
Operation and Installation Manual

PV STRING BOX-12
Board for series of panels

Operation and Installation Manual



Operation and Installation Manual

Introduction

The engineers who have contributed to the development of this board for series of panels would like to thank you in the first place for choosing board **PV STRING BOX-12** for your network photovoltaic system.

We believe that owners expect maximum performances and reliability from their SIEL photovoltaic systems. These boards are designed and manufactured to guarantee long-term efficiency and reliability, and are suitable to be used in large power stations.

SIEL is always interested in receiving feedback from its customers in order to be able to continuously improve its products.

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Symbols used in the manual

Graphical symbols have been used in this manual to warn users or draw their attention to different situations of particular importance. The symbols used and their meanings are described below:

LIST OF GRAPHICAL SYMBOLS:	
Symbol:	Description:
	INFORMATION: Complementary description that must be taken into account. Used to highlight an important note or memo.
	ATTENTION Situation that may cause serious damages to equipment or injuries to people.
	DANGER Highlights a mandatory instruction. Failure to comply with the instructions highlighted by this symbol may cause accidents with serious damages.
	INSPECTION UPON RECEIPT Describes the steps that must be performed upon opening the packaged system.
	USER User manual. Instructions on how to use the system, menus and other functions. Installation and start-up.
	INSTALLER Maintenance and Supervision Manual. Advanced menu options.

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Glossary of technical terms and abbreviations

Term	Description
PV	Photovoltaic field
AC	Alternate current
DC	Direct current
DC line	Line that connects the photovoltaic modules to the board
TT	Ground connection

Compliance with Regulations

(**Note:** for further information on certifications, visit www.sielups.com)

- Direttiva Europea 2006/95/CE in materia di Materiale Elettrico Bassa Tensione
 - EN 62109-1. Safety power converters for use in photovoltaic power systems – Part 1: General requirements
 - EN 62109-2. Safety power converters for use in photovoltaic power systems – Part 1: Particular requirements for inverters
- Direttiva Europea 2004/108/CE in materia di Compatibilità Elettromagnetica
 - EN 61000-6-2:2005. Immunità. Ambiente industriale.
 - EN 61000-6-3:2007. Emissione di disturbi EMI. Ambiente industriale.
- Direttiva 93/68/CEE Denominazione CE

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Safety instructions



Please read this section carefully, because the operating voltages used inside the board could be dangerous for people.

Dangerous voltages are used in the system. Please read and carefully follow the instructions provided in this manual.

If the equipment is not used as specified in this manual, its protections may not work correctly, causing damages to people, even fatal, due to electrical shock.

- PV STRING BOX-12 must be installed and opened by trained and qualified electricians only, who have been approved by the supplier.
- Do not use the product if one of its many mechanical or electrical components is faulty.
- Before performing any operations on the fuses, it is mandatory to place the main switch of the system PV STRING BOX-12 in position OFF.
- Before connecting or disconnecting the DC line cables, it is mandatory to remove the fuses.
- Precaution: always follow the installation instructions provided in this document. Failure to follow the described procedure shall result in the invalidation of any warranty or other claim.
- The working tools used for the installation of the PV generator must be suitable for the type of work required because there are dangerous voltages in the system.
- All the electrical conductors used must have a suitable section and fitted with a solid protection, because they are designed to be installed outdoors where they could be exposed directly to sunlight.
- During installation, protect the conductors to prevent accidental contacts with dangerous voltages.



The cable routes must provide mechanical support to the conductors and be fitted therefore with an appropriate protections.

After start-up, the system and wiring should not be moved. The system must be installed in a location where it cannot be accidentally touched by unauthorized people.

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Packaging checklist

A. Delivery by the carrier

Examine the product packaging before opening it in order to verify that it is not damaged.



If damage is visible, it is necessary to immediately inform the carrier. The supplier of the system will be pleased to provide assistance in case of need.

Damages must be notified in writing and the notice must be sent to the carrier within a maximum of six days.

B. Content of the packaging

Inspect the content of the packaging of system PV STRING BOX-12 for network connection. Verify that the following components are present:



- 1 PV STRING BOX-12 board for series of panels
- Installation Manual.
- 1 wrench
- 24 fuses, 16A 1000V

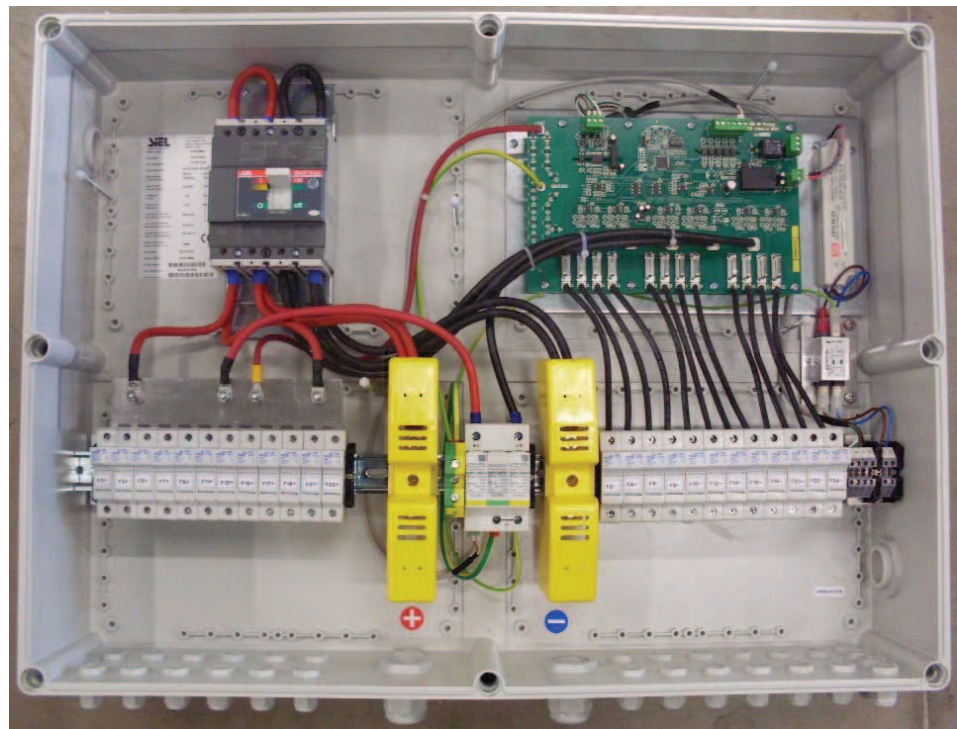
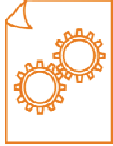


Fig. 1

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Description of the system



PV STRING BOX-12 is a connection box that simplifies the grouping of series of panels and that is fitted with protection and current supervision devices for each series.

The board has inputs for 12 series with a maximum capacity of 10A and 1000Vdc.

A. General description of the system

- Parallel connection of a maximum of 12 series with a capacity of 10A per series (*)
- Inverter connection box output line switch. A release coil to open the switch from remote can be installed as an option.
- Positive and negative 1000Vdc fuses to protect each series of panels
- Overvoltage protection that can be easily replaced in the event of failure
- 230 Vac auxiliary input for electronic control power.
- RS485 communication output and alarms output designed to be connected to a voltage free relay
- IP44 grade polycarbonate cabinet for outdoor installations. IP66 with optional anti-condensation kit.

