**Every time the SUNWAY STRING BOX LT 1500V is opened and reclosed, it must be done to the highest working standards, ensuring that the product remains intact and that no damage is caused to the sealing and fixing elements. Before reclosing the front cover, always check that the inside of the SUNWAY STRING BOX LT 1500V is free from condensate or water residues; if this is not the case the product must be placed in safety conditions (please refer to section 2.8) and thoroughly dried out. Make sure that the front cover is properly tightened and that the correct degree of watertightness and IP rating (IP65) is restored. .**

## 6.1. Product Handling

Remove the product from the packaging through the sides, keeping it horizontal to the ground.

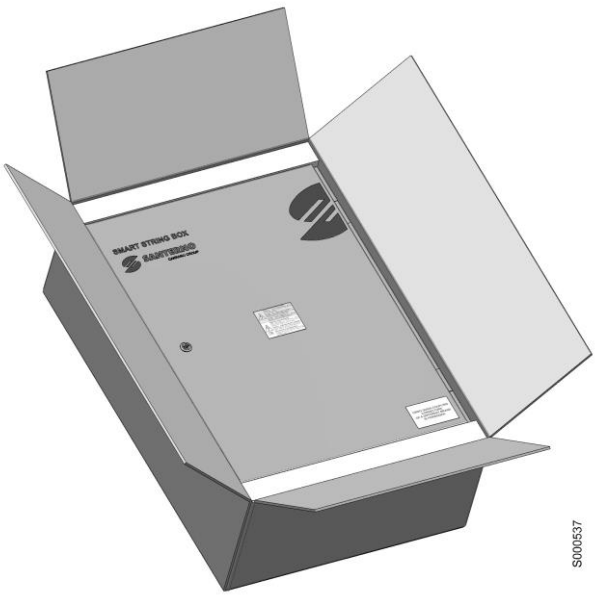



**Figure 7: Packaging of the SUNWAY STRING BOX LT**

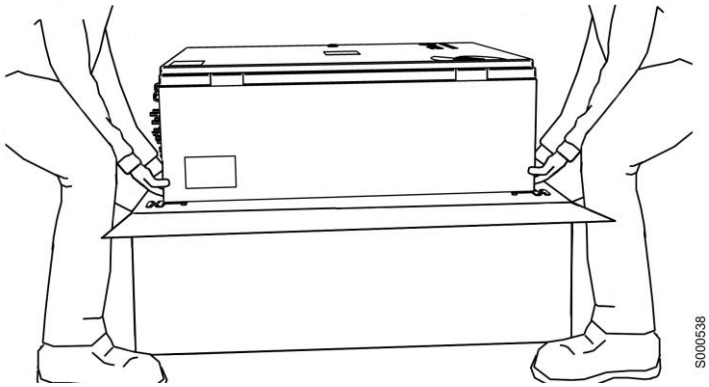



**Figure 8: Unpacking the SUNWAY STRING BOX LT**

Make sure that the front cover is closed when handling the product. Avoid twisting, bumping or dropping the product. Avoid any mechanical stress.

*Note*

*The key to open the front cover is fastened externally to the string box connectors*

*The packaging may be different from what is reported in Figure 10.*

## 6.2. Mounting the Product on the Installation Site

**Warning**

**Being as the ambient conditions significantly affect the life-expectancy of the product, do not install it where water build-up may be created due to dips in the installation surface or where it may be exposed to constant dripping.**

All the parallel string boxes must be installed in upright position as shown in Figure 9. To facilitate installation, the parallel string boxes come supplied with special brackets.

To allow for easy installation and effective air circulation, make sure that there is enough free space around the equipment.

Dimensions, weight and necessary clearance are indicated in section 11.5.

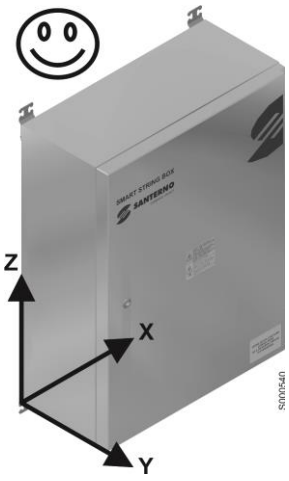



**Figure 9: Correct mounting**

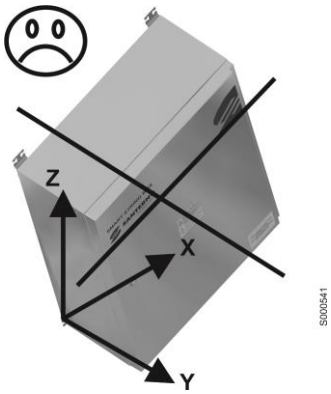



**Figure 10: Incorrect mounting**

# 7. INSTALLATION AND COMMISSIONING

## 7.1. Preliminary Notes

**Warning**

**To carry out the following operations, check that the parallel string box is in safety conditions. Please refer to section 2.8.**

The following paragraphs provide information on power and signal cable connection and commissioning.
Each string must be made up of the same number of panels. All panels must have the same nominal characteristics. Failure to observe these specifications will lead to a plant with low performance and possible malfunctions.
Do not install devices and/or components (SPDs, return or switch terminals, joins on the cables) on the wiring between the SUNWAY STRING BOX LT 1500V and the modules. As well as lowering the level of plant safety and performance, malfunctions may occur.

**Danger**

**Before carrying out the electrical installation, make sure that the following conditions are met:**
**All switches of the other string boxes connected to the same inverter are open,**
**No string fuse is inserted.**

Follow the sequence below for the electrical installation:

- Connection of the output cable and functional earth bonding
- Connection of the strings

Electricians must wear personal protective equipment.

