



INVERTER FOR LIFE



**Technical Manual of FIMER string boxes
SBC04, SBC08, SBC12, SBC16, SBC20, SBC24**



INVERTER FOR LIFE

Via J.F. Kennedy
20871 Vimercate (MB) Italy
Phone: +39 039 98981
Fax +39 039 6079334

www.fimer.com
solar@fimer.com



INFOLINE
Tel. +39-039-6079326

Istruzioni Originali

Original instructions

Übersetzung der Originalbetriebsanleitung

Notice originale

Manual original



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GENERAL INFORMATION

Document Title: Document Title
Model SBC04 – 08 – 12 – 16 – 20 – 24
Document Classification: User and Installation Manual ORIGINAL INSTRUCTIONS

Manufacturer's information

FIMER S.p.A
Via J.F. Kennedy - 20871 Vimercate – (MB) - Italy
Tel. +39 039 98981 r.a. - Fax +39 039 6079334 - www.fimer.com - solar@fimer.com

Information about manual

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Fimer shall not assume any liability for any damages caused by its improper use, the same applies to people or companies involved in the preparation or production of this manual. The product specifications are subject to change without notice. The images are only indicative.

Environmental impact declaration

The Fimer products offer lower consumption of raw materials and lower amounts of waste throughout their entire working life. In typical applications, these positive effects on the environment far outweigh the negative impacts of the manufacturing of the products and final disposal.

The packaging of the products is of a good quality and can be reused. All the products are placed inside sturdy cardboard and wooden boxes, which are themselves made with a high percentage of fibre and recycled materials. If not reused, the packaging can be recycled. Polyethylene used to make the protective film and bags for wrapping the products can be recycled for the same purpose. The packaging strategy adopted by Fimer is based on easily recyclable products with low environmental impact and, thanks to regular controls and analysis, aims at identifying new improvement opportunities in this area.



At the end of their life and operation, the Fimer products can be dismantled very easily by separating the main components which can then be recycled. Some parts of these devices are snap-locked to each other and therefore can be separated without the use of tools, while many other components are secured with normal screws and therefore can be easily disassembled with the use of common screwdrivers. In any case, virtually every part of the product is recyclable. Do not dispose of the device or its parts with household waste. In accordance with European Directive 2014/19/UE on electric and electronic waste and its application in national law (The Italian DLGS 14 march 2014 N° 49), used electronic devices must be collected separately and recovered ecologically. The device must be disposed of in compliance with the collection and disposal system adopted and authorised in your area. Failure to comply with this EU Directive may adversely affect the environment and human health!

INTRODUCTION

Dear Customer,

Congratulations on choosing our “smart” string box, whose characteristics of high technology and reliability make it a highly innovative and durable product.

This manual contains all the information necessary to install and use the product safely. It is recommended to carefully read its contents before connecting and operating the machine.

Proper use of the product guarantees the reliability and quality of the system over time, which is indispensable to obtain excellent performances and outputs.

The contents of the manual will help you resolve most doubts and problems. Do not hesitate to contact your usual installer, distributor or sales representative if you experience problems during the use and installation which are not clearly described or documented in the manual. To obtain the latest information on the product or the latest version of the manual, please visit our website.






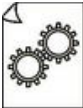

Keep this manual in a safe place near the machine for quick reference. This manual is an integral part of the machine; in case of resale of the product this manual should also be given to the purchaser.

The manual must accompany the product each time it is moved.

Thank you again for choosing our products.

GENERAL INFORMATION

Symbols used in the manual

	INFORMATION: It is recommended that the user carefully considers what is described and pays attention to the instructions contained in the manual.
	CAUTION or DANGER: The user is asked to pay the utmost attention to what is described in order to prevent the occurrence of situations that may cause serious damage or malfunctions to the equipment, as well as accidents, injuries or death to people.
	RISK OF ELECTRIC SHOCK: It is compulsory to follow the instructions to avert the danger of electric shock and electric discharges.
	PACKAGING INSTRUCTIONS
	INSTALLATION INSTRUCTIONS: Describes the installation procedure of the product.
	OPERATING INSTRUCTIONS: Describes the use of the product and its graphic display.
	DISPOSAL: Contains useful information for disposing of the product.

SAFETY INSTRUCTIONS AND WARNINGS

The failure to follow these instructions may have serious consequences, such as the destruction of the device, personal injury or death due to electrocution. Therefore, the following safety instructions must be read and understood before installation and use of the inverter. For any clarifications or additional information, contact the Fimer technical service.



Once the product has been removed from its original packaging, visually inspect for damage that may have occurred during shipment. If damage is found, contact the dealer or manufacturer.



This manual is an integral and essential part of the product.

Carefully read the recommendations contained in it since they provide important information on safe use and maintenance. If the device will be sold to another person or another customer is mandatory to transfer the present user manual to the new owner of the combiner box.



This product must only be used for the purpose for which it has been designed.

Any other use is considered improper and therefore dangerous. The manufacturer is not liable for possible damage caused by improper, incorrect or unreasonable use.



Fimer holds itself responsible only for the product in its original configuration.

Fimer declines all responsibility for consequences deriving from non-original spare parts.



Any intervention that alters the structure or the operating cycle of the product must be carried out or authorised by the Fimer Technical Office. Any changes made without the express permission of Fimer result in immediate revocation of the warranty conditions and the cessation of the manufacturer's liability for the consequences derived from it. Ignoring the environmental conditions of operation of the installation of the cassettes of the first parallel to the field described in this manual can cause damage to the equipment or PV plant and are considered equal to the inadequate use of the device for which Fimer declares exempt from all responsibility.



Fimer may make technical changes in this manual and to the product at any time without notice. In case of typing errors or other types of errors, the corrections will be included in the new versions of the manual.



Fimer consider itself responsible for the information reported in the original version of the manual in Italian.



All the safety and danger signs applied on the device:

- must be kept legible
- must not be damaged
- must not be removed
- must not be covered with stickers or writing



The identification plate of the product reporting the code, serial number and technical data of the apparatus, can be accessed by opening the front door of the devices. For any communications relating to the apparatus, report the serial number affixed on this identification plate.



Do not introduce objects into the device and avoid contact with any type of liquid; only clean with a dry cloth. These precautions must also be observed when the machine is installed on field turned off.



The upper part of the enclosure of the string box is not designed to support heavy loads. Never climb on the equipment, do not rest against it and do not use it as a support for additional devices (walkways, pipes, ventilation ducts etc...).



Dangerous voltages:

Inside the string box it is present high voltage that may cause damage, even serious, to people. The conductors and components with dangerous voltage are segregated into special areas that can only be accessed by using tools not supplied with the device. The string box must always be used with all the panels properly secured and with the front door closed in order to ensure the declared IP degree. All maintenance and repairs that require access to the inside of the device can only be performed by Fimer technicians or by properly trained personnel.

Before removing any panels of the machine (which can only be performed by Fimer personnel), it is absolutely necessary to open the switches on the direct current side (solar field). Always make sure there are no dangerous voltages by measuring with a voltmeter.



In addition to the installation and operating operations, it is important to comply with the local security and safety regulations on accident prevention and environmental protection.



Follow the directions and requirements given by the manufacturer of the panels that make up the photovoltaic generator, and by the electric grid company.



Make sure the cables entering and exiting the inverter are of the appropriate size. Also check the cables of the PV plant. The connections, section of the cables used and the installation must comply with the national or local regulations in force.



Repairs:

- Never repair the string box by ourselves, but always contact the manufacturer or their authorised service centre or a properly trained personnel.
- Any repair not authorised in writing and not directly managed by Fimer, besides being objectively dangerous, determines the immediate termination of the warranty and cessation of any liability for any malfunctions and resulting consequences.
- In case of repair, only use original spare parts, as there is no guarantee that any unoriginal parts will be able to withstand the stresses to which they are subjected during normal operation.
- Never make any changes and never install unauthorised devices inside the device.
- Never bypass the safety devices and have them reset by personnel specialised to perform the necessary repairs before restarting the apparatus



After sales assistance:

- Assistance must be requested when the apparatus has been damaged in any way such as in cases where liquid has penetrated, objects have fallen on top or inside the apparatus, when it has been exposed to rain or humidity (outside the specified values), when it does not operate properly, when there are evident changes in performance or when it has been dropped.
- Faults that may affect the safety of the machine and the entire system must be repaired before restarting the device.

**Maintenance:**

- To ensure the effective and expected life expectancy of the apparatus, it is necessary to perform the maintenance described in this manual.
- Routine maintenance of the apparatus must be periodically performed by qualified service personnel (such as the installer of the PV), visually checking the status of the machine and its components internal to it and checking the tightening of the screws connections and fuse holders. For more detailed information refer to as set out in proper appendix of this manual.
- The extraordinary maintenance of equipment must always be carried out by authorized personnel by Fimer or its service center; this is the only way to ensure original and new spare parts are always used and it is the only way to ensure that (according to maintenance contract) the device is constantly updated with any improvements made in the meantime (in accordance with state of the art).
- In particular, if unoriginal spare parts are used, which are not new or not in line with the state-of-the-art, the apparatus will be considered “modified” with the resulting legal and practical consequences

TECHNICAL DATA

SBC04 SBC08 SBC12 SBC16 SBC20 SBC24

TECHNICAL DATA / DATI TECNICI						
OUTPUT SWITCH / SEZIONATORE USCITA						
Typology / Tipologia	Rotary switch / Sezionatore rotativo 1000 V _{DC} (Note1)					
Connection mode / Connessione	Unprotected terminals / Contatti a vista					
Operating class / Categoria d'impiego	DC21					
Max voltage (V _{DC}) / Tensione massima (V _{DC})	1000 V					
Max current (A _{DC}) / Corrente massima (A _{DC})	100 A	160 A		250 A		
INPUT FUSE HOLDERS / SEZIONATORE FUSIBILI INGRESSO						
Typology / Tipologia	Fuse holder type / Porta fusibili tipo 10x38 GPV					
Max voltage (V _{DC}) / Tensione massima (V _{DC})	1000 V					
Max current (A _{DC}) / Corrente massima (A _{DC})	32 A					
N° of DC+ input / N° Ingressi DC+	4	8	12	16	20	24
N° of DC- input / N° Ingressi DC-	4	8	12	16	20	24
FUSES INPUT / FUSIBILI INGRESSO						
Typology / Tipologia	Cylindric / Cilindrici 10x38 GPV					
Max voltage (V _{DC}) / Tensione massima (V _{DC})	1000 V					
Max current (A _{DC}) / Corrente massima (A _{DC})	To be defined during the order (up to 30 A) / Da definire in fase di ordine (max 30 A)					
N° fuse / N° fusibili	8	16	24	32	40	48
DC SURGE PROTECTION / SCARICATORE LATO DC						
Typology / Tipologia	Class 2 SPD (varistor type Y) / Classe 2 (Varistori collegamento a Y)					
Operating voltage (V _{DC}) / Tensione lavoro (V _{DC})	1000 V					
STRINGS CURRENT MONITORING / CONTROLLO CORRENTI STRINGA						
N° of input strings / N° stringhe controllate	4	8	12	16	20	24
Max voltage (V _{DC}) / Tensione massima (V _{DC})	1000 V					
Max current (A _{DC}) / Corrente massima (A _{DC})	25 A					
Method of measurement / Metodo di misura	Using Hall effect probes / Mediante sonde a effetto Hall					
VOLTAGE CONTROL STRINGS / CONTROLLO TENSIONE STRINGHE						
Max voltage (V _{DC}) / Tensione massima (V _{DC})	1000 V					
GENERAL DATA / DATI GENERALI						
Auxiliary AC Power supply / Alimentazione ausiliaria AC	Stabilized power supply / Alimentatore stabilizzato 230 V _{AC} /24 V _{DC} 15W					
Communication port-protocol / Porte-protocollo comunicazione	RS485 - MODBUS RTU Protocol / Seriale RS485 - Protocollo MODBUS RTU					
Safety class / Classe di isolamento	II					
Accuracy / Precisione	0.5% f.s.					
Dimensions (DxWxH mm) / Dimensioni (LxPxH mm)	423x265x685			550x270x700		
Weight / Peso	15.7 Kg	17.6 Kg	19.5 Kg	23 Kg	24.5 Kg	25.5 Kg
Colour / Colore	RAL 7035					
External protection degree / Grado di protezione esterna	IP65					
Internal protection degree / Grado di protezione interna	IP20					
Operating temperature / Temperatura lavoro	-20 / +50 C°					
Height above the sea / Altitudine installazione (Note 2)	up to 2000 m					
Installation / Montaggio	Vertical wall mounting, by means of fixing brackets / Verticale a parete, mediante staffe di fissaggio					
Box and back plate material / Materiale cassa-piastra fondo	Fyber glass reinforced by polyester / Galvanized metal sheet / Fibra di vetro rinforzata in poliestere / Lamiera zincata					
Door / openig angle / lock Porta / angolo apertura / serratura	Blind / > 120° / Standard Cieca / >120° / Standard					
Cables input-output / Ingresso - Uscita cavi	By cable gland / Mediante pressacavo					

Warnings: to feed the electronic devices of the string box control unit is required an auxiliary external single-phase power supply 230 V_{AC} (L + N).
Avvertenze: per alimentare l'elettronica di controllo è necessaria una alimentazione ausiliaria esterna monofase 230 V_{AC} (L+N).

Please note that the string box doesn't contain blocking diodes. Si ricorda che il quadro di parallelo non contiene diodi di blocco.

Note1. Molded case circuit breaker is a necessary optional if the releasing coil is required / Sezionatore scatolato opzionale se richiesta bobina di sgancio.

Note2. For further information keep in contact with Fimer technical Dpt / Per ulteriori informazioni mettersi in contatto con ufficio tecnico Fimer.

DECLARATION OF CONFORMITY



INVERTER FOR LIFE

Uffici: Via J.F. Kennedy
20871 Vimercate (MB) Italy
Tel. : +39 039 98981
Fax.: +39 039 6079334

website: www.fimer.com
e-mail: solar@fimer.com

DICHIARAZIONE DI CONFORMITÀ CE	DECLARACIÓN DE CONFORMIDAD CE	BEKREFTELSE OM OVERENSSTEMMELSE CE
CE DECLARATION OF CONFORMITY	DECLARAÇÃO DE CONFORMIDADE CE	OVERENSSTEMMELSESERKUERING CE
KONFORMITÄT SERKLÄRUNG CE	FÖRSKRAN OM OVERENSSTAMMELSE CE	
DÉCLARATION DE CONFORMITÉ CE	VERKLARING VAN CONFORMITEIT CE	YHDENMUKAISUUSVAKUUTUS CE

Si dichiara che l'apparecchio tipo
We hereby state that the machine type
Wir erklären, dass das Gerät Typ
On déclare que la machine type
declara que el aparato tipo
Declara-se que a máquina tipo
Vi försakrar att maskinen av typ
Verklaard wordt dat het apparaat type
Vi bekræftelser, at maskinen type
Vi erklærer, at maskinen type
Todistamme etta laite mallia

MODEL

SBC04 - SBC04s - SBC08 - SBC08s
SBC12 - SBC12s - SBC16 - SBC16s
SBC20 - SBC20s - SBC24 - SBC24s
SBC20R - SBC20RS - SBC24R - SBC24RS

è conforme alle direttive
is in compliance with the directives
den Richtlinien entspricht
est conforme aux directives
es conforme a las directivas
é conforme as directivas
ar i överensstammelse med direktiven
overeenkomstig de richtlijnen
er i overensstemmelse med direktivene
er i overensstemmelse med direktivene
on yhdenmukainen direktiivissa

2006/42/CE
2006/95/CE
2004/108/CE
2011/65/UE ^(RoHS)

è conforme alle norme
is in compliance with the rulls
den Normen entspricht
est conforme aux normes
es conforme a las normas
é conforme as normas
ar i överensstammelse med direktiven
overeenkomstig de richtlijnen
er i overensstemmelse med direktivene
er i overensstemmelse med direktivene
on yhdenmukainen direktiivissa

CEI EN 61439-2
CEI 44-6
EN 61000-3-2
EN 61000-3-3

VIMERCATE (MB), 2015-07-23

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AMBROGIO CARZANIGA

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Jokainen valiintulo tai muutos ei valtuutettu FIMER rappliditaa k'fseisen lausunnon pitävyyden.

