• 15P00EEB170 •

SANTERNO TG NA

Grid-connected Solar Inverter

OUTDOOR INSTALLATION

INSTALLATION AND MAINTENANCE INSTRUCTIONS

Issued on February 5, 2013
R.01
Software Version 4.00

English

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

1.1. Manufacturer

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1.2. Scope and Intended Audience of this Manual

This equipment is delivered with two different instruction manuals:

- **Operating Instructions**, intended for **Operators, Installers, Maintenance Technicians and Plant Managers**[1]
- **Installation and Maintenance Instructions**, intended for the **Installers, Maintenance Technicians and Plant Managers**. They include, in particular, detailed instructions and prescriptions for the following activities:
    - Unpacking
    - Assembly
    - Positioning
    - Cable Connection
    - Routine maintenance

This manual only contains instructions for installation and routine maintenance.

⚠ CAUTION	The operator shall carefully read this manual in order to: • Operate the equipment in compliance with the intended use specified by the manufacturer; • Be aware of all the risks related to improper as well as correct use of the equipment; • Be aware of behaviours and restrictions to respect and procedures to implement when using the equipment.

The instructions provided herein are organized in chapters, paragraphs and sub-paragraphs. Within each chapter, paragraphs and sub-paragraphs are numbered following a hierarchical order. Tables and Figures are numbered following a progressive order. A table of contents and the lists of the figure and tables are provided for practical purposes. The pages are numbered in a progressive order. Next to each page number, the total number of pages is also indicated.

In case the equipment is transferred to others, under any form (sale, loan, etc.), it must always be accompanied by the complete documentation bundle.

ℹ	Elettronica Santerno is committed to update its User Manuals available for download from santerno.com with the latest software and hardware version officially released. Please contact Elettronica Santerno if you require technical documents related to previous product versions.

[1] Definitions are provided in paragraph 1.7 - Definitions

1.3. Updating Procedure

The instructions provided herein are univocally referred to by means of the code specified in the cover. They are revised and updated, if necessary, each time the equipment undergoes modifications. The codes provided in the cover allow tracking the manual version:

Date of updating	Updated on DD.MM.YY
Revision index	R. XX
Software version	SW Version X.XX

Any modification to the equipment authorized by the Manufacturer entails changes to this documentation as well. Therefore, a new manual version will be provided to the user.

1.4. Document Preservation

All the documents related to the Santerno TG NA inverter shall be preserved for the entire service life of the product, along with the PV plant documentation, and shall always be easily accessible for the Operator.

	The equipment documentation shall not be stored inside the equipment.

In case of partial or complete destruction of the documentation, contact Santerno Inc. to receive a new copy by indicating the technical name of the equipment. It is also possible to download the User Manuals from the Manufacturer's website.

1.5. Documents Provided

The following documents are always provided with the Santerno TG NA inverter:

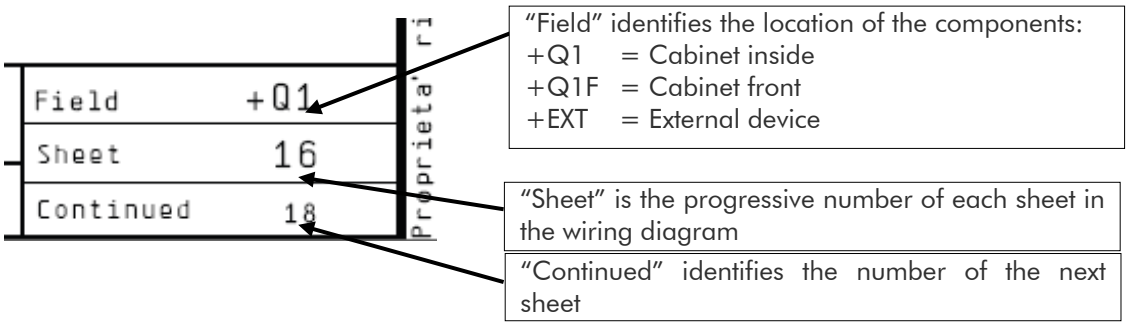
Document Name	Scope
Operating Instructions	This document contains all the information on the functions of the equipment. It also provides instructions for measure readout and parameter programming.
Installation and Maintenance Instructions	This document contains all the information related to the transport, assembly, installation and maintenance of the product.
Electrical and Mechanical Diagram	This document contains detailed information related to the internal layout and the electrical diagram of the cabinet.
Final Test Certificate	This document contains information on the execution and the results of the Production Test.

Table 1: Documents provided with the product

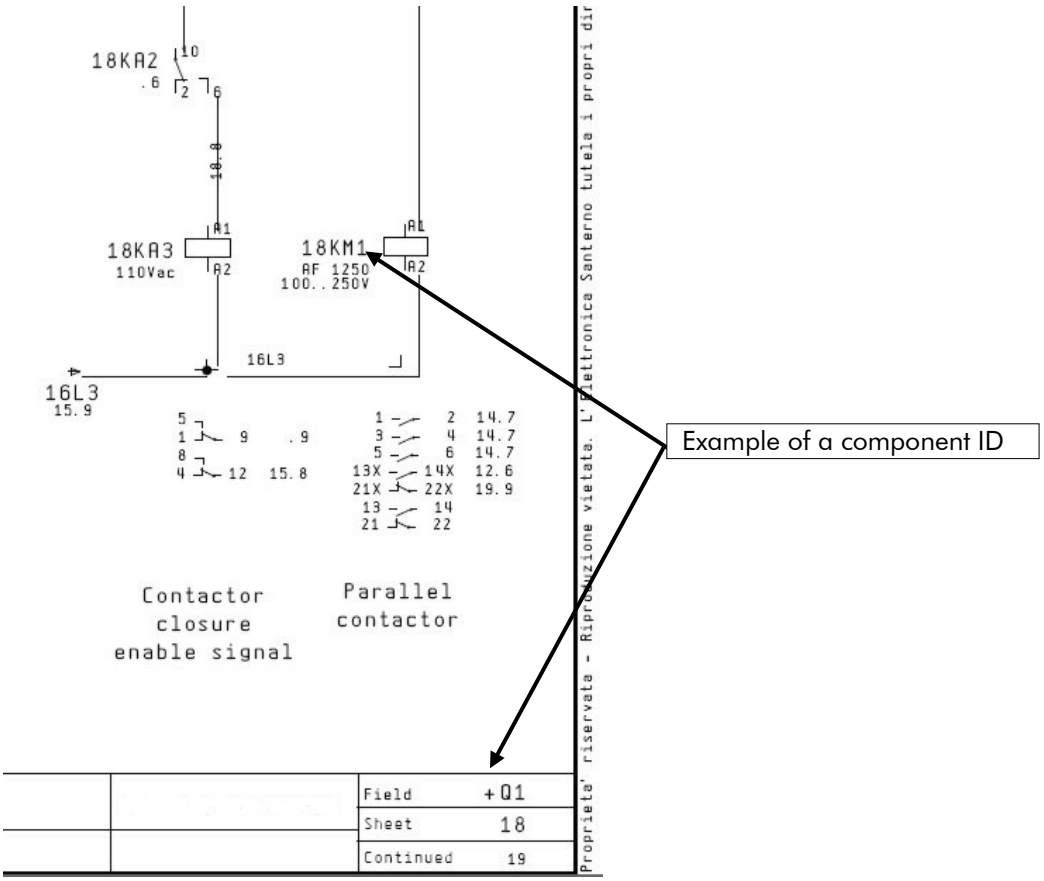
1.5.1. ELECTRICAL AND MECHANICAL DIAGRAM

The diagram editing technique is described hereafter. This section covers how to read the Wiring and Mechanical Diagram of the Santerno TG NA inverters.

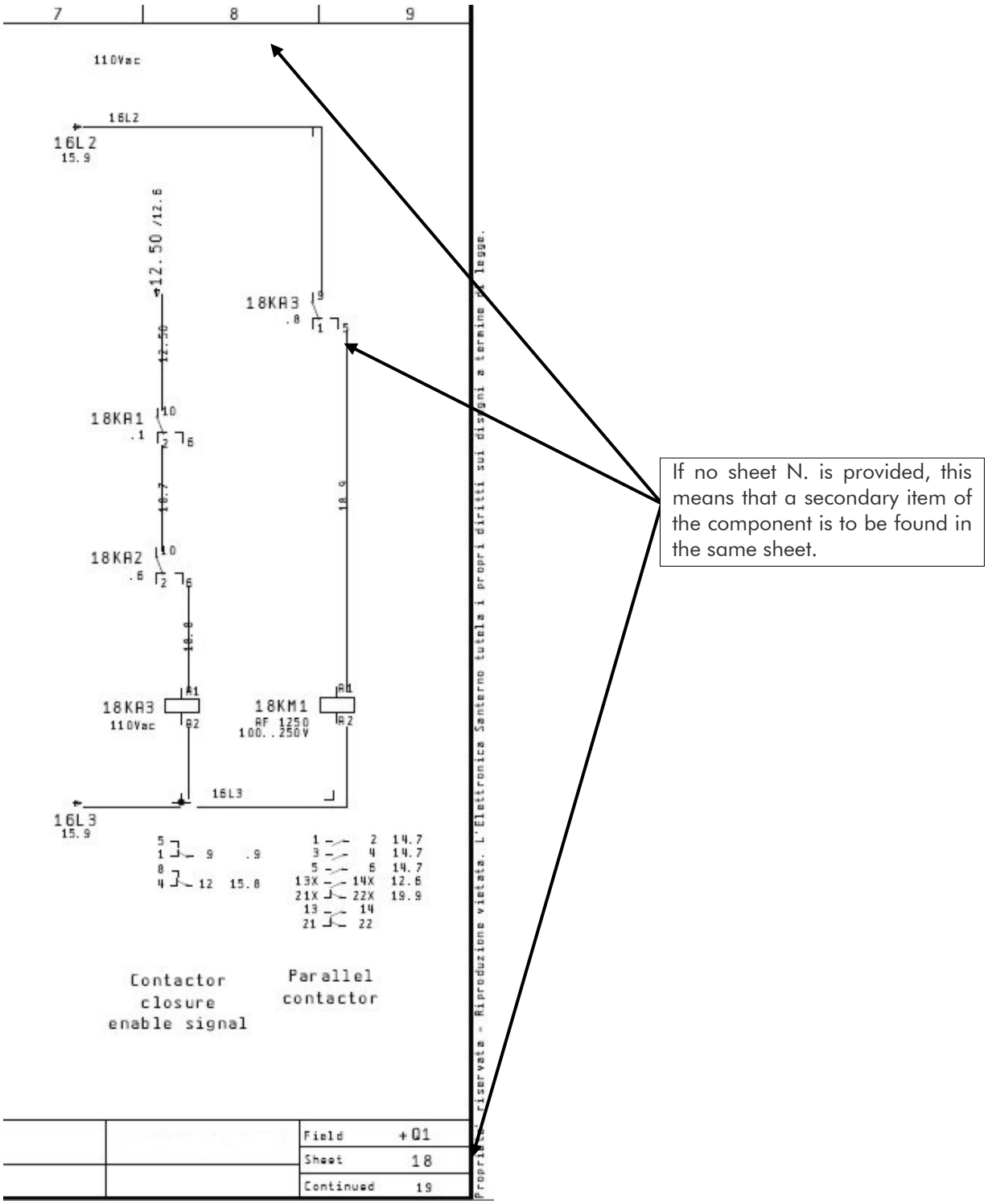
Three ID numbers are given in each sheet:



The ID number for each component and each conductor relates to the sheet where the component or the conductor is first used, usually based on the energy flowing direction, followed by a progressive number.



The electrical diagram also provides cross-references for conductors and components described on different pages. The format of a cross-reference is as follows: Sheet.Column.
The sheet number is not indicated in the cross-reference if the reference of the component appears in the same sheet. Only the column number is therefore indicated.



1.5.2. FINAL TEST CERTIFICATE

The Final Test Certificate is issued by the Manufacturer upon testing the equipment. It contains complete information on the execution and the results of the Production Tests and Functional Test as prescribed by CSA107.1-01 and UL1741 standard.
The presence of QPS and MET markings (see Figure 1) ensures that equipment complies with the CSA and UL standards respectively. The Final Test Certificate may be issued on the customer's request. Please contact Santerno Inc. if required.

1.6. Warnings

The following symbols and conventions have been adopted for easier and immediate understanding of the topics covered in this manual.
Moreover, any hazards the operator may be exposed to when working on the equipment are signalled by special warning labels applied on the equipment, as given below:

	DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.
	WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
	CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.
	This symbol indicates important information on the use of the equipment.

Table 2: Warnings

1.7. Definitions

Installer (Qualified personnel)
The Installer is a technician responsible for the placement, installation, PV/Grid connection and commissioning of the equipment, according to the plant diagram and in compliance with state-of-the-art practices and local regulations and standards for installation, such as the National Electrical Code ANSI/NFPA70. The Installer must be recognized as a 'Qualified Person'.

Qualified Person
One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

Service Personnel
Trained persons having familiarity with the construction and operation of the equipment and the risks involved.

Operator
A worker having suitable technical knowledge and having acquired familiarity with the equipment by reading and fully understanding the operating instructions given.

Equipment
The Santerno TG NA cabinet, complete and ready for connection to the photovoltaic plant and grid with the purpose of producing electric power. The equipment contains all the manoeuvring and control devices, the inverter and any other component required for operation.

Photovoltaic Plant
An electrical installation consisting of a linked system of photovoltaic modules equipped with disconnecting and monitoring devices and connected to the Santerno TG cabinet.

Bipolar Photovoltaic Array
A photovoltaic array that has two outputs, each having opposite polarity to a common reference point or centre tap.

Interactive System
A solar photovoltaic system that operates in parallel with and may deliver power to an electrical production and distribution network. For the purpose of this definition, an energy storage subsystem of a solar photovoltaic system, such as a battery, is not another electrical production source.

Grid
An AC electrical installation or system connected to the output of the Santerno TG NA cabinet.

Field Voltage
Rated voltage of the photovoltaic field.

Array
A mechanically integrated assembly of modules or panels with a support structure and foundation, tracker, and other components, as required, to form a DC power-producing unit.

Inverter
Equipment that is used to change voltage level or waveform, or both, of electrical energy.

Module
A complete, environmentally protected unit consisting of solar cells, optics, and other components, exclusive of tracker, designed to generate dc power when exposed to sunlight.

Panel
A collection of modules mechanically fastened together, wired, and designed to provide a field-installable unit.

Solar Cell
The basic photovoltaic device that generates electricity when exposed to light.

Solar Photovoltaic System
The total components and subsystems that, in combination, convert solar energy into electric energy suitable for connection to utilization load.

2. GENERAL

The general information about the product is given in the Operating Instructions manual supplied with the equipment.

2.1. Product Identification

The product ID is given in the nameplate located on the inverter.

	The nameplate is the only means acknowledged by the Manufacturer to identify the product. It is therefore recommended not to alter or erase the data items stated on the nameplate, since they are essential in order to identify the product and receive precise and immediate technical support.

2.1.1. PART NUMBER

The part number univocally identifies the equipment.

The product name is composed of multiple fields, as described below:

SANTERNO TG		XXX		NA		YYY		Z

XXX: 100 125

YYY: 208 240 480 600 output voltage

Z: Y D star or delta grid connection

2.1.2. NAMEPLATE

The technical and identification data items specified on the nameplate are described below:

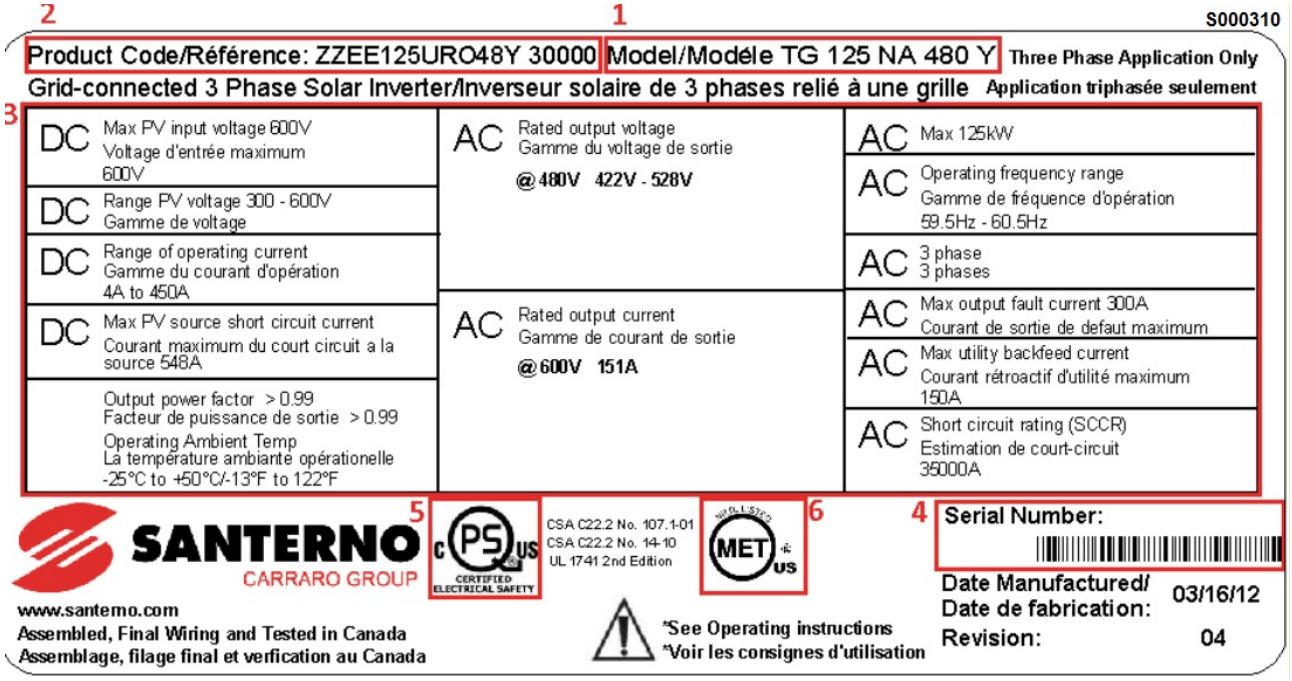


Figure 1: Example of equipment nameplate

1- Inverter type
2- Part Number assigned by Santerno Inc. to the equipment (ZZEExxxUabyy)
3- Ratings (rated input/output current and voltage, rated power, etc.)
4- Serial Number
5- QPS Marking
6- MET Marking

The nameplate is located on the outside of the equipment on the right-most door.

2.2. Technical Data

General Data		Santerno TG 100 NA	Santerno TG 125 NA
Maximum altitude		2000m / 6560ft. above sea level	2000m / 6560ft. above sea level
Operating ambient temperature range (full power) [1]		-25°C to +50°C -13°F to 122°F	-25°C to +50°C -13°F to 122°
Storage temperature range		-40°C to +70°C -40°F to 158°F	-40°C to +70°C -40°F to 158°F
Cooling system		Forced air	Forced air
Enclosure rating		NEMA 3R	NEMA 3R
Enclosure Finish		RAL-7047	RAL-7047
Cabinet dimensions		H 2.30m (96.1”) W 1.52m (63.0”) D 0.92m (39.4”)	H 2.30m (96.1”) W 1.52m (63.0”) D 0.92m (39.4”)
Cabinet weight		1400 kg (3090 lbs.)	1450 kg (3200 lbs.)
Integrated internal transformer		Provided	Provided
Testing and certification		UL1741 CSA 107.1-01 IEEE 1547 CEC IEEE C62.41.2 IEEE C62.45 IEEE C37.90.1 IEEE C37.90.2	UL1741 CSA 107.1-01 IEEE 1547 CEC IEEE C62.41.2 IEEE C62.45 IEEE C37.90.1 IEEE C37.90.2
Intelligent monitoring		- SunwayPortal - RemoteSunway - Third-Party compatibility	- SunwayPortal - RemoteSunway - Third-Party compatibility
Warranty	Five years	Provided	Provided
	Extended warranty (up to 10.15, 20 years)	Optional	Optional
	Extended service agreement	Optional	Optional
Number of Inputs and fuse rating		See Table 28	

Table 3: General data

1 Up to as low as 10°C (14°F) when no optional anticondensation heaters for TG 100 NA and TG 125 NA are used. The unit can work at full power at 50°C (122°F) at 315V_{DC}. The thermal limit for the operation at full power drops linearly to 45°C at 600 V_{DC}. Using filters for environments with a high degree of impurity may lead to a drop in temperature by up to 2°C of the maximum operating temperature at full power.