## 7.2. Connection to the output cables and functional earth

*Note*

*Some models may be connected to two output cables per pole. In this case connect first the lower cable for maximum ease of installation.*

Proceed as follows:

- Remove the polycarbonate panel by only loosening the two M8 screws and by slightly pulling down the panel since the head of the screws can pass through the holes on the panel. Then remove the panel (Figure 11).
- With a tester check that no voltage is applied between the output bars and between each output bar and the earth bonding.
- Insert the power cables already provided with cables lugs and spiral sheath, inside the string box by letting the cable go through the coupling device of the protective spiral sheath (Figure 12).
- Connect the cables to the + and - bars in accordance with Table 10.
- Fasten the tubing to the tubing joints, making sure that IP65 degree of protection is not affected.
- Insert the functional earth cable through the dedicated cable-gland (Figure 12).
- Connect the functional earth cable to the relative terminal.
- Tighten the cable-gland, making sure that IP65 degree of protection is not affected.
- Reassemble the polycarbonate protective cover and tighten the two M8 screws.

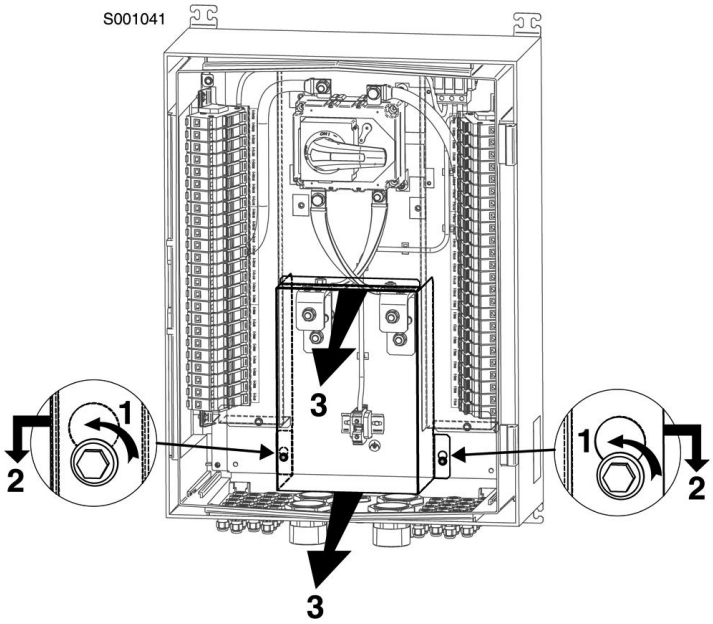



**Figure 11: Removing the polycarbonate cover protecting the output cables and the functional earth**

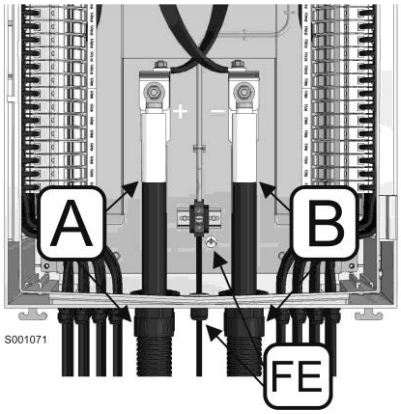



**Figure 12: Position of the output cable tubing and functional earth cable gland**

| Connections | Function | Dedicated cable-gland/tubing |
|---|---|---|
| A | Positive pole power cables connection bar to the inverter | A |
| B | Negative pole power cables connection bar to the inverter | B |
| FE | Functional earth cable connection terminal | FE |

**Table 3: Key to the output cable and functional earth connections**

For information about the sections and the diameters of the cables see Table 13 and Table 14.

**Warning**

**The cable glands must be correctly tightened once the cable has been inserted. Cable glands which are not used must be plugged. The gable glands and covers must be accurately tightened to prevent water, insects or small animals from getting inside and causing plant malfunctions as well as fire risks.**

**Make sure that water, condensation, insects or small animals cannot get inside cable tubing, thus avoiding plant malfunctions as well as fire risks.**

**Warning**

**Prevent the cable connected to the string box from being mechanically stressed. It is sometimes necessary to provide special anchoring for the output cable. Cable anchoring is particularly required for cable cross-sections over 240mm2 and when the free cable length exceeds 100cm.**

## 7.3. Connecting the strings

The connection of the cables to the panels must be made with the shortest possible route in order to minimize the resistive cable drop and therefore the system losses.

The STRING BOX LT 1500V provides cable glands to guarantee the IP65 degree of protection once the cables coming from the panels are connected.

**Danger**

**The internal DC switch disconnector must be open.**
**No fuse must be inserted.**
**Always wear PPE with a minimum rating of 2000 VDC.**
**Check polarity of each string before connecting them.**
**DO NOT CONNECT THE STRINGS IN CASE OF POLARITY MISMATCH.**

Up to 24 strings may be connected to SUNWAY STRING BOX LT 24 INPUTS.

The drawing below shows the box inside. The string inputs are highlighted.

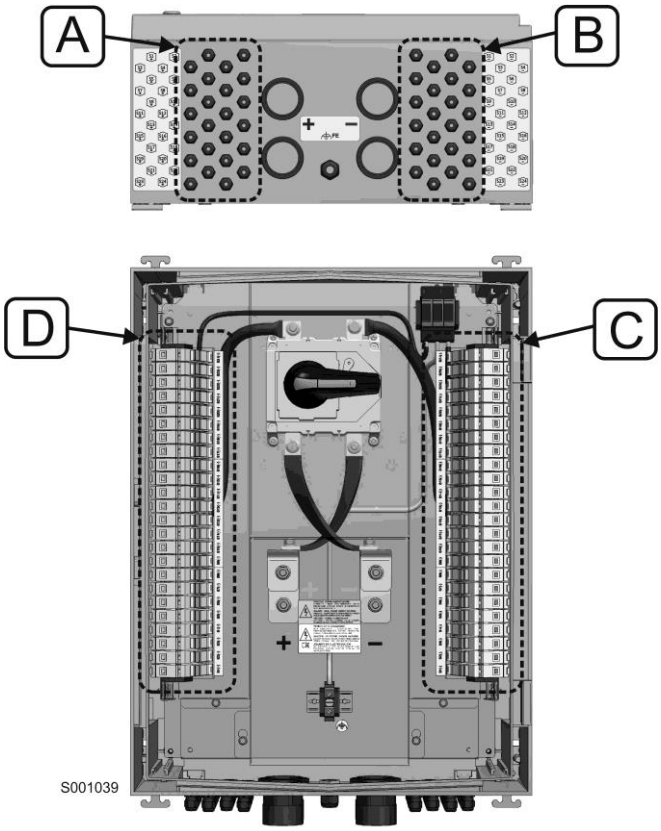



**Figure 13: Bottom side view and inside view with string inputs highlighted**

| Connections | Function |
|---|---|
| A | Cable glands of string positive pole |
| B | Cable glands of string negative pole |
| C | Negative pole fuses, strings 1-24 (numbering of fuseholders may vary depending on model, please refere to final product drawings). |
| D | Positive pole fuses, strings 1-24 (numbering of fuseholders may vary depending on model, please refere to final product drawings). |