BLOCK DIAGRAM OF STRING BOX

The block diagram of Figure 1 refers to the model SBC24, for the other string box from the family SBC FIMER the only difference consists in the appropriate number (but less than 24) of fuses that are present and necessary for connecting the strings of solar panels:

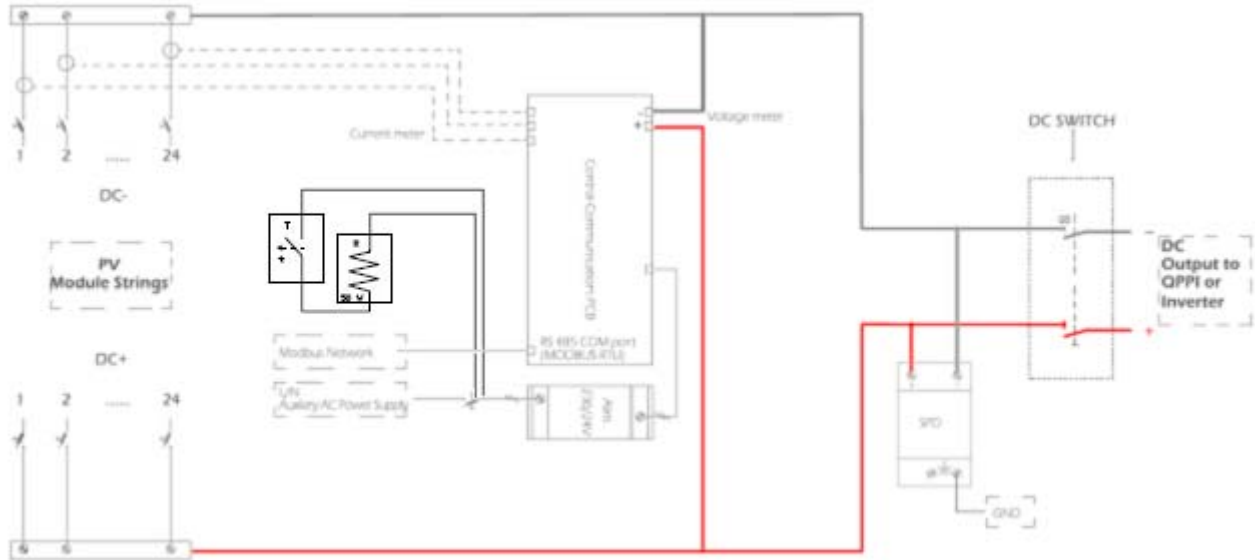
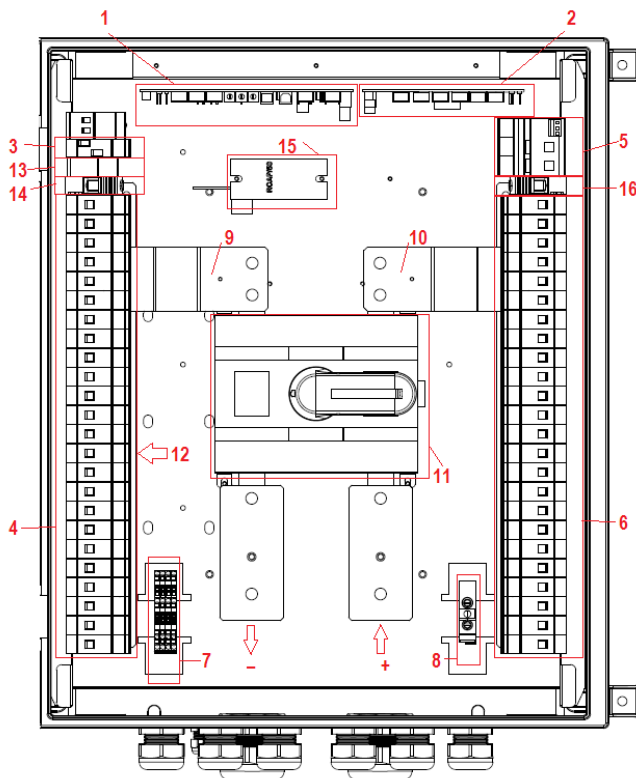


Fig. 1. Block diagram of string box.

TOPOLOGICAL DESCRIPTION

Figure 2 describes the main internal components present within the SBC string box model of Fimer:



- 1:** PCB card called Mother Board
- 2:** PCB card (optional) necessary for connecting environmental probes
- 3:** 230Vac/24Vdc power supply and proper switch and protection implemented by fuse
- 4:** FV DC - input fuses
- 5:** Surge protection device SPD
- 6:** FV DC + input fuses
- 7:** Screw terminals for MODBUS line
- 8:** GND screw terminal
- 9:** DC- copper BUS bar
- 10:** DC+ copper BUS bar
- 11:** Output switch
- 12:** Electronic cards with Hall effect sensors for detecting the string current
- 13:** Thermostat for set operating threshold temperature of heaters
- 14:** DC- terminal for SPD connection
- 14:** Heaters
- 16:** DC+ terminal for SPD connection

Fig. 2. Topological description of string box.

DESCRIPTION OF THE OPERATING MODE OF FUNCTIONING

The fimer string boxes, SBC series, are intelligent control boxes (SMART) which allow the measurement of the current of each input PV string from the solar generator and allow the creation of the parallel output of all the strings of PV modules connected to them. These high-performance devices implement the current measurement using Hall effect transducers and ensure an accurate localization of the malfunction of the PV field minimizing the production downtime and facilitating the timely and targeted intervention of Service. Each string box is equipped with protections against overvoltage implemented by SPD varistors, the switch in input is implemented by the fuse holders and in output by a switch; these devices allow to isolate the single sub-field PV or the individual strings from the solar generator, allowing operators to work safely. Through these advanced technology products you can also manage the complete control and monitoring of the PV field. The monitoring of the unbalance of currents (miss-matching) is built and available within the control logic of our inverters. Thanks to the string box FIMER, SBC series, is possible to control the solar installation, using the integrated MODBus RTU protocol, and in this way it's compatible with the most diffused communication systems on the market.

LOGIC CONTROL DIAGRAM OF STRING BOX

In the figure below shown it accurately described the logic control diagram of the various electromechanical and electronic devices that are installed inside a smart first parallel combiner box belonging to SBC model range:

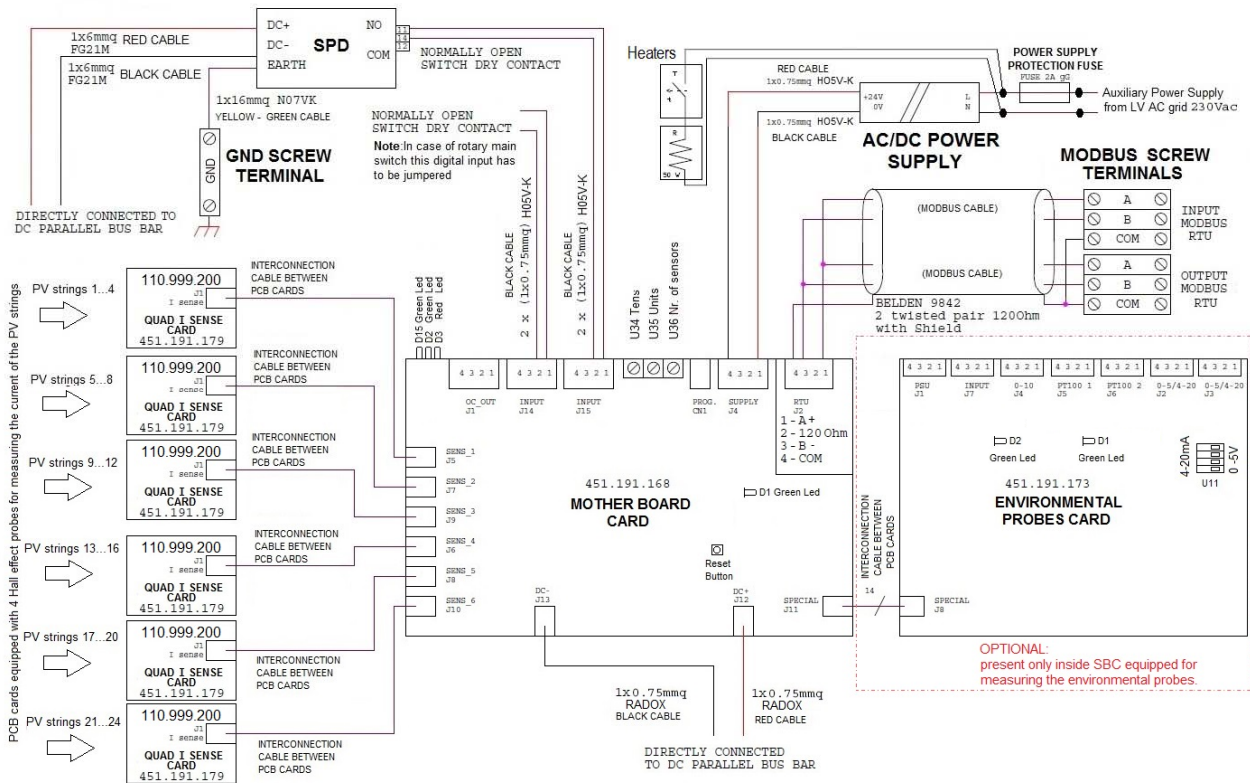


Fig. 3. Logic control diagram of a smart string box

STORAGE

If the device is not installed immediately, it must be stored in its original packaging and protected against humidity and weather conditions.

The storage room must meet the following requirements:

- Ambient temperature: $-25^{\circ}\text{C} \div +60^{\circ}\text{C}$
- Relative humidity: 95% max

The recommended storage temperature is between $+5^{\circ}\text{C}$ and $+40^{\circ}\text{C}$

BOX AND EXTERNAL ENCLOSURE

<u>Material:</u>	hot molded monolithic enclosure made by polyester resin reinforced with glass fiber (fiberglass), completely insulated and equipped with a solid door
<u>Colour:</u>	White (RAL 7035)
<u>Mode of installation:</u>	Vertical
<u>Antifire self-extinguishing:</u>	UL94 V0
<u>Approvals:</u>	CEI 23-48 CEI 23-49 IEC 60670-24



Self-extinguishing and highly insulated boxes for household and industrial application equipped with:

- a door with polyurethane gasket
- external hinges nylon and 120° opening
- triangular locks made in sealed-resin or cockerel with key
- internal reinforced supports that make the structure strong and resistant - ease to be drilled by tools and to be equipped with cable glands.

The maximum external dimensions of the box (included the cable glands and the fixing tool for wall mounting) are indicated in Table 1 expressed in mm:

Table 1
String box dimensions

SBC Model	Width	Height	Depth
SBC04 - SBC08	423mm	685mm	265mm
SBC12 -SBC16 - SBC20 - SBC24	550mm	700mm	270mm

CONNECTION PRECAUTIONS

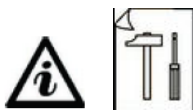
When you receive the device at first you have to verify that the packaging has not been damaged during the shipment and transport; the same in the case where it is stored, before reaching the PV plant, in the storehouse of the customer or of the installer.

Be careful when removing the carton packaging to avoid scratches to the external housing of the enclosure or damage of the cable glands. The device must be handled with care, any bumps and falls could damage it.

Check that the equipment is intact without dents so as to ensure the degree of protection. If the unit is damaged DO NOT CONNECT and contact immediately the manufacturer.




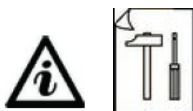
The casing is made of fibreglass with protection rating of IP65; the inputs and outputs ways of the cables from the PV modules and output from the string box, communication cables and signal cables and power supply are made using cable glands that can also ensure, if tightened and occluded if not used, the degree of protection IP65 of the entire device.



If positioning in a closed environment, make sure the area is ventilated and allows regular recirculation of air. If installing in an open environment, position the casing in an area that is constantly shaded and protected from exposure to direct sunlight. These precautions are important for preventing unnecessary and excessive overheating, which prolonged in time impairs the duration and operation of the electronic parts (communication and measurement PCB cards) present inside the string box, since the casing supports the correct dissipation of heat developed by the energy coming from the strings at a maximum temperature of 50°C.



The symbol  indicates that the enclosure is designed and manufactured so as to provide protection against indirect contacts via complete insulation (according to EN 61439-1 and EN 61439-2). For this purpose, the electrical panels must be correctly installed according to the instructions that accompany the product and using the special accessories (screw cover caps, mounting brackets are included in the supply purpose).