Electrical Data		Output Voltage	Unit of Measure	Santerno TG 100 NA	Santerno TG 125 NA
Input parameters	Max input voltage	--	Vdc	600	600
	Input voltage range (MPPT; full power)	@208V	Vdc	300-600	315-600
		@240V	Vdc	300-600	315-600
		@480V	Vdc	300-600	315-600
		@600V	Vdc	300-600	315-600
	Maximum input current	@208V	A	381	428
		@240V	A	381	428
		@480V	A	381	428
		@600V	A	381	428
Output values	Output voltage range	@208V	Vac	183-229	183-229
		@240V	Vac	211-264	211-264
		@480V	Vac	422-528	422-528
		@600V	Vac	528-660	528-660
	Output frequencies		Hz	59.3-60.5	59.3-60.5
	AC Voltage range		V	-12% +10%	-12% +10%
	Nominal output frequency		Hz	60	60
	Number of phases		--	3	3
	Maximum output current per phase	@208V	A	315	347
		@240V	A	273	301
		@480V	A	137	151
		@600V	A	109	121
	Maximum output power	--	kW	110	138
Efficiency	CEC-Weighted Efficiency	@208V	--	96%	96%
		@240V	--	96%	96%
		@480V	--	96%	96%
		@600V	--	96%	96%
	MPP matching efficiency	P_{OUT}>20%		99%	99%
	MPP matching efficiency	P_{OUT}<20%		98%	98%
	Tare losses		W	30.0	30.0
	Power factor @ full load			>0.99	>0.99
	Harmonic distortion			<3%	<3%

Table 4: Electrical data

2.3. Layout

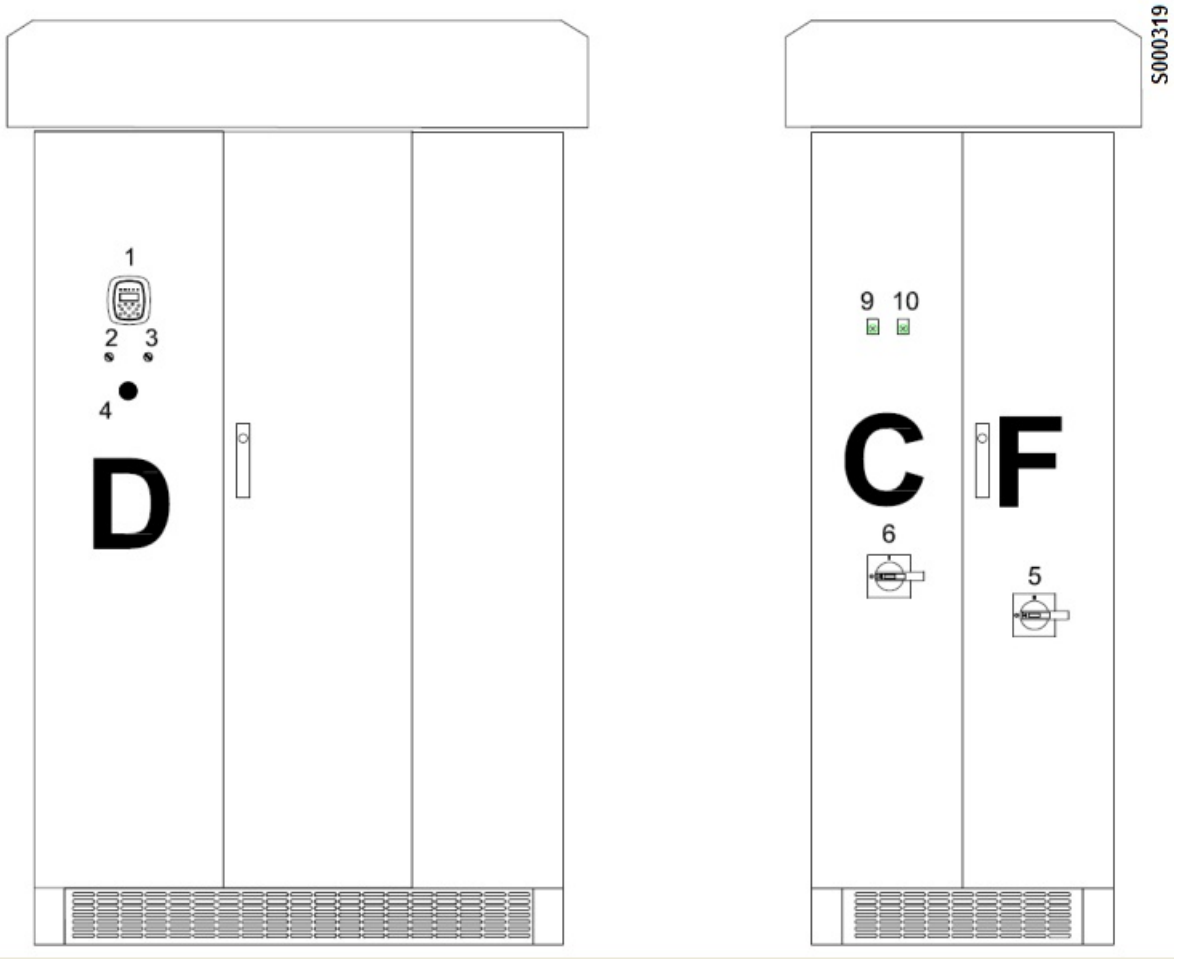


Figure 2: Layout of Santerno TG 100 NA and TG 125 NA

1- Keypad
2- On-off selector key
3- Maintenance key (by-pass interlock doors)
4- Emergency pushbutton
5- AC disconnect switch handle
6- DC disconnect switch handle
9- GFDI alarm lamp
10- C pole inversion lamp
C – D – F- Hinged doors

3. INFORMATION ON TECHNICAL SUPPORT

3.1. Request for Technical Support

Only technicians authorized by Santerno Inc. are allowed to carry out any kind of technical interventions on the equipment.
To submit a support request, always provide the following information:

1- Inverter type
2- Part Number
3- Serial Number
4- Code(s) of the alarm(s) displayed

4. SAFETY STATEMENTS

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

4.1. General Warnings

WARNING	All electrical installations must be done in accordance with the local and National Electrical Code ANSI/NFPA 70 or Canadian Electrical Code, Part I. The Santerno TG inverters do not contain user-serviceable parts. For repair and maintenance always contact Santerno Inc. or its authorized service. Before installing or using the Santerno TG inverter, read all of the instructions, cautions, and warnings on the Santerno TG given in this Operating Instructions and in the Installation and Maintenance Instructions. Before connecting the Santerno TG inverter to the electrical utility grid, contact the local utility company. This connection must be made only by qualified personnel. PV arrays produce electrical energy when exposed to light and thus can create electrical shock hazard. Wiring of the PV-arrays should be performed by qualified personnel only.

4.2. Intended Use

The equipment has been designed and constructed exclusively for the purpose of converting DC power produced by solar panels into AC power to be delivered to the distribution grid.
The equipment must be used in compliance with the environmental restrictions and the installation requirements specified by the Manufacturer in this Operating Instructions Manual and in the Installation and Maintenance Instructions Manual.

4.3. Improper Use

Any other use different from the one specified by the Manufacturer is to be considered as improper.
In particular, it is forbidden to:

- Connect the equipment to other energy sources different from PV panels
- Alter and tamper the equipment
- Install components not explicitly authorized by Santerno Inc.

4.4. Safety Instructions

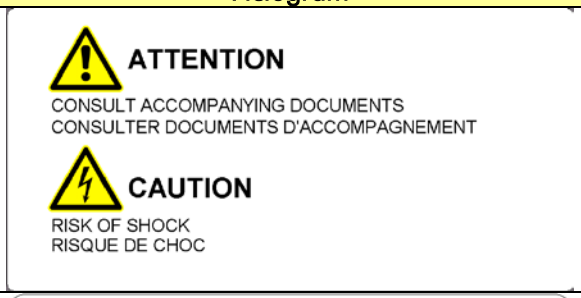
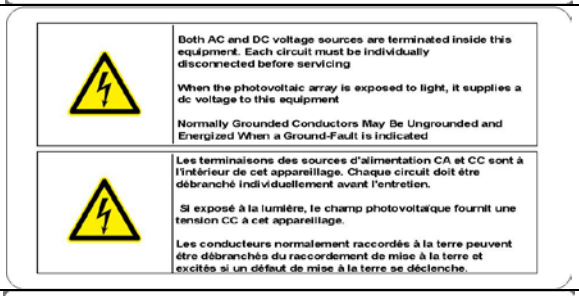
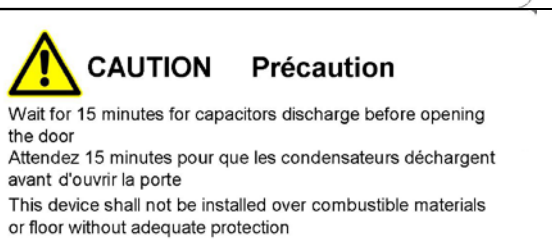
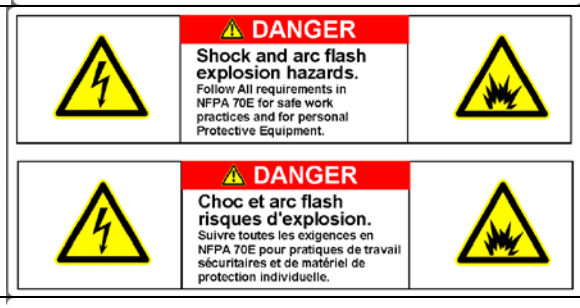
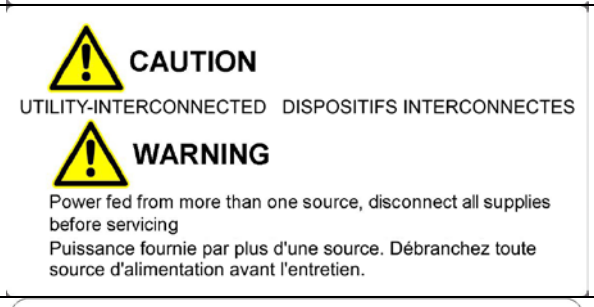
A list of risks is given for each operation:

- Unpacking
- Assembly
- Positioning
- Wiring
- Routine maintenance

	Danger: Hazardous voltage Do not remove any component from the equipment Danger: Hazardous voltage All doors must be closed Danger: Hazardous voltage Do not touch live parts
	The non-observance of the prescriptions and instructions contained in this Manual may cause serious injuries to people. • Any intervention on the Santerno TG NA cabinet must be carried out in compliance with the Instructions provided. • Always operate in compliance with the prescriptions provided by the safety warning labels. • Never operate the Santerno TG NA cabinet in case of visible damages. • Contact Santerno Inc. in case of one or more active alarms. • Contact Santerno Inc. if any problems arise. • Do not attempt to operate the Santerno TG NA if some problems still remain unsolved.
	Do not store this Operating Instructions Manual inside the equipment.

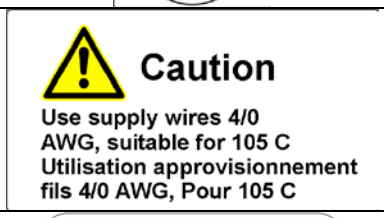
Table 5: General warnings

4.5. List and Location of the Safety Pictograms

Pictogram	Location
	On door D
	On door D, just below the previous label
	On all the doors
	On doors C and F just above the disconnect switch
	On doors C and F just above the disconnect switch
	On door C, just above the DC switch

	On door F, just above the AC circuit breaker

Table 6: List of the external safety pictograms

Pictogram	Location
	Adjacent to fuse holders
	Adjacent to input/output terminals, metal screen
	Adjacent to field wiring terminal
	Adjacent to the main protective earth terminal
	Adjacent to the field wiring terminal
	Adjacent to the wiring terminal

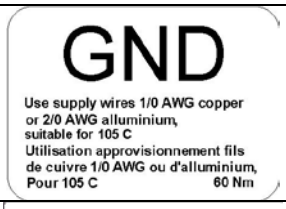
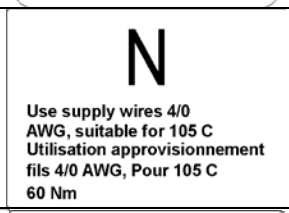
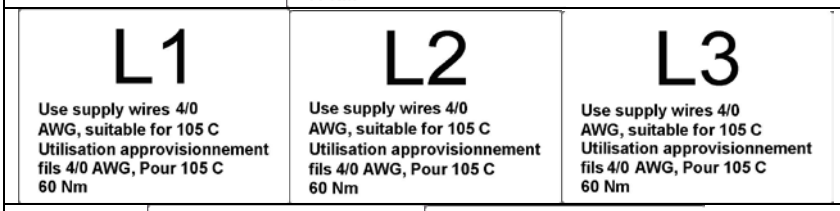
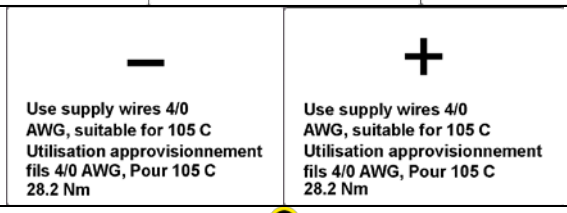
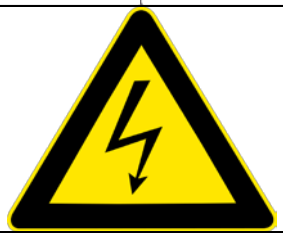
	Adjacent to the main protective earth terminal
	Adjacent to the neutral terminal
	Adjacent to the utility connection terminals
	Adjacent to the field wiring terminals
	On some internal components of the equipment

Table 7: List of the internal pictograms

5. PACKING

Unless prior agreements between the parties exist, the equipment is packed by Santerno Inc. on wooden pallets. Mechanical protection from shock and environmental protection are ensured by bumpers on the corners.

	Santerno TG NA 100	Santerno TG NA 125
Packaged dimension WxHxD	1.2x2.5x1.8m. (47.2"x98.4"x70.8" inc.)	1.2x2.5x1.8m. (47.2"x98.4"x70.8" inc.)
Packaged weight	1430kg (3150 lbs.)	1530 (3370 lbs.)

Table 8: Size and weight of the packed equipment

On the packaging, the following information is provided by pictograms or text:

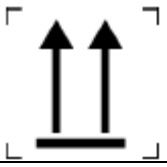
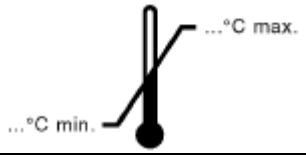
CG position	
High	
Max. and Min. allowed temperature	
Do not turn upside down	
Read the instructions	
Weight	--
Size	--

Table 9: Pictograms and information on the packaging

6. STORING

The equipment packaged, as described in section 5, shall be stored in environments with the characteristics described in Table 3. The equipment may be exposed to rain and, in case of exposure to humidity, the following condition must be observed:
5% to 95% from 1g/ m^3 to 25g/ m^3 non-condensing and non-freezing.

7. HANDLING

The packed equipment can be handled by a forklift of adequate capacity.

⚠ CAUTION	Observe the safety instructions on the packaging. Consider the CG position identified by a pictogram when handling the equipment. Choose a lift truck with adequate capacity. Avoid sudden movements or tearing during handling as the load may overturn.

The unpacked equipment can be handled by a forklift of adequate capacity. Gripping points are shown in Figure 3.

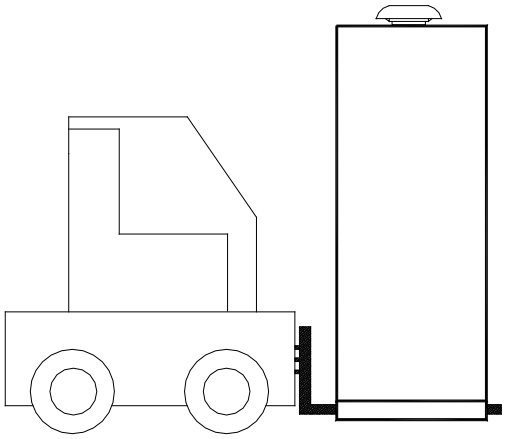


Figure 3: Gripping points

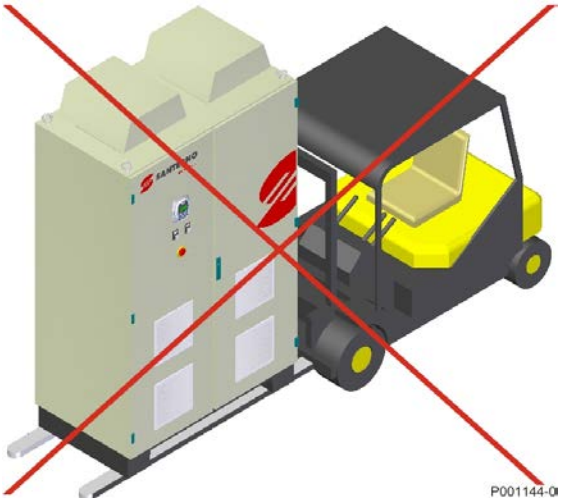


Figure 4: Example of wrong handling

8. UNPACKING AND DELIVERY CHECK

Inspect the product upon receipt, prior to unpacking the equipment. If visible damages are detected, please contact Santerno Inc. immediately.

	Read this manual before unpacking the equipment.

Avoid using cutters, as they could scratch the equipment and remove the protective paint.

The packing material should be taken to a waste collection centre in accordance with the local regulations in force.

Use a forklift of adequate capacity to lift the equipment from the pallet. The lifting forks should be placed below the electrical panel in the areas designated by the relevant pictograms, after removing the front and rear plates from the opening. Disassembly is performed by unscrewing four screws for each panel using a Phillips screwdriver.

	Gripping points to lift the electrical cabinet.

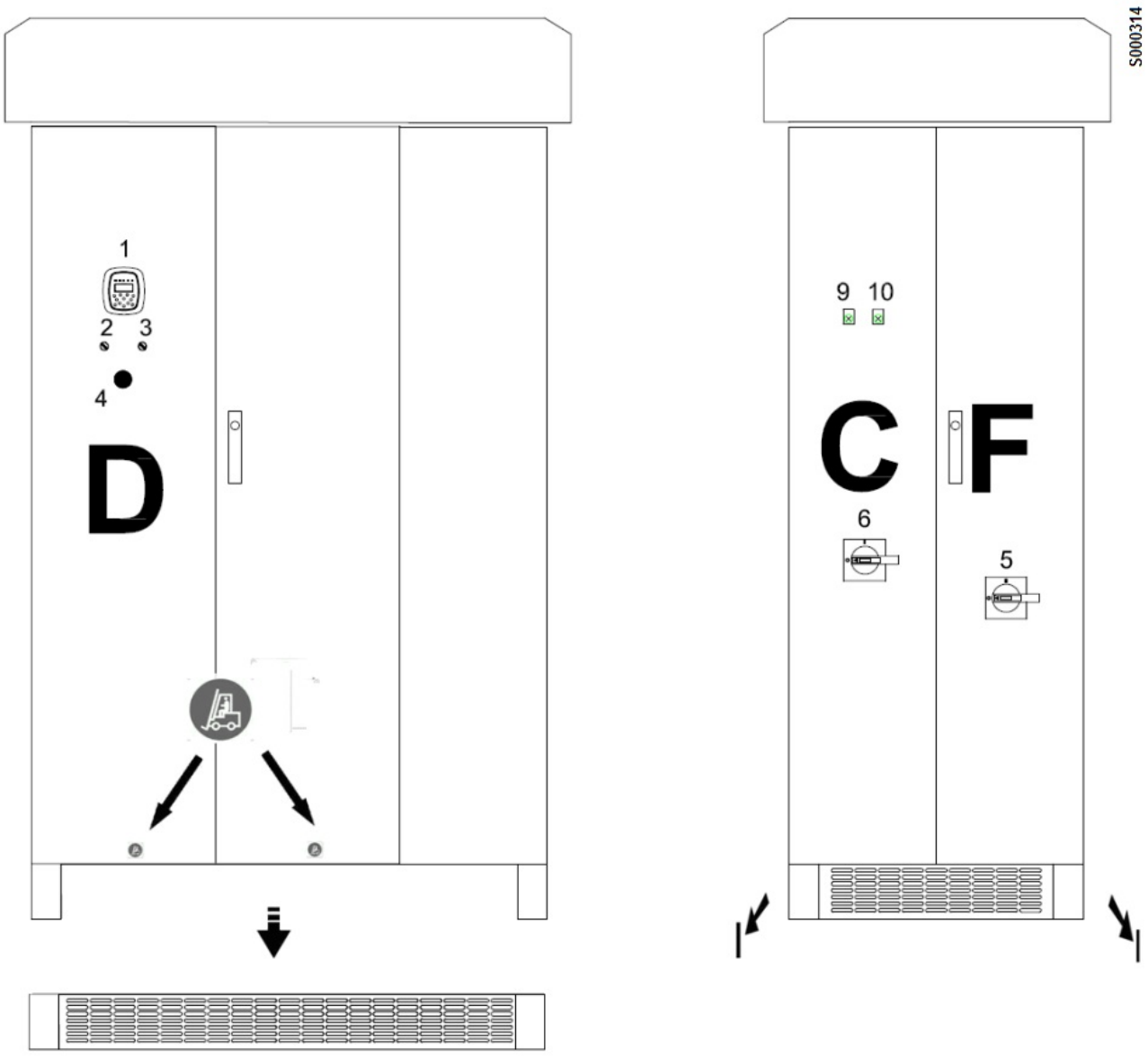


Figure 5: Gripping points to lift the electrical cabinet

9. INSTALLATION

9.1. Characteristics of the Installation Site

The equipment can be installed indoors or outdoors. If installed outdoors, special requirements must be met to ensure proper ventilation.
The equipment must be installed on flat surfaces, with adequate capacity, under no potentially hazardous conditions.

9.2. Properties of the Installation Site

9.2.1. INSTALLATION REQUIREMENTS

The following environmental requirements must be met.

Operating temperature[1]	-25°C to +50°C (-13°F to 122°F)
Installation site	Pollution degree 2 or better
Max. altitude	2000m / 6560ft. above sea level
Ventilation air flow for indoor installation	Min. 7500 m^3/h
Cooling power for indoor installation	Min. 5 kW for TG 100 NA Min. 6.25 kW for TG 125 NA

Table 10: Environmental conditions

⚠ CAUTION	Do not install in direct sunlight and in places exposed to conductive dust, corrosive gas, vibrations, water sprinkling or dripping; do not install in salty environments. Installing the equipment in sites with direct exposure to sunlight may lead to reduce power output.

[1] The temperature range may be limited in respect to the range given in the table based on the equipment configuration.

9.2.2. Installation Surface and Plate Preparation for Cable Entry

The installation surface must:

1- Be able to support the weight of the equipment
2- Be flat
3- Not be made of conductive or flammable material.

Before placing the equipment, all channels should be arranged for the cable run from the PV field array and from the power grid (Figure 6).