The PV STRING BOX-12 enables users to check the correct connection of the series, the status of fuses, the status of overvoltage protections, any switch opening, the lack of string insulation compared to grounding potential, internal panel temperature and the current of each series without the need of measuring tools, which simplifies the installation, inspection and start-up of the system

Maintenance is simplified because it is possible to rely on a continuous monitoring system that checks the operation of each series and generates a warning when an anomaly is detected.

The board is fully programmable from remote at any time via the communications bus and setup software which can be installed on any PC with Windows OS and USB 2.0 communications port.



Note: the board is designed to be used for a field of panels with a maximum short-circuit current per line of 10A. The maximum short-circuit current output from the board is 120A. Therefore, the board is protected by means of fuses with a direct current of 16A and a disconnection capacity of 50KA at the rated voltage of each line.

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Physical characteristics

The protective case is made up of an IP44 grade polycarbonate cabinet for outdoor installation. With an optional anti-condensation kit, the protection degree can be IP66. The dimensions and total weight of the system are detailed below:

- Dimensions: 560x760x250mm.
- Weight: 16kg

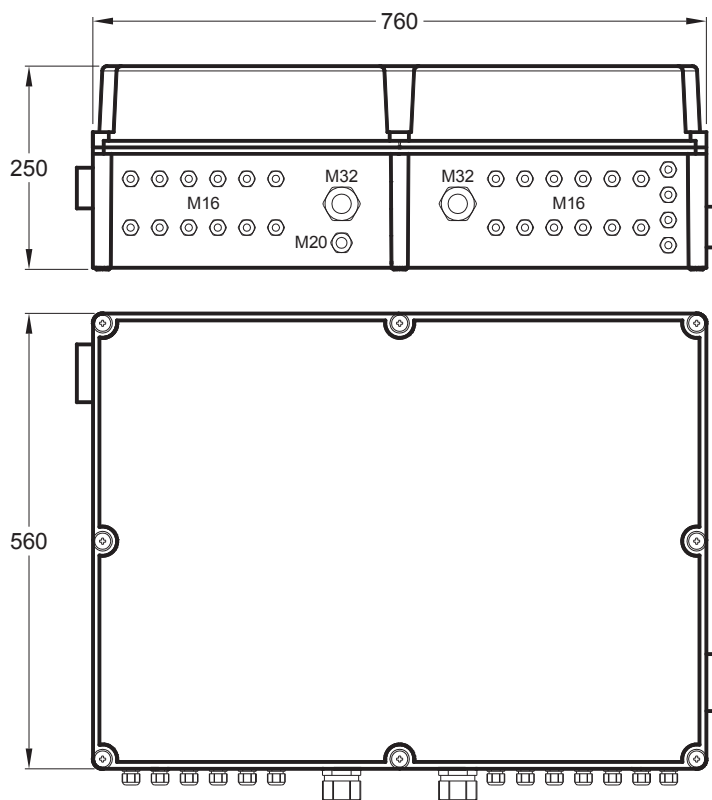


Fig. 2

Inputs and outputs

The inputs and outputs of the cables are situated in the lower section of the system, as described below:

- Cables of 5 up to 10mm of external diameter are used for the connection of the inputs of the series of panels, communications and auxiliary 230Vac power purposes.
- Cables of 13 up to 21mm of external diameter are used for the outputs of the positive and negative terminals for the box.
- Cables of 7 up to 13mm of external diameter are used for the output of the TT cable.

The use of cables with external diameters ranging between these two values, that vary according to situations, is an essential requirement to ensure that the box is completely waterproof.



Note: Cover the unused packing glands to ensure full water-proofing and prevent the entrance of undesired animals.

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Technical characteristics

To simplify the description of the board, we have schematically divided the system in several blocks:

Power

The main characteristics of this block are the following:

- Section of the cables:
 - Input for series of panels: from 4 to 10 sqmm
 - Inverter output: from 50 to 120 sqmm, for copper and aluminium cables and T.T. from 16 to 35 sqmm for copper cables
 - 2x1-2x1,5 sqmm 230 Vac auxiliary power input.
- Maximum current per series 10A. Measurement range -2.0A ... +10.0A
- Protection by means of varistors on positive side (+); (-); (earth) with a capacity of 40kA 8/20µs, with removable modules
- Main disconnecting switch: 1100Vdc, 160A. Type T1D/PV160 4P - ABB

Control

Main characteristics:

- *Standard electronic control consumption between 1.0 ... 1.5W @ 24Vdc*
- Data and alarm output: galvanically insulated RS485
- Alarm output: voltage-free relay
- Distance for RS485 communications: max 500 m
- Current monitoring for each series
- *Modbus addressing from remote via specific software (admitted addresses 1 ... 32)*

Monitored data

Monitored data that can be viewed:

- VDC voltage of the output line (in V)
- *Total connected string current (in tenths of A)*
- *Real time power (in tenths of W)*
- *Icc current in each series (in mA with sign)*
- Alarm status for each string
- Fuse status (*positive and negative separately*) *OPTIONAL (*)*
- Protection status (*discharger, open switch*)
- Ground insulation (*as analogue value*)
- *Internal board temperature (in hundredths of degrees with sign) and overheating alarm*

(*) Requires the replacement of the standard fuse box and fuses with indicated fuse box and fuses.

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Block diagram

The various parts of the protection board are illustrated below.

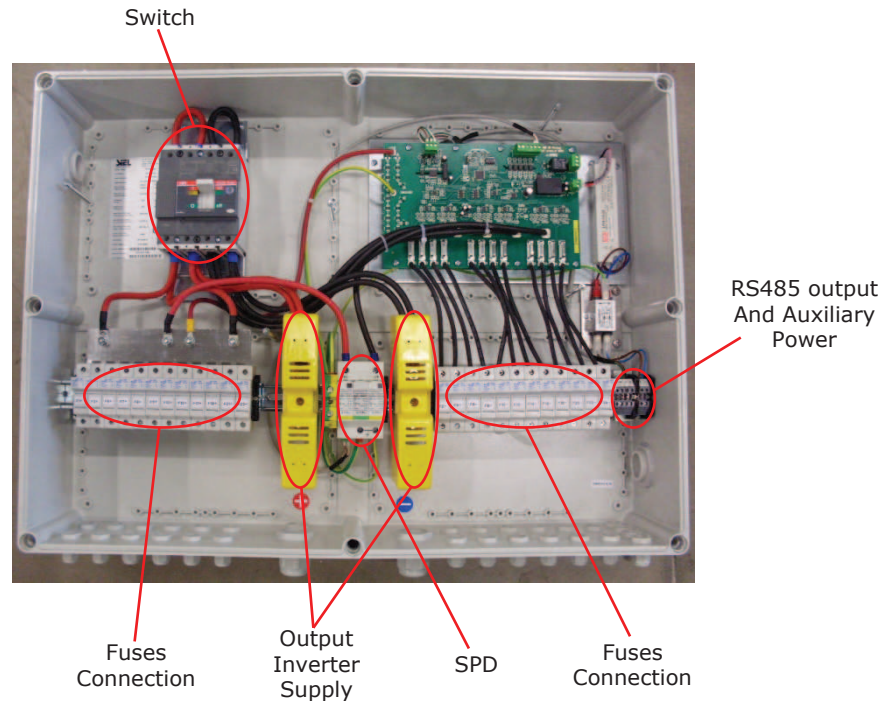


Fig. 3

Note: further information on the system is provided in section Technical specifications of *PV STRING BOX-12*.

B. Layout of the system

PV STRING BOX-12 receives the electrical power directly from the DC photovoltaic generator (PV). Its purpose is to group the series of panels in a single DC series that can be connected to the converter.