Make sure the wall where the string box is to be mounted is suitable to support the weight. The weight of these casings varies from 15kg for the 4 string model to over 25 kg for the model with 24 strings

For the installation of the string box please refer to Figure 4 and in Table 2 where are described the indications for the realization of the drilling template:

Drilling template

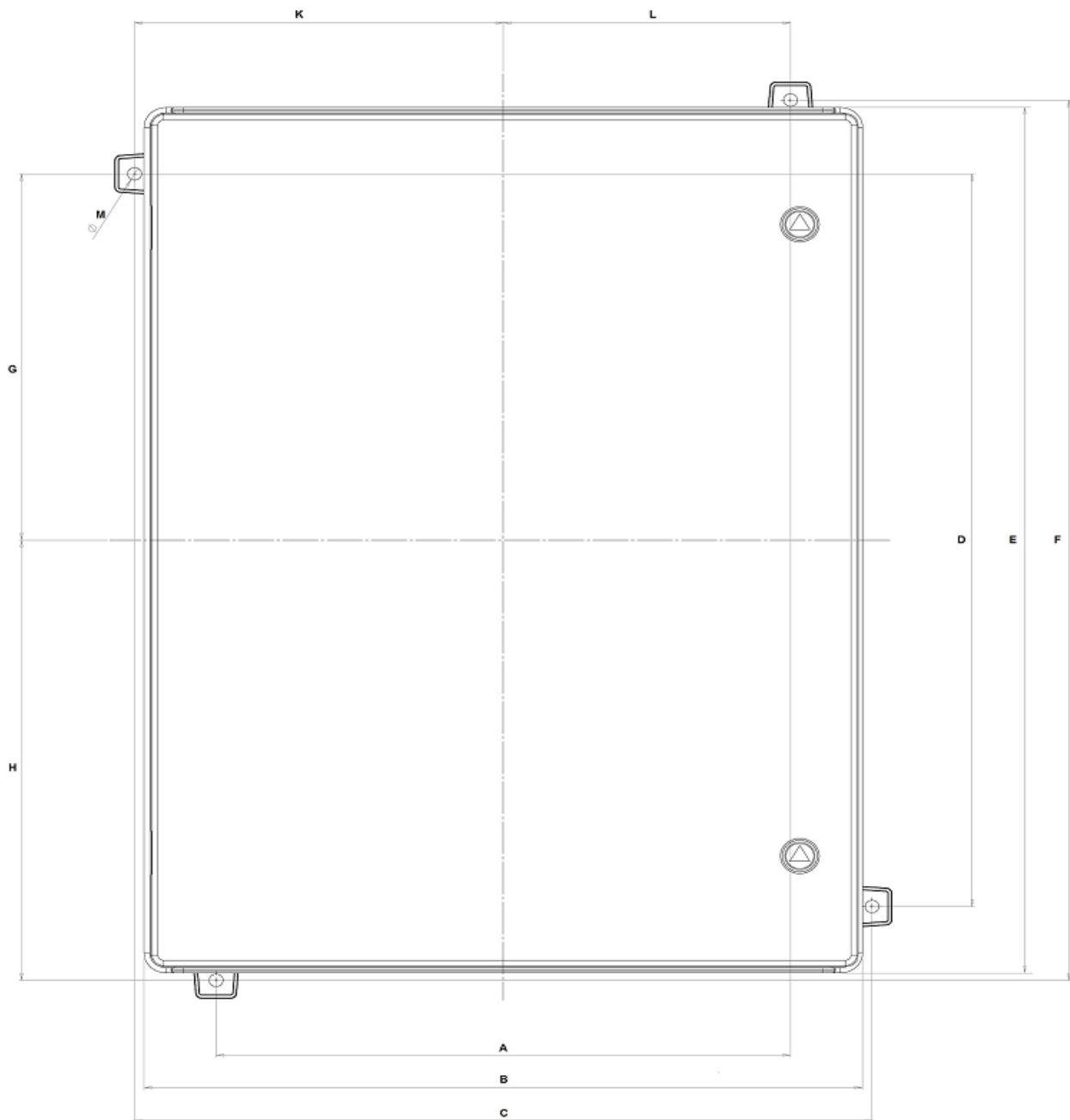


Fig. 4. Drilling template of the string box

Table 2
Dimensions of the string box

		Dimensions (mm)										
		A	B	C	D	E	F	G	H	K	L	M
Model	SBC 04 -08	312	423	455	530	640	670	263,5	336,5	227,5	156,5	12
	SBC 12 -16 -20 -24	498	550	575	599	650	675	299,5	335,5	284	241	8

ELECTRICAL CONNECTION OF STRING BOXES

Preliminary precautions

The operations and items described in this chapter can be carried out only by experienced and properly trained personnel.

Remember that for the proper operation and interfacing of the control logic card must also be provided:

- a connection to a single-phase auxiliary power supply 230Vac (2A max) for the supply of the control logic PCB cards; this power supply is protected by a fuse switch holder that can be open under load and it protects only the line phase of power the power supply line but not the neutral phase.
- the wiring of a RS485/Modbus-RTU data network to the PV FIMER inverters or monitoring and data acquisition systems it is made in order to receive information and data from the string box.

Preliminary checks



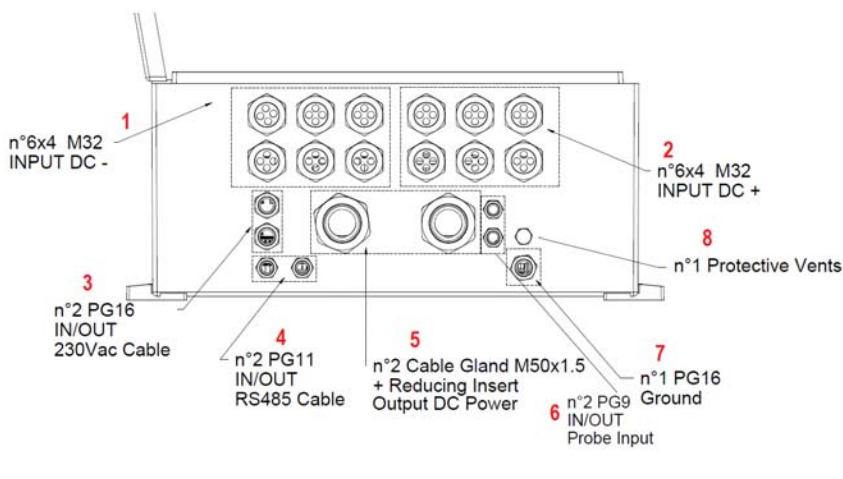
Before connecting the panel to the PV panels, make sure that:

- The fuses are not inserted in the fuse boxes.
- The disconnecting switch is open (lever on OFF).
- The panel is in good condition and there was no damage during transport.
- The panel is firmly anchored to walls and stable supports.
- Ensure that there are no remaining metallic parts, chips and derivatives from the installation activities, inside the enclosure or in the external upper side of the string box.

Input and output cables from the string box

After the checks listed in the previous steps, you can proceed to wire of the PV cables according to the scheme of the entire PV plant, taking care to use suitable sections and colors for cable conductors corresponding to what is reported and described in the specifications of the PV installation project.

In the below figure and its description is specified in detail the input and output cables of a SBC24S string box equipped with the electronic control board for collect the information of the environmental probes:



- 1:** Cable entry for negative pole o PV strings
- 2:** Cable entry for positive pole o PV strings
- 3:** Cable entry the auxiliary 230Vac power supply line
- 4:** Cable entry for MODBUS line
- 5:** Cable entry to the output switch
- 6:** Cable entry for radiation an temperature sensors
- 7:** Cable entry for ground connection (GND)
- 8:** Protective vents

Fig. 5. Input/output cable glands for string box

The following table shows the models of cable gland which are installed on the string box in the standard and default factory configuration (any change in the type and model number or of cable glands can and must be requested prior to the Sales Department and the Technical Office of Fimer):

NR. OF CABLE GLANDS	TYPE	NR. MAX OF CABLES	SBC MODEL
1	M32	4	SBC04..SBC24
2	M32	1	SBC04..SBC24
3	PG11	1	SBC04..SBC24
4	PG11	1	SBC04..SBC24
5	PG36	1	SBC20 e SBC24
	PG29	1	SBC12 e SBC16
	PG21	1	SBC04 e SBC08
6	PG9	1	SBC04..SBC24
7	PG16	1	SBC04..SBC24



NOTE:

Close with proper plugs or pieces of wire all the holes of the glands that are not used in order to ensure compliance with the declared IP protection degree.

Electrical connection of the cables within the string box



For the implementation of the electrical connections it is necessary to keep in mind the following precautions:

1. The first connection to be made is to fix the ground wire that arrives from the field to the yellow / green screw terminals clamp within the enclosure, the standard clamp supplied is suitable for connecting cables whose max size is up to 25mmq.
2. Before connecting the cables coming from the PV strings to the DC fuse holders, the cables of the 230Vac auxiliary line to the AC fuse disconnecter and the cables of MODBUS network and environmental sensors to the terminals is recommended to use a adequate tip to lug every single cord, in order to avoid possible short circuits between adjacent wires.
3. The attestation of the cables to the output DC switch of the string box is achieved by using M10 ring terminals, so that the wires can be connected to appropriate fastening screws present on the output copper bar.

Note:



Please remind that inside the string box is not present and installed any blocking diode.

If the photovoltaic array has zones that are not irradiated evenly (for example, due to partial shading), it could be necessary to use blocking diodes to prevent the circulation of inverse currents in the strings which may lower the system's performance

For the final decision of the use of such devices must be follow and keep in consideration the instructions given in the executive design of the PV installation provided by the designer of the PV plant.

In the next figure and corresponding description are given the fastening points to which must be connected to the electric wires and the input signal to the string box:

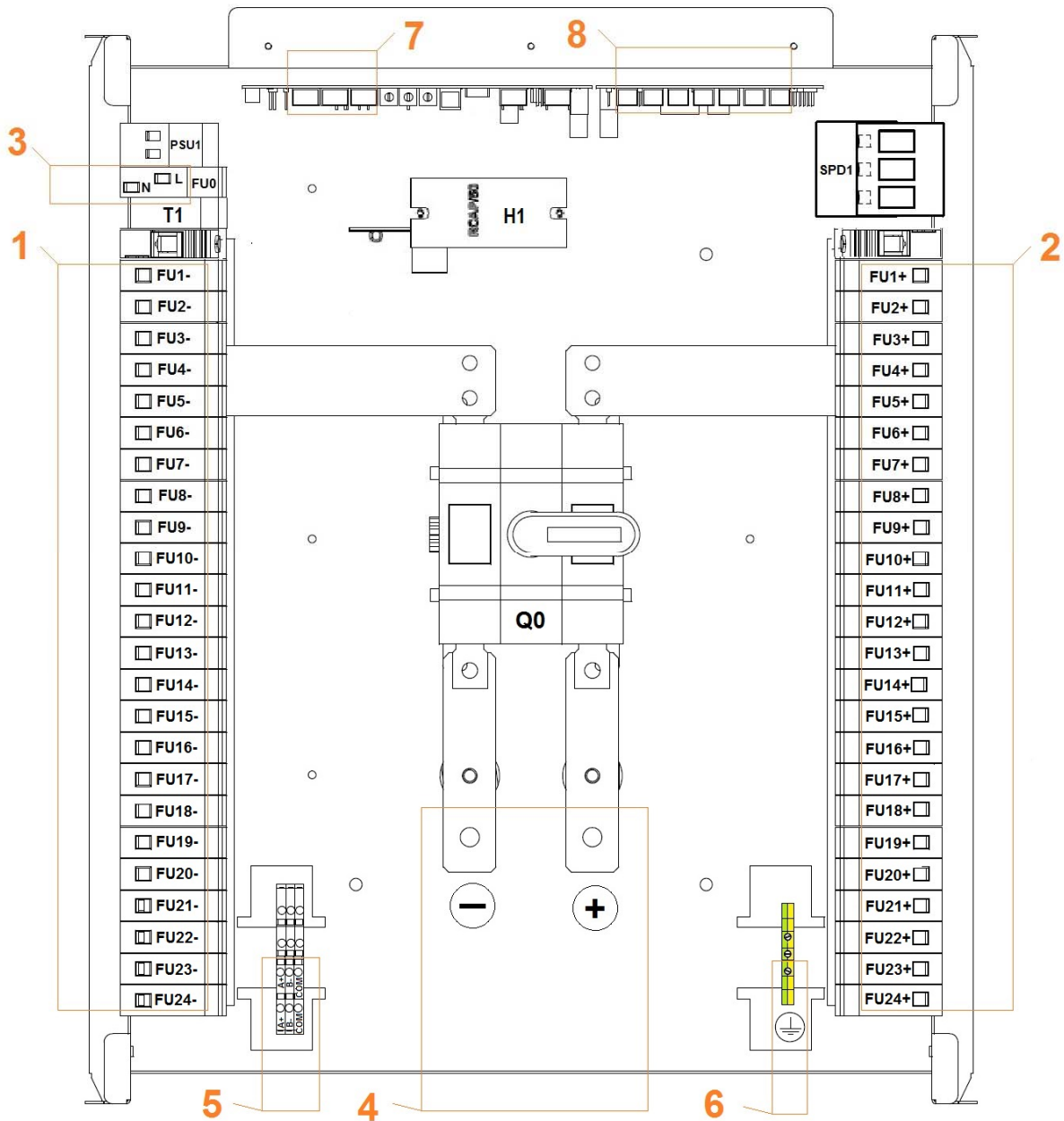


Fig. 6. Electrical connection of the string box

- 1: Connect the input cables of the negative PV strings directly to the appropriate fuse holder FU i -.
- 2: Connect the input cables of the positive PV strings directly to the appropriate fuse holder FU i + .
- 3: Connect the input cables of the external 230Vac power supply line to the fuse holder called FU0 with correct respect of the position L and N cables.
- 4: Connect the output cables coming out of the switch called Q0 to the proper + and - terminals.
- 5: Connect the cables of the MODBUS network to the A+ , B - e COM terminals as shown by the picture.
- 6: Connect the ground cable (GND) to the proper Yellow/Green screw terminal.
- 7: Terminals attestation of digital inputs and outputs cable.
- 8: Terminals attestation of environmental sensors.

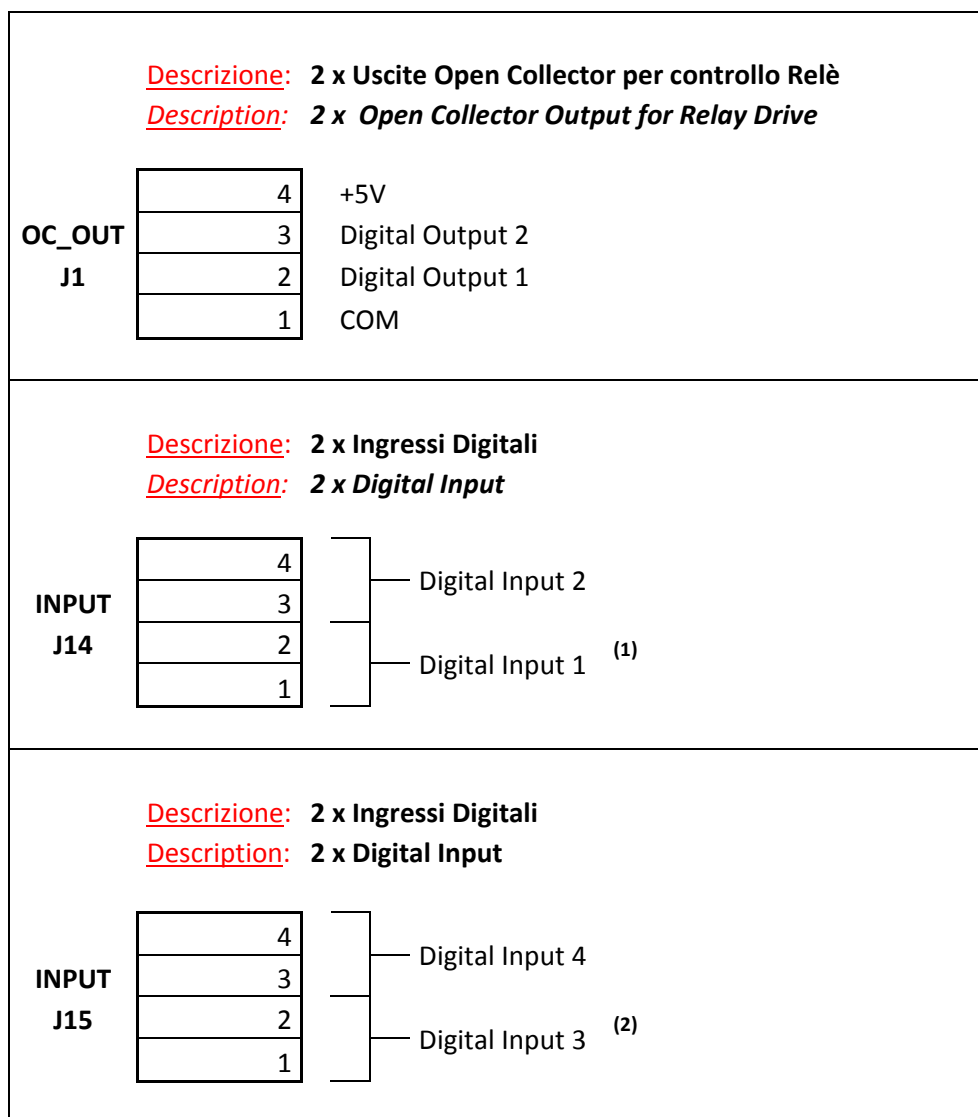
Note concerning heaters options: Heaters optional is a special version of string box; the maximum power consumption of heaters (H1) is 50W and the intervention temperature threshold is set by using a screwdriver that set on the thermostat T1 the desired value of heater power up