**Table 4 Key to string connections**

The string connections are to be made when the string box is in safe conditions:

- DC switch disconnector open
- Fuse-holders open
- There is a dangerous voltage up to 1500V on the string cables when they are connected to PV panels exposed to the sunlight. Check there is no voltage and in any case wear dielectric gloves. Touching cables with live voltage causes death or serious injury.

Cables from string must be routed through the cable glands on the bottom panel and connected directly onto the fuse-holders.

Connect the string cables as follows:

- Connect cable strings:
  - Loosen the cable gland
  - Route the cable through the cable gland
  - Connect the cable to the fuse-holder

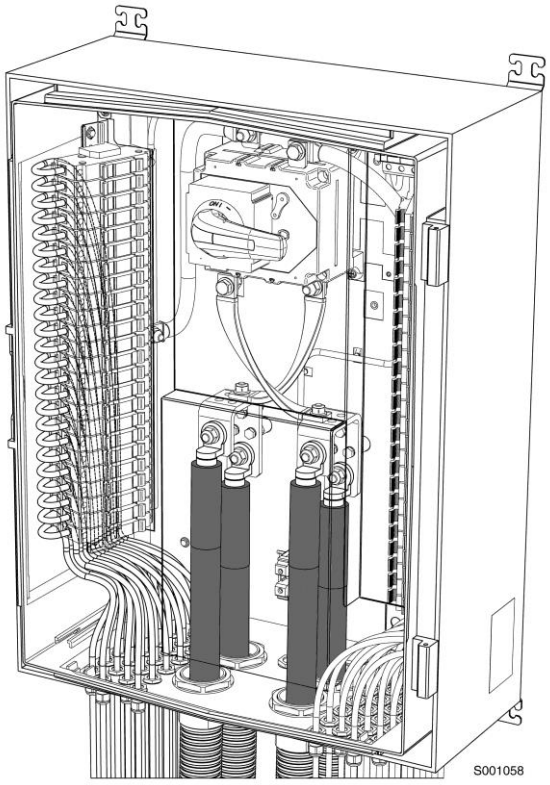



**Figure 14 Routing of cables inside the string box**

*Note*

*Refer to paragraph 11.6.1 regarding how to connect the cables and the inputs to be used in case of strings with short-circuit currents greater than 11.7A.*

## 7.4. Replacing and Inserting the String Fuses

Before inserting the fuses inside the string box, check the string polarity by measuring voltage between the positive and negative pole of each string on the connection screws of the relative fuse-holder.

All the strings must have positive voltage values (approx. +/-10% of the average value), unless some strings are in the shadow.

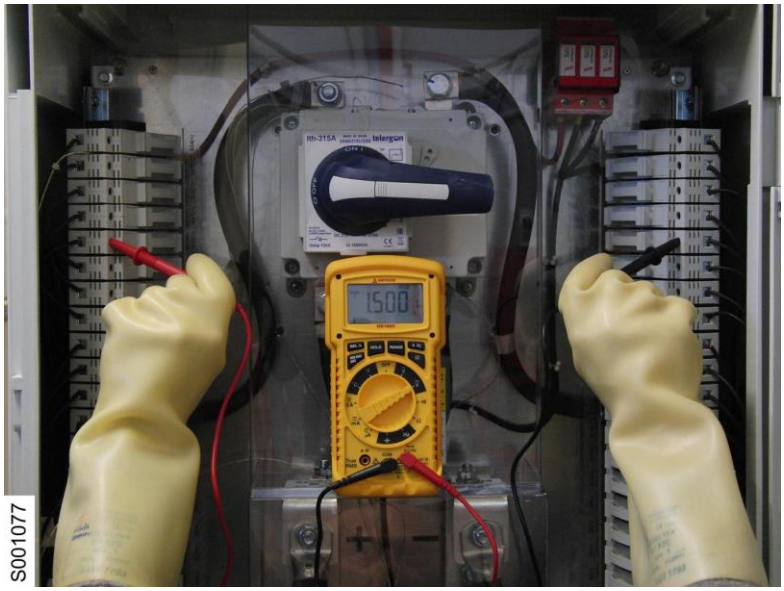


**Figure 15: String voltage measurement points**

**Danger**

**Avoid opening and closing the fuse-holders when the string is live. Check string polarity before inserting a fuse. Make sure that no current flows in the string box before removing a fuse. The presence of a short-circuit on the string connected to the fuse to be removed may lead to current flowing in case the safety fuse is not open.**

Do the following to remove and insert a fuse:

- Open the front cover of the SUNWAY STRING BOX LT 1500V
- Open the disconnector in the SUNWAY STRING BOX LT 1500V.
- Make sure that no current is flowing.
- Remove or insert the fuse from the fuse-holder
- Upon completion, restore all operating conditions.
- Close the front cover in the SUNWAY STRING BOX LT 1500V.

**Danger**

**Wear PPE when removing or inserting a fuse. In particular, dielectric gloves are required (see section 2.6), as opening the fuse-holder does not ensure that both fuse contacts are properly cut off (dual voltage power supply).**

## 7.5. Commissioning

Once all the string boxes have been connected, do the following to carry out the equipment commissioning:

- Close the disconnector in the SUNWAY STRING BOX LT 1500V.
- Close the front cover of the SUNWAY STRING BOX LT 1500V.
- Close the inverter DC-side switch disconnector.