The following chart provides a general overview of the system with the boards that include the series of panels.

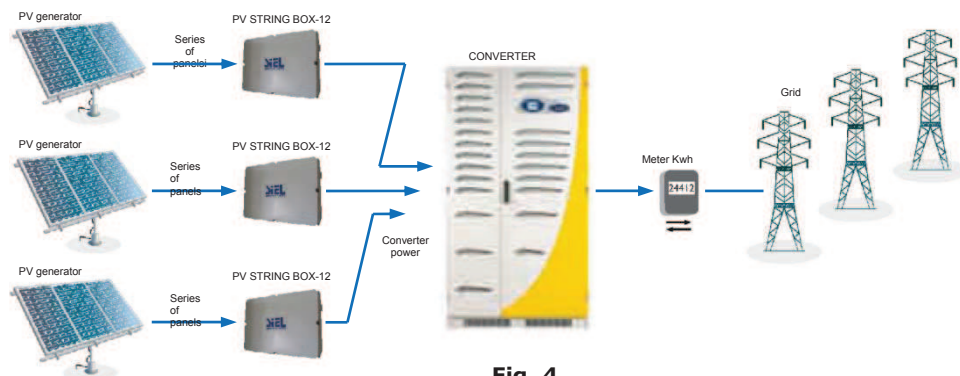
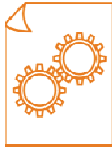


Fig. 4

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PV STRING BOX-12 setup software installation



A. Premise

The setup sequence refers to the non-binding case of software installation at *D:\Configuratore_12_stringhe*

The operator may choose a different installation path.

B. Installation steps

- Create, for example, in D:\, folder *Configuratore_12_stringhe*
- Copy the zip file called *CONFIGURATORE_12_Stringhe* to folder *D:\Configuratore_12_stringhe*
- In folder *D:\Configuratore_12_stringhe*, create sub-folder *Programma*
- In folder *D:\Configuratore_12_stringhe*, create sub-folder *Archivio_config*
- Unzip the previously copied *CONFIGURATORE_12_Stringhe* zip file in folder *D:\Configuratore_12_stringhe*
- 6 new files will appear, include the *setup.exe* file
- Start software installation by launching the *setup.exe* file
- Click Next
- Use the Browse key to select the previously created folder *D:\Configuratore_12_stringhe\Programma*
- Click Next, click Next and then click Finish.
- Using My Computer, create a desktop link to file *D:\Configuratore_12_stringhe\Programma\12str.exe*.
- Use this link to launch the setup program.
- The file called *12str.ini* is also in folder *D:\Configuratore_12_stringhe\Programma* This file contains the default settings that can be loaded on the screen. Any editor, even Note Pad, can be used to edit this file and customise default settings.

C. Uninstallation steps

- For the uninstall wizard, use the Windows control panel, Application Installation tab (Windows XP) or the Windows control panel, Programs and functions (Windows Seven), and select *12str* to uninstall the program.
- Also delete all the directories and copied files by deleting folder *D:\Configuratore_12_stringhe* and all its sub-folders.

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PV STRING BOX-12 CONFIGURATOR

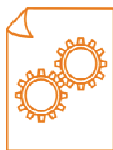



Fig. 5

A. Premise

The Modbus default address for each board is 255 while the Serial Number differs for each, printed on a sticker on the PCB board and permanently in Flash.

B. Serial port settings

The RS485 on COM key is found at the top left and is used to set the serial communications port for the USB-485 converter and thus RS485 bus connected to field devices. The following should be set in this window:

- Baud Rate = 9600
- Parity = none
- Data Bits = 8
- Stop Bits = 1
- Timeout = 1200

The only setting that may be edited is the COM label. Click this key to open a list of serial ports and select the suitable one (if more than one appears).

To learn which port is the correct one, for Windows XP look in the *Control Panel, System, Hardware, Peripherals, ports (COM and LPT)* or, for Windows Seven, look in *Control Panel, Device Management, ports (COM and LPT)* to find out which is actually connect to the USB-485 converter, The one marked **USB Serial Port (COMxxx)** is the one to be selected in the open setup program window by clicking the COM key.

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C. Connection logic

The setup software and board to be installed are connected when the *Serial number* and *OLD Modbus address* match. The latter, if never changed, is 255. If, thus, the *Serial Number* and *Modbus* address actually refer to those relevant to one of the boards connected to the RS-485 bus, click the *Connect* key and the software automatically updates the entire page with all the values in the board univocally identified by the *Serial Number*. If there is a match and the page is updated, the required modbus address can be edited and assigned to the board.

D. Assigning a new Modbus address

The setup software and board to be installed are connected when the *Serial number* and *OLD Modbus address* match. The latter, after connection, can be replaced with a new one. To do this, simply enter the required address in the *NEW* box. The *UPDATE* key will be highlighted in red and, when clicked, will save the address in the board flash memory. After editing the board Modbus address, re-connect to be able to communicate. For this purpose, update the *OLD Modbus* address with the newly assigned one and click *Connect*. If the *Serial Number* and *OLD Modbus* address match, the window is refreshed with all the current board settings.

Should the operator erroneously assign the same *Modbus* address to two different boards (with different *Serial Numbers*), this can be fixed by assigning a new *Modbus* address to the correct board. As already mentioned, the *Serial number* and *OLD Modbus* address must match while the *NEW* value is the new address to be assigned.

E. Editing setup parameters

To edit setup parameters, the board must be connected and the screen refreshed by clicking the *Connect* key. In this case, if a single parameter is edited, the *Write Module* key will be highlighted in red to indicate that the displayed parameters have not yet been saved in the board flash memory. To do this, click the *Write Module* key to save settings and view all settings in the board to confirm.

F. Loading default settings

Regardless of the saved settings, *Default settings* can be loaded on the screen with the board connected. These settings are loaded by clicking the *Load Default* key. They can be edited and saved in a specific text file. *Default* settings can thus be saved on the board by clicking the *Write Module* key or edited to be saved in the board.

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G. Saving – opening a settings file

All settings saved in a board can be saved in a text file. For this purpose, there is a *File Save* key that opens a small standard Windows window where the user can select the folder where the file is to be saved and change the file name. To facilitate saving the saved settings while minimising the chance for error, the file name is automatically preset to *Serialnumber_OLD* to provide immediate information when saving the *Modbus* address associated with that *Serial Number* (or board).

Similarly, instead of loading the *Default* setting, any saved file can be opened. In this case, the window is updated with all loaded file settings except the *Serial number* and *Modbus OLD* address fields which remain those of the connected board. Thus they can be saved directly on the board using *Write module* or edited before saved.

H. Various functions

In addition to the keys described above, a *Read module* key is included which, with the module connected, forces addressed board reading and updates its saved settings on the screen. An *RS485 Status* led is also provided in the box on the bottom right which turns Green or Red according to the last communications between the software and board (Green = OK, Red = FAILED).

NOTE: Keep in mind that communications between the software and board is *EVENT* driven meaning it only physically occurs after an operator read or write event. Therefore, the board is not read by the software according to a timed cycle.

I. Transmission

Modbus communications between PV STRING BOX-12 and the datalogger have the following characteristics:

- speed: 9600 baud
- 8 data bit
- No parity
- 1 stop bit

The setup software can be installed on any PC with Windows OS and a USB 2.0 port.

Software can be used to:

- Set up and edit the modbus address from remote for each board with addresses admitted from 1 to 32
- Set up and edit all board settings, including any string enabling or disabling

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Installation of the system

PV STRING BOX-12 must be installed by trained and qualified personnel only. Special tools that are generally available to specialised technicians only are required.