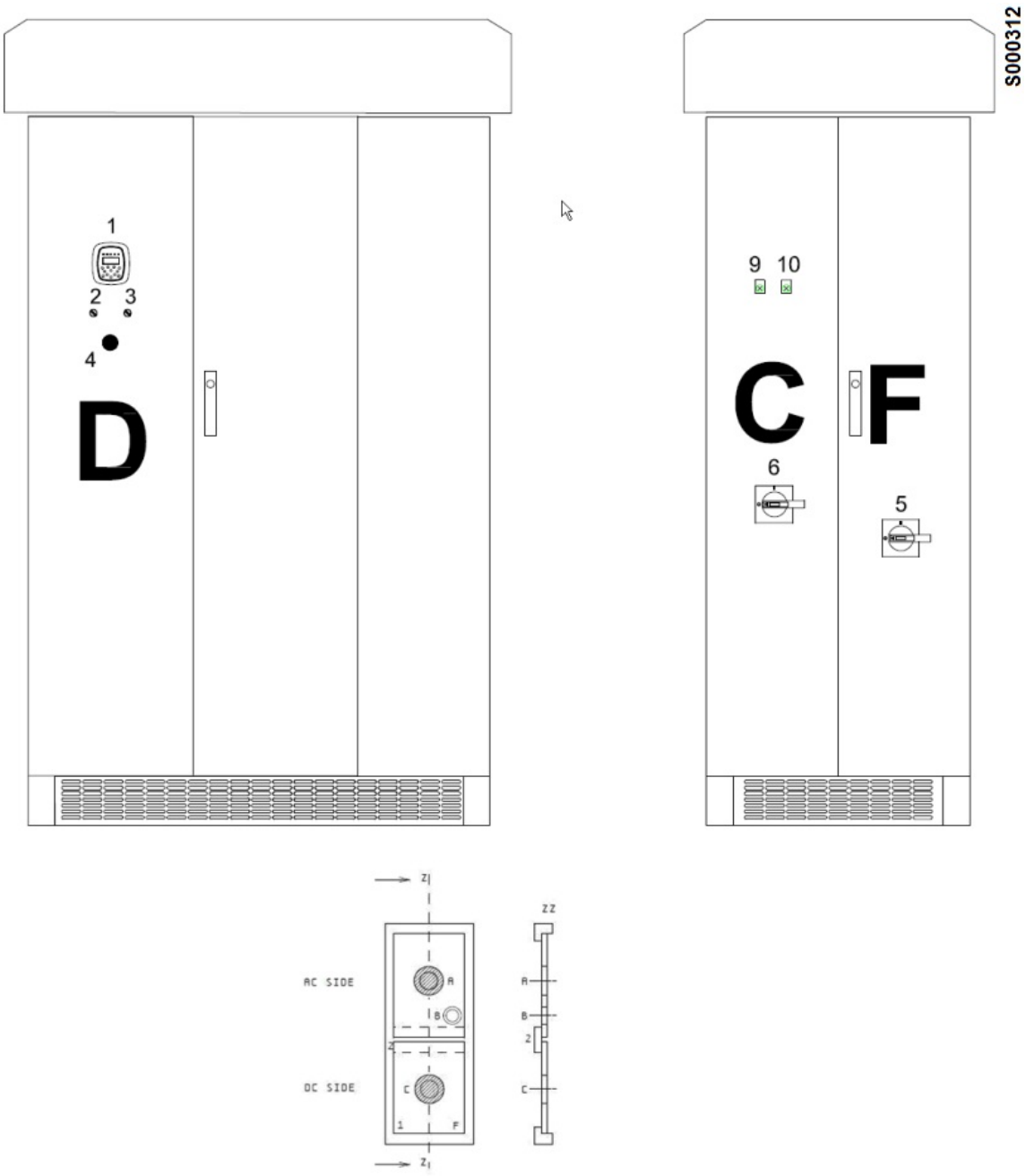


Figure 6: Cable entry

The DC- and AC-side cable entry plates are completely closed when supplied. The axes of the holes in entry device cables (cable glands or conduits) are plotted on them.

⚠ WARNING	Cable entry accessories must be chosen by the installer so as to restore type 3R for the equipment. The AC cable must enter in the same entry hole. If not, parasitic currents can be generated and the entry plate can melt.

Use appropriate tools for drilling holes in galvanized sheet metal of 2 mm (0.08") thickness. We recommend a punching press.

⚠ CAUTION	Remove any metal burrs that may have formed during the drilling of the cable entry panels.

Proceed as follows to perform this operation on the panels shown in Figure 6:

1. Unscrew by means of a Torx® wrench T25 and remove the 4 screws (A) in Figure 7
2. Unscrew the connecting pin of the equipotential circuit
3. Remove the panel
4. Drill holes in the panel and install the cable entry devices on the panel. Then place the panel inside the equipment again
5. Connect the cable of the pin equipotential circuit
6. Fix the panel by screwing the four screws (A) in Figure 7.

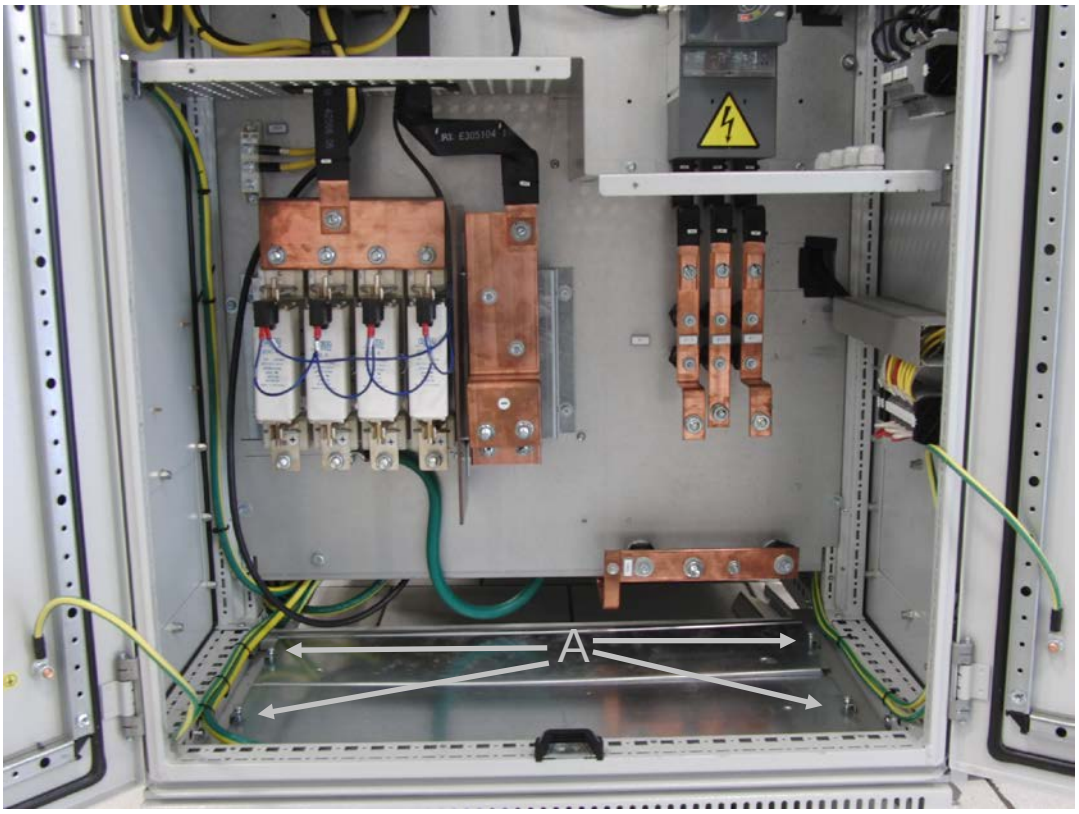


Figure 7: Cable entry plate

9.3. Minimum Clearance

The equipment must be installed leaving minimum allowable clearance from walls or obstacles in order to ensure:

- Ventilation as needed
- Space for opening doors
- Space for maintenance operations

The equipment comes out in two different layouts:

- Right
- Left

The type of layout is indicated in the Part Number given on the nameplate (see Figure 1).
The Part Number of the Santerno cabinets is made up as follows: ZZEExxxUabyyy. Letter "a" may be R (right) or L (left). The "right" cabinets have one double door on the right, whereas the "left" cabinets have one double door on the left. "Right" and "left" are considered by watching the double door with the LCD keypad from the front.
Consequently, cabinets of type "R" may be leant against the wall with their rear panel and left panel, whereas cabinets of type "L" may be leant against the wall with their rear panel and right panel. All the other sides of the cabinets must be left free to allow for a minimum clearance of at least 3 feet (91cm), as shown in Figure 8.
The min. top clearance must be 1 foot (31 cm) to allow handling the device using a forklift.

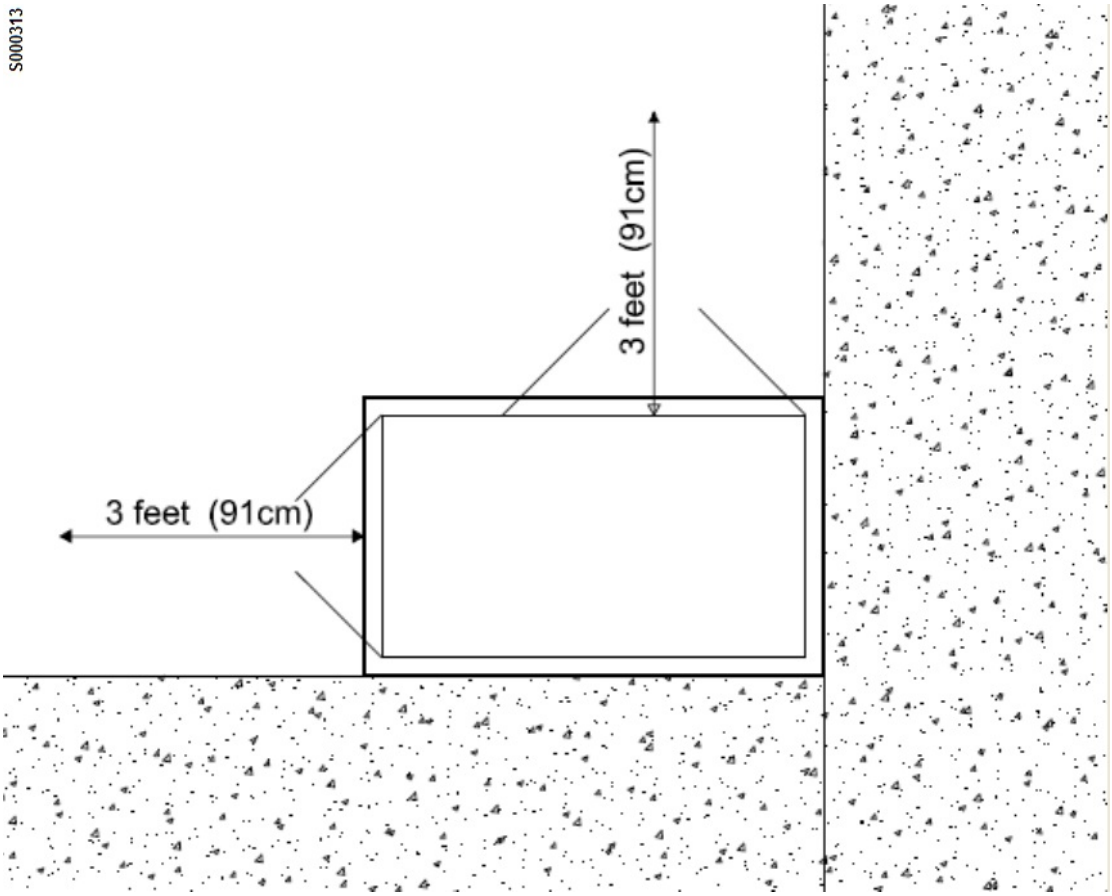


Figure 8: Minimum clearance

9.3.1. INSTALLATION IN CLUSTER

This type of layout for symmetrical cabinets allows cluster installation of multiple cabinets. Examples of cluster installation and relevant clearance are given below.

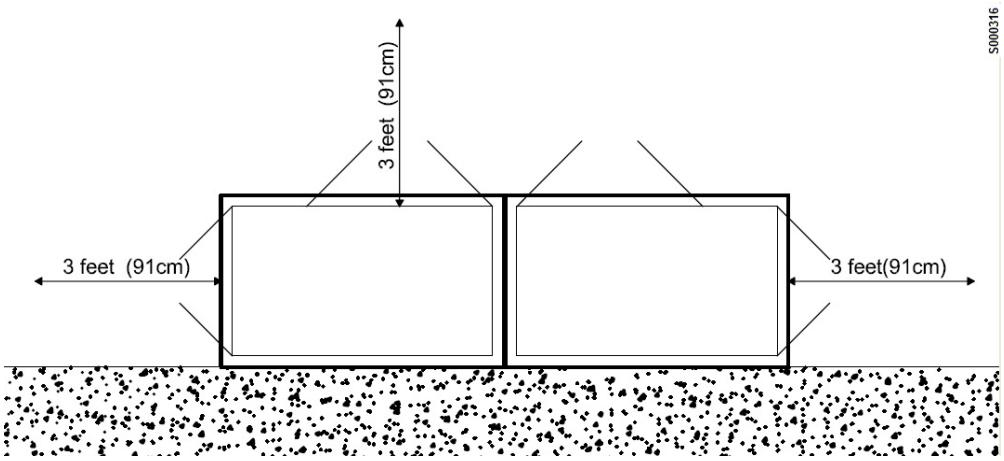


Figure 9: Cluster 2x

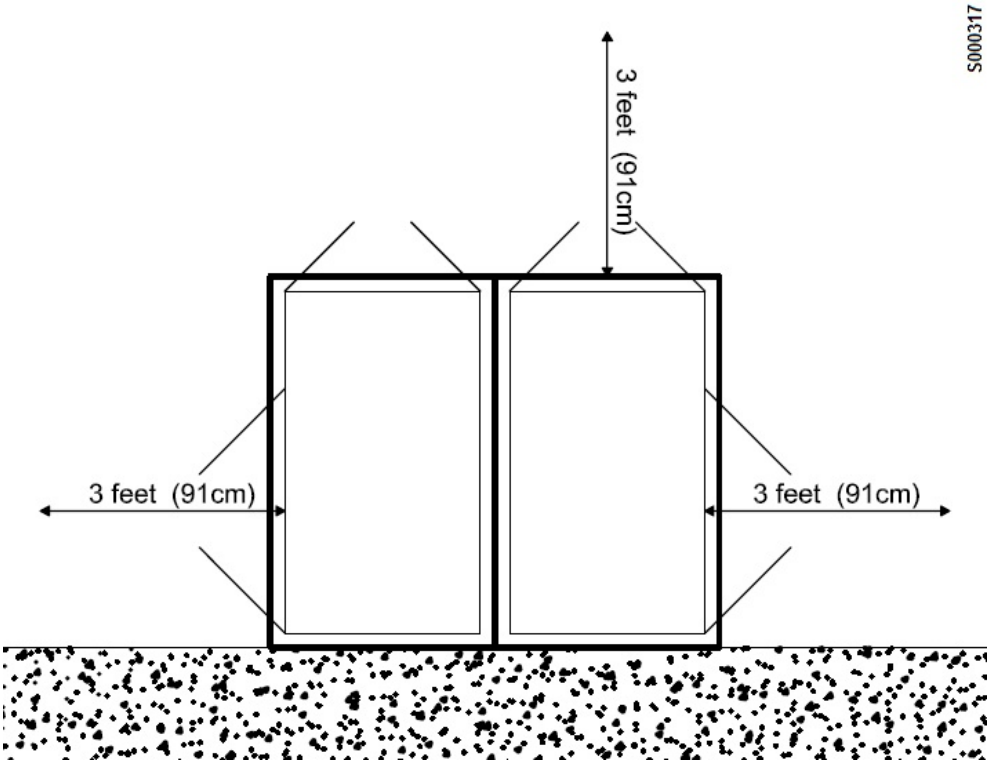


Figure 10: Cluster 2x

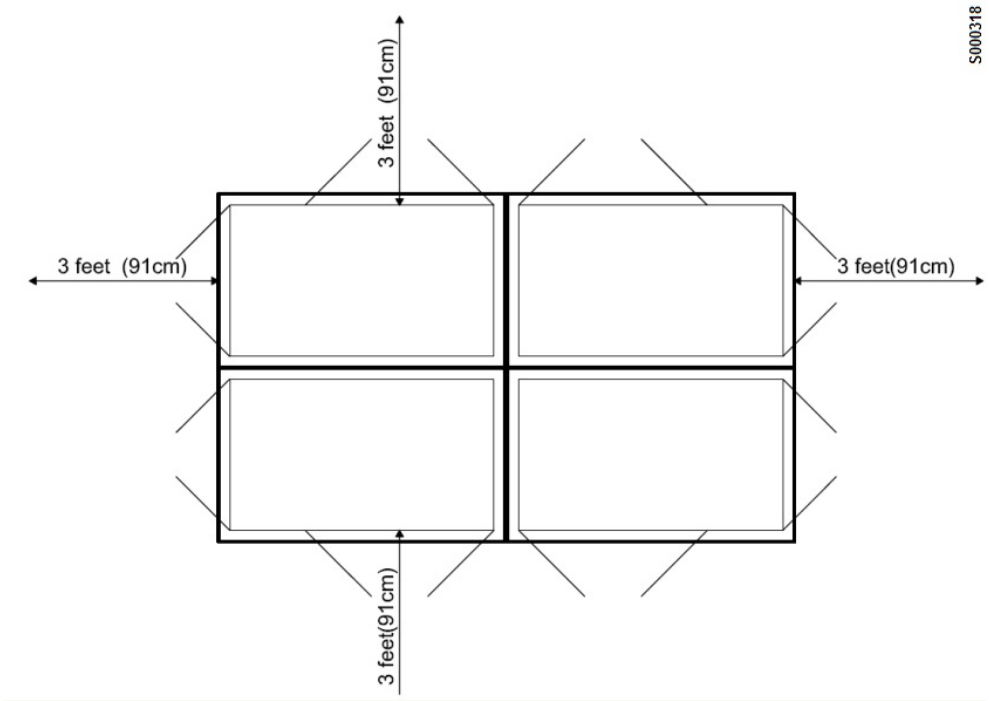


Figure 11: Cluster 4x

9.4. ACCESSING THE CABINET

DANGER	Danger of electrocution. Danger of death. Only Qualified Persons can access the internal parts of the equipment.
WARNING	WARNING: THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONENEL ONLY. TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT SPECIFIED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

The equipment is designed to allow access to internal manoeuvre components safely. Line entries are located in areas behind doors A and B, where voltage is always applied unless the equipment is isolated externally. These areas have been secured with doors fixed with screws, and a tool (screwdriver) is required to remove them.

The remaining areas of the equipment can be accessed through hinged doors that open with keys. Each door is interlocked with a position switch that, in case of door opening with voltage on, controls the opening of the disconnect switch DC- and AC-side.
Behind the doors, perforated steel panels reduce the risk of accidental contact with live parts.



S000215

Figure 12: Equipment door key



Figure 13: Internal protective grilles

The equipment can be accessed when it is:

1. Isolated
2. Live

9.4.1. ACCESSING THE ISOLATED EQUIPMENT

DANGER	Danger of electrocution. Danger of death. Before working on the equipment, make sure that no voltage is applied. Use appropriate tools and wear appropriate protective equipment. Prevent voltage from being unexpectedly applied to the equipment after locking the disconnect switches. Use appropriate warning signs to make the operation safe. Only Qualified Persons can access the internal parts of the equipment.
WARNING	WARNING: THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONENEL ONLY, TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT SPECIFIED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

How to access the isolated equipment:

1. Isolate the PV field and the AC grid (refer to the relevant section in the Operating Instructions Manual)
2. In case an external power supply source is used to power the ventilation system or the equipment is power supplied via UPS, isolate these sources using appropriate external disconnect switches
3. Open the door using the key provided
4. To reach the parts protected by the grilles, use a 10mm wrench to remove the protective grilles.



S000217

Figure 14: Locking system on OFF isolator with DC or AC disconnect switch lock

DANGER	Danger of electrocution. Danger of death. After removing the protective grilles, reassemble them using all the screws supplied. Connect the cable of the equipotential circuit.

9.4.2. ACCESSING THE LIVE EQUIPMENT

	Danger of electrocution. Danger of death. Use personal protection equipment appropriate for the task to be performed. Use appropriate warning signs to make the operation safe. Only Qualified Persons can access the internal parts of the equipment.
	WARNING: THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONENEL ONLY, TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT SPECIFIED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

How to access the live equipment:

1. Control the door by-pass by setting key-operated selector switch 50S2 to ON
2. Open the door concerned
3. If you need to reach internal components protected by the protective grilles, remove the protective grilles using a 10mm wrench
4. Reassemble the protective grilles, close the door, set key-operated selector switch 50S2 to ON, and remove it.

	Danger of electrocution. Danger of death. After removing the protective grilles, reassemble them using all the screws supplied. Connect the cable of the equipotential circuit.

9.5. Electrical Connection of the Equipment

The electrical connection of the equipment shall be carried out when the equipment is isolated, i.e. when it is not powered from the PV field, the grid and the auxiliary power supply. The connection must be performed according to the sequence of Table 11, according to the following requirements.

	The equipment is supplied with all the fuses in their fuse holders and all the switches and disconnect switches in the open position (OFF).

	Danger of electrocution. Danger of death. Before working on the equipment, make sure that no voltage is applied. Use appropriate tools and wear appropriate protective equipment. Prevent voltage from being unexpectedly applied to the equipment after locking the disconnect switches. Use appropriate warning signs to make the operation safe. Only Qualified Persons can access the internal parts of the equipment.
	WARNING: THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONENEL ONLY, TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT SPECIFIED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

All cable connections must be performed on different terminal boards based on the type of circuit to be connected.

Terminal board	Description	Location
X3	Ambient signals and PV field I/Os terminal board	Behind panel B
X4	RS485 terminal board	Behind panel B
X7	UPS terminal board	Behind panel B
X1	Grid terminal board	Behind panel B
X2	PV field terminal board	Behind panel A

Table 11: Terminal board list

	Do the following before connecting the equipment: 1. Make sure that the DC switch is isolated (OFF) 2. Remove the fuses in DC line input (X2) 3. Check if the AC switch is disconnected (OFF) 4. Check if the following switches are isolated (OFF): a. 30 Q1- 30Q2 – 30Q3 – 30Q4 – 30Q5 5. Check if the following fuse holders are isolated and their fuses removed: a. 30F1 – 30F2

9.5.1. CONNECTING THE CONTROL CIRCUIT CABLES TO TERMINAL BOARD X3

The cables of the control circuits must be connected to terminal board X3, located in compartment B.
All the terminals are spring terminals. The connection procedure is as follows:

1- Strip the cable for about 10 mm (0.4 in.)
2- Open the terminal spring clamp by inserting a flat screwdriver (max. 4 mm) (0.16 in.)
3- Insert the conductor and remove the screwdriver
4- Check tightness by slightly pulling the cable.

Max. AWG14 Min. AWG26
Cu Only
75°C cable

Table 12: Terminal board X3 electrical ratings

The table below lists the terminals available in terminal board X3 and their allocated functions.