## 7.6. Notes on Output Short-Circuit

The SUNWAY STRING BOX LT 1500V are equipped with a suitable under-load disconnect device in output but are not fitted with protection against short circuits, such as fuses, in output.

Fault caused by a short circuit on the output cables must be envisaged during the design phase and appropriate protective measures must be adopted.

Some design examples:

1. If the PV field is composed of multiple SUNWAY STRING BOX LT 1500V, the Sunway DC-Parallel or input fuses inside the inverter effectively solves this problem.
2. If the PV plant is made up of a very small number of SUNWAY STRING BOX LT 1500V, a connection directly to the inverter can be envisaged, without inserting fuses, as long as the cables are sized for the maximum fault current.
3. If the PV plant is made up of just one SUNWAY STRING BOX LT 1500V, the problem does not exist.

In the first case, the Sunway DC-Parallel input fuses protect the equipment against short-circuits. In the second case, oversized cables are adopted, that are capable of withstanding the short-circuit fault. In the third case, cable oversizing shall make it possible to withstand the short-circuit current of each individual string.

Being as the PV field is a current-limited generator, even in the event of a short circuit the current delivered by this kind of generator cannot exceed the maximum sizing value.

If the PV plant is made up of more than one SUNWAY STRING BOX LT, consider the example of a short-circuit occurring downstream from a SUNWAY STRING BOX LT, but upstream from the connection to the Sunway DC-Parallel, as shown in Figure 16.

When this happens, the current from all the strings but one is localized in the section of cable between the point where the short circuit has occurred and the connection to the Sunway DC-Parallel.

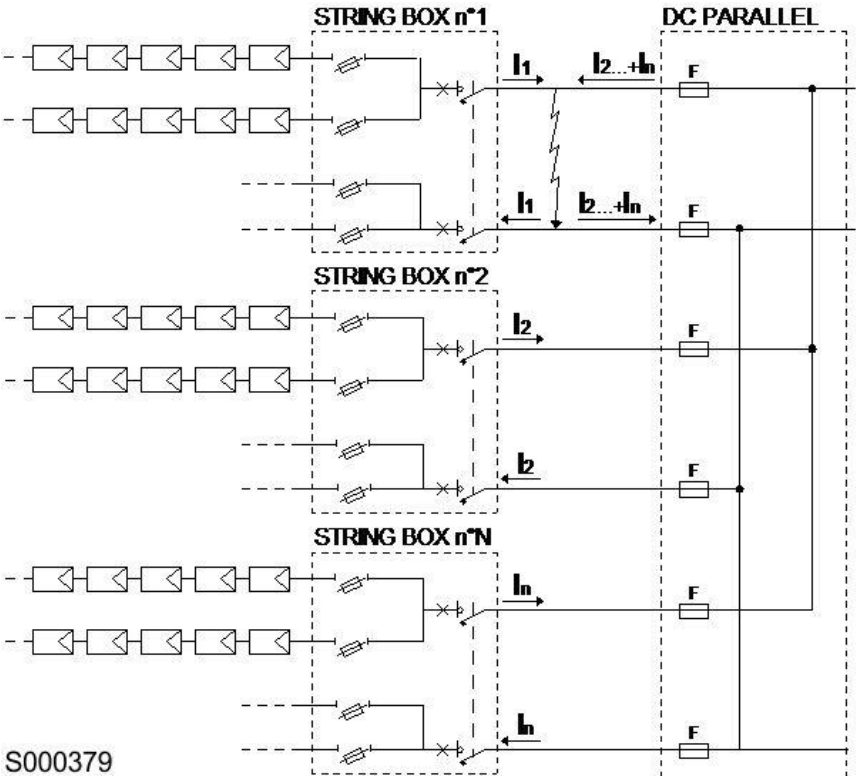



**Figure 16: Short-circuit located downstream from the SUNWAY STRING BOX LT 1500V**

# 8. MAINTENANCE

**Danger**

**Death from electrocution and burns due to contact with live components of the grid and PV field.**

**Make sure that no voltage is applied to the equipment. Power must be cut off.**

**Danger**

**Before carrying out any kind of operation, please refer to section 2.8.**

*Note*

*In the event of any fault, please contact the Enertronica Santerno SpA CUSTOMER SERVICE for instructions on the necessary corrective action to be taken.*

Adequate maintenance ensures conversion performance and inverter reliability is maintained over time.

This heading describes all the activities required to keep machine parts which are subject to wear and deterioration and/or components which are essential for guaranteeing safety and optimum performance in good condition.

Access to products for the purpose of maintenance, modifications and management involves all persons responsible for production and maintenance. It must be carried out in observance of the health and safety regulations described in section 0.

The minimum maintenance interval is indicated in the table below.

Equipment installed in an environment where there is a high concentration of dust requires more frequent maintenance than generally indicated.

The activities described may involve stopping the inverter. Once the maintenance procedure has been completed restart the inverter by pressing the START button.

## 8.1. Maintenance Sheet

| Maintenance tasks | Frequency (recommended) |
|---|---|
| Box visual inspection and cleaning | Every 12 months |
| Check the state of connectors | |
| Check the state of cable glands and tubing joints | |
| Check the state of fuses | |
| Check the state of the switch disconnector | |
| Check SPDs | |
| Check that cables and bars are securely tightened | |
| Check the condition of nameplate and warning signs | Every 24 months |
| The frequency of scheduled maintenance may need to be increased depending on the location in which the equipment is installed and the relevant ambient conditions. | |

**Table 5: Maintenance sheet**

### 8.1.1. Box Visual Inspection and Cleaning

- Visually inspect the state of cables. Check that cables show no signs of damage caused by rodents and remove any insects.
- Check to see if any condensation has formed inside the equipment. Should this be the case, clean with a cloth, find out where water is getting in and rectify the problem.