Before starting the board installation process, it is very important to plan and organise the work that needs to be performed. The steps required to install the board are the following:

- A. Photovoltaic generator
- B. Grounding sockets of the system
- C. Location of the board
- D. Fixing of the board
- E. Cabling route
- F. Electrical connections
- G. System start-up
- H. Uninstallation of the board

A. Photovoltaic generator



Warning. Electric shock

When photovoltaic modules are exposed to light, the voltage present in electrical connections could pose risks due to the fact that the modules are connected in series.



Important: Shaded areas

The PV generator must not be shaded in any way. Partially shaded areas like chimneys, trees and small obstacles could cause significant power losses.

B. Grounding connections



Warning. Electric shock

PV STRING BOX-12 must be permanently connected to appropriate grounding connections to maximise the protection of people.

The grounding connection system must be compliant with the current standards applicable in the relevant countries.

Atmospheric overvoltage

The grounding connection must be constituted by a single point. Therefore, it will be necessary to group all grounding conductors in a single point in order to reduce the risks of damaged caused by the overvoltage produced by atmospheric discharges.

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C. Location of the board

The main criteria to use to select the installation of the board should include the conditions of the surrounding environment and the easiness of connection of the lines of the panel series.

The system is designed to work appropriately in industrial environments (type B environments).



Note: this product is designed to be used in industrial environments. If it is installed in domestic environments, it can cause radio interferences that must be corrected with appropriate measures (consult the manufacturer for assistance).

Elements to consider

Mechanical considerations



- Install the system on a stable and resistant surface that is able to support a weight of approximately 16 kg.
- Install the system horizontally. Do not leave any object on the system.

Thermal considerations

- The surface on which the system is installed must not be made of inflammable material. In case this cannot be avoided (for example if the system has to be installed on a wooden surface), it will be necessary to coat it with a layer of heat and non inflammable material.
- If the system is installed indoors in a closed location, it will be necessary to verify that it is adequately ventilated. The air temperature directly influences the performance and life of the system.
- Do not install the system inside a cabinet or in a closed location.
- Although the board is designed to be installed outdoors, it must be protected from the direct exposure to sunlight.
- The recommended installation height should not exceed 2000 meters.

Safety



- Do not store the system close to inflammable liquids and materials, because the high temperature produced by the system could cause the ignition of these materials, with the consequent risk of fires.
- Protect the wiring from rodents that could damage the electrical insulation, causing dangerous situations for people along with the risk of fires.
- To avoid direct and indirect contact, make sure the cabinet is fully closed.
- Verify that the system is internally shielded in order to prevent the risk of direct contact.
- Indirect contact has been prevented through the ground connection of all metal parts and the insertion of all active parts in the cabinet (IP44, IP66 with optional anti-condensation kit).
- The installation and maintenance of the system must always be performed with appropriate working tools in order to ensure full compliance with precautions regarding direct and indirect contact (industrial boots, gloves resistant to a maximum operating voltage of 1000V...).

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Electrical considerations

- PV STRING BOX-12 must be installed in the shortest point of the route between the PV generator and inverter in order to minimise conductor losses.
- Electrical cables must not be overstretched and fixed to masonry work.

D. Fixing of the board

The cabinet is fixed to the wall using at least 4 of the 8 holes accessed by removing the board cover.

Wall mount is recommended horizontally on a flat wall. Take the following measurements into account during installation:

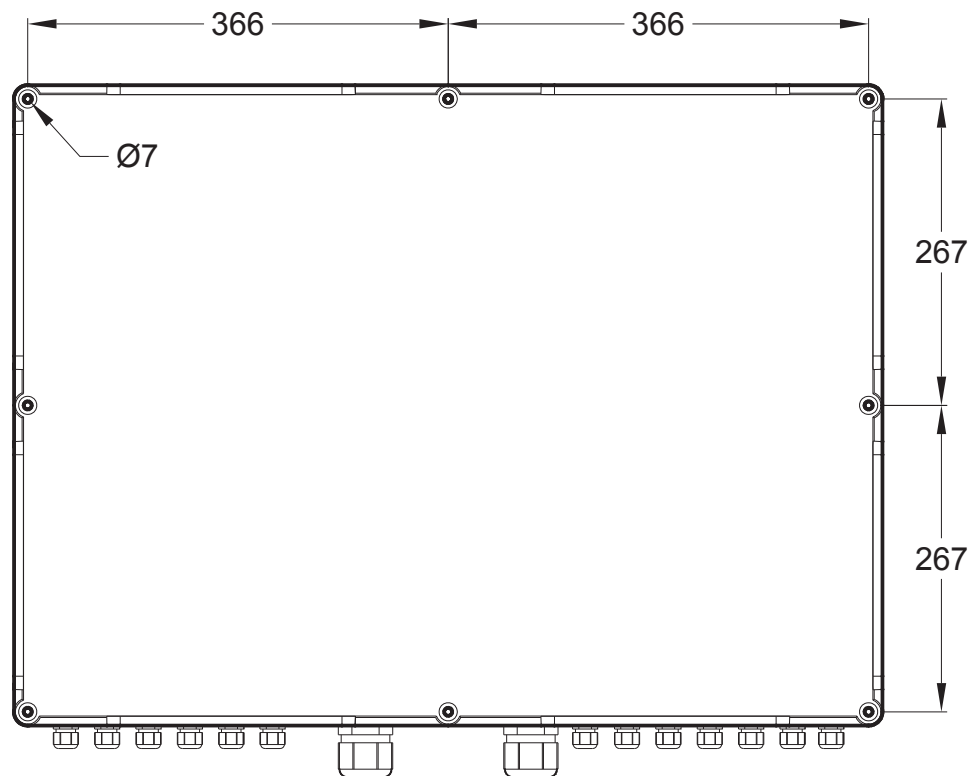


Fig. 6

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E. Cabling route

The preparation of the conductor routes simplifies installation.



Warning. Electric shock

Before drilling holes, verify that there are no pipes or electrical systems that could cause dangerous electrical discharges.

It is advisable to carefully protect conductors in order to extend their life cycle.

F. Electrical connections



Before connecting the system, observe the following precautions:

- Adopt the necessary safety precautions to handle maximum voltages of 1000 V inside the cabinet.
- Verify that all the metal parts of the system are grounded.
- Verify that the main disconnecting switch is in position **OFF** before performing any electrical connection.



Fig. 7



- Verify that there are NO fuses and remove them if present.
- Do not reverse polarity.

Cable inputs and outputs

The inputs and outputs of the cables are situated in the lower section of the system, as described below:

- **Communication inputs and outputs:** inputs and outputs with IP68 fittings for cables of 5 up to 10mm of external diameter
- **P.T. output:** output for P.T. with IP68 fittings for cables of 7 up to 13mm of external diameter
- **DC output:** positive and negative output with IP68 fittings for cables of 13 up to 21mm of external diameter
- **Inputs of the series of DC panels:** positive and negative inputs with IP68 fittings for cables of 5 up to 10mm of external diameter
- **Auxiliary power input and output:** 230 Vac auxiliary power inputs and outputs with IP68 fittings for cables of 5 up to 10mm of external diameter

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The following chart shows the layout of the board connections.