Terminal	Function	Rating
3-4	Module temperature analog signal	9.5.1.1
5-6	Module surface radiation analog signal	9.5.1.1
7-8	Horizontal radiation analog signal	9.5.1.1
9-10	Aux 1 analog signal	9.5.1.1
11-12	Aux 1 analog signal	9.5.1.1
13-14	Interface protection external contact	LVLE 24Vdc 4A
19-20	External contact for grid switch closed	LVLE 24Vdc 4A
21-22	External contact for low voltage switch closed	LVLE 24Vdc 4A
23-24	External contact for medium voltage switch closed	LVLE 24Vdc 4A
25 common 26 NC 27 NO	External contact for low voltage switch open	6A 250V
28 common 29 NC 30 NO	External contact for low voltage switch closed	6A 250V
31 common 32 NC 33 NO	External contact for medium voltage switch open	6A 250V
34 common 35 NC 36 NO	External contact for medium voltage switch closed	6A 250V
37 common 38 NC 39 NO	External contact, Santerno connected	6A 250V
40 common 41 NC 42 NO	External contact, inverter programmable output 1	6A 250V
43 common 44 NC 45 NO	External contact, inverter programmable output 2	6A 250V
46-47 NC	External contact: Equipment emergency stop pressed	A300 B600
48	External contact for delivered energy pulse	LVLE 24Vdc 4A 9.5.1.6
49	External contact for absorbed energy pulse	LVLE 24Vdc 4A 9.5.1.6
50	Common for terminals 48 and 49	LVLE 24Vdc 4A
51	Ambient sensor supply (positive pole)	24Vdc 500mA
52	Ambient sensor supply (negative pole)	24Vdc 500mA
54-55 NC	External contact, line contactor	A600 P300
58-59	External contact for inverter enable	LVLE 24Vdc 4A
60-61	Emergency stop external contact	LVLE 24Vdc 4°
64-65	ID5	LVLE 24Vdc 4°
68-69	ID8	LVLE 24Vdc 4A

Table 13: Terminal board X3 terminals

9.5.1.1. CONNECTING THE AMBIENT SENSORS AND THE PV FIELD I/OS

Six inputs acquiring ambient measures are available on the Santerno TG NA. They are located on ES847 expansion board for environmental sensors and PV field I/Os. ES847 board is covered in section 14.2 ES847 Board.

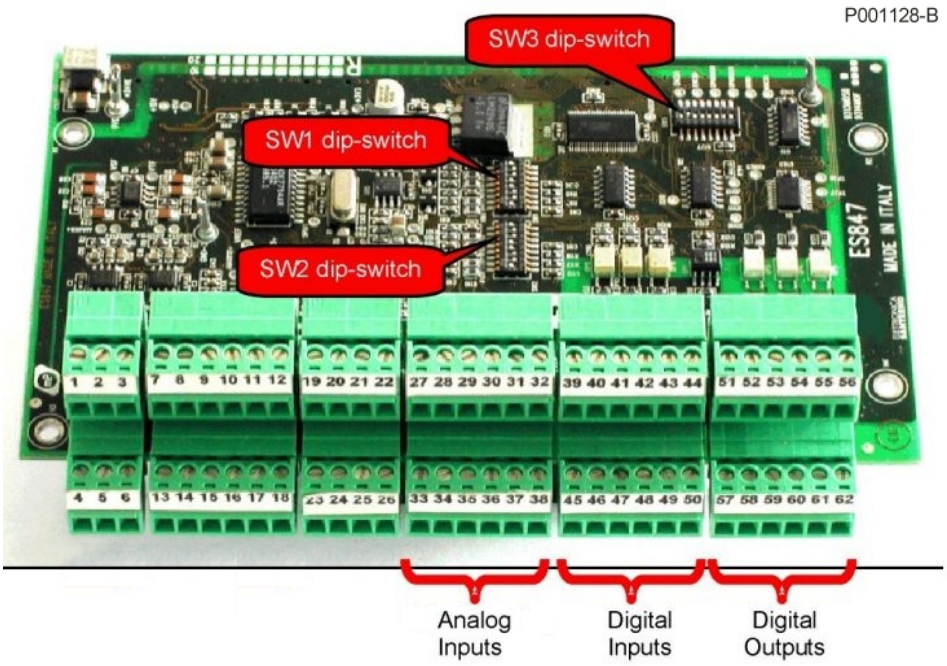


Figure 15: Environmental Sensors and I/Os Expansion Board

Environmental Measure	Factory-set Sensor	Factory Setting	Terminal
Ambient Measure 1	Module radiation	0-100mV	X3, contacts 5-6
Ambient Measure 2	Horizontal radiation	0-100mV	X3, contacts 7-8
Ambient Measure 3[1]	Integrated PT100	PT100	--
Ambient Measure 4	Module temperature	PT100	X3, contacts 3-4
Ambient Measure 5	Aux 1 signal	(0-10)V	X3, contacts 9-10
Ambient Measure 6	Aux 2 signal	(0-10)V	X3, contacts 11-12

Table 14: List of environmental sensor terminals

[1] Ambient measure 3 is allocated to PT100 probe, allowing detecting the temperature inside the cabinet. Factory setting for ambient measure 3 cannot be changed.

9.5.1.2. ES847 BOARD CONFIGURATION DIP-SWITCHES

ES847 board is provided with three configuration DIP-switches allowing setting the operating mode as described in Table 15.

DIP-switch	Operating Mode
SW1	Sets the operating mode of environmental analog inputs 1 and 2
SW2	Sets the operating mode of environmental analog inputs 3 and 4
SW3	Factory-set configuration: SW3.2=ON, SW3.5=ON, all the other DIP-switches OFF (DO NOT MODIFY)

Table 15: Functionality of the 3 DIP-switches in control board ES847

The possible configurations of DIP-switch SW1 and SW2 based on the setting of the environmental channels are shown in the tables below:

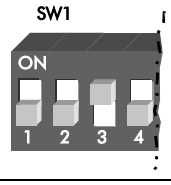
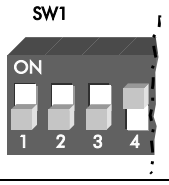
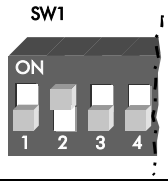
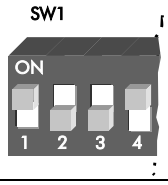
Configuration of environmental analog channel 1			
0-10V f.s. mode	0-100mV f.s. mode	0-20mA f.s. mode	Temperature reading with PT100 thermostat
			

Table 16: Environmental analog channel 1 DIP-switch

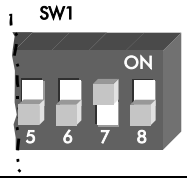
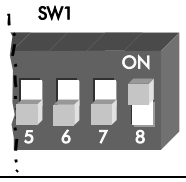
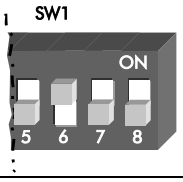
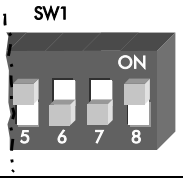
Configuration of environmental analog channel 2			
0-10V f.s. mode	0-100mV f.s. mode	0-20mA f.s. mode	Temperature reading with PT100 thermostat
			

Table 17: Environmental analog channel 2 DIP-switch

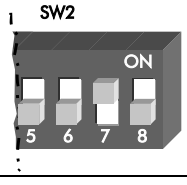
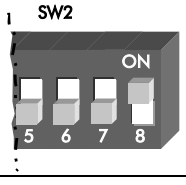
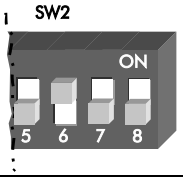
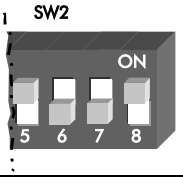
Configuration of environmental analog channel 4			
0-10V f.s. mode	0-100mV f.s. mode	0-20mA f.s. mode	Temperature reading with PT100 thermostat
			

Table 18: Environmental analog channel 4 DIP-switch

The DIP-switches are factory set as follows:

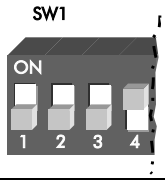
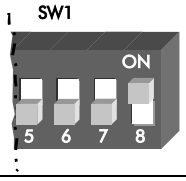
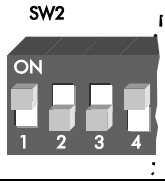
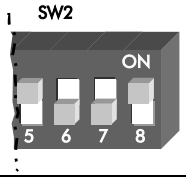
Environmental analog channel 1	
0-100mV f.s. Mode	
Environmental analog channel 2	
0-100mV f.s. Mode	
Environmental analog channel 3	
Temperature reading with PT100 thermostat	
Environmental analog channel 4	
Temperature reading with PT100 thermostat	

Table 19: Factory setting of the configuration DIP-switches in ES847 board

	The software parameter setting must be consistent with the DIP-switch setting. Otherwise, no predictable result is given for acquired values. Refer to the Operating Instructions Manual.
	Any voltage or current value exceeding full-scale values or dropping below min. values will generate an acquired value limited to the max. measure or the min. measure respectively.
	Voltage inputs have high input impedance and must always be closed when active. Isolating a conductor connected to an analog input set as a voltage input will not ensure that its channel reading will be equal to zero. Zero is detected only if the input is short-circuited or wired to a low impedance signal source. Relay contact should not be series-connected to the inputs to reset the detected value.

9.5.1.3. CONNECTING ANALOG INPUTS TO SENSORS PROVIDED WITH VOLTAGE OUTPUTS

Use a screened pair data cable and connect its braiding to the side of ES847 board.
Although "slow" acquisition analog channels have a cut-off frequency slightly exceeding 10Hz, and the mains frequency, which is the main disturbance source, is weakened, make sure that wiring is correct, particularly if the full-scale value is 100mV and if wires are longer than 10 m. Figure 16 and Figure 17 show a wiring example for the acquisition of a voltage source.
Properly set the DIP-switches for the configuration of the analog channel being used: set the full-scale value to 10V or 100mV. The setting of the programming parameter must be consistent with the hardware setting.

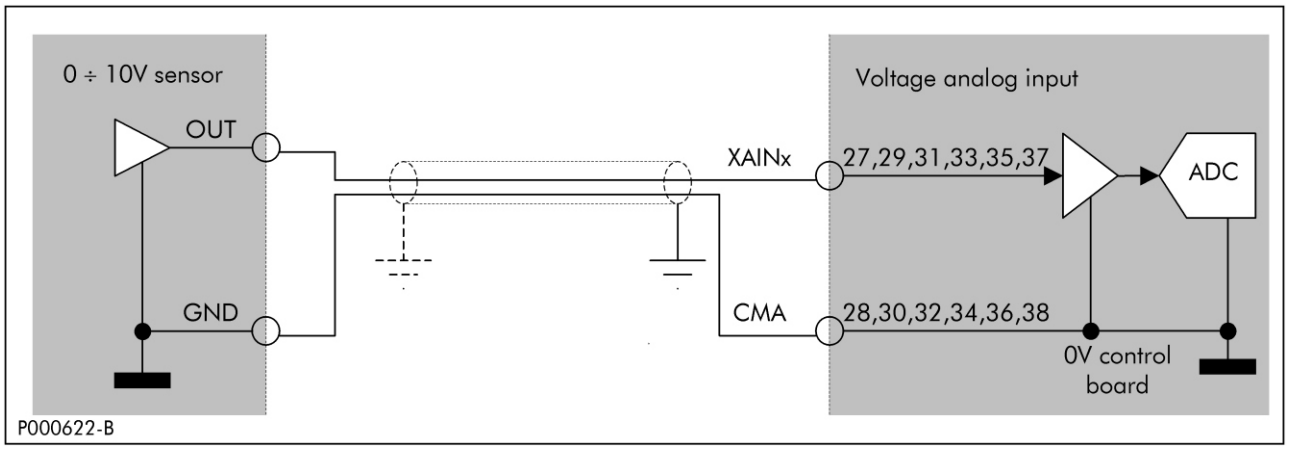


Figure 16: Connection of voltage output to 0 ÷ 10V analog input

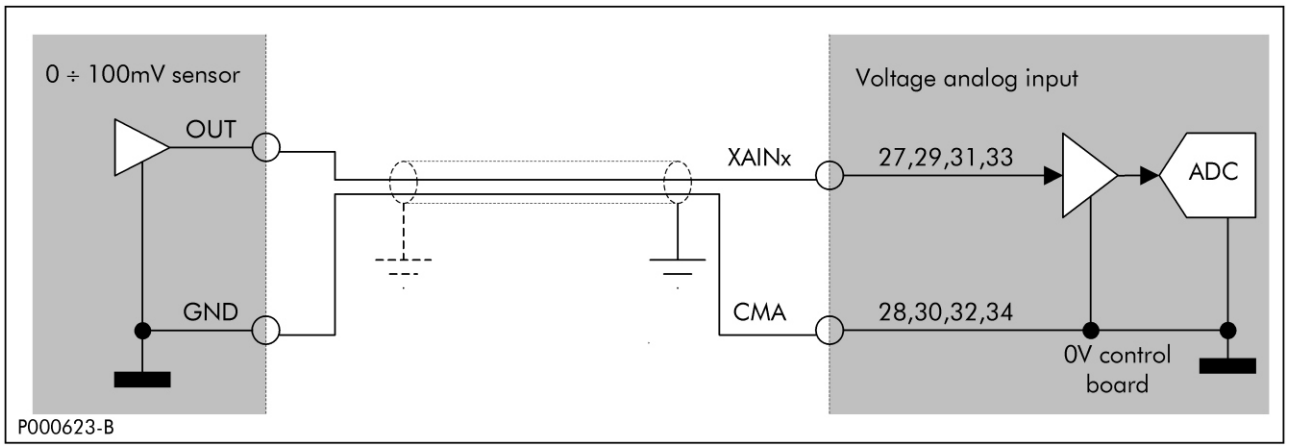


Figure 17: Connection of voltage output to 0 ÷ 100mV analog input

9.5.1.4. CONNECTING ANALOG INPUTS TO SENSORS PROVIDED WITH A CURRENT OUTPUT

Figure 18 shows how to connect slow analog inputs to current sources. Channels XAIN8, XAIN9, XAIN10, XAIN11—corresponding to terminals 27, 29, 31, and 33—are capable of acquiring current signals with a full-scale value of 20mA. Properly set the DIP-switches for the configuration of the analog channel being used: set the full-scale value to 20mA and set the relevant programming parameter to 0÷20mA or 4÷20mA.

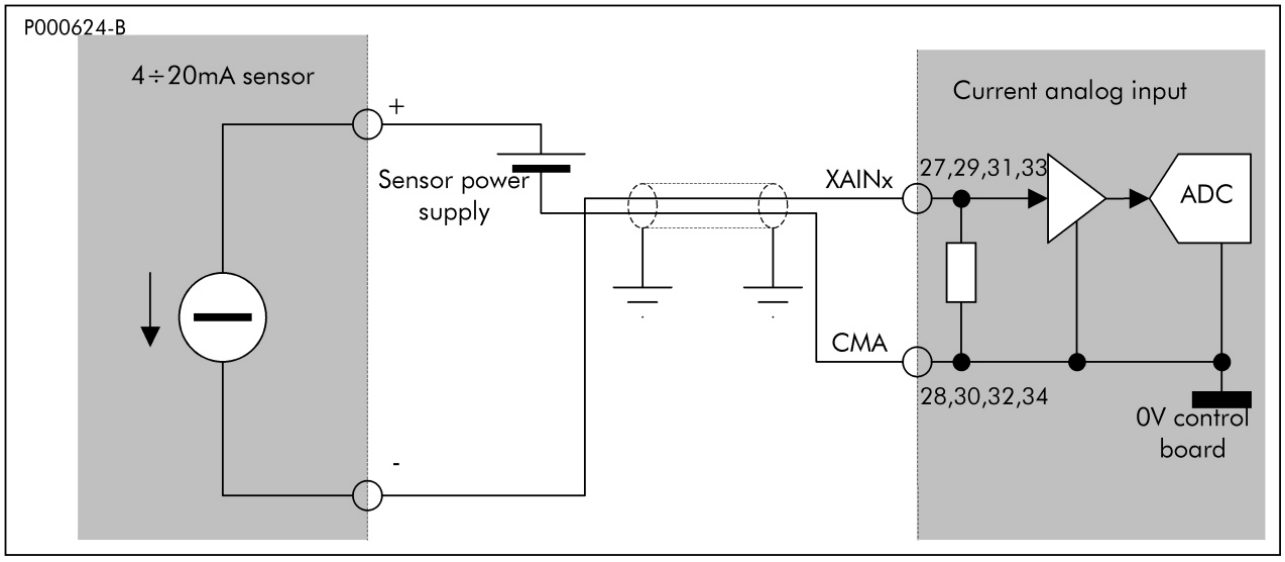


Figure 18: Connecting 0÷20mA (4÷20mA) sensors to current inputs

9.5.1.5. CONNECTING ANALOG INPUTS TO PT100 THERMISTOR

ES847 board allows reading temperatures directly from the connection of standard thermistors PT100. Two-wire connection is used for easier wiring. Use relatively short cables and make sure that cables are not exposed to sudden temperature variations when the inverter is running. Proper wiring is shown in Figure 19: use a screened cable and connect its braiding to the inverter metal frame through the special conductor terminals.
If a cable longer than approx. 10 metres is used, on-site measure calibration is required. For example, if a 1sqmm (AWG 17) screened pair data cable is used, this results in a reading error of approx. +1°C every 10 metres.
To perform measure calibration, connect a PT100 sensor emulator set to 0°C (or connect a 100Ω 0.1% resistor) to the line terminals, then rectify the resulting offset value (more details are given in the Operating Instructions Manual).

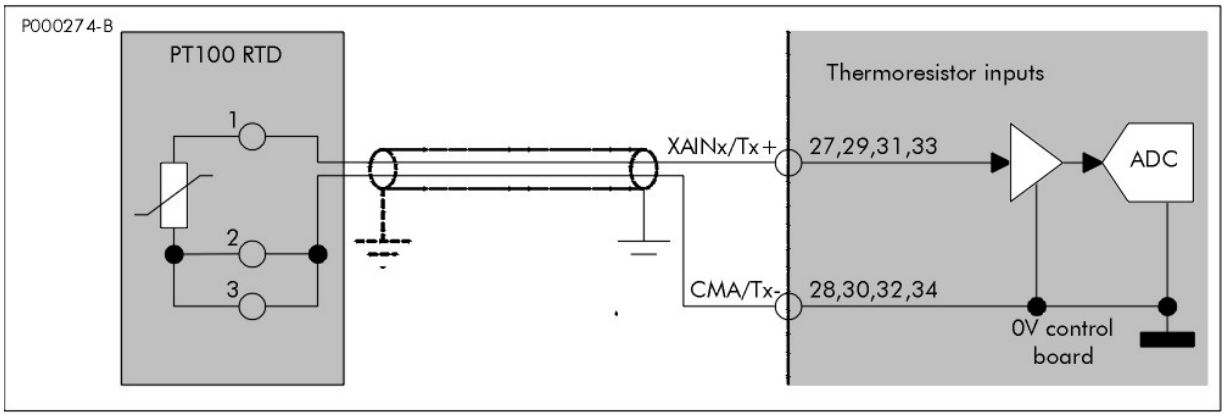


Figure 19: Connecting PT100 thermoresistors to the analog channels

9.5.1.6. CONNECTING EXTERNAL PULSE COUNTERS FOR PRODUCED AND ABSORBED ENERGY MEASUREMENT

The external counters are connected by means of one or two voltage-free contacts, as shown below.

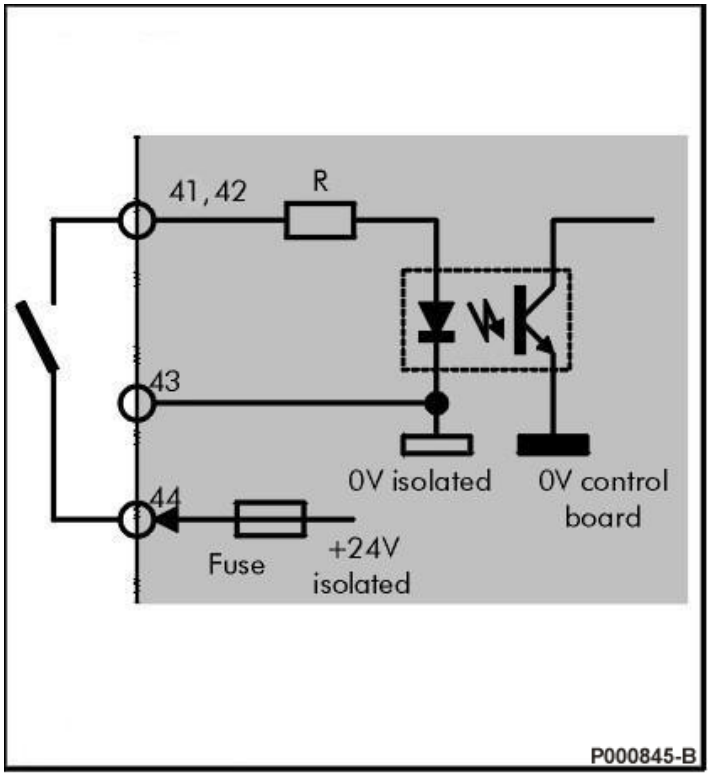
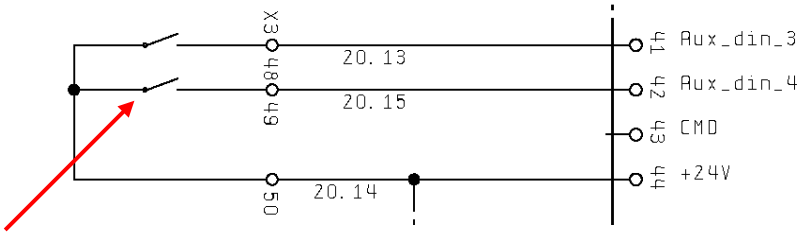


Figure 20: Connection of a voltage-free energy counter

	The voltage levels for the pulse counters are the following: 0V – Low level 24V – High level Otherwise, use a voltage-free contact or a PNP contact and on-board +24V power supply.
	The maximum input frequency for the auxiliary digital inputs is 40Hz.

Wiring is as shown below:

- X3 48-50 External contact for energy produced pulse
- X3 49-50 External contact for energy absorbed pulse



The external contacts shall be potential-free.