- General box cleaning.
- Check the water-tightness of the casing and for any signs of damage.
- Check that the front cover, the cable-glands, the tubing joints and each watertight device is correctly positioned and consequently that IP65 protection is guaranteed.
- Check that no wires, clamps or anything else has inadvertently been left inside the string box.

### 8.1.2. Checking the Connector State (if present)

- Check the state of the quick-fit PV connectors.
- Check that connectors are firmly inserted.
- Close off all the unused connectors (ask Enertronica Santerno SpA CUSTOMER SERVICE).

### 8.1.3. Checking the Cable Glands State

- Check the state of the cable glands.
- Check that cable glands are securely tightened around the cable.
- Close off all the unused cable glands (ask Enertronica Santerno SpA CUSTOMER SERVICE).

### 8.1.4. Check Tubing State

- Check the state of the cable tubing and make sure that it is properly fastened to the cable gland.

### 8.1.5. Checking the Fuses

- Routine maintenance entails checking the continuity of the fuses installed (to remove the fuses, see section 0).

### 8.1.6. Checking the SPDs

- Inspect the status of the SPDs (Surge Protective Devices) by checking the status of the button/slot on the discharger.

The exact position of the SPDs can be seen on the Electrical and mechanical schematic.

**Figure 17: Example of a typical Surge Protective Device (for reference only)**

| Button/slot status | SPD Status |
|---|---|
| Button/slot with green indicator visible | SPD in good conditions |
| Button/slot with red indicator visible | Faulty SPD |

Please refer to Table 15.

### 8.1.7. Check Cable Tightening

In order to guarantee correct tightness of the electrical contacts, periodical checking of the tightening torques is to be carried out over the equipment's life cycle.

- Pay particular attention to any colour variations or anomalies affecting the terminals and bars. Replace any damaged connections or corroded contact elements.
- Check the tightening of all the terminal clamps for connecting the power wiring and tighten if necessary. The tightening torques can be found in section 11.6.

# 9. UNINSTALLING

This section covers how to uninstall a SUNWAY STRING BOX LT.

**Warning**

**Only skilled technicians wearing PPE are authorized to uninstall the product.**

**Danger**

**ELECTRIC SHOCK HAZARD**

**Carry out all safety procedures described in the following sections before operating on the product and on the connected conductors.**

**Danger**

**ELECTRIC SHOCK HAZARD**

**DO NOT disconnect the conductors or open the string fuses under operating conditions other than the ones described in this Installation Guide.**

**Disconnecting the conductors or opening the string fuses when current flows inside the product may cause electric arcs and lead to personal injury or product malfunctions.**

## 9.1. Preliminary Safety Procedures

The SUNWAY STRING BOX LT 1500V products are nodes of complex plants. Safety procedures involve both the node concerned and the all the other nodes connected to the system.

The safety procedure also considers the dangers that may be caused by photovoltaic sources, that operate as voltage and current generators when exposed to solar radiation. Voltage generated by those sources may be dangerous for the operators and may cause electric arcs if they are improperly cut off.

Safety procedure to follow in order to uninstall a SUNWAY STRING BOX LT:

- **Operate exclusively after sunset and before dawn so that no current flowing is to be found through the string conductors;**
- Make sure that the inverter connected to the product is STOPPED;
- Open the inverter DC-side switch disconnector;
- Open the output switch disconnector;
- Open the output switch disconnectors of all the string boxes connected to the same inverter as the string box to be uninstalled.

## 9.2. Uninstallation Procedure

Do the following once the product to be uninstalled is in safety conditions as described in the section above:

- Make sure that no voltage is applied:
  - Between the output negative pole and positive pole, after removing the polycarbonate panel;
- Disconnect the output conductors;
- Disconnect and insulate (do not leave live cable ends unprotected) all string cables;
- Proceed with the mechanical uninstallation of the product.

Refer to section 7 Installation and commissioning for installing a new SUNWAY STRING BOX LT.

**Danger**

**ELECTRIC SHOCK HAZARD**

**If the SUNWAY STRING BOX LT 1500V that has been uninstalled and removed from the plant is not immediately replaced, put all the conductors that have been disconnected in safety conditions before restoring the operation of the PV plant section concerned.**

# 10. TROUBLESHOOTING

The SUNWAY STRING BOX LT 1500V products are completely protected against short-circuits and overvoltage caused by system failure or temporary phenomena. Furthermore, the control system performs complete self-diagnosis operations to help personnel solve any problems which may occasionally arise. The modular design of Enertronica Santerno inverters makes repair and/or reset operations quick and easy to perform.

This chapter indicates the most likely causes of the most common problems. The steps to be taken to remove these causes are also described.

**WARNING**

**To carry out the following operations, check that the parallel string box is in safety conditions. Please refer to section 2.8.**

*NOTA*

*If necessary, please contact the Enertronica Santerno SpA CUSTOMER SERVICE.*

## 10.1. General Principles in the Event of Failure

Access to the PV system components for the purpose of maintenance, modifications and management involves all persons responsible for production and maintenance. It must be carried out in observance of the health and safety regulations described in section 0.

### 10.1.1. Fault Containment

The following prescriptions are of a general nature.

- Place the equipment affected by the fault in safety conditions. This operation may involve stopping and disconnecting all the up- and downstream devices. Please refer to section 2.5.
- If the fault has occurred inside an inverter, press an emergency stop button to cut the inverter off up- and downstream. Open the switch disconnectors of all the string boxes so that the entire DC input section is safe, including the DC-Parallel (if installed).
- In multi-inverter systems it is usually sufficient to cut off the inverter affected by the fault both up- and downstream so that the other inverters can remain in operation.
- If the fault has occurred in one of the components downstream from the inverter (AC parallel cabinet, external transformer, metering cabinet etc.) STOP all the machines and then press the emergency stop button to cut off the inverter both up- and downstream.
- If the fault has occurred in one of the components upstream from the inverter (DC-parallel, String Box, etc.) STOP all the machines and then press the emergency stop button to cut off the inverter both up- and downstream. Open the disconnect switch disconnectors of all the String Boxes so that the entire DC input section is safe, including the DC-Parallel (if installed).
- If the fault has occurred in one of the String Boxes, open all the strings connected in input and open the disconnect switch disconnectors of all the String Boxes connected at the same inverter of DC-Parallel of the faulty String Box, in order to place all the equipment in safety conditions, including the cable output section. If is not possible to open the strings because there is current flowing in the relative cables, wait the absence of solar radiation to open the strings of faulty string box.
- Proceed with analysis of the causes and consequences of the fault.