(factory set is 5°C and the installer or the end customer has to set the right value according to environmental condition of the PV installation)

The following tables set out a detailed description of the terminals of digital / analog - input/output of the Mother Board card (see point 7 of Figure 6) and of the Environmental Probes card (see section 8 of Figure 6):

Scheda Mother Board: descrizione dei connettori

Mother Board Card: description of the screw terminal connectors



(1) Ingresso digitale riservato per rilevare il contatto di stato del sezionatore in uscita della cassetta di stringa
Digital input used for detect the status of the main output switch of the string box

(2) Ingresso digitale riservato per rilevare il contatto di stato del sezionatore in uscita della cassetta di stringa
Digital input used for detect the status of the Source Protection Device

Scheda Sensori Ambientali: descrizione dei connettori

Environmental Probes Card : description of the screw terminal connectors

<p>Descrizione: Uscita di alimentazione ausiliaria per sonde esterne Description: Auxiliary power supply for external device</p>											
<p>PSU J1</p>	<table border="1"> <tr><td>4</td><td>+24 +/-10% (max. 40mA)</td></tr> <tr><td>3</td><td>+12 +/-10% (max. 40mA)</td></tr> <tr><td>2</td><td>+5 +/-10% (max. 40mA)</td></tr> <tr><td>1</td><td>0</td></tr> </table>	4	+24 +/-10% (max. 40mA)	3	+12 +/-10% (max. 40mA)	2	+5 +/-10% (max. 40mA)	1	0		
	4	+24 +/-10% (max. 40mA)									
	3	+12 +/-10% (max. 40mA)									
	2	+5 +/-10% (max. 40mA)									
1	0										
<p>Descrizione: 2 x Ingressi Digitali (Open Collector/Open Drain/Push-Pull 0-5) Description: 2 x Digital Input (Open Collector/Open Drain/Push-Pull 0-5)</p>											
<p>INPUT J7</p>	<table border="1"> <tr><td>4</td><td rowspan="2">Digital Input 2</td></tr> <tr><td>3</td></tr> <tr><td>2</td><td rowspan="2">Digital Input 1</td></tr> <tr><td>1</td></tr> </table>	4	Digital Input 2	3	2	Digital Input 1	1				
	4	Digital Input 2									
	3										
	2	Digital Input 1									
1											
<p>Descrizione: 2 x Ingressi Analogici in tensione (0-10V) Description: 2 x Voltage Analogue Input (0-10V)</p>											
<p>0-10 J4</p>	<table border="1"> <tr><td>4</td><td>+10V</td><td rowspan="2">Analogue Input 2</td></tr> <tr><td>3</td><td>0</td></tr> <tr><td>2</td><td>+10V</td><td rowspan="2">Analogue Input 1</td></tr> <tr><td>1</td><td>0</td></tr> </table>	4	+10V	Analogue Input 2	3	0	2	+10V	Analogue Input 1	1	0
	4	+10V	Analogue Input 2								
	3	0									
	2	+10V	Analogue Input 1								
1	0										
<p>Descrizione: Ingresso sonda PT100 Description: PT100 Probe Input</p>											
<p>PT100_1 J5</p>	<table border="1"> <tr><td>4</td><td>White</td></tr> <tr><td>3</td><td>White</td></tr> <tr><td>2</td><td>Red</td></tr> <tr><td>1</td><td>Red</td></tr> </table>	4	White	3	White	2	Red	1	Red		
	4	White									
	3	White									
	2	Red									
1	Red										

Descrizione: Ingresso sonda PT100

Description: PT100 Probe Input

PT100_2 J6	4	White
	3	White
	2	Red
	1	Red

Descrizione: 2 x Ingressi Analogici Configurabili
0-5V o 4-20mA

Description: 2 x Adjustable Analogue Input
0-5V o 4-20mA

0/5-4-20 J2	4	Analogue Input 2
	3	0
	2	Analogue Input 1
	1	0

Descrizione: 2 x Ingressi Analogici Configurabili
0-5V o 4-20mA

Description: 2 x Adjustable Analogue Input
0-5V o 4-20mA

0/5-4-20 J3	4	Analogue Input 4
	3	0
	2	Analogue Input 3
	1	0



Note: After the electrical connection of all DC, AC and signal cables please verify that all the wires are tight screwed inside their terminals in order to prevent overheating or malfunctions that may cause in dangerous situations.

Final electric check

Voltage check – reverse polarity check of PV strings and not homogeneous length of the PV strings



Before closing the fuse holders, proceeding with all the checks PV field side using a voltmeter with voltage range up to 1000VDC, so check and correct any wiring errors such as reversal polarity connection of strings or excessive DC voltage values, higher than the maximum permissible . Such wiring errors strings can cause serious damage to the system or create dangerous situations for people.

Wiring errors of this type can cause fire and damages of the devices.

Voltage check – Measuring Procedure

Equip yourself with a voltmeter with a voltage range up to 1000 V_{DC}. This check is made by measuring the open-circuit voltage of the panels obtained at minimum irradiation; for a correct operation of the strings in order to avoid problems of mismatching is necessary that the strings connected to the same box field are uniformly radiating.



Make sure that:

- the inverter is off and disconnected on the DC side.
- the disconnecting switch of the string box is in OFF.
- the fuse box holders are open.

Measure the open-circuit voltage of each string and check that:

- the maximum deviation between the voltages is less than 10%.
- no values higher than the maximum allowable are measured.
- no negative values are measured



Only if the previous test results were positive you can insert the fuses in the fuse holders and proceed with the start up the PV system.



Immediately correct the wiring if one of the upper said conditions is not valid because continuation of this situation may cause serious damage to the system and people.



The fuse holders are not suitable for isolating the on-load string current. Therefore, these fuse holders should only be opened or closed if there is no passage of current (main disconnecting switch must be put in OFF) in order to prevent the formation of electrical arches that are dangerous to the health and safety of people and the integrity of the materials.

DESCRIPTION OF THE MEASUREMENT SYSTEM

The String Box Combiner implements a measurement system and monitoring of the currents and of the other physical quantities typical of the photovoltaic plants, data collected are then transmitted to the Inverters by mean of Modbus connection. comunicazione Modbus¹.

The system is made by three electronic cards

- **Mother Board** (451.191.168) – This is the main board: it contains a micro controller that manage the overall function of the measurement system, it acquires the string current values and sent such data to the Inverter.
- **Environmental Probes Card** (451.191.173) –This card is an option of the String Box Combiner, it can enhance its measurement capabilities. Temperature sensors, pyranometer, anemometers, etc. can be connected to it.
- **Current Sensors card** (451.191.179) – Each card of this kind contains four Hall effect current sensors that measure the magnitude of the current flowing in the strings. Several configuration are available, ranging from 1 (SBC04) up to 6 (SBC24).

Mother Board

This section contains a detailed description of the connectors, switches and LEDs of the Mother Board and can be used as reference for the other sections of this manual, please refer to figure 7.

LEDs

The card has four LEDs which purpose is explained in the following

- **LED D1 (green)** –This LED shows whether the card is powered or not: when it's steady ON the Motherboard is correctly powered.
- **LED D2 (green)** – This LED has two purposes: when pulsed “slowly” (1 s period) means that the Mother Board is functioning correctly, when pulsed “rapidly” (100 ms period) means that the card is receiving data on the Modbus communication interface.
- **LED D15 (green)** – This LED shows the data transmission from the Modbus communication interface to the inverter (fast pulses with 100 ms period). When there's no communication between Inverter and String Box Combiner it's OFF.
- **LED D3 (red)** – The purpose of this LED is to signal error conditions due to wrong configuration of the String Box Combiner, in this case the LED is pulsed “rapidly” (100 ms period). For further details see the section “*How to define Modbus addresses of the node (String Box Combiner)*”. Normally this LED is OFF.

Digital outputs connector J1

The pins 2 and 3 of the connector J1 are open collector digital output. The pin 1 is a ground connection while the pin 4 is connected to the 24 V power supply. These outputs are not used in the current version of the String Box.

Digital inputs connectors J14 e J15

- **J14** – The pins 1 and 3 of the connector J14 are digital inputs: the pin 1 is used to sample the status of the circuit breaker while the pin 3 is not used in the current version of the String Box Combiner. The status of the circuit breaker is a dry contact and it's normally closed. The pins 2 and 4 are ground connections.
- **J15** – The pins 1 and 3 of the connector J15 are digital inputs: the pin 1 is used to sample the status of the protection module while the pin 3 is not used in the current version of the String Box Combiner. The status of the protection module is a dry contact and it's normally open. The pins 2 and 4 are connected connections.

¹ In current manual data communication with Modbus correspond to network serial line RS-485 whose transmission mode is RTU.

Rotary switches U34, U35 and U36

These switches must be used to set the Modbus address of the String Box Combiner and to set the number of the current sensors actually installed, for further details see the section *“How to define Modbus addresses of the node (String Box Combiner)”*

- **U34** – Modbus address (tens)
- **U35** – Modbus (unit)
- **U36** – current sensors number

Programming Connector CN1

This connector is used only during the production process of the String Box Combiner and must not be used by the final user to prevent possible damages.

Power Supply Connector J4

The connector J4 provides power supply to the Mother Board. The pin 1 must be connected to the positive terminal of a power supplier (24 volt and 10 milliampere) while the pin4 to the negative terminal. The pins 2 and 1 are connected together, the pins 4 and 3 are connected together.

Modbus Interface Connector J2

The connector J2 can be used to connect the mother board to a Modbus bus. The pins 1 and 3 are associated respectively to the pins A+ and B- (inverting pin) of the RS-485 interface. The pin 4 is ground connection and can be used as common reference (COM). The pin 2 is connected to the pin 1 by mean of a 120 ohm resistor, this can be used to implement a bus termination. To do this the user must connect the pins 2 and 3 together, anyway be aware that the best solution is to place an external resistor as described in the section *“Creation of a MODBUS RTU network”* below.

Environmental Probes Card

This section describes in details all the connectors of the Environmental Probes Card and can be used as reference for the remaining sections of this manual (see figure 8). As already said this card si an option: it can be installed or not.

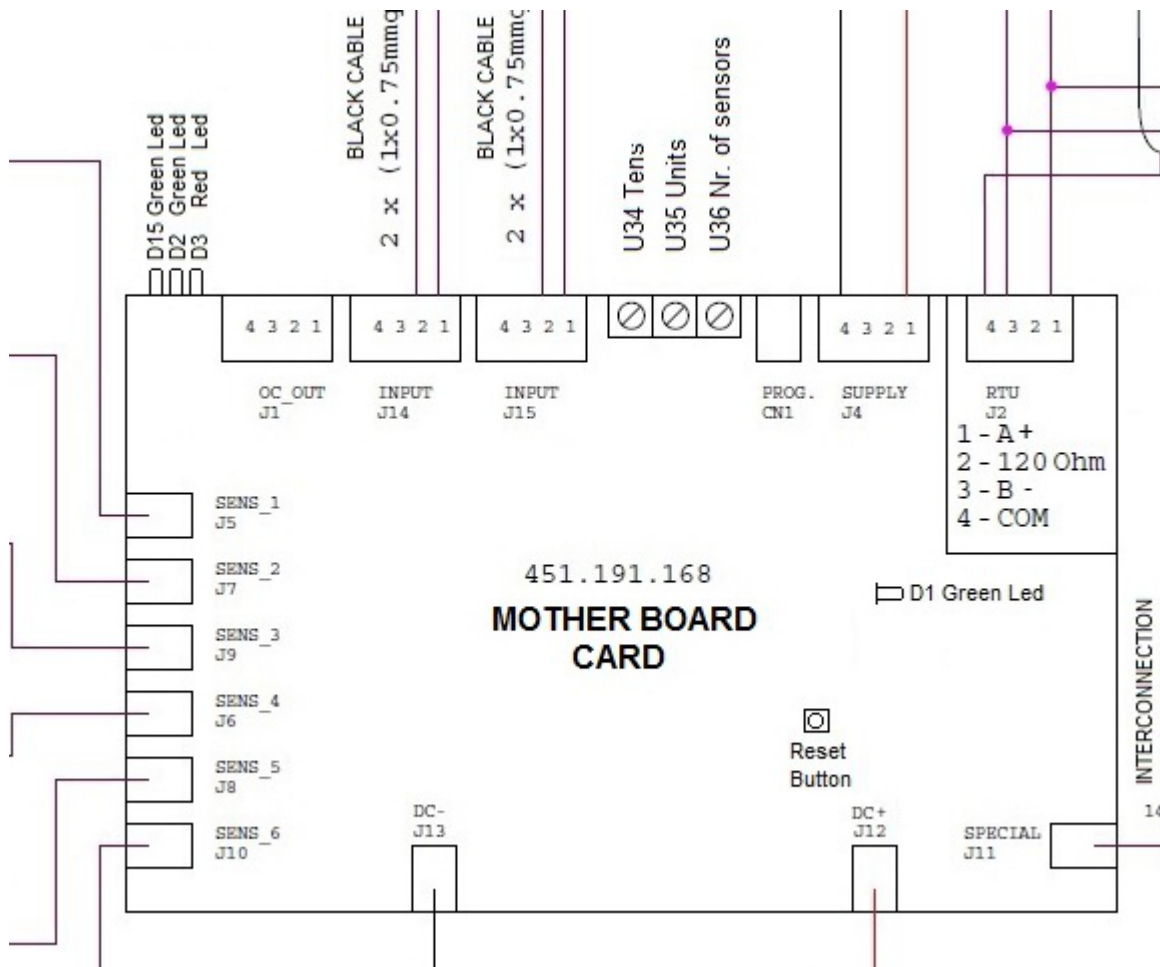


Fig. 7. Mother Board Card Layout.

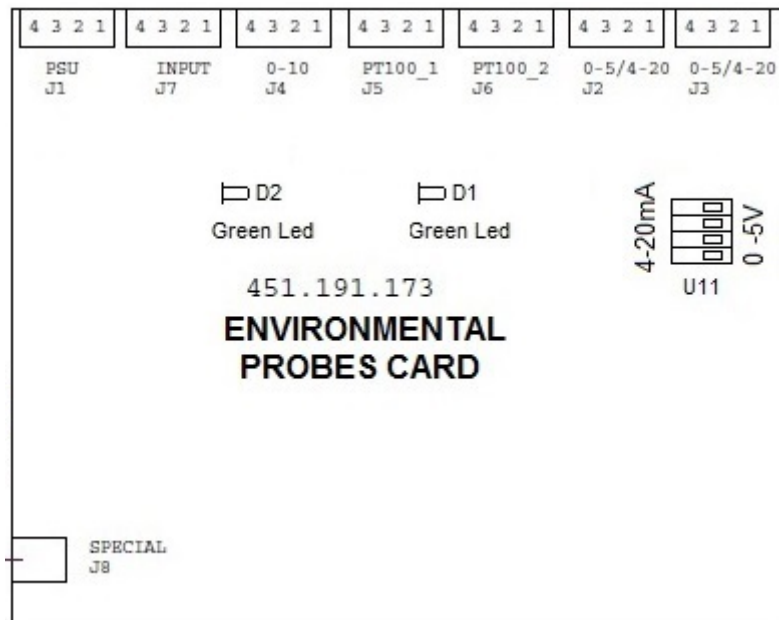


Fig. 8. Environmental Probes Card Layout.