To activate this functionality, set the software accordingly through parameters P111 and P112 (see Operating Instructions manual).

9.5.2. CONNECTING TERMINAL BOARD X4 SERIAL LINKS

Check tightness by slightly pulling the cable. All the terminals are spring terminals. The connection procedure is as follows:

1- Strip the cable for about 10 mm (0.4 in.)
2- Open the terminal spring clamp by inserting a flat screwdriver (max. 4 mm) (0.16 in.)
3- Insert the conductor and remove the screwdriver
4- Check tightness by slightly pulling the cable.

Max AWG14 Min AWG26
Cu Only
75°C cable

Table 20: Terminal board X4 electrical ratings

The table below lists the terminals available in terminal board X4 and their allocated functions.

Terminal	Function	Notes
1	RS485 link COM0 Channel A	Available in the Basic version Slave Modbus
2	RS485 link COM0 Channel B	
3	RS485 link COM0 0V	
4	RS485 link COM0 SCH	
5	RS485 link COM1 Channel A	Data Logger Option Master/Slave Modbus
6	RS485 link COM1 Channel B	
7	RS485 link COM1 0V	
8	RS485 link COM1 SCH	
9	RS485 link COM2 Channel A	Data Logger Option Master/Slave Modbus
10	RS485 link COM2 Channel B	
11	RS485 link COM2 0V	
12	RS485 link COM2 SCH	

Table 21: Terminals in terminal board X4

The MODBUS-IDA (http://www.modbus.org) association defines the type of connection for MODBUS communications over RS485 serial link, which is used by the Santerno TG NA inverters, as a "2-wire cable". Specifications are as follows:

Wiring cable	
Type of cable	Screened cable composed of a balanced pair named D1/D0 + common conductor ('Common'). Recommended cable: Belden 3106A Paired EIA Industrial RS-485 PLTC/CM.
Min. cross-section for the conductors	AWG23 corresponding to 0.258mm^2. For long lengths, cross-sections up to 0.75mm^2 are recommended.
Max. length	500 meters based on the max. distance measured between any two stations.
Characteristic impedance	Greater than 100Ω (recommended): typically 120Ω.

Table 22: Serial connection cable requirements

The wiring procedure is detailed in section 14.3.

	All the devices connected to the communication multidrop network should be earthed to a common conductor to minimize any difference of ground potentials between devices that can adversely affect communications.
	All the devices connected to the communication multidrop network should have their common conductor (0V) connected in common to minimize any difference of ground potentials between devices that can adversely affect communications.
	The common terminal for the supply of the inverter control board is isolated from grounding. If one or multiple inverters are connected to a communication device with a grounded common (typically a computer), a low-impedance path between control boards and grounding occurs. High-frequency disturbance could come from the inverter power components and affect the operation of the communication device. If this happens, provide the communication device with a galvanically isolated RS485 communications interface or with a galvanically isolated RS485/USB converter.
	Category 5 cables (two-pair, three-pair or four-pair) cannot be used for obtaining the serial link, even for short cable paths.

9.5.3. AUXILIARY POWER SUPPLY FROM UPS AND CONNECTION TO TERMINAL BOARD X7 FOR VENTILATION

The control circuit of the equipment can be powered via UPS (optional). The ventilation system can be powered via an external source. Any power supply source must be connected to terminal board X7, which is located in compartment B.

9.5.3.1. AUXILIARY POWER SUPPLY FROM UPS

The power supply via UPS must have the following features:

Rated voltage	115V
Frequency	50/60Hz
Minimum power	250VA
Cable	AWG12/AWG24 Only Cu

Table 23: Electrical characteristics of UPS power supply line

The terminals are spring terminals. The connection procedure is as follows:

1- Remove voltage from the equipment and open circuit breakers 26QM1, 20QM1, 30Q3
2- Remove the cable insulation for about 13 mm (0.4 in.)
3- Remove bridge between terminals 1 and 3 and between 2 terminals and 4. To do so, open the terminal spring clamp by inserting a flat screwdriver (max 4 mm, 0.16 in.)
4- Connect the cables of the UPS-generated power to terminals 3 and 4 (Figure 21). To do so, open the terminal spring clamp by inserting a flat screwdriver as described in step 3, then fit in the cable and remove the screwdriver.
5- Check tightness by slightly pulling the cable

WARNING	Do not connect the UPS power to terminals 1 and 2 of terminal board X7.

6- Before closing C/B 30Q3, check that the UPS output voltage is equal to 115V, otherwise stop the connection procedure and check the UPS
7- Close switch 30Q3.

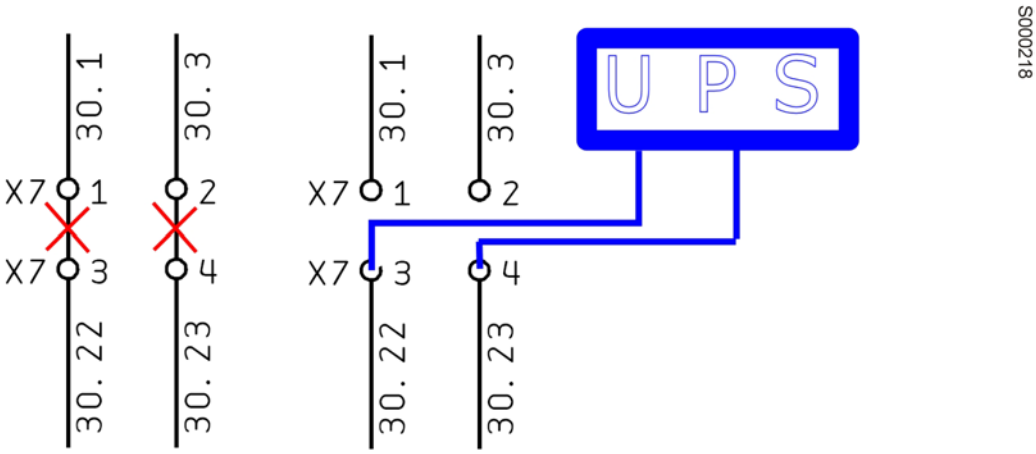


Figure 21: UPS connection to terminal board X7

9.5.3.2. CONNECTION OF EXTERNAL POWER SUPPLY FOR THE VENTILATION SYSTEM

The power generated externally for the equipment ventilation system must have the following characteristics:

Voltage	115V
Frequency	50/60Hz
Power	1000VA
Cable	AWG8/AWG16 Only Cu

Table 24: Electrical characteristics of external power supply line for the ventilation system

All the terminals are 'spring' type. The connection procedure is as follows:
1- Work in absence of voltage with switches 26QM1, 20QM1 and fuse holder 30F2 open
2- Remove the cable insulation for about 18 mm (0.4 in.)
3- Open the terminal spring clamp by inserting a flat screwdriver of max 4 mm (0.16 in.)
4- Insert the cable and remove the screwdriver
5- Check tightness by slightly pulling the cable
6- Remove bridge between terminals 5 – 7 and 6 – 8.
7- Connect the power supply cables to terminals 7 and 8 (Figure 22)

WARNING	Do not connect power supply to terminal 5, 6 and 7 in terminal board X7.

8- Before closing fuse holder 30F2, check if the voltage supplied from an external power supply source is applied and is the same as the expected current. If this is not the case, stop the wiring procedure and check the external power supply source
9- Close circuit breaker 30F2.

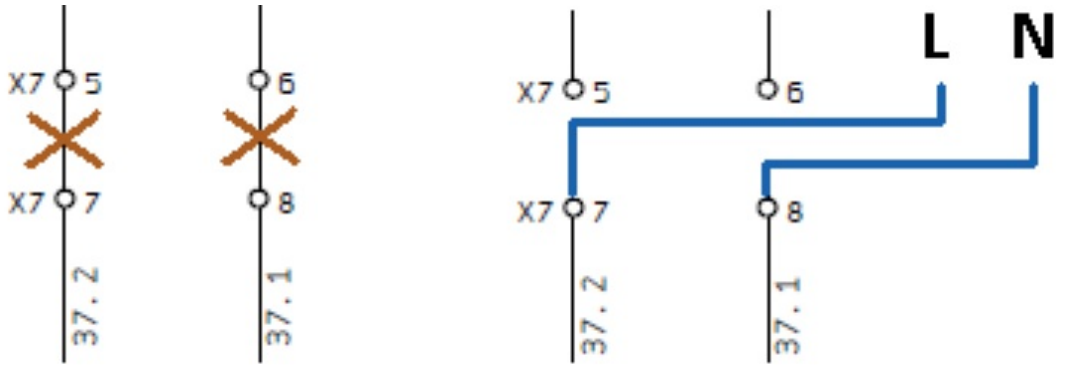


Figure 22: Connecting an external power supply source to terminal board X7

Set parameter C006 relating to auxiliary power supply accordingly (refer to the Operating Instructions manual).

9.5.4. CONNECTION OF AC SIDE CABLES IN TERMINAL BOARD X1

⚠ DANGER	Risk of death from burns and electrocution. Remove voltage from the equipment before operating on electrical parts. Open the main circuit breaker and prevent accidental closing. Before operating on the equipment, make sure it is isolated. Connect the ground wire to GND terminal as the first cable. The installer is responsible for checking the effectiveness of the grounding system. Only Qualified personnel may operate the equipment.

Terminal board X1 is composed of five poles.

Pole	Cable to be connected
X1.1 – X1.2 – X1.3	Grounded or ungrounded three-phase power cables having the same voltage rating as the one given in the equipment nameplate.
X1.4	Neutral cable, to be grounded by the grid administrator. To be connected only if required by the grid system.
GND	Ground wire, to be effectively connected to the ground by the plant operator.

Table 25: Terminal board X1

⚠ WARNING	Input and output circuits are isolated from the enclosure. System grounding, when required by the local electric code, is the responsibility of the installer. Only the proper GND terminal shall be used.

⚠ WARNING	Electrical Connections Options for REFERENCE ONLY. Please check with Local Building and Electrical Code for approval prior to start-up of the equipment.

The cable connection on the AC side is by copper bar with screw clamping; terminal board X1 is housed in compartment B. Data for proper connection is shown in Table 26.

Equipment	Grid connection	Pole	Number of cables that can be connected to each screw	Max. cable cross-section[1]	Screw supplied	Tightening torque	Max. lug width
Santerno TG NA 100 125	208-240V	L1 - L2 - L3	2 Cu only 105°C	AWG4/0 (107 mm^2)	M10	44.25 Lb. ft. 60 Nm	1.18 in. 30 mm
		N[2]	1 Cu only 105°C	AWG4/0 (107 mm^2)	M10	44.25 Lb. ft. 60 Nm	1.18 in. 30 mm
		GND	1 Cu only 105°C	AWG2/0 (67 mm^2)	M10	44.25 Lb. ft. 60 Nm	1.57 in. 40 mm
Santerno TG NA 100 125	480-600V	L1 - L2 - L3	1 Cu only 105°C	AWG4/0 (107 mm^2)	M10	44.25 Lb. ft. 60 Nm	1.18 in. 30 mm
			2 Al only 105°C	AWG4/0 (107 mm^2)	M10	44.25 Lb. ft. 60 Nm	1.18 in. 30 mm
		N	1 Cu only 105°C	AWG4/0 (107 mm^2)	M10	44.25 Lb. ft. 60 Nm	1.18 in. 30 mm
		GND	1 Cu only 105°C	AWG1/0 (53 mm^2)	M10	44.25 Lb. ft. 60 Nm	1.57 in. 40 mm
			1 Al only 105°C	AWG2/0 (67 mm^2)	M10	44.25 Lb. ft. 60 Nm	1.57 in. 40 mm

Table 26: AC cable connection data

[1] The suggested wiring fits connections up to 50 meters (54 yards).
[2] The connection to the neutral fits 5-wire devices only. It is not suitable for 4-wire devices.

9.5.5. CONNECTION OF DC SIDE CABLES OF TERMINAL BOARD X2

DANGER	Risk of death from electrocution. Dangerous voltage flows when the solar panels are exposed to direct solar radiation. Open the PV field box switches and prevent accidental closing. Before operating on the equipment, make sure it is isolated. Connect the ground wire to GND terminal as the first cable.
CAUTION	In grounded systems, if the GFD indicates ground failure, the cable connected to ground has lost ground reference. Risk of electrocution. Check DC cable voltage before operating on the equipment. Only Qualified personnel may operate the equipment.

Terminal board X2 is offered in four configurations, depending on how the photovoltaic field is managed:

1. **Configuration 1** Floating PV field, max. 4 cables per pole for Santerno TG100-125 (Figure 23)
2. **Configuration 2 or 3** PV field with grounded positive or negative pole, max. 8 cables per pole for Santerno TG100-125 (Figure 24, Figure 25)

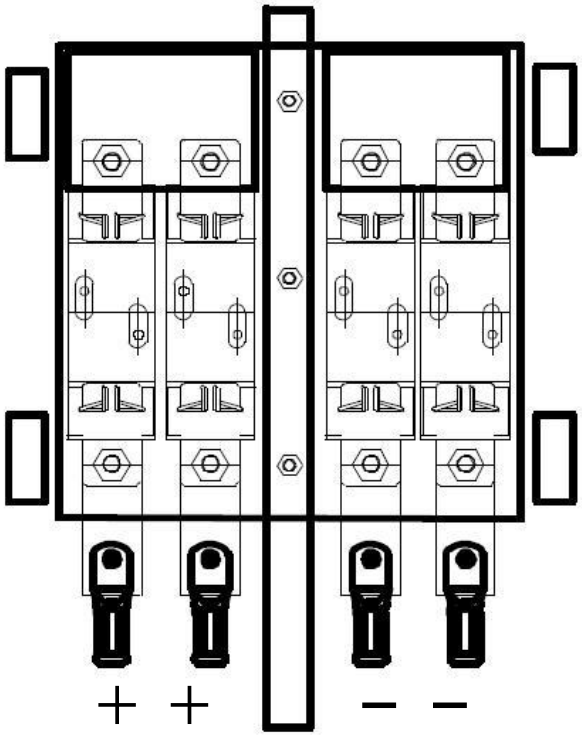


Figure 23: Configuration 1 of terminal board X2, floating PV field, max. 4 cables per pole for Santerno TG100-125

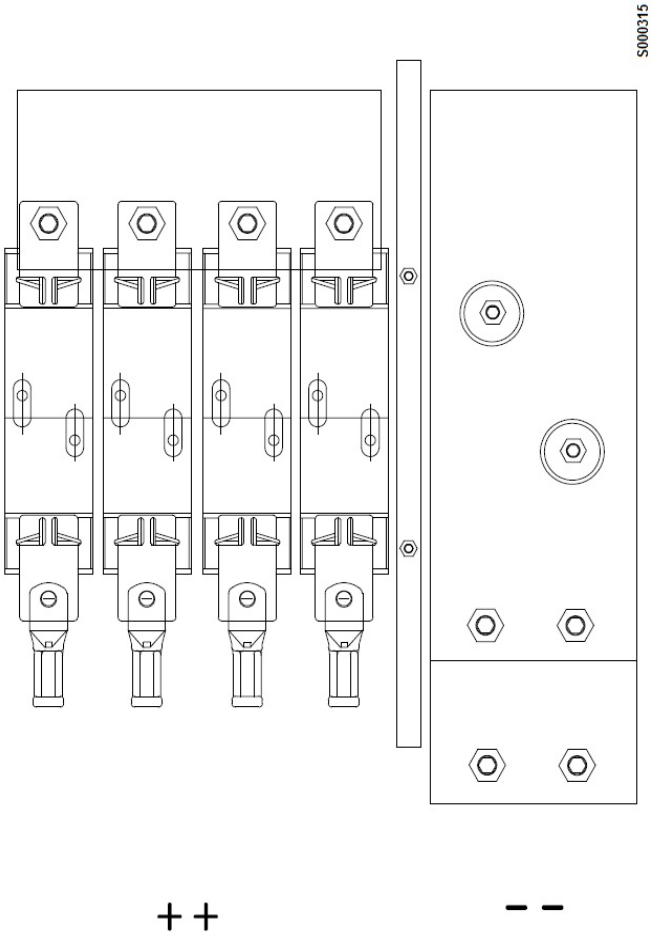


Figure 24: Configuration 2 of terminal board X2, PV field with negative grounded pole, max. 8 cables per pole for Santerno TG100-125

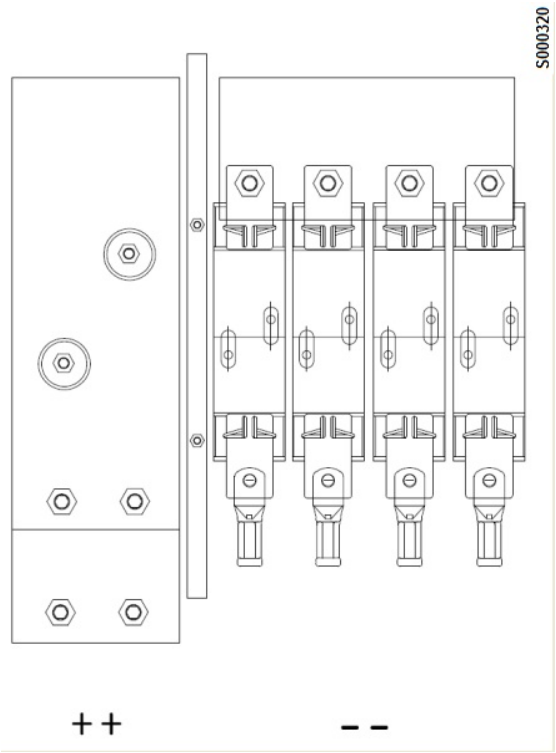


Figure 25: Configuration 3 of terminal board X2, PV field with positive grounded pole, max. 8 cables for Santerno TG100-125

Pole	Cable to be connected
+	Cable of the PV field, + potential
-	Cable of the PV field, - potential

Table 27: Terminal board X1

The cables coming from the string boxes are to be connected onto the poles in the fuse holders.

Equipment	Pole	PV field connection configuration	Number of cables that can be connected to each screw	Max. cable cross-section	Screw supplied	Tightening torque	Max. lug width
Santerno TG NA 100 -125	+ / -	1	2 Cu only 105°C	AWG4/0 (107 mm^2)	M10	20.80 Lb. ft. 28.2 Nm	1.18 in. 30 mm
		2	1 Cu only 105°C	AWG4/0 (107 mm^2)	M10	20.80 Lb. ft. 28.2 Nm	1.18 in. 30 mm
			2 Al only 105°C	AWG4/0 (107 mm^2)	M10	20.80 Lb. ft. 28.2 Nm	1.18 in. 30 mm
		3	1 Cu only 105°C	AWG4/0 (107 mm^2)	M10	20.80 Lb. ft. 28.2 Nm	1.18 in. 30 mm
			2 Al only 105°C	AWG4/0 (107 mm^2)	M10	20.80 Lb. ft. 28.2 Nm	1.18 in. 30 mm

Table 28: DC cable connection data

9.5.6. ELECTRICAL POWER CONNECTIONS - X1 - X2

The electrical connections of the power circuits in terminal boards X1 and X2 must be performed according to the following requirements.

	During transport, the contact surfaces of the poles of the terminal boards X1 and X2 may become oxidized or dirty. Before connecting the cables, check the condition of the contacts: if dirty or oxidized, clean them using antioxidants or degreasing products.

1. Connect the cables to the equipment as shown in Figure 26 when connecting a cable per screw or in Figure 27 when connecting two cables per screw
2. Tighten the connections as indicated in Table 26 for connections on X1 (AC connections) and in Table 28 for connections on X2 (DC connections)
3. The type of connection entails that the cables are terminated by ring lugs suitable for connections on copper bars. The diameter of the lug hole must range from 11.5 (0.453") to 12.5 mm (0.503").

	The installer is responsible for the connection of the PV field and the grid cable. The installer is also responsible for the termination of such cables. Lugs should be crimped with dies and equipment recommended by their manufacturer.

	Use Thomas and Betts lugs with M12 hole for cables AWG4/0 (Part Number 58165) or equivalent products. Use proper tightening tools as recommended by the lug manufacturer. Be sure to respect the recommended tightening torques.

WARNING	Electrical Connections Options for REFERENCE ONLY. Please check with Local Building and Electrical Code for approval prior to start-up of the equipment.

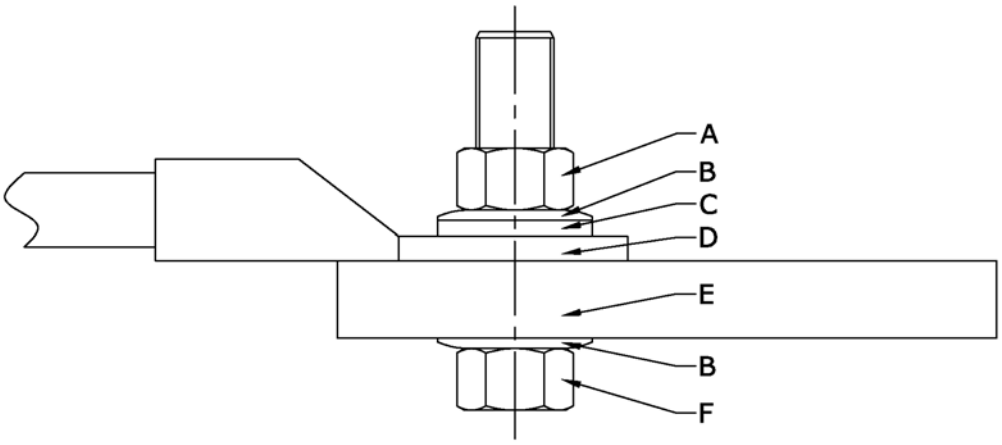


Figure 26: Power circuit (X1-X2), electrical connection of one cable per screw

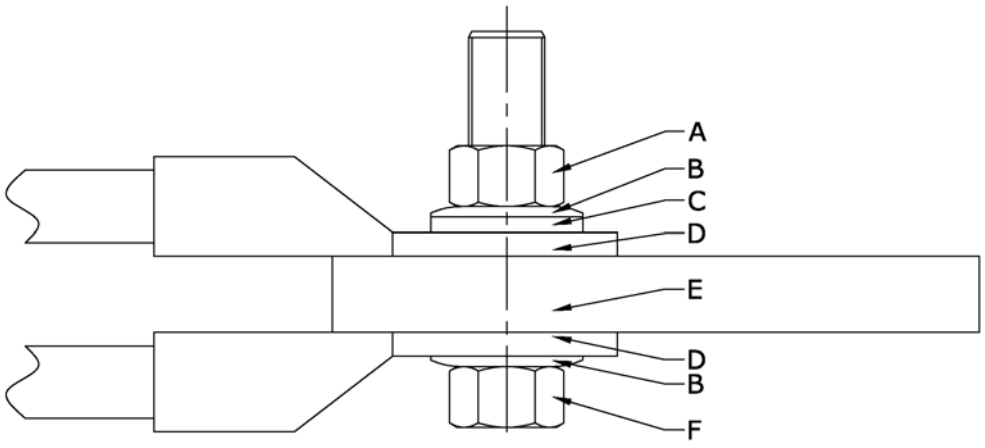


Figure 27: Power circuit (X1–X2), electrical connection of two cables per screw

A – Nut
B – Spherical washer
C – Flat washer
D – Lug
E – Terminal board copper bar
F – Screw

All the parts shown in Figure 26 and Figure 27 are supplied with the Santerno TG NA inverter.