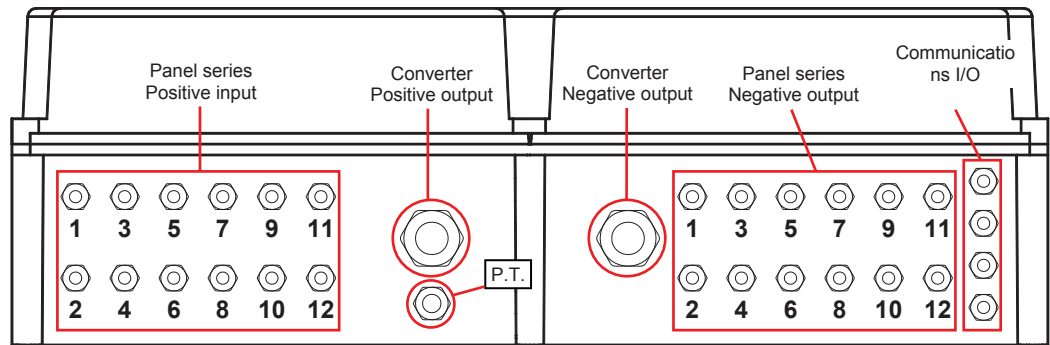


Fig. 8

Connection cables

INPUT / OUTPUT	CABLES SECTION	TERMINALS
Input for Strings	4÷10sqmm	/
DC Output	50÷120sqmm	Ring terminal hole Ø8
GND	16÷35sqmm	Insulated end sleeves
Auxiliary Input Supply 230V	2x1÷2x1,5sqmm	Insulated end sleeves
Communication Link	Shielded Cable for EIA-RS485 impedance 120ohm (example Belden 9841)	Insulated end sleeves

Location of the internal connection terminals

DC outputs connections and grounding connection

The terminals used to connect the DC and TT outputs are situated on a terminal board installed on a DIN guide. The connections are shown below:

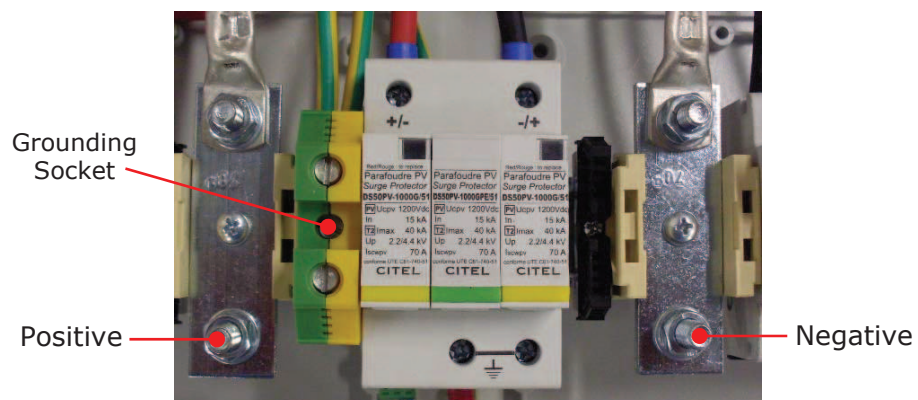


Fig. 9

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Connection of the inputs of the panel series

Panel line connection terminals are the fuse boxes mounted on the DIN guide; the positives to the left and the negative to the right, as shown below. If "standard" fuse boxes are used (without Failure contact) and if the open switch contact is not connected (which should be a closed switch) all the corresponding alarms must be enabled using the setup software. Otherwise, in fact, the same inputs must be wired to avoid false alarms.



Fig. 10

Auxiliary Power Connection

230 Vac auxiliary power connection terminals are on the terminal board mounted on the DIN guide as shown below.

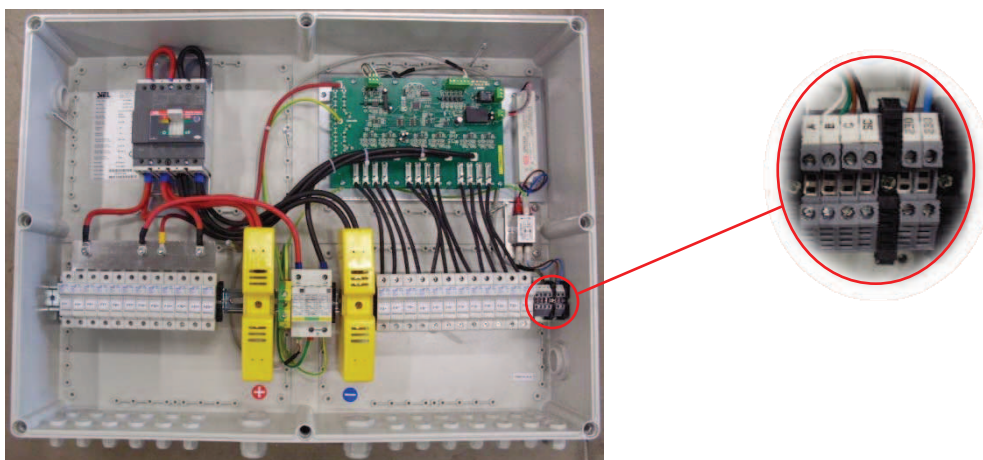


Fig. 11

230 Vac auxiliary power

The control board requires 230 Vac auxiliary power



230 – 230 Vac auxiliary power
230 – 230 Vac auxiliary power

Fig. 12

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Communication connections

The connection must be performed using two dedicated communication connections.

SiEL supplies all the cables required to complete the installation and can be contacted for further assistance. The recommended communication cable is the double braided cable (2x0.22) with protective mesh supplied with the system.

RS485 connection terminals are found on the terminal board mounted on the DIN guide, while alarm output ones via voltage free relays are on the control board connector as shown below.

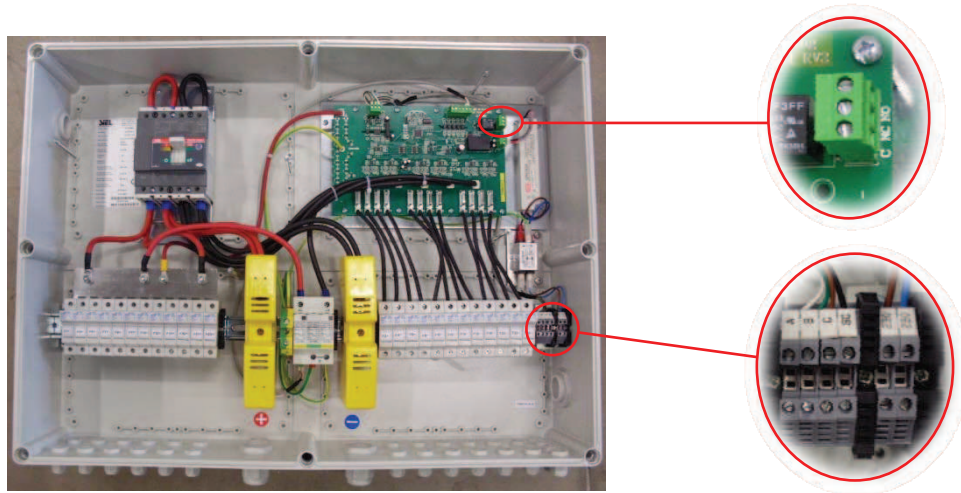


Fig. 13

Communications through bus RS-485

The electronic board autonomously powers and suitably insulates the RS-485 communications bus. Communications are indicated by the blinking red receiving and transmission leds on the board.



- A - RS485 communications bus A contact
- B - RS485 communications bus B contact
- C - Equipotential balanced wire
- SC - Shield

Fig. 14

Voltage free relay

Relay trip is signalled by a red led on the board.