LED

The card has a couple of LEDs whose purpose is explained below

- **LED D1 (green)** – This LED shows if the 5 volt power supply is active, normally it's steady ON.
- **LED D2 (green)** – This LED shows if the 24 volt power supply is active, normally it's steady ON.

Power Supply connector J1

This card can provide power supply for external devices, instead it's powered by the Mother Card. The pin 1 can provide 24 V voltage and current up to 40 milliampere, the pin 2 can provide 12 V voltage and current up to 40 milliampere, the pin 3 can provide 5 V voltage and current up to 40 milliampere. The pin 4 is ground connection.

Digital Inputs Connector J7

The pins 1 and 3 of the connector J7 are digital inputs, in the current version of the String Box Combiner these inputs are not used. The pins 2 and 4 are ground connections.

Voltage Analog Inputs Connector J4

The pins 1 and 4 of the connector J4 are analog inputs (input voltage ranging from 0 up to 10 volt). The pins 2 and 4 are ground connections.

Connectors for PT100 probes J5 and J6

PT100 temperature sensors can be connected to the card by mean of connectors J5 and J6, both two and four wires connection are supported. The pins 1 and 4 are respectively the positive terminal and negative terminals of the current source, pins 2 and 3 are the terminals of the voltage measurement circuit.

Voltage/Current Analog Inputs Connectors J2 e J3

The pins 1 and 3 of the connector J2 and J3 are analog inputs, they are configurable either as voltage input (ranging from 0 up to 5 volt) or current (ranging from 4 up to 20 milliampere). To select between the two kind of input one must set the switch U11 accordingly; the channel number and the voltage/current selection are clearly reported on the printed circuit board.

INVERTER AND STRING BOX COMMUNICATION CONFIGURATION



In current chapter is described how to realize and set the Modbus network that connect the string boxes to the solar inverter.

Creation of a MODBUS RTU network

The network consists of a 3-wire bidirectional bus, for the physical realization of this we recommend the use of the cable model BELDEN 9841 or BELDEN 9842. The connection is made with a type of in-out topology. Each component of the network shall have input terminals and output terminals.

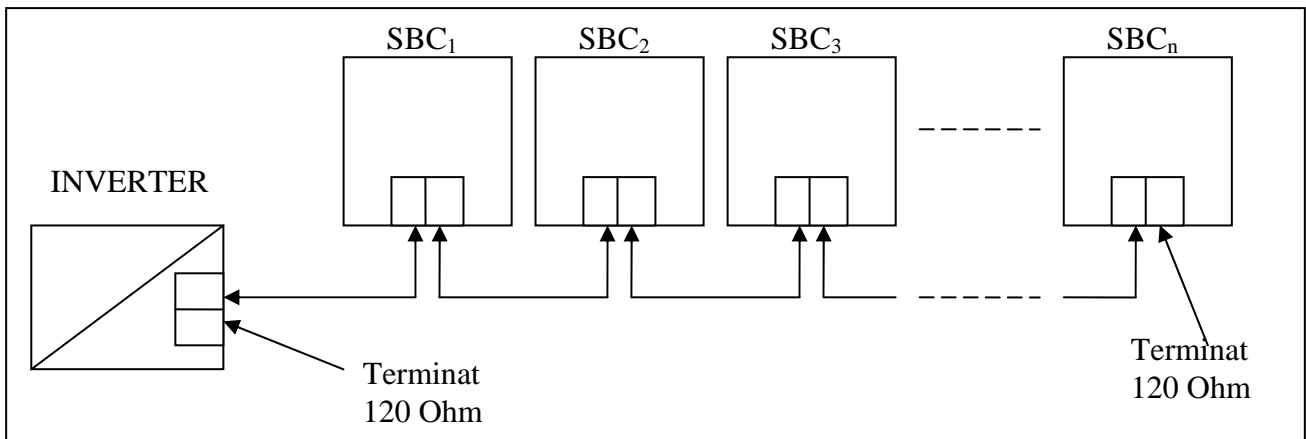


Fig. 9. Topology of Modbus network.

In order to reduce coupled disturbances as much as possible:

- Use a shielded cable with twisted pair controlled impedance (the shield can be connected to COM).
- Decouple the data bus from the power cables as much as possible (for example, pass them through a conduit that is different from that of the DC and AC wires).
- Keep the path of the bus as short as possible.
- Follow the termination rules of the bus (the first and last node in the network must be terminated with a resistance of 120 Ohm).

The MODBUS connector on the inverter side is a RJ45-8P8C connector.

The pin-out with a wire for 8-pole LAN networks is as follows:

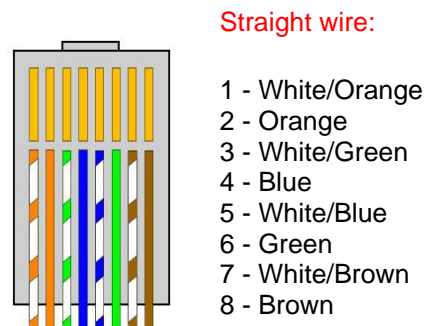


Fig. 10. RJ45-8P8C connector.

Inverter side

Pin 4 A+ (BLUE)

Pin 5 B- (WHITE-BLUE)

Pin 7 COM (BROWN-WHITE)

String box side SBC04..SBC24

Wire the terminals present as indicated below:

A+ Terminal: wire (BLUE)

B- Terminal: wire (WHITE-BLUE)

COM Terminal: wire (BROWN-WHITE)

Bus Termination (Inverter side)

Figure 11 represents the set of signal connectors of the inverter, the bus termination is via jumper on the terminals of the inverter card following this rule:

- Jumper closed → 120 Ohm termination is inserted
- Jumper open → 120 Ohm termination is not inserted

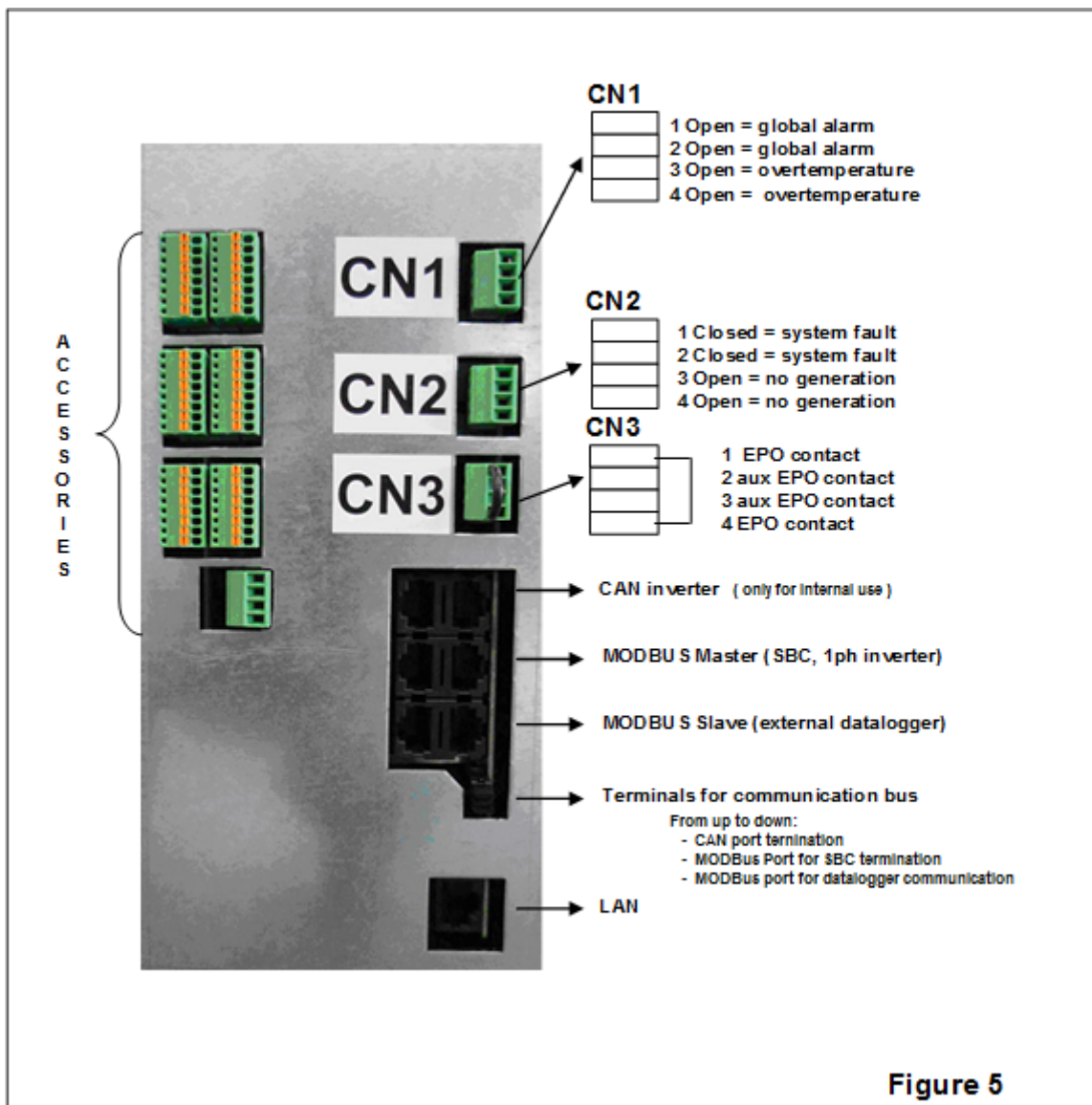


Fig. 11. Terminals of the inverter communication card.

Bus Termination (string box side)

Figure 12 shows the details of the terminals divided as IN and OUT sides. The termination request is obtained by inserting a 120 ohm resistor (1 / 4W) between terminals A + and B- at the end of the bus network. See the figure to determine the position of the terminals for the connection to the Modbus network.

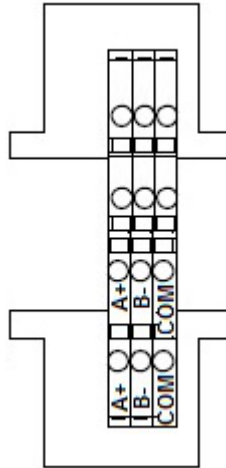


Fig. 12. Screw terminals of the string box for the MODBUS network interface.

Addresses set of Modbus nodes (string box side)

Current paragraph explains how to be set Modbus addresses of the string box and what has to be done for set the number of current sensors present inside the device and connected to the mother board card; to do this you must refer to the rotary switches U34, U35 and U36.

The **rotary switches U34 and U35** are used to set the Modbus address of the node of the string box in object. This address number can be selected between 1 and 99. Since each node can be associated with up to eight strings maximum, so the total maximum number of strings that can be monitored in a photovoltaic field is equal $8 \times 99 = 792$.

If the string box is not powered by the AC grid (D1 LED is off), to set the Modbus address you have simply to place the switches U34 and U35 to the desired position with the help of a screwdriver. If the string box is powered by the AC grid (D1 LED is on), so after placing the switches, you must reset the Main Board card by pressing the "Reset Button" (see Figure 7), this will activate the new address.

If the Modbus address of the motherboard is set to 0^2 the PCB card gives an error message by flashing the red LED D3. In this condition, the motherboard is active but is in a state *not functional*, does that some current measurement it nor is able to meet the request of the inverter.

During the choice and set of MODBUS addresses you must not distinguish the cases of inverter equipped single or multiple MPPT³ (models R800 2MPPT, R1000 2MPPT and R1200 3MPPT).

In the first case it is sufficient to assign addresses to the MODBUS nodes, taking care to start from the value 1 up to the last required value (this can be worth up to 99) without leaving unused addresses number on the network between the device present. In other words, in case it is required to use 10 addresses number these must necessarily set between the numbers 1 and 10, it is not possible to use a solution of the type 1 to 5 and 8 to 12, omitting the values 6 and 7⁴.

² This statement means = tens 0 and = units.

³ MPPT is correspondent to the acronym of *Multi Power Point Track*.

⁴ A set made in this may result in incorrect behavior of the system inverter / string box and therefore must be avoided.

In the second case (multi- MPPT inverter) is necessary to take care about the relationship between the different MPPT input of the inverter and node addresses (see Table 3). For example the input MPPT n. 2 addresses must necessarily start from the value 34 and must not exceed the value 66. Also in this case within each interval node addresses the address setting must be assigned in the same way of the address setting the inverter single MPPT, without leaving unused address node.

Table 3
Address setting in case of multi-MPPT inverter

MPPT Input	Range of address	Maximum number of strings
1	1 - 33	264
2	34 - 66	264
3	67 - 99	264

Keep clear that :

- The inverter model R1200 with 3 MPPT has inputs 1 – 2 – 3.
- The inverter model R800 and R1000 with 2 MPPT only has inputs 2 – 3, therefore for these models the addresses nr. 1-33 are not usable.

The **rotary switch U36** is used to specify the number of current sensors present in the string box and then it is set during the factory production and start up of the device, anyway it is useful to illustrate the criterion by which this operation is carried out.

Any Modbus address are related to four or eight current sensors⁵ each of which can be connected to a string of the photovoltaic field, the string box are designed in different configurations by adding sensors "progressively": 4, 8, 12, etc. . up to 24. For example in an SBC12 string box eight sensors are assigned to the first node and four to the next one, in an SBC20 string box eight sensors are assigned to the first node, eight to the second one and four in the third one. On the other hand It is not possible to realize configurations in which, for example twelve sensors are assigned four at a the first node and four at the second one and four at the third one. Table 4 summarizes what is described.

Therefore the motherboard of a string box can implement one, two or max three Modbus nodes depending on the number of current sensors installed in it. These addresses, however, are not independent, and in fact have consecutive values. If we set, by using rotary switches U34 and U35, the value N correspondent to the address number of the PCB card present inside the string box model SBC24 then the other two nodes take automatically the value N + 1 and N + 2.

Table 4
Set of the rotary switch U36 (correspondent to the number of the current sensors)

Model	Total nr. of sensors	N. of sensors related to address N	N. of sensors related to address N+1	N. of sensors related to address N+2	Position of rotary switch U36
SBC04	4	4	-	-	1
SBC08	8	8	-	-	2
SBC12	12	8	4	-	3
SBC16	16	8	8	-	4
SBC20	20	8	8	4	5
SBC24	24	8	8	8	6

⁵ This means that for each Modbus node may correspond to a card or two *current sensors cards (451 191 179)* each of which contains four effect Hall current sensors. This criterion has been adopted for compatibility with the tapes of field of the previous generation.

If the rotary switch U36 is set to 0, 7, 8 or 9, the motherboard would report the inconsistency by flashing the red LED D3 and *wouldn't run* because the set is wrong.

Finally we illustrate the concepts expressed above with an example. In figure 13 the rotary switch U34 (tens) is set to the number 4, the rotary switch U35 (units) is set to the number 9 and the rotary switch U36 (number of sensors) is set to the number 6, this means that the address of the node is equal to $4 \times 10 + 9 \times 1 = 49$ and that the card is configured to monitor $6 \times 4 = 24$ strings of which 8 of them are correspondent to the node number 49, 8 of them are correspondent to the node number $49 + 1 = 50$ and 8 of them are correspondent to the node number $49 + 2 = 51$.