9.6. Preliminary Checks

DANGER	Danger of electrocution. Only Qualified personnel may operate on the equipment when doors are open and voltage is applied.

Before starting the equipment, check its status as described in the sequence below.

1. AC C/B and DC switch in open position (OFF)
2. DC line input fuses (X2) removed
3. Equipment OFF
4. PV field and grid cables connected (X1, X2)
5. Signal cables connected (X3, X4, X7)
6. PV field disconnect switches in open position (OFF)
7. Maintenance key 3 in Figure 2 (by-pass interlock doors) on 'disabled'

Proceed as follows:

1. Insert fuses in terminal board X2
2. Close the AC C/B
3. Close the disconnect switches of the PV field
4. Check polarity of the DC field. Proceed if correct, otherwise open the disconnect switches of the PV field, reverse polarity and re-test starting the procedure again.

DANGER	Danger of electrocution. Remove voltage from the PV field before operating on the wiring system to reverse polarity.

5. Reopen the disconnect switches of the PV field
6. Open the AC C/B
7. Insert fuses in fuse holders 30F1 and 30F2 according to the wiring diagram
8. Close C/B (ON) 30Q1 - 30Q2 - 30Q3 - 30Q4 - 30Q5
9. Close again the disconnect switches of the PV field
10. Close switch on the AC C/B
11. Close switch on DC side

You can now proceed with the checks described in the following sections.

9.6.1. Voltage Check

Please refer to the wiring diagram for this check.

1. Check if auxiliary voltage is applied to the poles of C/B 26QM1; check aux voltage value
2. Check if 110V AC auxiliary voltage is applied to the poles of C/B 30Q1; check aux voltage value
3. Check if AC auxiliary voltage of the utility is applied to the poles of fuse holder 30F3; check aux voltage value
4. Check if 24V DC auxiliary voltage is applied on the poles of C/B 30Q4; check aux voltage value

In case of negative results, please contact Santerno Inc. Service Personnel.

9.6.2. Ventilation Check

Turn on the equipment as described in the Operating instructions manual and visually check if all fans are on. Refer to the wiring diagram to identify how many fans the equipment is supplied with.
The air flow should be bottom-up.
Make sure that all shutters open when fans are on. If not, manually check that the shutters are not mechanically locked. If this is the case, force the release, then try again; if they still do not open automatically when ventilation is started, please contact Santerno Inc. Service Personnel.

9.6.3. INTERNAL THERMOSTAT CHECK

The equipment is provided with an internal thermostat, which is set at 60°C (140°F). Before starting the equipment, check if the thermostat is set to that value.
When the thermostat activates, the DC side disconnect switch opens.

9.6.4. INTERNAL ANTI-CONDENSATION THERMOSTAT CHECK (OPTIONAL)

If the equipment is provided with an anti-condensation system, an internal thermostat is supplied, which is set at 5°C (41°F). Before starting the equipment, check if the thermostat is set to that value.

9.6.5. PROGRAMMING

Programming is covered in the Operating Instructions manual supplied with the equipment.

10. RESETTING THE PROTECTIVE DEVICES

10.1. AC Circuit Breaker 26QM1

This is a MCCB operated by the rotary handle mounted on the door. If used, it moves to the TRIP position; the switch then resets and brings the handle on OFF and then on ON.
The ON, OFF, and Trip positions are shown on the manoeuvre picture in Figure 28.



S000222

Figure 28: AC switch manoeuvre

The switch can be locked to the OFF position (max. 3 locks) as shown in Figure 29.



S000217

Figure 29: Locked AC switch

10.1.1. DC DISCONNECT SWITCH 26QM1

The DC disconnect switch is a disconnecting device that can be controlled via its rotary handle mounted on the cabinet door. It is also provided with a release coil controlled by the operating logic of the equipment.
The ON, OFF positions are indicated on the rotary handle (Figure 28).
The DC disconnect switch can be locked to the Open position (max. 3 locks) as shown in Figure 29.

10.1.2. GFDI 20F2

This is a fuse protective device tripping when the pole of the PV field is not properly grounded due to a fault.
This protective device interrupts the fault current and sends a failure indication (lamp 9 in Figure 2 ON).

	The photovoltaic field is grounded internally to the inverter. Do not carry out any external ground bonding for the photovoltaic field.

When the protective device trips, remove the cause responsible for the protection activation and reset the protective device by replacing the fuse as described in the wiring diagrams.

DANGER	Danger of electrocution. Insert the fuse with the striker upward.



Figure 30: Correct positioning of GFDI fuse

S000224



Figure 31: Wrong positioning of GFDI fuse

10.1.3. PROTECTIVE DEVICE AGAINST PV FIELD POLARITY MISMATCH 20F1

This is a fuse protective device tripping when the poles of the PV field are mismatched.
This protective device interrupts the fault current and sends a failure indication (lamp 10 in Figure 2 ON).

When the protective device trips, remove the cause responsible for the protection activation and reset the protective device by replacing the fuse as described in the wiring diagrams.

DANGER	Danger of electrocution. Insert the fuse with the striker upward.



Figure 32: Correct positioning of GFDI fuse



S000224

Figure 33: Wrong positioning of GFDI fuse

10.1.4. PV Field Cable Protective Device 18F1...18F4

This is a fuse protective device for the protection of the PV field cables.
When the protective device trips, remove the cause responsible for the protection activation and reset the protective device by replacing the fuse as described in the wiring diagrams..

DANGER	Danger of electrocution. Replace only when no voltage is delivered from the PV field.

10.1.5. Control Circuit and Service Protections

There are two types of protections:

1. Fuses
2. Circuit breakers

In the first case, after the protection is activated, replace the fuse with an identical one (refer to wiring diagrams).
In the second case, if the protection is activated, just move the control lever to ON to restore it.

In both cases, if the protection is activated, search for and resolve the fault that caused the intervention before restoring the protection.

11. HOW TO CONTACT THE CUSTOMER SERVICE

The following information is required when contacting Santerno Inc.'s Customer Service:

- Product model
- Serial Number
- Date of Commissioning
- ID of the Confirmation of Order, if available

If the product is an inverter, the data below shall be retrieved from its memory:

- Hours running (see Operating Instructions manual)
- Fault List (see Operating Instructions manual)

You can retrieve this data using the display/keypad or via the RemoteSunway in local/remote mode.

Please contact Santerno Inc. for repairing or returning the equipment.

12. ROUTINE MAINTENANCE

The routine maintenance is defined in Table 29.

The Operator is only allowed to carry out cleaning operations of the outside of the equipment.
The external cleaning must be carried out once a year, or more often, depending on the conditions of the installation site.
Use a cloth moistened with water.

	Do not use solvents.

Code of the Maintenance Activity	Maintenance Tasks	Maintenance Interval (recommended)
OM1	Read the stored data and Fault List	Every month
OM2	Check the external/internal conditions of the electrical cabinet	Every 6 months
OM3	Air filter maintenance	Every 6 months
OM4	Check the emergency stop	Every 12 months
OM5	Check the door microswitches	Every 12 months
OM6	Check the gaskets, locks and hinges	Every 12 months
OM7	Check the fans	Every 6 months
OM8	Check control and auxiliary voltages (110 V and 24 V)	Every 6 months
OM9	Check fuses, relays, circuit breaker and disconnect switch	Every 6 months
OM10	Check the tightening torques	Every 12 months
OM11	External visual inspection	Every 12 months
OM12	Check the anticondensation heater	Every 6 months
OM13	Check the microswitches on the DC input fuses	Every 12 months
OM14	Calibrate environmental sensors	Every 12 months

Table 29: Routine maintenance tasks

12.1. Reading the Stored Data and Fault List

To guarantee correct operation of the system, all its components must be correctly matched up. Incorrect operation leads to lower efficiency with a subsequent reduction in system profitability.
The inverter includes functions to warn the user of failures or faults affecting the system. Periodical checks of system operation are in any case still necessary for the detection of minor operating faults which are not associated with an alarm. The inverter's alarm memory and the data stored in the Data Logger (if installed) must be analyzed at least once a month. To do this, proceed as described in the Operation Instructions Manual.

12.2. Checking the External/Internal Conditions of the Electrical Cabinet

To check the external/internal conditions of the electrical cabinet, proceed as follows:

OVERALL CONDITION OF THE CABINET:
Check the external condition of the cabinet.
Check the state of the insulating sheaths on the conductors.
Check that there are no signs of overheating on the power conductors (especially near the connection points on the equipment).
Check that there are no signs of cable gnawing caused by rodents.
Check the state of all the signs/dataplates affixed to the equipment. Signs must always be in good condition and legible.

GENERAL CABINET CLEANING
Check the interior of the cabinet for the build-up of dust, dirt, humidity and infiltration of water from the outside.
Check that the ventilation ducts on the inductors and transformers are clear.

Should it be necessary to clean the Santerno TG NA, always adopt adequate measures. The electronic section in the Santerno TG inverter series is well protected and hence does not require any maintenance.
Carry out a visual inspection only and clean the printed circuit board with a soft brush or a vacuum cleaner fitted with a soft cleaning tool. The cleaning accessories used must be antistatic tools in compliance with ESD specifications.
Do not use heavy brushes or brushes with coarse bristles.
NEVER use compressed air for cleaning operations.

DANGER	Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death! NEVER work on the equipment unless it is switched off and disconnected from the power supply.

DANGER	Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death! Do not touch any components other than those specifically indicated in the instructions.

12.3. Air Filter Maintenance

DANGER	Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death! NEVER work on the equipment unless it is switched off and disconnected from the power supply.

To clean or replace the filters in the air suction system, remove the relative grilles.

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

12.4. Checking the Emergency Stop

DANGER	Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death! Do not touch any components other than those specifically indicated in the instructions.

To check correct operation of the emergency stop switch, proceed as follows:

- STOP the inverter.
- Make sure that key-operated selector switch 50S2 is turned to DISABLED.
- Open the doors.
- Make sure that the inverter is connected to both supply voltages (DC and AC) and that it is powered.
- Check that the external emergency stop button has not been activated.
- Press the emergency stop button.
- Check that the AC and DC control devices on the inverter are correctly opened.
- Release the emergency stop button.
- Close the AC and DC control devices on the inverter.
- Close electrical cabinet doors.
- Turn key-operated selector switch 50S2 to ENABLED.

12.5. Checking the Door Microswitches

DANGER	Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death! Do not touch any components other than those specifically indicated in the instructions.

To check correct operation of the door opening safety microswitches, proceed as follows:

- STOP the inverter.
- Make sure that the inverter is connected to both supply voltages (DC and AC) and that it is powered.
- Make sure that key-operated selector switch 50S2 is turned to ENABLED.
- Open the doors.
- Check that the AC and DC control devices on the inverter are correctly opened.
- Turn key-operated selector switch 50S2 to DISABLED.
- Close the AC and DC control devices on the inverter.
- Close electrical cabinet doors.
- Turn key-operated selector switch 50S2 to ENABLED.

12.6. Checking the Seals, Locks and Hinges

DANGER	Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death! NEVER work on the equipment unless it is switched off and disconnected from the power supply.

To check the cabinet door seals, locks and hinges, proceed as follows:

- Visually inspect the cabinet seals for any signs of cracking or damage. Any seals showing signs of damage in the areas of door contact must be completely replaced.
- It is suggested to use talc to stop the seals from sticking to the sheet metal of the cabinet over time.
- Check correct operation of the inverter cabinet and compartment locks by locking and unlocking the doors.
- Check the door hinges operate smoothly.
- Spray all movable parts and parts subject to wear with a water-free lubricant.

12.7. Checking the Fans

DANGER	Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death! Do not touch any components other than those specifically indicated in the instructions.

Check operation and noisiness of all the fans. If it is necessary to open the doors to carry out this inspection, proceed as follows:

- STOP the inverter.
- Make sure that the inverter is connected to both supply voltages (DC and AC) and that it is powered.
- Make sure that key-operated selector switch 50S2 is turned to DISABLED.
- Open the doors.

12.8. Checking Control and Auxiliary Voltages (110 V and 24 V)

DANGER	Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death! Do not touch any components other than those specifically indicated in the instructions.

To check the cabinet control and auxiliary voltages, follow the instructions provided below.
The exact position of the control points can be seen on the Electrical and Mechanical Diagram.

To check the 24 Vdc power supply proceed as follows:
STOP the inverter.
Make sure that the inverter is connected to both supply voltages (DC and AC) and that it is powered.
Make sure that key-operated selector switch 50S2 is turned to DISABLED.
Open the doors.
Check the presence of 24 Vdc control voltage on the terminals referring to switch 30Q4 (see Figure 34).

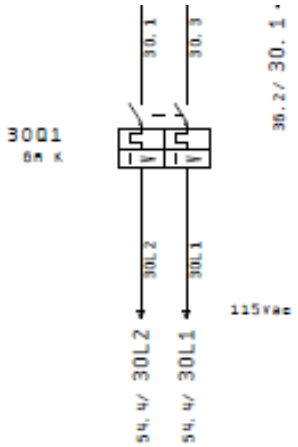


Figure 34: Checking the 24 Vdc control power supply

- Open the PV generator DC switch (20QM1).
- Check the presence of 24 Vdc control voltage on the terminals referring to fuse holder 16F3.
- Close the PV generator DC switch (20QM1).
- Open the electric grid AC switch 26QM1).
- Check the presence of 24 Vdc control voltage on the terminals referring to fuse holder 16F3.
- Close the electric grid AC switch (26QM1).
- Close electrical cabinet doors.
- Turn key-operated selector switch 50S2 to ENABLED.

To check the 110 Vac power supply proceed as follows:
STOP the inverter.
Make sure that the inverter is connected to the AC supply voltage and that it is powered.
Make sure that key-operated selector switch 50S2 is turned to DISABLED.
Open the doors.
Check the presence of 110 Vac voltage on the terminals referring to switch 30Q1 (see Figure 35).

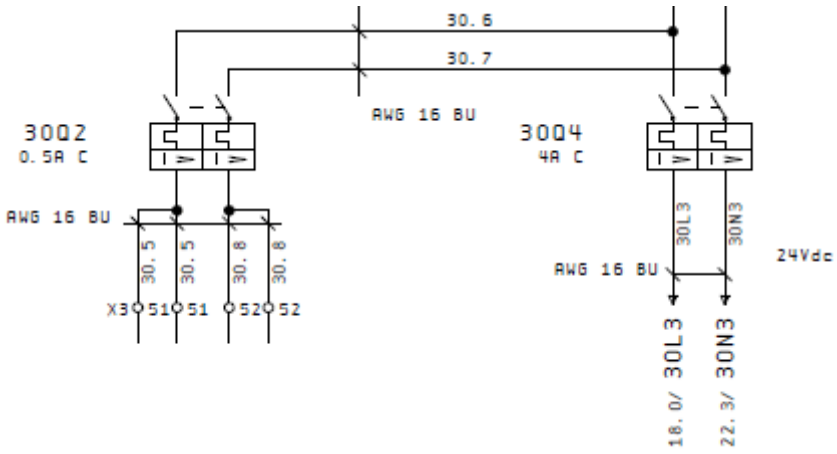


Figure 35: Checking the 110 Vac control power supply

Close electrical cabinet doors.
Turn key-operated selector switch 50S2 to ENABLED.

12.9. Checking the Relays, Fuses, Circuit breaker and Disconnect switch

DANGER	Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death! NEVER work on the equipment unless it is switched off and disconnected from the power supply.

This section refers to relays, fuses and fuse holders/disconnect switches located inside the cabinet.

Visually inspect the installed fuses and the fixing springs on the fuse holders.
If necessary, grease the contact points on the holders.
Visually inspect the installed relays, checking that they fit well into their holders.

12.10. Checking the Tightening Torque

The Santerno TG cabinets have special Belleville springs in all the internal tightening points for the copper bars and power cables. Usually no maintenance on these points is required.
However, for all tightening works carried out in the field, in order to guarantee correct tightness of the electrical contacts, periodical checking of the tightening torques is to be carried out over the equipment's life cycle.

Check the tightness of all the terminal clamps for connecting the power wiring and tighten if necessary.
Pay particular attention to any colour variations or anomalies concerning the insulation and the terminals.

DANGER	Risk of death from electrocution. Dangerous voltage flows when the solar panels are exposed to direct solar radiation. Open the PV field box switches and prevent accidental closing. Before operating on the equipment, make sure it is isolated. Connect the ground wire to GND terminal as the first cable.

	The maintenance operations must be recorded in the Maintenance Record Tables provided as Annex 4.

12.11. External Visual Inspection

A visual inspection of the electrical cabinet is required to prevent the external surface from being attacked by rust.
If the external coating of the cabinet is spoilt, apply a rust-proof product and coat the affected area again.
If rust is found, contact Elettronica Santerno Inc. to ask for replacing the affected part.

12.12. Checking the Anticondensation Heater

Check the operation of the anticondensation heater. Close relay 52KA7 by operating on the toggle lever. Make sure that the fan in heater 36R1 is on and that the heater is hot. The heating process may take a few minutes.

12.13. Checking the Microswitches on the DC Input Fuses

Check if the microswitches on the DC input fuses (18F1..18F4) switch correctly. When the toggle lever is pushed upward, the switch clicks (this indicates that switching is successful). Use a multimeter to check if the microswitch opens the link between 30L3 and 18.5 (18.8 if the link is connected to a floating PV array).

12.14. Calibrating the Environmental Sensors

The Santerno TG NA cabinets have special calibration parameters for each channel relative to environmental measures. Please refer to the Operator manual.

13. ANNEX

13.1. Annex 1 – Maximum Voltage Derating

When the equipment is to be installed at high altitudes, the maximum allowable DC voltage, such as the maximum allowable Voc, applicable to the inverter is to be derated as in Table 30:

Altitude [m]	Maximum DC/Voc voltage
0-2000	Based on Table 4
2001-3000	846 V

Table 30: Maximum correction factor based on altitude

For installations above 3000m, please contact Santerno Inc.

13.2. Annex 2 – Rated Power Derating

If the ambient temperature exceeds 50°C (122°F), the inverter limits its output power to prevent overtemperature from damaging the internal components. Figure 36 shows the curve of the maximum power delivered based on the ambient temperature. This applies to installations at sea level.

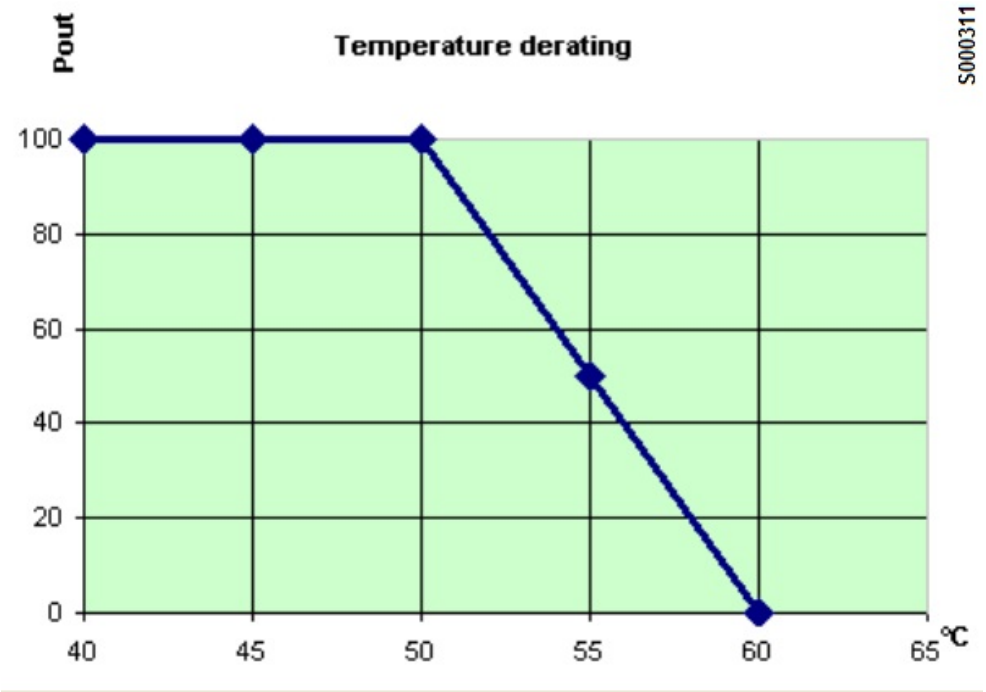


Figure 36: Temperature derating (at sea level)

Both temperature and altitude affect the continuous power output of the inverter.
The **'Kt'** coefficient is assigned to ambient temperature, whereas the **'Ka'** coefficient is assigned to altitude. See Figure 37 and Figure 38.