- C - Voltage free shared contact
- NC - Voltage free normally closed contact
- NO - Voltage free normally open contact

Fig. 15

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Electrical connections

The steps to follow to electrically connect the system are the following:

1. Connection of the DC output and grounding connection

- Connect the grounding connector cable to the system. Insert the cable in the dedicated PT connector. Use a suitable screwdriver to open the PT terminal.
- Connect the DC output lines to the power terminals inside the cabinet, using packing glands and copper terminals. The recommended terminals for this type of connector are: DIN 46 234 and DIN 46 237 for M8 and M10.
- Verify that the fittings are firmly seated to prevent the voltage in the cable from being transmitted to the terminals.

2. Connection of the inputs of the series of panels



- Identify the lines of the panels and number them from 1 to 12. Do not reverse the polarity and observe the numbering. An incorrect connection may cause faults in the system.
- To connect the ends of the cables to the inputs of the fuse-holder, use tips that are compatible with the section of the chosen cable. The torque required for a correct connection must be max 2.5 Nm.
- Perform the connections in this sequence:
 - Open the fuse boxes that can be sectioned.

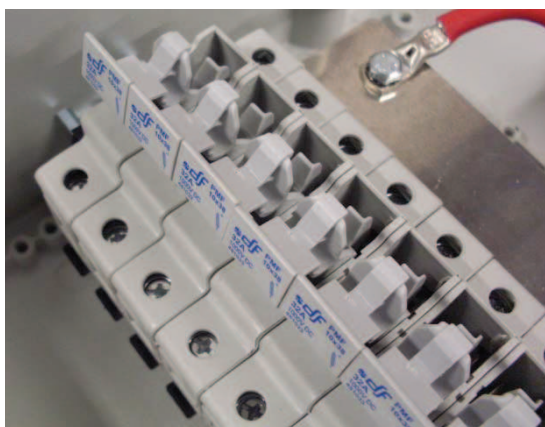


Fig. 16

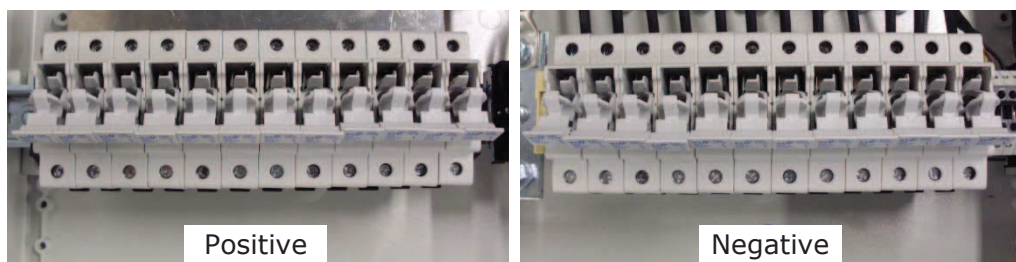


Fig. 17

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- Connect cable 1 + (positive cable of series 1).
- Connect cable 1 - (negatives cable of series 1).
- Use a voltmeter to check that the polarity and voltage of the series are correct.
- Follow the same procedure for the rest of the series.



- Verify that the clamps are correctly tightened to prevent the voltages of the cable from being transmitted to the terminal boards.

3. Auxiliary Power Connection

- Connect the 230 Vac auxiliary power cables to the terminals in the cabinet using the packing glands and suitable screwdriver.



- Verify that the clamps are correctly tightened to prevent the voltages of the cable from being transmitted to the terminal boards.



Fig. 18

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G. System start-up

Warning.

Data may be subject to temporary variations during cloudy days or due to rapid radiation changes. Therefore, it will be necessary to validate the data for all the panels being monitored for at least 10 seconds when radiation is stable.

Communication, auxiliary power connections and fuse mounting

1. Make sure the PV STRING BOX-12 output switch is **OFF** and 230 Vac auxiliary power is off.

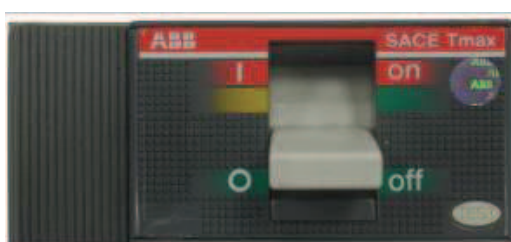


Fig. 19

2. Before connecting communications, as specified in point **Communication Connections**, make sure no fuse is connected. In this case, it will be necessary to open the fuse box and remove it.
3. Once the communications circuit is connected, power the board with 230 Vac auxiliary power, checking correct control logic operations. The green Power ON and Power ON RS485 leds turn on and the red led next to the dip-switch starts to blink.
4. Once correct control logic operations are checked, place all the positive and negative fuses for the entire series connected to the panels in the fuse box and close them.

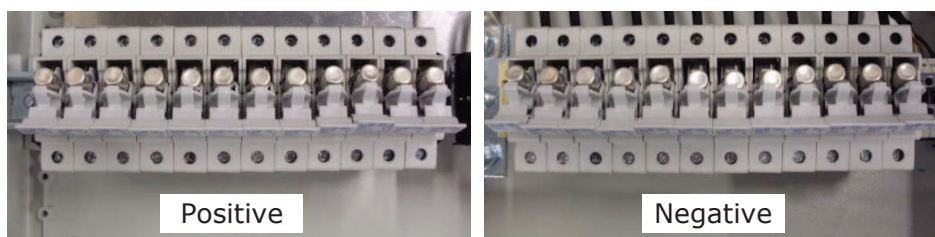


Fig. 20

Check general system status using the setup software monitor. When communications start, the red receiving and transmission leds will start to blink on the control board.

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5. Turn the output switch ON



Fig. 21

To check whether the PV STRING BOX-12 is operating correctly, a series of panels and an inverter must be connected so that current circulates throughout the series connected to the board. For an accurate measurement, it is important that the intensity of each series is above the intensity threshold of the series that is not connected, which by default is 600 mA per series.

H. Uninstallation

Perform the installation steps in reverse order.

1. Move the output disconnecting switch to position OFF.
2. Cut off 230 Vac auxiliary power
3. Disassemble all the fuses.
4. Disconnect the series, cable by cable, insulating the active parts.
5. Disconnect the general DC output.
6. Disconnect the communications.
7. Disconnect the ground connection.

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PV STRING BOX-12 technical specifications

Description	
Maximum input current	12 x 10A
Maximum input voltage	1000V _{DC}
Maximum output current	120A
Cut-off voltage:	1000V
Short-circuit intensity	120A
Aux. power rated voltage	230 Vac 50/60Hz
Aux. power rated current	0,045A
Input terminals connector	Screw-type
Protection class of the housing	IP44 IP66 with optional anti-condensation kit
Operating temperature	-25°C ... + 50°C
Relative humidity	4%÷100% condensing
Environment category	Non-conditioned outdoor
Use in humid ambient	Yes
Maximum altitude	1000 m a.s.l.
Pollution class	3

Protection devices	
Overvoltages between + and -	40kA varistors
Overvoltages between + and TT	40kA varistors
Overvoltages between - and TT	40kA varistors
Overload on the varistors between + and TT	Thermal disconnection of the discharger
Overload on the varistors between - and TT	Thermal disconnection of the discharger
Overvoltages on the varistors between + and -	Thermal disconnection of the discharger
Overvoltages in each series of lines +	16A fuses, 1000 VDC
Overvoltages in each series of lines -	16A fuses, 1000 VDC
General disconnecting switch	160A, 1100 VDC