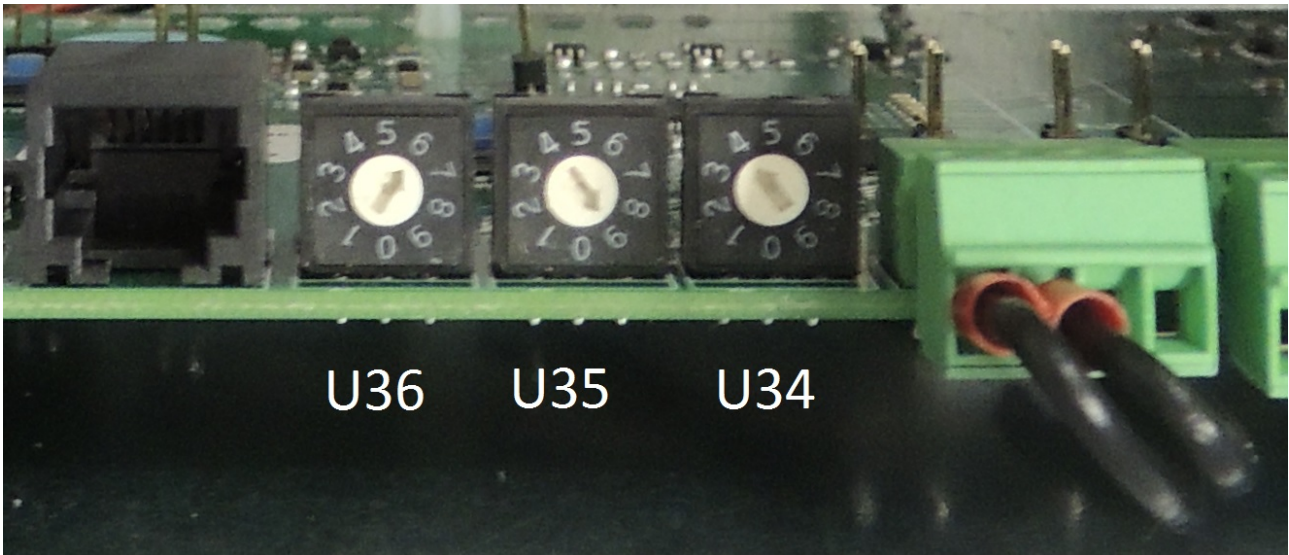


Fig. 13. Rotary switch of the motherboard for set the node address and the number of current sensors

Addresses set of Modbus nodes (inverter side)

In current chapter is described how it has to do for set the inverter in order to enable the MODBus network communication between the inverter and the string boxes connected to it. Starting from the main menu of the display of the inverter you have to select the following button that one by one will appear sequentially on the screen of the converter:

- “Inverter”
- “Plant”
- “User configuration”
- “String box”

At the end of the sequence the display shows the page where can be set the string box parameter⁶ (refer to figure 14). In order to avoid not unwanted modification when the end user modifies the set value of a parameter or get into this page all the parameters are protected by password. The password in object is the first level one correspondent to 5577.

Please note that the screen is related both a single MPPT converter and also to a Multi-MPPT inverter, in first case the field of the display correspondent to MPPT2 and MPPT3 can be not considered, and you can maintain the preset values.

⁶ On the screen of the inverter the combiner box is called *String Box*.

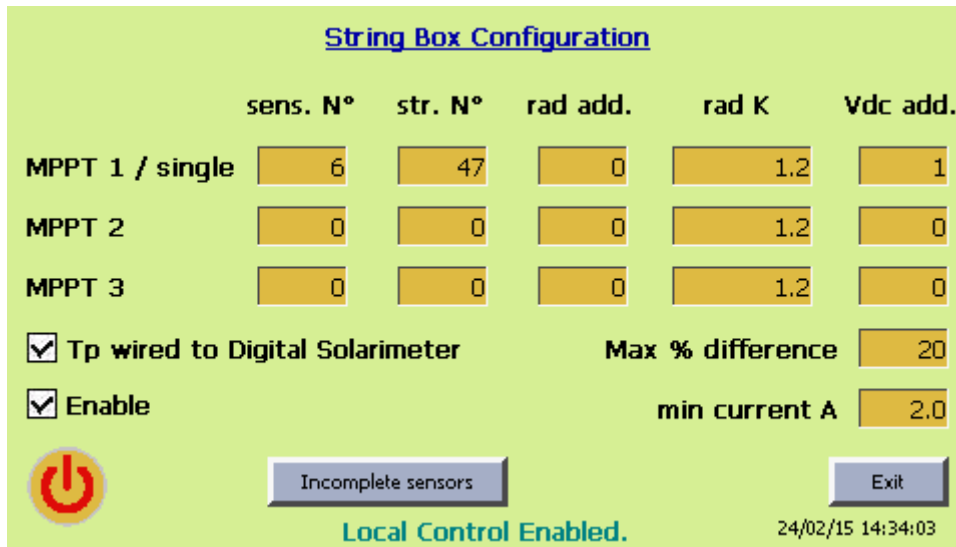


Fig. 14. Screen shot of "String Box Configuration page".

The fields related to the different configuration parameters must be set according to the PV plant design.

- In the column "**Sens. N °**" it is indicated the number of nodes connected to the Modbus network which refer to the corresponding MPPT input of the inverter⁷. Note that the measuring system of each string box can implement up to three Modbus nodes depending on the number of connected strings.
In the column "**Str. N °**" it is indicated the total number of strings that refer to the corresponding input MPPT inverter.
- In the column "**rad.add.**" indicates the Modbus address box of field it is attached to the radiation sensor⁸.
- The column "**rad. K**" it represent a normalization factor which is used to adjust the calculation of the radiation to the full scale value of the radiation sensor used, it must therefore refer to the documentation of the device in object installed on the PV field. The default value is equal to 1.2, this means that the value acquired by the inverter is multiplied by 1000 and then by 1.2, in this way a sensor that expresses the value of irradiation with a value between 0 and 1 will be reported as a value between 0 and 1,200.
- In the column "**Vdc add.**" it is indicated the Modbus address string box from where is readings the value of the DC voltage of the solar plant⁹.
- The field "**Max% difference**" defines the threshold of the *imbalance string alarm*¹⁰, the default value is 10%, the installer / PV plant designer has to define and set which is the value of maximum allowable imbalance.

⁷ Pay attention not consider this parameter as the number of current sensors.

⁸ The address shown is the same set with the rotary switches U34 and U35, not those N + 1 or N + 2 derived from this.

⁹ As the same meaning described ed for the parameter "rad.add.".

¹⁰ The mendium current value is defined by the following formula $\overline{I_m} = \frac{\sum_{i=1}^N I_i}{N}$, for each string current I_n occurs that

the value of the unbalance of current A does not exceed the threshold: if the inequality $\left| \frac{(\overline{I_m} - I_n)}{\overline{I_m}} \cdot 100 \right| < A$ is not

verified, the inverter displays an alarm.

- The cell "**min current A**" contains the value of the threshold below which no verification is performed about unbalancing of string currents.
- If it is set the checkmark called "**Tp wired to Digital Solarimeter**" then the measure taken by the temperature probe of the photovoltaic panels are multiplied by 220 and then the result is subtracted from the value of 40; Otherwise, the value in object is multiplied by 190 and then subtract the value 40. These operations are required to bring the temperature values displayed by the inverter panel within the limits of the scale.

The box "Enable" allows to enable (check mark) or not monitoring string current from the inverter.

Description of incomplete Modbus nodes

To every Modbus nodes present in each string box can be may be associated with up to max. 8 different input strings.

In the case where a photovoltaic plant does not have a number of strings multiple of 8, there will be a some current sensors not connected to any string. Therefore this case is defined as *incomplete Modbus node* and it correspond to a node that does not have all of the current sensors linked and connected to the PV strings of the solar installation.

So a photovoltaic plant can have Modbus nodes incomplete but it is necessary to respect a the following rule: the strings are to be connected to the nodes in a consecutive manner, ie without leaving DC unused inputs. Each node can then have unused inputs but these will only ever the last inputs.

As an example, it is assumed to have a photovoltaic PV plant with 18 strings and this example is described in three different ways in the following pictures (two correct and one incorrect) in which these PV strings can be connected to the string boxes. In the case of Figure 17 the node 02 has been wired incorrectly because they have been used inputs 1 and 8 (not consecutive) leaving unconnected inputs from 2 to 7.

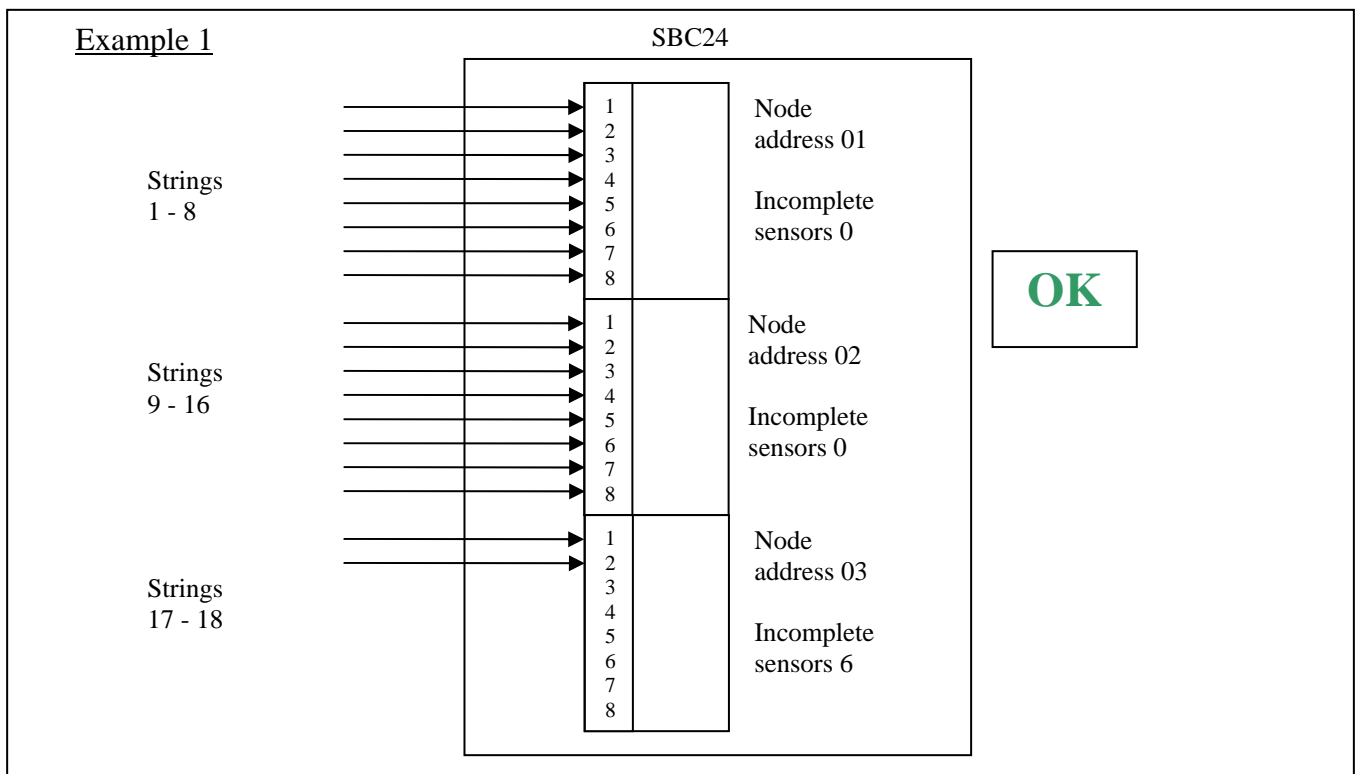


Fig. 15. Solar plant with 18 PV strings, Example 1.

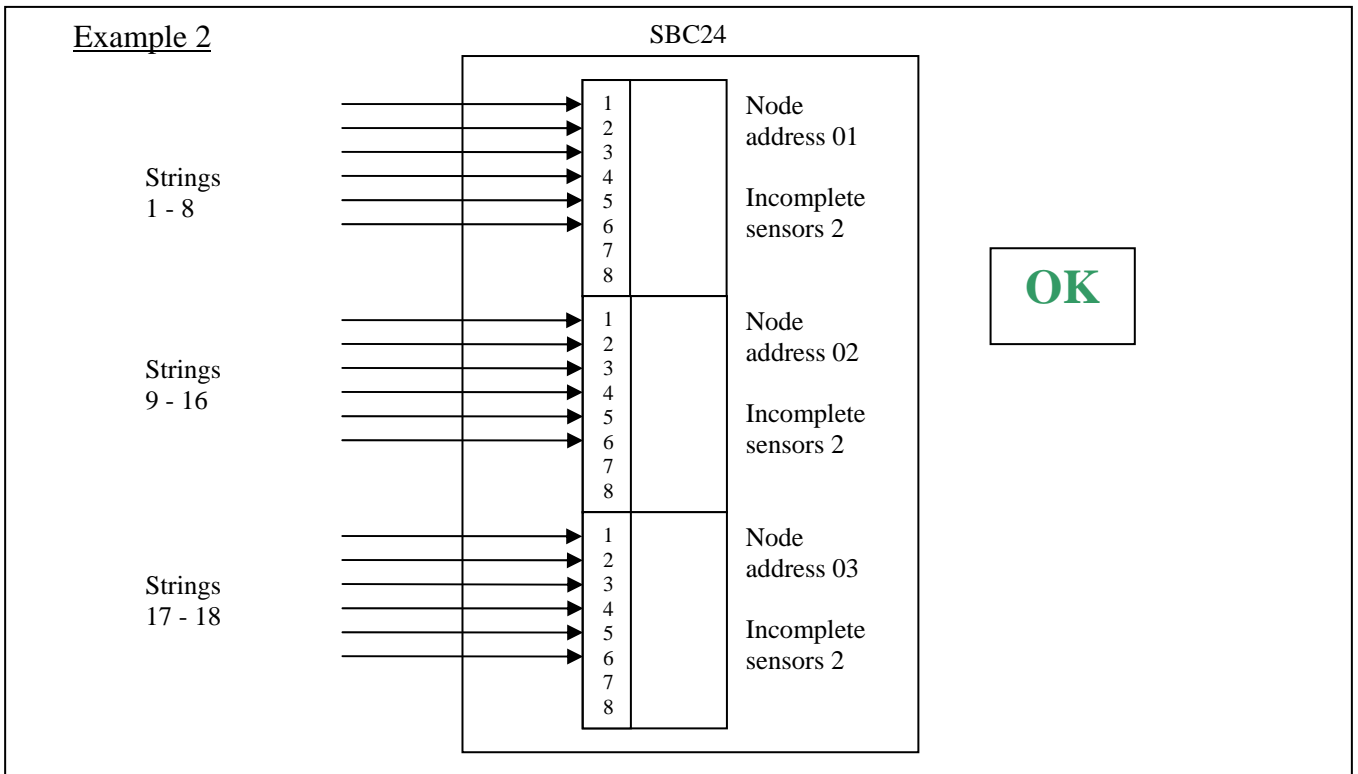


Fig. 16. Solar plant with 18 PV strings, Example 2.