## 10.2. Fault Analysis

This section covers the main principles to be observed when analysing the causes and consequences of faults.

A PV inverter usually operates as part of an overall system. All the components adopt various protective measures therefore, in general, the consequences of a generic fault affecting an upstream component or element does not extend to other components downstream.

However, the causes and the consequences of any faults which may arise need investigating on the plant as a whole.

Fault investigation and analysis activities represent one of the most hazardous tasks assigned to maintenance technicians. This manual only provides indications of an extremely generic nature concerning

the precautions which must be adopted when fault investigation and analysis activities need to be carried out on live components.

In the event of a fault, before proceeding to resolve the problem, the following tasks must be performed to evaluate:

- The state of components and the system as a whole:
- Check the state of the contacts.
- Check the state of cables.
- Check the state of any interface protection installed in the system.
- Check the state of all protective elements installed in the system.
- Check the state of any auxiliary power supplies.
- Check the level of humidity present on system components.
- Possible faults that may occur on each box, inverter and/or the system:
- Check for any earth faults on the DC side and the AC side.
- Make sure that all prescriptions have been observed relative to the neutral connection or those relative to field configuration (floating, Positive Earthed, Negative Earthed).
- Check the state of the SPDs.

Once all the aforementioned steps have been performed, proceed with evaluating:

- The causes of faults.
- The consequences of faults on the electrical, electromechanical and electronic components.
- The steps to be taken to remove the cause of the fault.

Once all the aforementioned steps have been performed, proceed with rectifying the causes of the fault.

### 10.2.1. SPDs Tripped

- If the SPDs have tripped, replace the cartridges after placing the string box in safe conditions.

**Prohibition**

**It is forbidden to use cartridges different from the ones installed (same brand and model required).**

Please refer to section 11.6.4.

### 10.2.2. String Fuse Blown

This section describes faults relevant to one or more SUNWAY STRING BOX LT 1500V fuses blowing. If a fuse blow, procedures cannot be limited to simply replacing the fuse. Suitable analysis of the fault which caused the problem must be also carried out.

*Note*

*After replacement, if the fuse blows again, please contact Enertronica Santerno SpA CUSTOMER SERVICE.*

Before replacing a blown fuse, all the tasks described in section 10.1.1 and 10.2 must be performed.

## 10.3. Disconnecting a String

**Danger**

**Disconnecting a string is allowed only if no current flows in the relative cable, as it is forbidden to open the fuse-holders, remove the connectors of the string box, when present, and the connectors of the PV modules under load. If the safety fuse has not blown, current may flow if a short-circuit is to be found in the string to be removed. Check polarity of each string before connecting it to the product.**

**Carry out step 2 below at night if you are not sure that no current is flowing.**

Procedure:

1. Open the disconnector inside the string box.
2. Open the fuse-holders inside the string box.
3. Remove the cable harnessing ties.
4. Loosen the cable glands of the string to be disconnected.

5. Disconnect the string cables.

Once the string cabling has been rectified, restore the conditions for the plant operation (section 7.5).
Do not leave any cable gland open. If no cable is routed through a cable gland, seal it.

## 10.4. How to Contact the Custom Service

Should it be necessary to contact the Enertronica Santerno SpA CUSTOMER SERVICE, please provide the following data:

- Equipment model
- Serial Number
- Date of commissioning
- Order confirmation reference, if available

*Note*

*Should it be necessary to send the equipment in for repair or to return the equipment, contact the Enertronica Santerno SpA CUSTOMER SERVICE, to agree upon the terms.*

# 11. TECHNICAL DATA

## 11.1. Nameplate

Each nameplate indicates the product's technical data and identification details:

- Name of the product (1).
- Part Number assigned to the product by Enertronica Santerno (2).
- Technical data (rated input/output voltage and current, rated power, etc.) (3).
- CE marking and indications of the relative reference Standards applied in the construction of the equipment (4).
- Product revision index (5).
- Serial Number: identifies the product serial number (6).

The nameplate measures 110 x 70 mm and is silver in colour.


**Figure 18: SUNWAY STRING BOX LT 1500V nameplate**

## 11.2. Environmental Requirements for Storage and Transport

| **Required conditions for storage** | |
|---|---|
| Ambient temperature for storage | -25 °C ÷ +55 °C (the product must be clean, dry, closed and packed) (class 1k4 in compliance with EN 60721-3-1). |
| Ambient humidity for storage | From 5% to 95%, from 1 g/m$^3$ to 25 g/m$^3$, with no condensation or ice formation (class 1k3 in compliance with EN 60721-3-1). |
| Atmospheric pressure for storage | From 70 to 106 kPa (class 1k4 in compliance with EN 60721-3-1). |
| Required conditions for transport (class 2k3 in compliance with EN 60721-3-2). | |
| Ambient temperature during transport | -25 °C to +70 °C (the product must be clean, dry, closed and packed) |
| Ambient humidity during transport | Maximum 95% up to 60 g/m$^3$. |
| Atmospheric pressure during transport | From 70 to 106 kPa |

**Table 6: Environmental requirements for storage and transport**

## 11.3. Installation Requirements

| Installation requirements | |
|---|---|
| Operating ambient temperature | -25 °C ÷ +45 °C |
| Operating ambient humidity | From 4% to 100%, from 0.9 g/m$^3$ to 36 g/m$^3$, with no condensation or ice formation (category 4K4H in compliance with IEC/EN 60721-3-4) |
| Altitude | Up to 2000 m ASL<br>For higher altitudes, please contact Enertronica Santerno |
| Installation site | Do not install the equipment where it is exposed to direct sunlight or where it is exposed to conductive dust, corrosive gases, vibrations, water spray or dripping. Do not install in salty environments |
| Degree of protection | IP 65 |
| Degree of pollution (IEC/EN 60721-3-4) | Class 4C2 for chemically active substances<br>Class 4S3 for mechanically active substances |