Alarms generated	
Overvoltage protection provided by the varistors	Alarm due a fault in the discharger (general)
Open switch signal	Open switch alarm (general)
Fuse protection on + branches	General alarm for at least one fuse (general). If available.
Fuse protection on - branches	General alarm for at least one fuse (general). If available.
Negative current	Negative current alarm (on alarm for each string with adjustable shared limit between 0.1 A and 2.0A)
Out of range current	One alarm per series (Limit can be set between 1% and 90% with settable enable values between 0.6A and 8.8A)
Ground insulation	No ground insulation alarm (settable limit between 1% and 99%)
Housing overheating	Overheating alarm (settable limit between 40°C and 100°C)
Alarm delay	Settable (from 0 to 60 minutes)

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Viewable data on PC monitor	
General data of the board	Power
	Bus voltage.
	Grounding potential compared to negative terminal
	Current
	Fuse series alarm on Positive. If available.
	Fuse series alarm on Negative. If available.
	Discharger protection alarm
	Open switch alarm
	Insulation to ground alarm
	Internal board temperature
	485 bus termination status
	RS-485 communication status
	Connected board serial number
Detailed data displayed for each series	Total instant current
	Current per string
	"Disabled" string status signal
	"Connected and in generation" string status signal
	"Connected but not in generation" string status signal
	String with "current out of range" alarm
	String with "negative current" alarm
Voltage reading error (0... 1000V)	< 2.5%, bottom scale
Positive current reading error (0... 10.0A)	< 1%, bottom scale
Negative current reading error (0... -2.0A)	< 2.5%, bottom scale

NOTE: System PV STRING BOX-12 is compliant with EMC standards. However, in some systems voltage, current and power measurements could be inaccurate due to external interferences caused by electromagnetic fields with a very high intensity, such as those produced by a cell phone used at a short distance. In this case, the user may be required to adopt special measure to limit potential interferences (consult the manufacturer for assistance).

Auxiliary SPDT alarm relay	
Contact	1 normally closed voltage free exchange contact (alarm disabled)
Resistive rated load	10A - 250Vac
Electrical connection	5.08 mm step removable female connector
Resistance at contact	30 mOhm

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Communication via insulated and self-powered RS-485	
Standard	RS485 half duplex
Baud rate	9600 bps MODBUS
Galvanic insulation	2500 Vrms, 1 minute
Maximum distance	500m
Modes	Slave. The system responds to commands only.
Addresses available for the node	From 01 to 32 for MODBUS protocol
Maximum number of nodes at 500 m	32
Device serial number	10 numbers which, by identification, permit data transfer
Communication cable	Use two pairs of double braided cables with a low capacity. One pair for data (A and B) and the other for equipotent (C wire) The two pairs have to be connected to the same shielding.
Connection of the shield to the communication cable	Must be connected to the grounding, at end of the master.

Electrical connections	
24V in (board power input).	5.08 mm step 2-pole removable terminal board. Polarity silk screened on the board "+" positive pole terminal "-" negative pole terminal
Alarm relay contact output	5.08 mm step 3-pole removable terminal board. SPDT contact indication silk screened on the board. SHARED "C" contact terminal NORMALLY CLOSED "NC" contact terminal NORMALLY OPEN "NO" contact terminal
DIGITAL INPUT (normally closed digital inputs). All inputs are opto-insulated with 5000V withstanding voltage Input power on the side outside the board is the same as primary power.	5.08 mm step 6-pole removable terminal board. Function silk screened on the board SHARED "C" negative reference terminal for 5 input closing "1" NC terminal to "C": DISCHARGER alarm "2" NC terminal to "C": SWITCH OPEN alarm "3" NC terminal to "C": Copper + FUSE alarm "4" NC terminal to "C": Copper - FUSE alarm "5" NC terminal to "C": OPTIONAL input not used
RS-485: Self-powered serial communications port galvanically insulated by 2.5kV board potential	5.08 mm step 3-pole removable terminal board. Function silk screened on the board Signal "A" terminal Signal "B" terminal "C" equipotent terminal between modules "S" screen terminal

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Power and consumption	
Power supply	Continuous voltage between 15 V and 36 V
Standard consumption (alarm relay OFF, discharger input closed and RS-485 receiving)	49mA @ 24Vdc or <1.2W
Transmission consumption (alarm relay OFF, discharger input closed and RS-485 transmitting)	65mA @ 24Vdc or <1.6W
Maximum admitted consumption (alarm relay ON, 5 inputs closed and RS-485 with bus short circuit)	125mA @ 24Vdc or 3W

Packaging	
External dimensions of packaging	800 x 570 x 270mm
Total weight including packaging	17 Kg

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Maintenance



The system must be maintained by trained and qualified personnel only, Special tools that are generally available to specialised technicians only are required.

The preventive maintenance of the system must be performed after the first year of installation and then at regular intervals of three years.

Follow these instructions to perform a correct maintenance:

- Verify that all the mechanical connections of the system are firmly seated and, if necessary, tighten them with suitable tools.
- Verify that all the input connectors of DC lines, all the output connectors of AC lines and communication lines are correctly tightened.
- Verify that there are no insects in the system and, if necessary, remove them.
- Verify that there are no animals or insects inside the system and, if necessary, remove them.

Quick troubleshooting guide

The section that follows illustrates the corrective actions that can be implemented to correct some of the problems that may occur during the operation of the system.

1. Fuse alarm	Identify the cause, correct the problem and replace the fuse.
2. Insulation fault alarm	<p>Disconnect the disconnecting switch.</p> <ul style="list-style-type: none">• If the alarm persists, the fault probably originates from another box or from the inverter.• If the alarm continues to be displayed, the fault originates from the box. Remove the fuses from each of the series, one by one. When the display shows the fault, it means that the series with the insulation fault has been identified. Inspect the cables and panels of the series where the fault has been detected.

Operation and Installation Manual

SIEL communications protocol for PV STRING BOX-12.

General description

- All systems that are able to communicate using the accepted standard can act as masters of the RS485 communication network.
- All peripheral PV STRING BOX-12 are in listening mode (slave).
- ***Configuration and commissioning are performed via supplied setup software, connected by the USB-485 converter to the pre-wired bus.***
- ***Any Master can query a box via MODBUS RTU and, specifically, all box data can be read via the "read holding register" in the admitted register interval 2000...2020 included.***
- Speed ***9600 bps, 8 bit, no parity, 1 stop bit***

Addresses

- Each peripheral PV STRING BOX-12 has one address (hub) constituted by two NN characters.
- The addresses available for the hub range from 01 to 32.
- It is possible to connect up to 32 units of system PV STRING BOX-12 using one master only.

Connections

- PV STRING BOX-12 is equipped with internally insulated and self-powered RS485 connection (A, B, C equipotent).

Commands

- The only command admitted for the master is data reading via "read holding register" in the admitted interval 2000 ... 2020 included.
- Communication features: 9600 bps, 8 bit, no parity, 1 stop bit

Operation and Installation Manual

MODBUS communications protocol for PV STRING BOX-12.

General description

- System PV STRING BOX-12 can be integrated in an RS-485 communication bus that uses the standard MODBUS communication protocol, by configuring a master and slave.
- Type of MODBUS RTU.
- Messages available in the MODBUS standard:
 - Record reading (0x03 Read Holding Register).
- All peripheral PV STRING BOX-12 units act as slaves
- Frame setting: 8 bits, no parity, 1 stop bit, no flow control
- Speed 9600 bps.