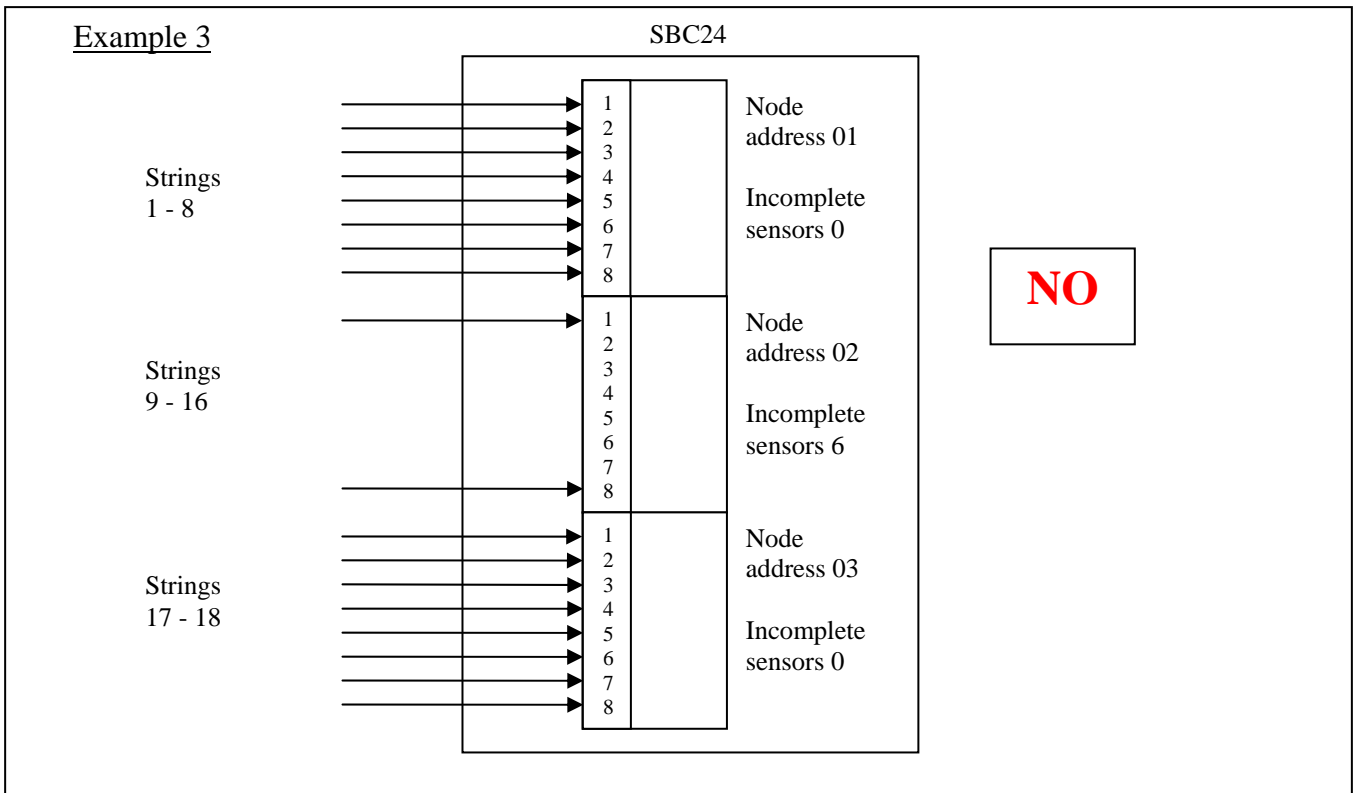


Fig. 17. Solar plant with 18 PV strings, Example 3.

Setting of incomplete sensors from the inverter control panel

The incomplete sensors must be configured from the inverter display. From the “*STRING BOX CONFIGURATION*” page you have to press the button “*INCOMPLETE SENSORS*” to open the following screen (figure 18).



Fig. 18. Screen shot “String Box configuration – Free places”.

Each cell of the table identifies a Modbus node (correspondent to four or eight sensors of current) for a maximum of 99 available nodes. The lines correspond to tens of node addresses. The columns correspond to the units of the node address. For all the addresses used, indicate whether there are incomplete sensors of the PV plant and incomplete address of Modbus.

Below is the definition of the incomplete sensors relating to the examples described in figure 15 and figure 16.

Example of Solution 1

Node 01 (row 0x, column x1) → incomplete sensors 0 → cell value 0

Node 02 (row 0x, column x2) → incomplete sensors 0 → cell value 0

Node 03 (row 0x, column x3) → incomplete sensors 6 → cell value 6

Example of Solution 2

Node 01 (row 0x, column x1) → incomplete sensors 2 → cell value 2

Node 02 (row 0x, column x2) → incomplete sensors 2 → cell value 2

Node 03 (row 0x, column x3) → incomplete sensors 2 → cell value 2

Complete example of configuration

This section provides a complete example of the configuration of the Modbus communication between string box and inverter. It is supposed that the specs are:

- Inverter model R800 (2 MPPT)
- A photovoltaic plant composed of two sub fields respectively from 14 and 13 strings.
- Two string boxes (one per each sub-field) model SBC16

Figure 19 contains a diagram with the layout of connection strings – string box - inverter. The figure 20 and 21 describe the screen shots instead of the inverter display.

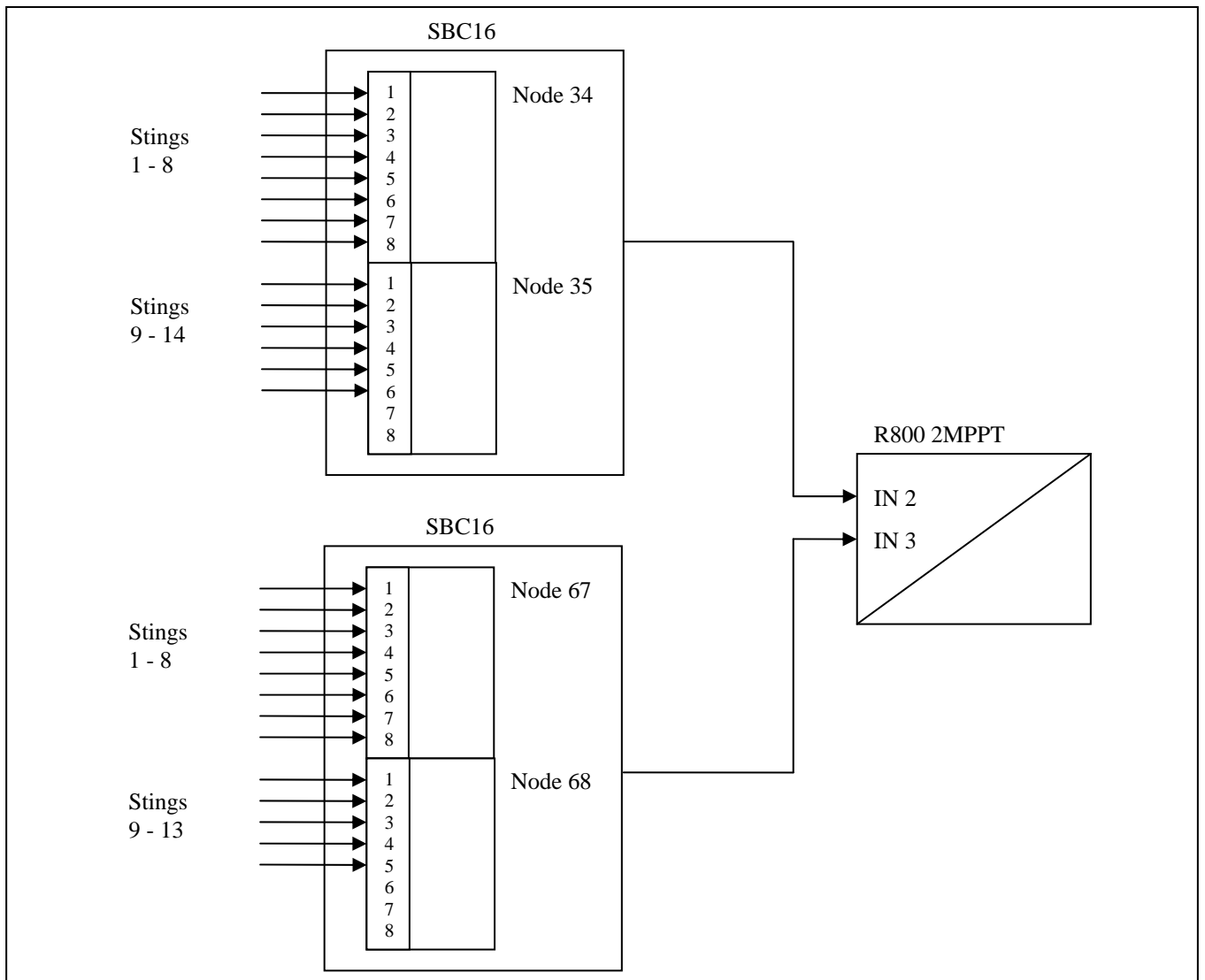


Fig. 19. Example of PV plant.

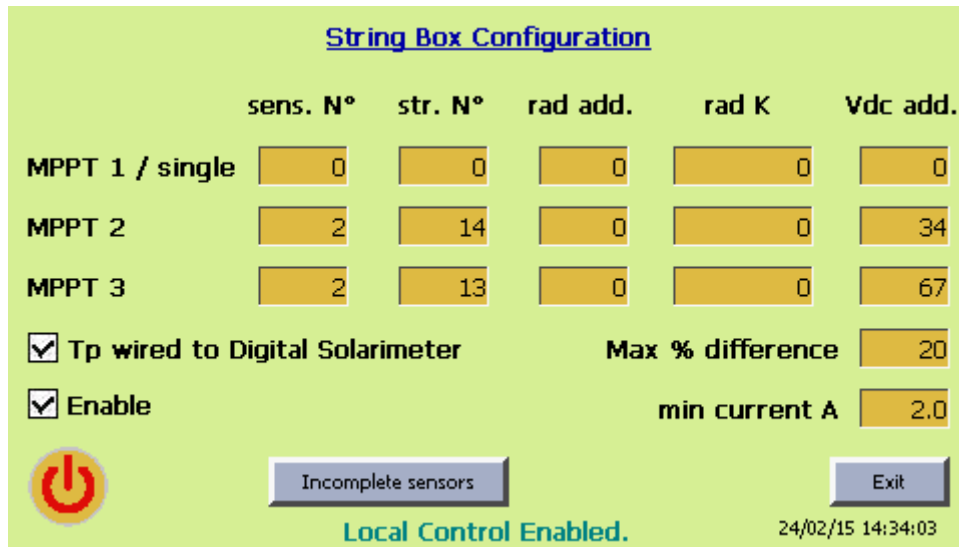


Fig. 20. Esempio di schermata “Configurazione String Box”.

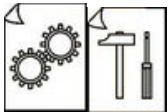
Since the DC input nr. 1 of R800 is not used the corresponding cells should not be changed. 2 sensors are connected to DC input 2, 14 strings and tension is read from the node 34. At the DC input 3 there are connected 2 sensors, 13 strings and tension is read from the node 67. The alarm is active with strings imbalance threshold 10%, the average current minimum above which is carried out the control of unbalance is equal to 10 Amps.



Fig. 21. Example of screen “String Box configuration – Free Position”.

The node nr. 35 (row 3, column 5) two PV strings that is not connected, the cell then shows the valor 2, while the node nr. 68 (line 6, column 8) has three strings and is not connected to the corresponding cell so it is set the value 3.

FUNCTIONAL CHECK



After the mounting, connections and wiring operations, and then configured the Modbus network communication between inverter and string boxes and defined the association between the connected strings and current sensors you can now test the functional operation of the system inverter / string boxes.

Motherboard

The first check should be carried out directly observing the string box. In normal operating conditions should be verified these conditions

- The green LED D1 is steady → the card is properly powered
- The green LED D2 pulses alternately with a cadence "slow" (on / off every second) and a rate faster (on / off every 100 millisecond) → the card is working and receives data from the inverter
- The green LED D15 alternately remains off and pulses with a cadence "fast" (on / off every 100 millisecond) → the card sends the data to the inverter



If one or more of these conditions are not met there it is no guarantee the proper functioning of the system inverter / sting box. In fact, the lack of or incorrect display of current measurements of the photovoltaic field can cause alarm from the converter.

Environmental probes card

If environmental probes card are installed it is necessary to verify that the LEDs D1 and D2 (both green) are both permanently on, this fact means that the card is properly powered. Obviously this verification must be done directly observing the string box.



In the case that at least one or both LEDs are turned on it can be concluded that the environmental probes card may be malfunctioning. This did not necessarily mean that the system inverter / string box can not work (assembly of this PCB card is optional) but clearly it indicates an abnormal condition that must be analyzed in detail.

Inverter display

The page of the inverter display where are shown the measures of the values of current and voltage of the photovoltaic field allows to us to check the correct operation of the whole system.

From the main page of the inverter display press the button "*Measures*" and then "*String Box*" so that it will open the screen shot "*String Box Measures*" (Figure 22). By pressing the arrows to the side of the cell "*Address*" you can increase the value of the Modbus in order to access to the measures of the current sensors connected to the other Modbus nodes.

Cells "*str1, 2, ...8*" report the current values measured in Amps by the string box.

Cell "*Vdc*" reports the value of the DC voltage, measured in Volt, of the PV array read by the string box . If the radiation sensor is present, this information can be displayed in the "*Irr*" cell, measured in *W/m2*.

In standard operating conditions and with the photovoltaic field sufficiently irradiated on the inverter screen it should appear consistent values according to the ones measured during the electrical tests.



In the event that a cell value correspond to the string "*****" instead of a numeric value it means that there is a problem in the acquisition or show the measures. In the case of string currents it may be the case that a current sensor is not connected to any PV string (Modbus node incomplete), in the case that the DC voltage of the field is not shown it may be that the voltage value is beyond the full scale. In general it may be that there is a communication problem between inverter and string boxes, in this case it is necessary to check the wiring and network address settings. Of course it is also possible that there may be a fault in the wiring of the string to the string box.

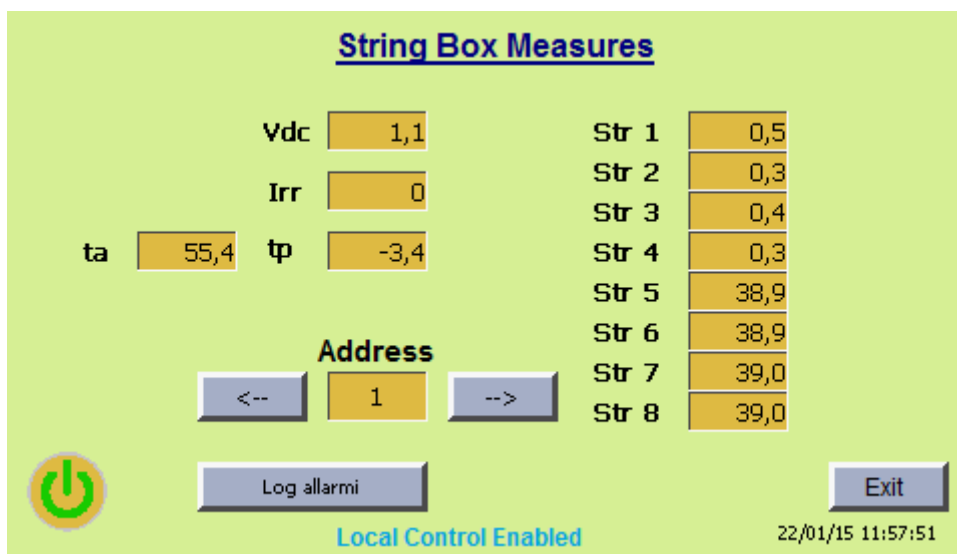


Fig. 22. Screen shot "String Box Measures".

MAINTENANCE

Preventive and periodic maintenance







Fimer recommend to their customers to comply with a correct and constant preventive maintenance of string boxes, so that we can maximize the reliability of service and minimize repair costs not prevented.