**Table 7: Installation requirements for SUNWAY STRING BOX LT 1500V**

## 11.4. Electrical Specifications

| | Feature | | SB-24-LT07-1500V II | SB-24-LT08-1500V II | SB-24-LT10-1500V II WITH 20 A FUSES | SB-24-LT10-1500V II WITH 25 A FUSES |
|---|---|---|---|---|---|---|
| INPUT | Maximum DC input voltage | V | 1500 | | | |
| | DC String Fuses [1] | | 10x85 | | | |
| | Impp input current ($I_{MPP}$) per string | A | 20 | | 14.5 | 16 |
| | Max. input current ($I_{SC}$) per string | A | 20 | | 14.5 | 16 |
| | Maximum number of connectable strings | | 24 | | | |
| | Uc Pulse withstanding voltage | kV | 6 | | | |
| OUTPUT | Rated output current @ 35 °C ($I_{UP}$) | A | 240 | | 325 | 360 |
| | Rated output current @ 45 ° C ($I_{NOM}$) | A | 300 | | 285 | 315 |
| | Uc Pulse withstanding voltage | kV | 6 | | | |
| | **NOTE 1** Fuse size to be defined and ordered separately basing on plant characteristics | | | | | |

**Table 8 Electrical ratings**

### 11.4.1. Choosing the String Fuse Size

The fuse size is to be chosen based on the string short-circuit current. Please refer to the table below. Fuse brands other than those in the table are to be explicitly authorized by Enertronica Santerno.

| Maximum Input Current Isc @ ambient 45°C (A) | Fuse Size | Type of fuse (Bussmann) | Type of fuse (Mersen) | Type of fuse (Siba) |
|---|---|---|---|---|
| ≤ 5.5 | 8 | N/A | HP 15M 8 | 50 115 28.08 |
| 5.5< ≤7.1 | 10 | N/A | HP 15M 10 | 50 115 28.10 |
| 7.1< ≤8.8 | 12 | PV-12A10F85L | HP 15M 12 | 50 115 28.12 |
| 8.8< ≤11 | 15 | PV-15A10F85L | HP 15M 15 | 50 115 28.15 |
| 11< ≤14.3 | 20 | PV-20A10F85L | HP 15M 20 | N/A |
| 14.3< ≤17.6 | 25 | PV-10M25F85L | HP 15M 25 | N/A |
| 17.6< ≤22 | 30 | N/A | HP 15M 30 | N/A |

**Table 9: Fuses recommended based on $I_{SC}$**

**WARNING**

**Fuse rating must also comply with the requirements featured in the datasheet issued by the photovoltaic panel manufacturer.**

**WARNING**

**The maximum number of strings connected to the product shall be calculated based on the allowable output rated power, as well as on the ambient temperature and the product configuration.**

## 11.5. Mechanical Specifications

| Product | Dimensions [mm] | Net weight [kg] | Gross weight [kg] |
|---|---|---|---|
| SB-24-LT07-1500V II<br>SB-24-LT08-1500V II<br>SB-24-LT10-1500V II | 635 x 890 x 300 | 37 | 41 |

**Table 10: Dimensions and weight of the SUNWAY STRING BOX LT**

### 11.5.1. Mechanical Dimensions

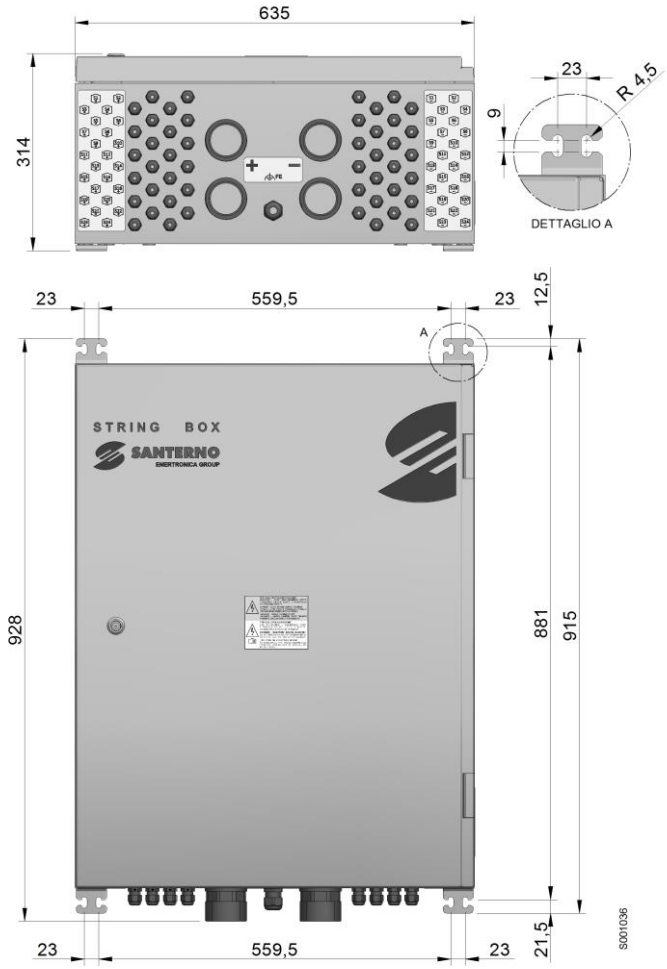



**Figure 19 Mechanical dimension**

### 11.5.2. Clearance Values

It is necessary to observe the following minimum distances from walls, other equipment and objects in order to ensure safety of access and adequate heat dispersion.

| Front [mm] | Side [mm] | Back [mm] | Top [mm] | Bottom [mm] |
|---|---|---|---|---|
| 700 | 120 | -- | 350 | 450 |

**Table 11: Minimum clearance values**

### 11.5.3. Fastening the Box to its support structure

Fasten the box to its support structure with at least N.4 screws M8 in the corners.