Addresses

- Every peripheral PV STRING BOX-12 unit has an address (hub) that ranges between 1 and 32.
- It is possible to connect a maximum of 32 units using a single master.

Connections

- PV STRING BOX-12 is equipped with internally insulated and self-powered RS485 connection (A, B, C equipotent).

Format of messages

- General format of the RTU message:

Slave number (hub)	1 byte	Address of the target unit
Function code	1 byte	Reading/writing function
Data field	Variable	Function and identification data
CRC12	2 bytes	Frame integrity check

- Standard functions available:
 - Reading of multiple records (0x03)
- Addresses can be set using 16 bits or 1 word (LSB and MSB).

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Records map

<u>Register</u>	<u>Content</u>	<u>Description</u>
2000	VBUS	Average voltage of the 12 strings (V)
2001	IBUS	Total string current (tenths of A, see note 1)
2002	PBUS	Total string power (tenths of KW, see note 1)
2003	Statuses and alarms	Bit 0: string 1 status (see note 2 for decoding) Bit 1: string 1 status (see note 2 for decoding) Bit 2: string 1 status (see note 2 for decoding) Bit 3: string 2 status (see note 2 for decoding) Bit 4: string 2 status (see note 2 for decoding) Bit 5: string 2 status (see note 2 for decoding) Bit 6: string 3 status (see note 2 for decoding) Bit 7: string 3 status (see note 2 for decoding) Bit 8: string 3 status (see note 2 for decoding) Bit 9: string 4 status (see note 2 for decoding) Bit 10: string 4 status (see note 2 for decoding) Bit 11: string 4 status (see note 2 for decoding) Bit 12: string 5 status (see note 2 for decoding) Bit 13: string 5 status (see note 2 for decoding) Bit 14: string 5 status (see note 2 for decoding) Bit 15: not used
2004	Statuses and alarms	Bit 0: string 6 status (see note 2 for decoding) Bit 1: string 6 status (see note 2 for decoding) Bit 2: string 6 status (see note 2 for decoding) Bit 3: string 7 status (see note 2 for decoding) Bit 4: string 7 status (see note 2 for decoding) Bit 5: string 7 status (see note 2 for decoding) Bit 6: string 8 status (see note 2 for decoding) Bit 7: string 8 status (see note 2 for decoding) Bit 8: string 8 status (see note 2 for decoding) Bit 9: string 9 status (see note 2 for decoding) Bit 10: string 9 status (see note 2 for decoding) Bit 11: string 9 status (see note 2 for decoding) Bit 12: string 10 status (see note 2 for decoding) Bit 13: string 10 status (see note 2 for decoding) Bit 14: string 10 status (see note 2 for decoding) Bit 15: not used
2005	Statuses and alarms	Bit 0: string 11 status (see note 2 for decoding) Bit 1: string 11 status (see note 2 for decoding) Bit 2: string 11 status (see note 2 for decoding) Bit 3: string 12 status (see note 2 for decoding) Bit 4: string 12 status (see note 2 for decoding) Bit 5: string 12 status (see note 2 for decoding) Bit 6: Discharger status ('1' = alarm) (note **) Bit 7: Insulation status ('1' = alarm) Bit 8: System status ('1' = alarm) SYSTEM alarm status (b6, b7, b11, b12 OR) Bit 9: Communicating with box (force to 0) Bit 10: Generic alarm ('1' = if at least one alarm triggered) (force to 0) Bit 11: ('1'=alarm) SWITCH alarm status OPEN (note **) Bit 12: ('1'=alarm) OVER TEMPERATURE alarm status Bit 13: FUSE + alarm status ('1' = alarm) (note **) Bit 14: FUSE - alarm status ('1' = alarm) (note **) Bit 15: ('1'= ON) RS-485 TERMINATOR status

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Note 1: divide the value by 10 to obtain the measurement in A and KW.

Note 2: string status and alarm decoding.

Note **: Idle status (not alarm) for DISCHARGER, SWITCH, FUSE +, FUSE -, SPD, inputs is normally CLOSED. Therefore, to avoid false alarms, force unused contacts closed or disable them using the configurator.

Bit 2 Bit 5 Bit 8 Bit 11 Bit 14	Bit 1 Bit 4 Bit 7 Bit 10 Bit 13	Bit 0 Bit 3 Bit 6 Bit 9 Bit 12	Meaning	Status (S) or Alarm (A)
0	0	0	String NOT CONNECTED (DISABLED)	S
0	0	1	String CONNECTED and generating (ENABLED with current > 600mA)	S
0	1	0	String CONNECTED and NOT generating (ENABLED with current < 600mA)	S
0	1	1	String CURRENT alarm OUT OF RANGE	A
1	0	0	NEGATIVE string CURRENT alarm	A

Register integration

<u>Register</u>	<u>Content</u>	<u>Description</u>
2006	Current 1	String 1 current [mA]
2007	Current 2	String 2 current [mA]
2008	Current 3	String 3 current [mA]
2009	Current 4	String 4 current [mA]
2010	Current 5	String 5 current [mA]
2011	Current 6	String 6 current [mA]
2012	Current 7	String 7 current [mA]
2013	Current 8	String 8 current [mA]
2014	Current 9	String 9 current [mA]
2015	Current 10	String 10 current [mA]
2016	Current 11	String 11 current [mA]
2017	Current 12	String 12 current [mA]
2018	VBUS	Average voltage of the 12 strings [Volt * 10]
2019	VEARTH	GROUND voltage referred to -Vbus [Volt * 10]
2020	TEMP	Internal box TEMPERATURE [°C * 100]

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Warranty terms and conditions

Validity of the warranty

The warranty period covers 2 years from the date of purchase of the system. It is however possible to optionally extend the warranty to 3 or 5 years. In this case, the warranty extension includes the data and communication service through this period of time.

Warranty conditions

It will be necessary to supply the original invoice showing the purchase date for warranty claims.

During the period of validity of the warranty, the manufacturer will repair the system without charging the customer for the cost of materials and labour. The warranty does not include assembly and transportation costs.

The system must be returned to SIEL only after receiving its authorization. The claim must be presented in writing to SIEL along with information like the name, address, telephone number and other contact details. SIEL will authorize the return of the system as soon as it receives the error form that contains detailed information on the fault and applicable warranty. SIEL will not accept systems that have been returned without previously sending the claim in writing.

The customer must wait for the reparation to be completed.

It is important to keep the original packaging even after the expiry of the warranty period, because, for protection during transport, carriers are only authorised to accept boards that are packaged in the original box. If the original packaging has been discarded, it is necessary to contact SIEL before returning the system. SIEL will provide the customer with a new packaging that will have to be paid by the customer.

Disclaimer

SIEL will not accept claims and declines any responsibility in the following cases:

- Damages caused by an incorrect use of the system
- Continuous use of loads with powers above the maximum rated power
- Use of the system in inadequate environmental conditions (see section Location)
- Damages of systems subject to impacts or that have been disassembled or repaired by unauthorized technicians
- Damages caused by atmospheric discharges, accidents, water, fire and other circumstances that are out of the manufacturer's control.

The manufacturer declines any responsibility for additional and further claims, in addition of direct or indirect damages, including the cancellation of the contract, unless these are required by law.

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Changes



The content of this document may be changed without warning. SIEL has undertaken all possible measures to verify the accuracy of the information contained in this manual. However, it cannot guarantee the absence of errors or omissions or exclude damages that may derive from the incorrect interpretation of the information contained in this manual.

SIEL reserves the right to change the product, at its discretion, without giving prior warning to users.