Through a proper preventive maintenance, the availability of string boxes has lengthened the life cycle.

Preventive maintenance if has not been delegated to a separate and appropriate maintenance contract with the manufacturer of the device is usually in charge of the customer, to whom are entrusted all the operations of periodic verification. By qualified service personnel may be carried out of the routine operations that can assess the state of the string box, with a frequency of intervention that varies according to the environmental conditions in which the drive is installed. In Italy or in country that has the same weather and environmental conditions an average of a single visits per year of preventive maintenance are recommended, including the controls of all the parts that make up the system including any replacement of consumables, if necessary.



We remind all operators authorized to carry out maintenance that before entering the converter be sure to be aware of the safety regulations specified in manual and control all of the personal protective equipment required by the manufacturer or by the local and national norms and rules .

	<p><i>When installing or servicing the devices in a plant with suspended materials handling wear helmet.</i></p>
	<p><i>Wear appropriate protective gloves before working on the device</i></p>
	<p><i>Wear appropriate shoes that can prevent accident to guard against falling heavy objects.</i></p>
	<p><i>In the event of prolonged exposure to noise wear hearing protection devices</i></p>
	<p><i>Be careful! Before performing any maintenance, disconnect the inverter from the grid line and from the PV field.</i></p>
	<p><i>All maintenance operations must be carried out safely, and verifying previously that the internal components are not under voltage! Before performing any maintenance disconnect the device from the DC panels and from the auxiliary power supply line .</i></p>

Preventive maintenance includes the following procedures:

- Visual inspection of the device for the purpose of determining that:
 - there are no obvious signs of rust or corrosion that may compromise the operation and safety of the equipment.
 - There are no water leaks or residues and traces due to condensation.
- Cleaning the exterior structure of the enclosure with a special focus on the seal installed on the front door.
- Cleaning of the inside of the device to remove dust, pollen, insects and all kinds of dirt that, if it was introduced in the equipment, it can damage the electronic cards or create short circuits.
- Check that there is insulation between electrical circuits and internal ground and metal structures.
- Check the correct functioning and safety of the AC and DC switches present inside.
- Check that all DC and AC connections to and MODBUS cables are tight and are not obvious signs of overheating.
- Check that there are no burn marks on terminal blocks and fuse holders present inside the string box.
- Check that the grounding cable of the SPD arrester is effective.
- Check that the SPD pads not give visual indication of being exhausted.
- Check that the fuses in the string box are not burned or fault for excessive overheat.
- Check at the end of all the checks and maintenance job that:
 - The lexan and the internal protection present inside the string box for ensuring IP20 protection degree is mounted.
 - The door of the enclosure is firmly closed

It is recommended to perform the inspection and maintenance only by personnel trained or qualified.

Extraordinary maintenance

If damaged components need to be replaced (for example, fuses, SPD pads, etc.) use only materials identical to those originally supplied. A list of these materials is available in the wiring diagram or, if in doubt, please contact the manufacturer.

If the electrical connections are damaged due to mechanical or electrical causes or due to the attack of rodents, immediately disconnect the system or at least the damaged part. After verifying that no failures were caused to the equipment, proceed with the replacement of the wires and of the others material using similar devices.

Below in the next page there is a typical example of table to describe and fix the verification operations and control performed during maintenance:

SHEET: String Box

String Box sheet Year: _____ SN _____ progressive nr. of sheet _____ STRING BOX: (Routine maintenance requires to put the system out of service and will only concern the parts of the plant directly served by them)					
N.B. Refer to the manufacturers' datasheets, if existing or available. Operations are performed after visual and / or instrumental inspection.		Maximum frequency	Date of control	Signature of technician	Measures taken or suggested
1	STRING BOX – Checks / interventions: check the status of the exterior of the enclosure: cleaning, damage to the "case", the absence of rust on metal parts and verify that the general conditions of maintenance are good	Yearly			
2	STRING BOX – Checks / interventions: Check for signs of infiltration of liquids or condensation within the device and in that case restore the seal installed necessary for ensure the correct IP degree on the front door of the box; exclude infiltration of pollen or rodents	Yearly			
3	STRING BOX – Checks / interventions: Verify that there are no signs of tampering or forced entry to the enclosures or the cable glands of the string box, so that it may have changed the technical specifications of the device	Yearly			
4	STRING BOX – Checks / interventions: Verify the data plate of the device	Yearly			
5	STRING BOX – Checks / interventions: Clean the inside of the apparatus to remove dust, pollen, insects and all kinds of dirt introduced in the equipment and it can damage the electronic boards or block the string box functioning mode	Yearly			
6	STRING BOX – Checks / interventions: Check of the safety disposal installed inside the string box and the correct mode of functioning of the output DC switch	Yearly			
7	STRING BOX – Checks / interventions: Check the tightness of the DC input and output cables, auxiliary power and signal cables and check the perfect insulation of each individual connections	Yearly			
8	STRING BOX – Checks / interventions: Check the integrity of the Surge Protection Device present in the string box by visually checking the appropriate warning window of the SPD	Yearly			
9	STRING BOX – Checks / interventions: Check the integrity and the perfect condition of the fuses and fuse holders	Yearly			
10	STRING BOX – Checks / interventions: Check that the GND connection is done correctly and that SPD pads are not exhausted	Yearly			
11	STRING BOX – Checks / interventions: Check the status of the connections of each card by checking the correct fitting of the cable connectors and the flat cable present into the string box	Yearly			
12	STRING BOX – Checks / interventions: Make sure at the end of the maintenance to fit correctly the internal protection lexan and the closing of the front door of the string box	Yearly			
13					
14					
15					
NOTE :					Signature of responsible of maintenance

TROUBLESHOOTING





ERROR MESSAGE	DESCRIPTION	CHECK TO BE DONE
1	<p>STRING CURRENT MISMATCHING</p>	<p>It reports a probable mismatching between the current measurements of the strings connected to the string box</p> <p>Check that:</p> <ul style="list-style-type: none"> the fuses (both positive and negative) of the PV input strings are not interrupted the clamping of the cables to the fuses holders (both positive and negative) of the PV string is adequate the minimum threshold of alarm verification is properly set the value of the percentage of the unbalance between the strings is set correctly
2	<p>SBC SPD</p>	<p>It reports that the SPD pads is exhausted and/or the surge protection device is fault</p> <p>Check that:</p> <ul style="list-style-type: none"> visual signaling present on the SPD does not indicate that one or more pads are exhausted terminals of the SPD output signal are wired and properly tightened, both side: on the SPD and on the board mother board card (J15 connector terminals 1 and 2)
3	<p>SBC SWITCH</p>	<p>It indicates that the opening output switch of the string box is open</p> <p>Check that:</p> <ul style="list-style-type: none"> the output switch of the string box (in the case of molded case circuit breaker) is not open the state contact (in the case of molded case circuit breaker) functions properly it is present, wired and secured the wire bridge (in the case of rotary switch) on connector J14 (terminals 1 and 2) of the mother board card
4	<p>DANGEROUS CURRENT</p>	<p>It report that the measure of one or more string current exceeds the maximum allowable by the Hall effect probes (see technical data)</p> <p>Check that:</p> <ul style="list-style-type: none"> through the use of a current clamp the value of the current currently flowing in the string and that it correctly matches the right value on the display of the inverter; if the current exceeds the maximum limit of 20 amps immediately open the string and put the system in security mode to prevent damages to the string box and damages to PV panels that can create as a result an irreversible damage to the entire system and / or things or people
5	<p>Measured value expressed as a string of asterisks (*****) by the display of the inverter or of the display of the datalogger</p>	<p>It reports a reading problem</p> <p>Check that:</p> <ul style="list-style-type: none"> Modbus network has been wired correctly and that the termination (120 Ohm resistor) is inserted only in the first and last device in the network the wiring and the corresponding functional settings configuration and communication of the strings connected to the string box have been carried out according to the instructions given in this manual the auxiliary power supply grid and 230Vac / 24Vdc power supply (called AL1) work properly in the case of incorrect reading of the temperature please check that it is within the current range indicated in the technical data

APPENDX: ACCESSORIES

Below the main optional accessories available and supplied for the string box are listed:

ACCESSORIES

SBC04 SBC08 SBC12 SBC16 SBC20 SBC24

STRING BOX ACCESSORIES / ACCESSORI STRING BOX		
IRRADIATION SENSOR / SENSORE DI IRRAGGIAMENTO		
	IA0.580.010	Irradiation sensor. Sensore irraggiamento.
ENVIRONMENTAL TEMPERATURE SENSOR / SENSORE DI TEMPERATURA AMBIENTE		
	IA0.580.011	Environmental temperature sensor. Sensore temperatura ambiente.
PV MODULE TEMPERATURE SENSOR / SENSORE DI TEMPERATURA PANNELLI		
	IA0.580.013	PV module temperature sensor. Sensore di temperatura pannelli.
SHUNT RELEASE / BOBINA SGANCIO		
	IA0.580.019	Releasing coil that operating at minimum voltage on the output DC switch (powered at 230V _{ac}) suitable for SBC04 - SBC08 - SBC12. Bobina di sgancio a minima tensione (230V _{ac}) per apertura sezionatore lato CC in uscita applicabile a SBC04 - SBC08 - SBC12.
	IA0.580.020	Releasing coil that operating at minimum voltage on the output DC switch (powered at 230V _{ac}) suitable for SBC16 - SBC24. Bobina di sgancio a minima tensione (230V _{ac}) per apertura sezionatore lato CC in uscita applicabile a SBC16 - SBC24.
	IA0.580.024	Releasing coil that operating in current mode on the output DC switch (powered at 230V _{ac}) suitable for SBC04 - SBC08 - SBC12. Bobina di sgancio a lancio di corrente (230V _{ac}) per apertura sezionatore lato CC in uscita applicabile a SBC04 - SBC08 - SBC12.
	IA0.580.022	Releasing coil that operating in current mode on the output DC switch (powered at 230V _{ac}) suitable for SBC16 - SBC24. Bobina di sgancio a lancio di corrente (230V _{ac}) per apertura sezionatore lato CC in uscita applicabile a SBC16 - SBC24.

NOTE:

Further accessories can be supplied on request, for the proper identification please get in contact with Technical and Sales Department of Fimer



Questo manuale ottempera agli obblighi del DLgs 14 marzo 2014, n. 49 sulla attuazione della direttiva 2012/19/UE sui rifiuti di apparecchiature elettriche ed elettroniche (RAEE)
Per RAEE s'intendono i rifiuti di Apparecchiature Elettriche ed Elettroniche (AEE) incluse di tutti i componenti, i sottoinsiemi ed i materiali di consumo che sono parte integrante del prodotto nel momento in cui si assume la decisione di disfarsene.

La Legislazione prevede la suddivisione in 2 categorie principali chiamate RAEE PROFESSIONALI o RAEE DOMESTICI.

Per lo smaltimento di un RAEE DOMESTICO

L'utente detentore di un'apparecchiatura elettrica ed elettronica domestica, nel momento in cui decide di disfarsene, può:

- conferirla gratuitamente presso il Centro di Raccolta pubblico (CdR) del proprio Comune (la "piattaforma ecologica");
- consegnarla al negoziante (distributore) nel caso l'apparecchiatura venga sostituita, tramite l'acquisto di un nuovo prodotto con equivalenti funzioni, con una nuova; tale opportunità sarà praticabile solo quando entreranno in vigore le semplificazioni operative per i distributori.

Per lo smaltimento di un RAEE PROFESSIONALE

L'utilizzatore professionale, ovvero l'impresa o l'ente che decide di dismettere un'apparecchiatura elettrica ed elettronica deve preliminarmente effettuare una valutazione volta a: individuare se i RAEE, pur provenendo da un'attività commerciale, industriale, istituzionale e di altro tipo, possano essere considerati analoghi ai RAEE originati dai nuclei domestici e quindi procedere come descritto per lo smaltimento domestico.

Nel caso in cui, invece, non vi sia dubbio che l'apparecchio dismesso debba essere qualificato come "RAEE professionale", ovvero rifiuto derivante dall'attività lavorativa e non assimilabile a domestico, è possibile scegliere tra due opzioni:

- contestualmente alla sostituzione dell'apparecchiatura obsoleta con una nuova di equivalente funzione (1 contro 1), l'utilizzatore professionale può richiedere al Produttore dell'apparecchiatura nuova, attraverso l'aiuto del distributore, di gestire la dismissione del suo RAEE professionale;
- l'avvio al recupero secondo le procedure previste per tutti i rifiuti speciali e, di conseguenza, con oneri a carico del produttore del rifiuto.



This product contains electrical or electronic materials.

Fimer as producer of electric and electronic components is in compliance with the European directive 2012/19/UE following the italian DLGS 14 march 2014 N°49.

The presence of these materials may have, if not disposed properly, potential adverse affects on the environment. Presence of this label on the product means it must not be disponded in normal household waste and must be disposed separately.

As a consumer you are responsible for ensuring that this product is disposed properly.

If your supplier offers a disposal facility please use it or alternatively contact your local authority/council to find out how to properly dispose this product.



Dieses Produkt beinhaltet elektrische oder elektronische Materialien.

Fimer als Hersteller von elektrischen und elektronischen Komponenten befolgt die europäische Richtlinie 2012/19/UE nach dem italienischen DLGS 14. März 2014 Nr. 49.

Die Präsenz dieser Materialien konnte negativ die Umwelt beeinflussen, wenn diese nicht richtig entsorgt werden. Dieses Etikett auf dem Produkt bedeutet, es darf nicht im normalen Hausmüll entsorgt werden sondern muss es separat entsorgt werden.

Als Verbraucher sind Sie verantwortlich, dieses Produkt ordnungsgemäß zu entsorgen.

Wenn Ihr Lieferant bietet eine Entsorgungsanlage, bitte verwenden Sie diese oder kontaktieren Sie die Behörde / Gemeinde, um dieses Produkt richtig zu entsorgen.



Ce produit contiène électriques ou électroniques materiau

Fimer comme producteur de électriques et électroniques composants se conforme à la directive européenne 2012/19/UE selon le italien DLGS 14 mars 2014 N°49.

La présence de ces matériaux peut avoir, si non éliminés régulièrement, un effet nocif sur l'environnement.

La présence de ce marque sur le produit signifie que il n'a pas d'être éliminé dans une domestique conteneur et doit etre éliminé séparément.

Comme consommateur Vous etes responsable de l'élimination de ce produit.

Si Votre fournisseur offre un service d'élimination pouvez le utiliser ou pouvez contacter l'autorité locale pour trouver une solution pour éliminer ce produit.



Este producto contiene materiales eléctricos o electrónicos.

Fimer como productor de componentes eléctricos y electrónicos está en conformidad con la Directiva 2012/19/UE europeo siguiendo en italiano DLGS 14 de marzo 2014 N ° 49.

La presencia de estos materiales puede tener si no se eliminan adecuadamente cualquier posible efecto adverso sobre el medio ambiente.

La presencia de esta etiqueta en el producto significa que no se debe colocar en la basura doméstica y debe ser tratado separadamente.

Como consumidor, usted es responsable de asegurarse de que este producto se desecha correctamente.

Si el proveedor tiene una instalación de eliminación por favor, utilice o bien, póngase en contacto con el consejo de la institución / local para averiguar cómo desechar correctamente este producto.



INVERTER FOR LIFE

Via J.F. Kennedy
20871 Vimercate (MB) Italy
Phone: +39 039 98981
Fax +39 039 6079334

www.fimer.com
solar@fimer.com



INFOLINE
Tel. +39-039-6079326