## 11.6. Connections

### 11.6.1. DC Connection – String Cables

*Note*

*Use PV copper cables only.*

*Note*

*String cables must be connected directly onto the fuse-holders.*

| Cross section [mm$^2$] | Cable diameter [mm] |
|---|---|
| 4-10 | 5-10 |

| Fuse-holder | Cable stripping (mm) | Torque [Nm] |
|---|---|---|
| Mersen (estrattore nero) | 9.5 | 2 |
| EATON/Bussman (estrattore blu) | 9.5 | 3.2 |
| Faultrap | 9.5 | 2.5 |
| SEPV | 9.5 | 2-2.5 |

**Warning**

**To get even temperature inside the string box components, use string inputs as per the table below.**

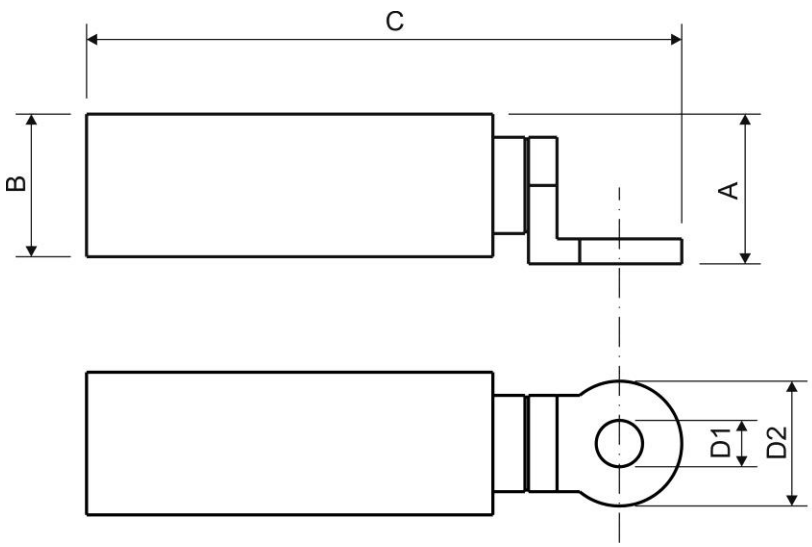
| Max. input current $I_{sc}$ @ ambient 45 °C (A) | Max. input current $I_{sc}$ @ ambient 35 °C (A) | Number of connected strings | Inputs to be not used |
|---|---|---|---|
| Up to 11.7 | Up to 14.7 | 21-24 | No requirement |
| From 11.7 to 13.5 | From 14.75 to 16.9 | 18-20 | 5, 10, 15, 20 |
| From 13.5 to 16.7 | From 16.9 to 18.4 | 15-17 | 4, 7, 10, 13, 16, 19 e 22 |
| From 16.7 to 19.6 | 18.4 to 24.5 | 13-15 | 3, 6, 9, 12, 15, 17, 19, 21 e 23 |
| From 19.6 to 22 | From 24.5 to 27.5 | 12 | 2,4,6,8,10,12,14,16, 18, 20, 22 e 24 |

**Table 12: Inputs to be used based on the string current**

### 11.6.2. DC Connections - Output Cables

| Description | | SB-24-LT07-1500V II | SB-24-LT08-1500V II | SB-24-LT10-1500V II |
|---|---|---|---|---|
| Cables per pole | n | 2 | 1 | |
| Panel connector | | Adaptaflex AL54/63 (54 mm conduit fitting) | | |
| Internal terminal | | Aluminum bar tin plated | | |
| Tightening torque for bolt M12[1] | Nm | 27 to 30 | | |
| Min/max outer diameter of the cable | mm | 14/46 | | |
| Panel connector thread | | M63 | | |
| Compatible spiral tubing | | Adaptaflex 54mm type PA, PI, CP, PR e PF | | |
| Maximum dimensions of cable lug | | See Figure 20 | | |
| Suggested cable lug for copper cable | | Cembre Series A-M12 contained palm | | |
| Cable lug compatible for aluminum cable | | Cembre Series AA-M12 | | |
| **NOTE 1** Use the bolts supplied (M12*25); if they are to be replaced, use screws having the same length. | | | | |

**Table 13: Power cables connection**




| | |
|---|---|
| A (max) | 42 mm |
| B (max) | 40 mm |
| C (max) | 200 mm |
| D1 | 13 +/-0,5 mm |
| D2 (max) | 35 mm |

S000853

**Figure 20: Maximum dimensions of the cable lugs to be used for the output cables**

### 11.6.3. Connection of functional earth cables

| Description | | Value |
|---|---|---|
| Cables | | 1 |
| Tightening torque | Nm | 3,2-3,7 |
| Max cross-section of the conductor (minimum \| maximum) | $mm^2$ | 1.5 \| 35 |
| Cable stripping | mm | 18 |
| Outer diameter of the cable (minimum \| maximum) | mm | 9 \| 17 |
| Cable gland | | M25 |

**Table 14: Functional earth cable**

### 11.6.4. SPDs

Technical specifications for SPDs are provided in the table below.

| Technical Specifications | | Value |
|---|---|---|
| Rated voltage of system | V | 1500 |
| Maximum voltage of system | V | 1500 |
| Rated discharge current | kA | 15 |
| Response time | ns | 25 |
| Residual current | mA | < 1 |
| Configuration | | Y connection of 3 SPDs as varistors |
| UP level of protection (L-L / L-PE) | kV | 5 |
| Removable cartridges | | Yes |
| UL94 Fire resistance | | V-0 |
| EN 50539-11 category | | Type 2 |

**Table 15: SPDs technical specifications**

# 12. ANNEX

## 12.1. Revision table

| Revision | Notes |
|---|---|
| 0 | First issue |
| 1 | Minor improvements across the document. |
| 2 | SB-24-LT10-1500V II model<br>Minor improvements across the document. |

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