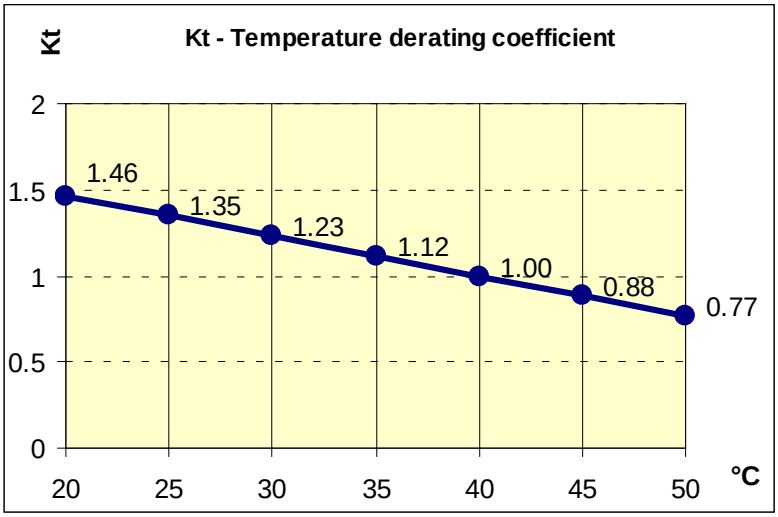


Figure 37: Kt coefficient for temperature derating (at sea level)

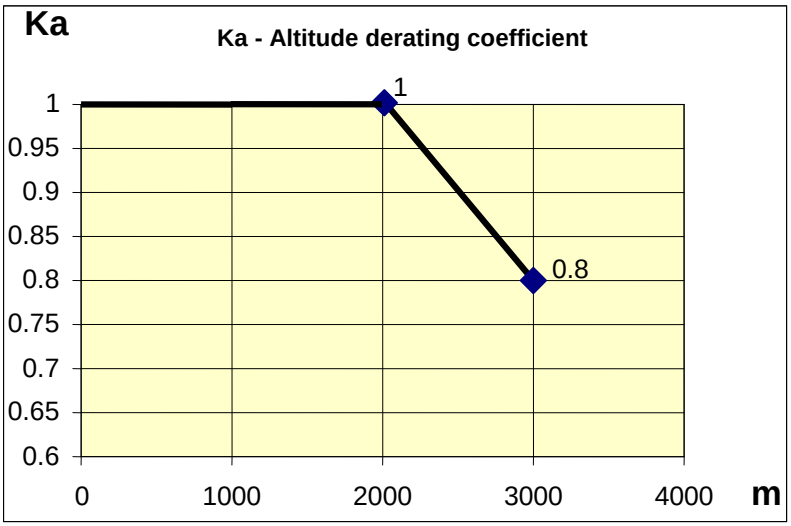


Figure 38: Ka coefficient for altitude derating

The following calculation method is used for rated power derating:

Calculation of the coefficients	Condition	Pnom Calculation
Ktot = Kt x Ka	If Ktot ≥ 1	Pnom unchanged
Ktot = Kt x Ka	If Ktot < 1	Pnom = Pnom x Ktot

Table 31: Calculation of the coefficient for the reduction of the rated power

13.3. Annex 3 – Operating Intervals

The Santerno TG NA inverters are designed to operate in accordance with IEEE 1547 and CSA 107.1. The voltage intervals are given in Figure 39. The disconnecting intervals in accordance with the regulations in force are given in Table 32.

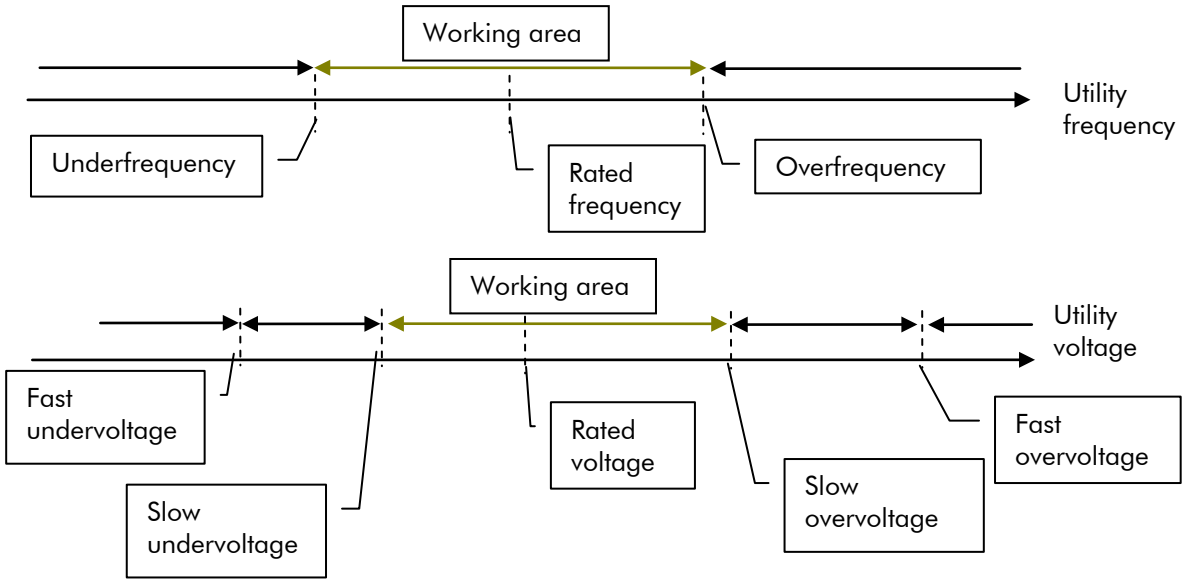


Figure 39: Voltage and frequency limits

Condition	CSA 107.1			IEEE 1547		
	Voltage (Nominal output rating)	Frequency (Hz)	Max number of cycles before disconnection	Voltage (Nominal output rating)	Frequency (Hz)	Max number of cycles before disconnection
Fast undervoltage	V<50%	rated	6	V<50%	rated	10
Slow undervoltage	50%<V<88%	rated	120	50%<V<88%	rated	120
Slow overvoltage	110%<V<137%	rated	120	110%<V<120%	rated	60
Fast overvoltage	V>137%	rated	2	V>120%	rated	10
Underfrequency	rated	f<rated – 0.5Hz	6	rated	<57.0	10
				rated	Adjustable 57.0-59.8	Adjustable 10-18000
Overfrequency	rated	f>rated + 0.5Hz	6	rated	>60.5	10

Table 32: Trip time

13.4. Annex 4 - Maintenance Record Tables

	Electrocution hazard. Make sure that voltage has been removed from the grid and the PV field before operating on the equipment. Open the grid circuit breaker and the DC circuit breaker and take any safety measure to avoid accidental closure of both circuit breakers. Service personnel only are authorized to operate on the equipment.

Record any maintenance intervention to the Maintenance Record Tables below.

OM1	Stored data and Fault List reading	Every month

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

OM2	Cabinet inside/outside check	6 months

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

OM3	Air filter maintenance	6 months

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

OM4	Emergency stop check	12 months

This maintenance activity involves checking the operation of the door control switches by opening one door at a time and making sure that the DC disconnect switch and the grid switch open.
In case of failure, please contact The Customer Service of Santerno Inc.

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

OM5	Door microswitch check	12 months

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

OM6	Gaskets, locks, and hinges check	12 months

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

OM7	Fan check	6 months

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

OM8	Control and auxiliary voltages (110 V and 24 V) check	6 months

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

OM9	Fuses and disconnect switches check	6 months

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

OM10	Tightening torques check	12 months

No.	DATE	NOTES	SIGNATURE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

14. APPENDIX

14.1. Min. and Max. Section Tightening Torques

Tightening torques for bar-to-bar or bar-to-Flexibar connections with 8.8 screws:

Bolt diameter	M6	M8	M10	M12	M14	M16
Tightening torque (Lb.ft./Nm)	7.37 (10)	18.44 (25)	36.87 (50)	66.38 (90)	103.3 (140)	154.89 (210)

Tightening torques for the connection of impedance and transformers using 8.8 screws:

Bolt diameter	M3	M4	M5	M6	M7	M8	M10	M12	M14
Tightening torque (Lb.ft./Nm)	0.73 (1)	2.21 (3)	3.68 (5)	6.63 (9)	10.32 (14)	15.488 (21)	30.97 (42)	53. 10 (72)	(84.08) 114

14.2. ES847 Board

14.2.1. TERMINALS IN ES847 BOARD

Screwable terminal board in twelve extractable sections suitable for cable cross-sections 0.08÷1.5mm^2 (AWG 28-16).

N.	Name	Description	I/O Features	DIP-switches/Notes
1-2		NOT USED – DO NOT CONNECT		
3	CMA	Analog inputs 0V (common with control 0V)	Control board Zero Volts	
4-5	+15VM-15VM	Stabilized bipolar power supply output protected against short-circuit for external sensors.	+15V, -15V; Iout max: 100mA	
6	CMA	Analog inputs 0V (common with control 0V)	Control board Zero Volts	
7-26		NOT USED – DO NOT CONNECT		
27	XAIN8/T1+	Aux analog input, AMBIENT MEASURE 1	Vfs = 10V, Rin = 30kΩ	SW1.3 = ON SW1.1-2-4 = OFF
			Vfs = 100mV, Rin = 1MΩ	SW1.4 = ON SW1.1-2-3 = OFF
			Ifs = 20mA, Rin = 124,5Ω	SW1.2 = ON SW1.1-3-4 = OFF
		Temperature measure of thermostat number 1	Temperature measure PT100	SW1.1-4 = ON SW1.2-3 = OFF
28	CMA/T1-	0V analog input for XAIN8 feedback	Control board Zero Volts	
29	XAIN9/T2+	Aux analog input, AMBIENT MEASURE 2	Vfs = 10V, Rin = 30kΩ	SW1.7 = ON SW1.5-6-8 = OFF
			Vfs = 100mV, Rin = 1MΩ	SW1.8 = ON SW1.5-6-7 = OFF
			Ifs = 20mA, Rin = 124,5Ω	SW1.6 = ON SW1.5-7-8 = OFF
		Temperature measure of thermostat number 2	PT100 temperature measure	SW1.5-8 = ON SW1.6-7 = OFF
30	CMA/T2-	0V analog input for XAIN9 feedback	Control board Zero Volts	
31	XAIN10/T3+	Aux analog input, AMBIENT MEASURE 3	Vfs = 10V, Rin = 30kΩ	SW2.3 = ON SW2.1-2-4 = OFF
			Vfs = 100mV, Rin = 1MΩ	SW2.4 = ON SW2.1-2-3 = OFF
			Ifs = 20mA, Rin = 124,5Ω	SW2.2 = ON SW2.1-3-4 = OFF
		Temperature measure of thermostat number 3	PT100 temperature measure	SW2.1-4 = ON SW2.2-3 = OFF

N.	Name	Description	I/O Features	DIP-switches/Notes
32	CMA/T3-	0V analog input for XAIN10 feedback	Control board Zero Volts	
33	XAIN11/T4+	Aux analog input, AMBIENT MEASURE 4	Vfs = 10V, Rin = 30kΩ	SW2.7 = ON SW2.5-6-8 = OFF
			Vfs = 100mV, Rin = 1MΩ	SW2.8 = ON SW2.5-6-7 = OFF
			Ifs = 20mA, Rin = 124,5Ω	SW2.6 = ON SW2.5-7-8 = OFF
		Temperature measure of thermostat number 4	PT100 temperature measure	SW2.5-8 = ON SW2.6-7 = OFF
34	CMA/T4-	0V analog input for XAIN11 feedback	Control board Zero Volts	
35	XAIN12	Aux analog input, AMBIENT MEASURE 5, 10V f.s.	Fs = 10V; Rin= 30kΩ	
36	CMA	0V analog input for XAIN12 feedback	Control board Zero Volts	
37	XAIN13	Aux analog input, AMBIENT MEASURE 6, 10V f.s.	Fs = 10V; Rin= 30kΩ	
38	CMA	0V analog input for XAIN13 feedback	Control board Zero Volts	
39	XMDI1	Multifunction, auxiliary digital input 1	Used for controlling the output power by means of a device external to the inverter.	
40	XMDI2	Multifunction, auxiliary digital input 2	Used for controlling the output power by means of a device external to the inverter.	
41	XMDI3	Multifunction, auxiliary digital input 3	Energy delivered from the external counter	
42	XMDI4	Multifunction, auxiliary digital input 4	Energy absorbed from the external counter	
43	CMD	Digital inputs 0V isolated with respect to control 0V	Common	
44	+24V	Aux supply output for multifunction to isolated digital inputs	+24 V	
45	XMDI5	Multifunction, auxiliary digital input 5	Used for controlling the output power by means of a device external to the inverter.	
46	XMDI6	NOT USED – DO NOT CONNECT		
47	XMDI7	Multifunction, auxiliary digital input 7	Used for controlling the output power by means of a device external to the inverter.	
48-62		NOT USED – DO NOT CONNECT		

Table 33: Terminals available on ES847 board

14.2.2. Environmental and Electrical Requirements

Operating temperature	0 to 50°C / 32 to 122 °F (ambient temperature)
Relative humidity	5 to 95% (non-condensing)
Max. operating altitude	4000m (4374.45 yards) (above sea level)

Table 34: Environmental requirements

Analog inputs

Analog inputs configured in 0-10V mode	Rating			
	Min	Type	Max	Unit
Input impedance		40		kΩ
Offset and gain error with respect to full-scale value		0.5		%
Temperature coefficient of the offset and gain error			200	ppm/°C
Digital resolution			12	bits
Voltage LSB		2.44		mV/LSB
Permanent overload on the inputs causing no damage to the equipment	-30		+30	V
Cut-off frequency of the input filter (low-pass first order filter)		1		Hz
Sampling period (depending on the application software being used)	10		1000	ms

Table 35: Analog inputs configured in 0-10V mode

Analog inputs configured in 0-20mA mode	Rating			
	Min	Type	Max	Unit
Input impedance		124.5		Ω
Offset and gain error with respect to full-scale value		0.5		%
Temperature coefficient of the offset and gain error			200	ppm/°C
Digital resolution			12	bits
Voltage LSB		4.90		μA/LSB
Permanent overload on the inputs causing no damage to the equipment	-3.7		+3.7	V
Cut-off frequency of the input filter (low-pass first order filter)		1		Hz
Sampling period (depending on the application software being used)	10		1000	ms

Table 36: Analog inputs configured in 0-20mA mode

Analog inputs configured in 0-100mV mode	Rating			
	Min	Type	Max	Unit
Input impedance	1			MΩ
Offset and gain error with respect to full-scale value		0.2		%
Temperature coefficient of the offset and gain error			50	ppm/°C
Digital resolution			12	bits
Voltage LSB		24.7		μV/LSB
Permanent overload on the inputs causing no damage to the equipment	-30		+30	V
Cut-off frequency of the input filter (low-pass first order filter)		1		Hz
Sampling period (depending on the application software being used)	10		1000	ms

Table 37: Analog inputs configured in 0-100mV mode

Analog inputs configured as temperature measure with PT100	Rating			
	Min	Type	Max	Unit
Type of probe	PT100 thermostat, 2-wire connection			
Measure range	-50		125	°C
PT100 polarisation current		0.67		mA
Measure temperature coefficient			50	ppm/°C
Digital resolution			12	bits
Maximum cumulative measure error over -40÷+50°C		0.5	1.5	°C
Average value of temperature LSB (SW linearization function)		0.098		°C/LSB
Permanent overload on the inputs causing no damage to the equipment	-10		+10	V
Cut-off frequency of the input filter (low-pass first order filter)		1		Hz
Sampling period (depending on the application software being used)	10		1000	ms

Table 38: Analog inputs configured as temperature measure with PT100

Power supply outputs

Specifications of the analog supply outputs	Rating			
	Min	Type	Max	Unit
Voltage available in terminal +15V (4) with respect to CMA (6)	14.25	15	15.75	V
Voltage available in terminal +15V (4) with respect to CMA (6)	-15.75	-15	-14.25	V
Maximum current that can be delivered from +15V output and that can be absorbed by –15V output			100	mA

Table 39: Specifications of the analog supply outputs

Specifications of the digital supply outputs	Rating			
	Min	Type	Max	Unit
Voltage available in terminals+24V (44 and 49) with respect to CMD (43 and 50)	21	24	27	V
Maximum current deliverable from +24V output			200	mA

Table 40: Specifications of the digital supply outputs

	Irreversible damage occurs if the min./max. input/output voltage ratings are exceeded.
	The isolated supply output and the analog auxiliary output are protected by a resetting fuse capable of protecting the power supply unit inside the inverter against short-circuits. Nevertheless, in case of short-circuit, it can happen that the inverter does not temporarily lock.

14.3. Comms Port and Comms Protocol

The Santerno TG NA inverters allow extended and modular connectivity, both for the Basic version and for the version with the Data Logger option installed (see section 14.3.3).

- Full integration with Santerno's remote Monitoring service for the detection of the plant performance and the alarms tripped
- Full remote monitoring accessibility for remote control in local and remote mode, both from a PC and from the SunwayPortal.

Connectivity of the Santerno TG NA inverters:
- Up to three RS485 Modbus/RTU serial links available (optically isolated)
- One Ethernet port available

The serial ports of the Santerno TG NA inverters use 2-wire RS485 plus a 0 Volt wire. The standard Modbus/RTU protocol is used.
The inverter will typically behave as a slave Modbus (i.e. it only answers to queries sent by another device); a master device (typically a PC or a Data Logger board) is then needed to start serial communications.
The serial link of the inverter reads the measures internal to the inverter and permits to read, write and save all the parameters pertaining to the inverter operation (COM0 port).
Ports COM1 and COM2 may be used as Modbus Master for communication trunk lines which the Smart String Boxes are connected to.

The ETHERNET port in the Santerno TG NA inverters uses a proprietary Modbus over TCP/IP standard.
Connection is possible via the RemoteSunway or the Remote Monitoring services available from the SunwayPortal.

The connections pertaining to the serial ports are available on terminal board X4 as well. See Table 41.

SERIAL PORT	BASIC version	Data Logger Option	Protocol	Terminal
COM0	Available	Available	Modbus Slave	X4, contacts 1,2,3
COM1	Not available	Available	Modbus Master/Slave	X4, contacts 5,6,7
COM2	Not available	Available	Modbus Master/Slave	X4, contacts 9,10,11

Table 41: Serial ports

The connection for the Ethernet port is available on the Data Logger board. See Table 42.

PORT	BASIC version	Data Logger Option	Protocol	Terminal
Ethernet	Not available	Available	Proprietary Modbus Over TCP/IP	Data Logger board

Table 42: Ethernet port

Please refer to the Operating Instructions manual for the specifications of the comms protocol, the programming of the serial link parameters, the Modbus address, etc.

14.3.1. CONNECTION TOPOLOGIES

The wiring topologies can be point-to-point connections or multidrop connections, as detailed in the sections below.

14.3.2. SANTERNO TG NA – BASIC VERSION

Configuration diagram for the BASIC version of Santerno TG NA inverter.

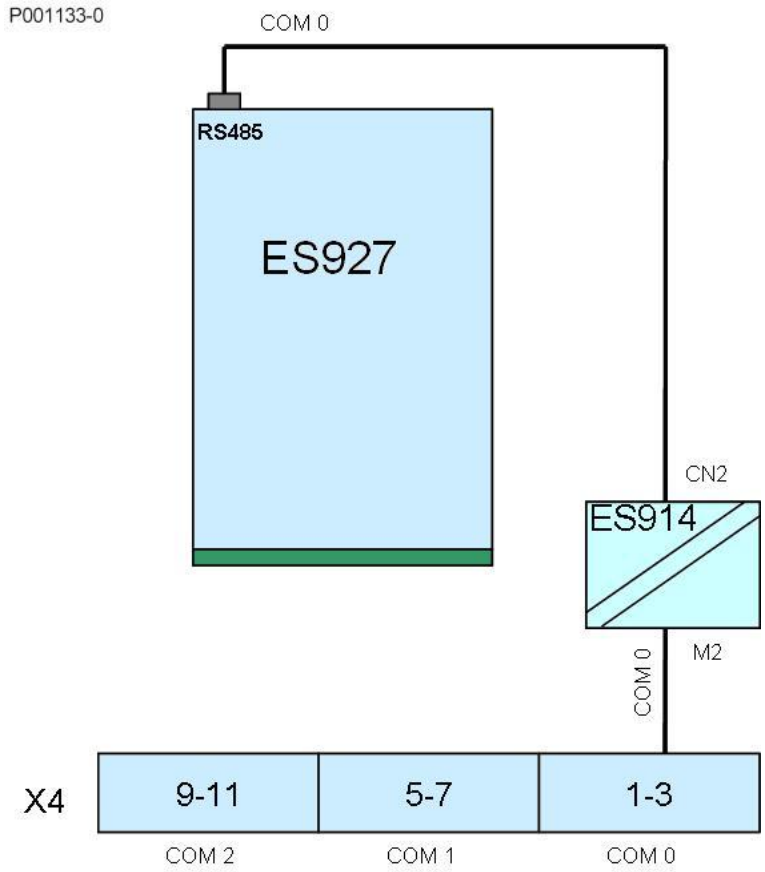


Figure 40: Configuration diagram of a basic Santerno TG NA inverter (no Data Logger board installed)

COM ports on terminal board X4:

- COM0 in ES927 Control board.

The COM0 in control board ES927 is available also on terminal X4 via ES914 board, allowing galvanic isolation for RS485 serial link. This serial link can be used in Modbus Slave mode only. The default Modbus address is 1.

	The values for the voltage bus (when idle) for the COM0 port connected to the drivers in ES914 board providing RS485 galvanic isolation are the following: ▪ 2.7 V for line A ▪ 2.3 V for line B

14.3.3. SANTERNO TG NA WITH OPTIONAL DATA LOGGER BOARD

Configuration diagram for the Santerno TG NA inverter with optional Data Logger board.

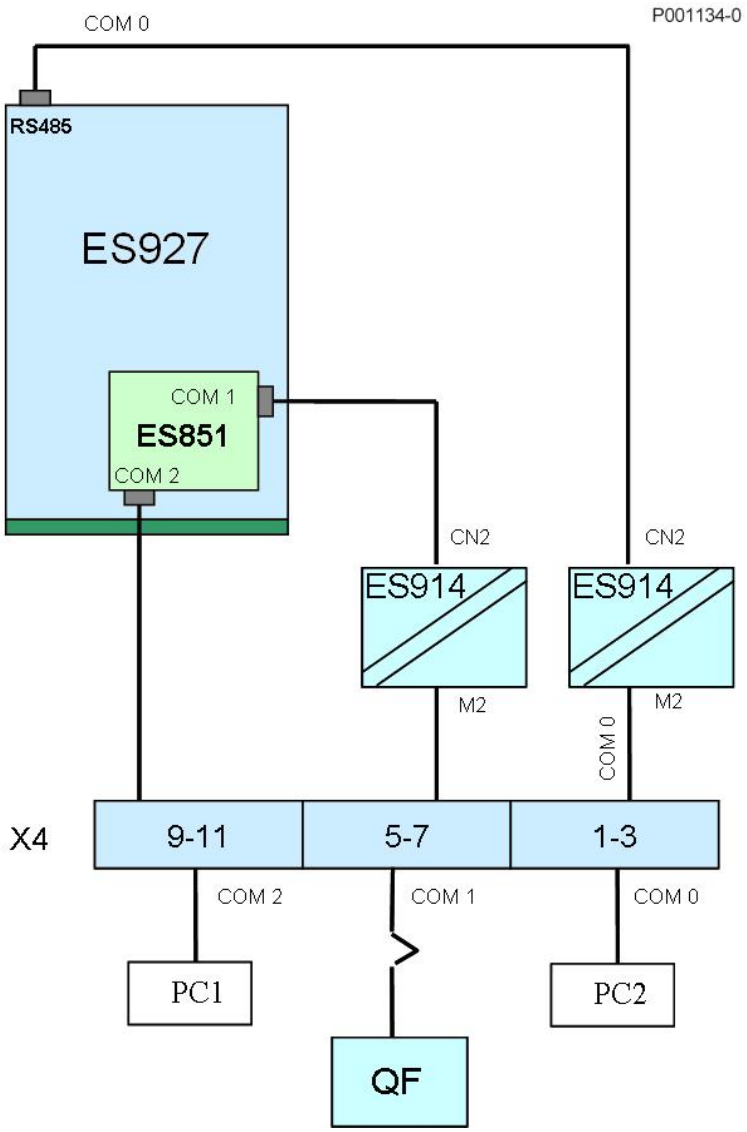


Figure 41: Configuration diagram of a Santerno TG NA inverter with optional Data Logger board

- PC1: a PC, a PLC or a different Modbus Master device
- PC2: a PC, a PLC or a different Modbus Master device
- QF: a trunk line (RS485) between the inverter and the Smart String Boxes (e.g. connected to subfield modules)

COM ports in terminal board X4:

- COM0, ES927 Control board
- COM1, ES851 Data Logger board
- COM2, ES851 Data Logger board

The COM0 port in ES927 control board is available also on terminal board X4 via ES914 board, allowing galvanic isolation for RS485 serial link. This serial link can be used in Modbus Slave mode only.

The COM1 port in the Data Logger board is available also on terminal board X4 by means of ES914 board, allowing galvanic isolation for RS485 serial link. This serial link can be used in Modbus Master or Slave mode. The COM1 port can be used as Modbus Master for PV field trunk lines to the Smart String Boxes.

The COM2 port in control board ES927 is available directly on terminal board X4. The COM2 port is galvanically isolated inside the Data Logger board. It can be can be used in Modbus Master or Slave mode. The COM2 can be used as Modbus Master, but the COM1 is more suitable for the PV field trunk lines reaching the Smart String Boxes.

⚠ CAUTION	If the COM1 port is used as a Master port for the PV field trunk to the Smart String Boxes, manually program the routing table in Data Logger board over COM1 port. Please refer to the Operating Instructions manual.

ℹ	The values for the voltage bus (when idle) for COM2 port connected to the drivers of the Data Logger board are the following: 2.6 V for line A 2.4 V for line B
ℹ	The terminators for COM2 port are disabled. If the COM2 is used for the multidrop connection between inverters, only the terminators of the last connection must be enabled.

14.3.4. INTERCONNECTION OF SANTERNO TG NA INVERTERS WITH DATA LOGGER BOARD

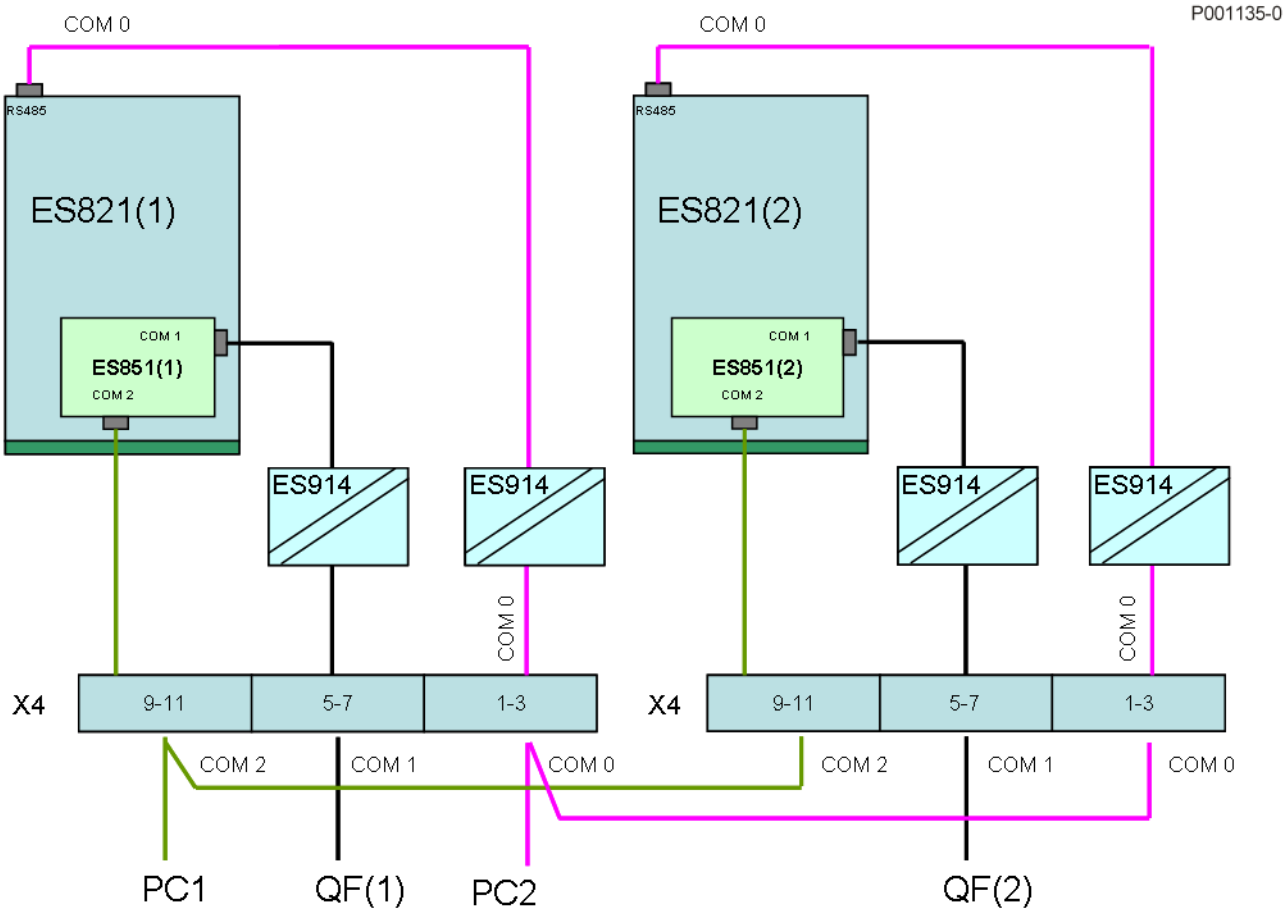


Figure 42: Configuration diagram for Santerno TG NA with multiple optional Data Logger boards

The following external communication devices are shown in the diagram above:

- PC1: a PC, a PLC or a different Modbus Master device.
- PC2: a PC, a PLC or a different Modbus Master device.
- QF(1): a trunk line (RS485) between the inverter and the Smart String Boxes (e.g. connected to subfield modules).
- QF(2): a second trunk line (RS485) between the inverter and the Smart String Boxes (e.g. connected to subfield modules).

14.3.5. POINT-TO-POINT CONNECTION

The point-to-point connection is made by connecting the inverter to a PC, a PLC or a different Master Modbus device.
If a PC is used, this must be provided with one RS485 port, which is an option for most industrial computers. When only USB ports are available, a USB/RS485 converter is required, which can be ordered directly from Santerno Inc.. It is advisable to use the port COM0 on the inverter and to enable the line terminators.

14.3.6. MULTIDROP CONNECTION

A multidrop connection of multiple Santerno TG NA inverters can be made to the RS485 bus.

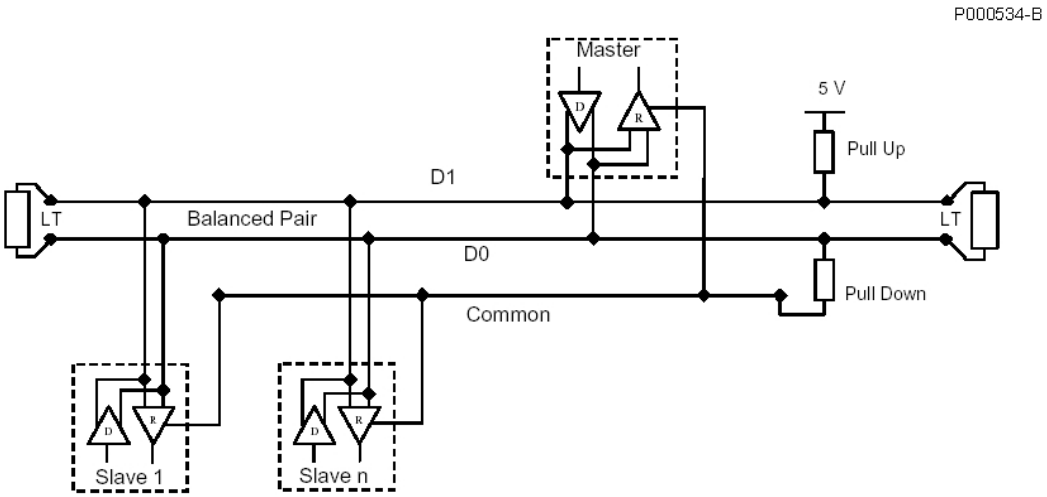


Figure 43: Multidrop connection diagram

Provide a linear wiring (not a star wiring) for RS485 multidrop line. The first device in the multidrop connection will have only one outgoing line, while the last device will have only one incoming line. The line terminator is to be installed on the first device and the last device.

The devices connected to RS485 serial link are called “nodes”. The maximum number of nodes that can be connected depends on the following:
- Logic limit of the bus, or 247
- Length of the connection
- Baudrate
- Electronic drivers being used

The line drivers of the Santerno TG NA inverters accept maximum 30 devices connected in multidrop mode. The cable paths should be no longer than 500m. If more than 30 devices are to be connected to the same line, or if the cable path exceeds 500m, RS485 repeaters should be used.

	The baudrate by default of the RS485 bus is 57600 bauds. It is suggested that this value be not exceeded. Lower baudrates can be set up (38400, 19200 or 9600 bauds) if communications failures occur.

Each inverter has its own ID number in the connection to the PC. In order to change the factory setting for the Modbus addresses, please refer to the Programming Instructions Manual.

14.3.7. CONNECTION

Use terminal board X4 for the connection to the serial link. Please refer to section 14.3 Comms Port and Comms Protocol.

⚠ CAUTION	The module wiring is to be done when NO VOLTAGE is applied to the inverter. Take all the safety measures required before operating on the connectors and before handling the control board.

The MODBUS-IDA (http://www.modbus.org) association defines the type of connection for MODBUS communications over RS485 serial link, which is used by the Santerno TG NA inverter, as a "2-wire cable". Specifications are as follows:

Wiring cable	
Type of cable	Screened cable composed of a balanced pair named D1/D0 + common conductor ('Common'). Recommended cable: Belden 3106A Paired EIA Industrial RS-485 PLTC/CM.
Min. cross-section for the conductors	AWG23 corresponding to 0.258mm^2. For long lengths, cross-sections up to 0.75mm^2 are recommended.
Max. length	500 meters based on the max. distance measured between the two stations that are farthest apart
Characteristic impedance	Greater than 100Ω (recommended): typically 120Ω

ℹ	All the devices connected to the communication multidrop network should be earthed to a common conductor to minimize any difference of ground potentials between devices that can adversely affect communications.
ℹ	All the devices connected to the communication multidrop network should have their common conductor (0V) connected in common to minimize any difference of ground potentials between devices that can adversely affect communications.
ℹ	The common terminal for the supply of the inverter control board is isolated from grounding. If one or multiple inverters are connected to a communication device with a grounded common (typically a computer), a low-impedance path between control boards and grounding occurs. High-frequency disturbance could come from the inverter power components and affect the operation of the communication device. If this happens, provide the communication device with a galvanically isolated RS485 communications interface or with a galvanically isolated RS485/RS232 converter.

⚠ CAUTION	Category 5 cables (two-pair, three-pair or four-pair) cannot be used for obtaining the serial link, even for short cable paths.

14.3.8. COM0 AND COM1 PORTS

The connection to COM0 and COM1 ports is made by means of terminal board X4. See section 14.3 Comms Port and Comms Protocol.

	The COM1 port is available only if the Data Logger option is installed.

The board indicated as 13A1 and 22A3 in the Wiring and Mechanical Diagram implements the galvanic isolation of RS485 signals on terminals X4 of the inverter and the external communication devices. The two RS485 ports in ES914 board are the following:

- MASTER port: connection to devices external to the inverter
- INVERTER port: connection to the ports internal to the inverter. It cannot be accessed by the user.

The line termination can be ON in each port of the galvanic isolation board RS485 ES914. The INVERTER port termination must not be changed.

DIP-SWITCHES FOR RS485 LINK TERMINATION

DIP-switch	Function	Factory setting	Notes
SW1-1, SW1-2 MASTER port terminations	RS485 termination, Master side	Both ON: terminations ON	ON: 150Ω resistor between A and B; 430Ω resistor between A and +5VE; 430Ω resistor between B and 0VE. OFF: no termination resistor and no polarization resistor
SW2-1, SW2-2 INVERTER port terminations	RS485 termination, inverter side **Do not change**	Both ON: terminations ON **Do not change**	ON: 150Ω resistor between A and B; 430Ω resistor between A and +5VM, 430Ω resistor between B and 0VM. OFF: no termination resistor and no polarization resistor

	Communication does not take place or is adversely affected if multidrop terminators are not properly set, especially in case of high baud rate. If more than two terminators are fitted, some drivers can enter the protection mode due to thermal overload, thus stopping dialoguing with some of the connected devices.

Remove the front cover protecting the galvanic isolation board RS485 ES914 DIP-switch SW1.

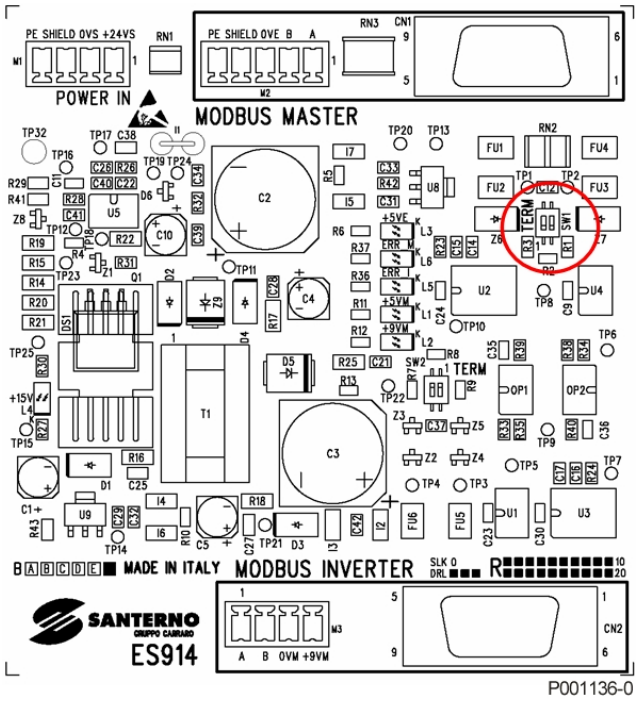


Figure 44: Location of DIP-switch SW1

The factory setting of the DIP-switches is given in the figure below.

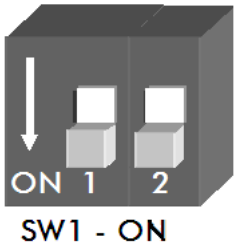


Figure 45: DIP-switch for ES914 board (galvanic isolation RS485 link terminator)

INDICATOR LEDS for RS485 galvanic isolation board (ES914)

	When the bus is idle, its voltage values for COM0 and COM1connected to the drivers in RS485 galvanic isolation board (ES914) are as follows: ▪ 2.8 V for link A ▪ 2.2 V for link B

ES914 board is equipped with 5 LEDs. 3 LEDs are for the detection of the power supply voltages of the board.

LED	Colour	Function
L1	Green	Supply voltage detected for RS485 circuits on the inverter side (5V)
L2	Green	Inverter supply voltage detected (9V)
L3	Green	Supply voltage detected for RS485 circuits on the Master side (5V)

Table 43: Voltage indicator LEDs

2 LEDs are available for the detection of faults occurring in RS485 signals, both to the inverter and to the Master. The FAULT indication is legal only when DIP-switches SW1 and SW2 are both ON.

LED	Colour	Function
L5	Red	RS485 signal faults (to the inverter)
L6	Red	RS485 signal faults (to the Master)

Table 44: Fault indicator LEDs

The possible faults are given below:

- Differential tension between A and B lower than 450 mV
- A or B exceeds the common mode voltage range [–7 V; 12 V]
- A or B is connected to a fixed voltage (this fault can be detected only when communication is established).

Figure 46 shows the indicator LEDs and the configuration DIP-switches.



Figure 46: Location of the indicator LEDs and of the DIP-switches

If serial communication failures occur, refer to the Alarm Code List in the Operating Instructions manual.

14.3.9. COM2 PORT

The connection to COM2 communication port is made by means of terminal board X4. See Table 41.

	COM2 port is available only if the Data Logger option is installed.

DIP-SWITCHES FOR RS485 LINK TERMINATIONS

DIP-switch	Function	Factory setting	Notes
SW-1, SW2-2 RS485 driver power supply	RS485 driver power supply	Both ON: internal isolated RS485 power supply	ON: Internal isolated RS485 driver power supply OFF: External isolated RS485 driver power supply from pin 6 in the connector
SW2-3, SW2-4 COM2 port terminators	COM2 RS485 termination	Both OFF: terminators off	ON: 120Ω resistor between A and B, 1500Ω resistor between A and +5VM, 1500Ω resistor between B and 0VM OFF: no termination resistor and no polarization resistor

Remove the front cover protecting the converter and remove ES847 board (environmental sensors and PV field I/Os expansion board) to reach DIP-switch SW2.

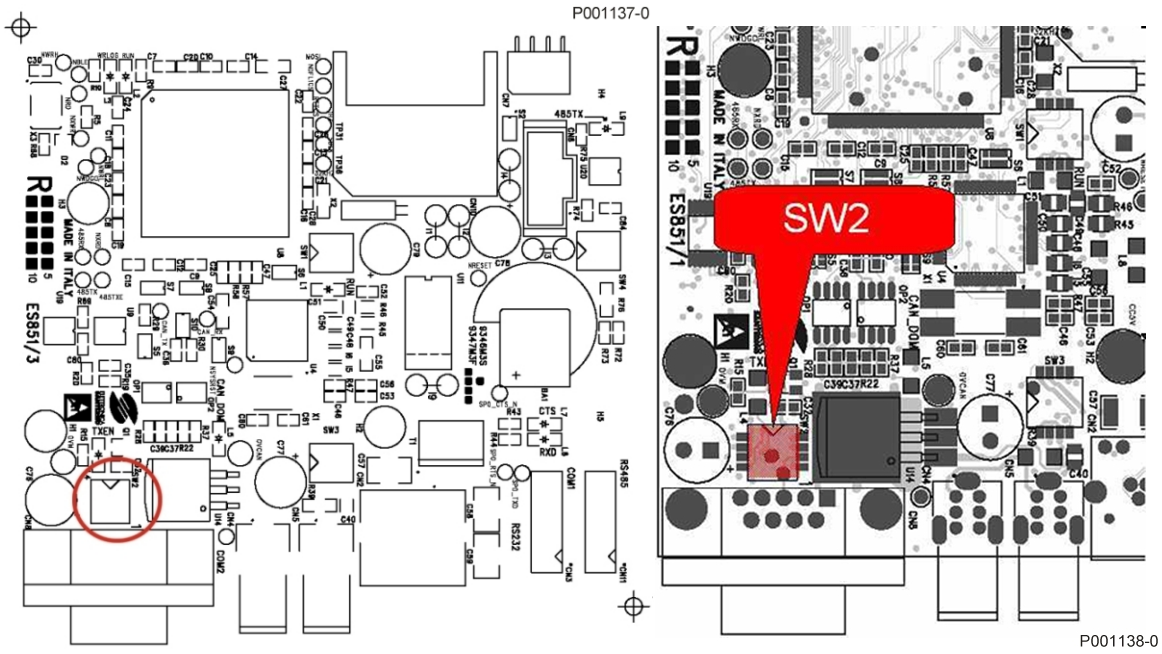
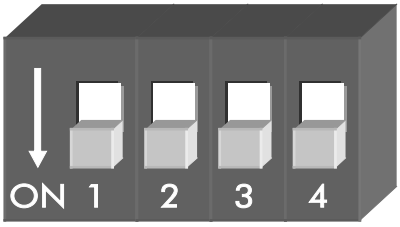


Figure 47: Location of DIP-switch SW2 on Data Logger board

The figure below shows the factory settings of the DIP-switches.



SW2 - ON

Figure 48: DIP-switch for Data Logger terminator

If serial communication failures occur, refer to the Alarm Code List in the Operating Instructions manual.

14.3.10. ETHERNET PORT

The Data Logger board is provided with the standard RJ45 connector (IEEE 802) for 10/100 (100Base-TX, 10Base-T) Ethernet connections. The pin layout is the same as that found in any network adapter on PCs.

	The Ethernet port is available only if the Data Logger option is installed.

Pin layout:

No.	Name	Description
1	TD+	Positive signal transmission line
2	TD-	Negative signal transmission line
3	RD+	Positive signal receiving line
4	Term	Terminated pair, not used
5	Term	Terminated pair, not used
6	RD-	Negative signal receiving line
7	Term	Terminated pair, not used
8	Term	Terminated pair, not used

Figure 49: RJ45 connector

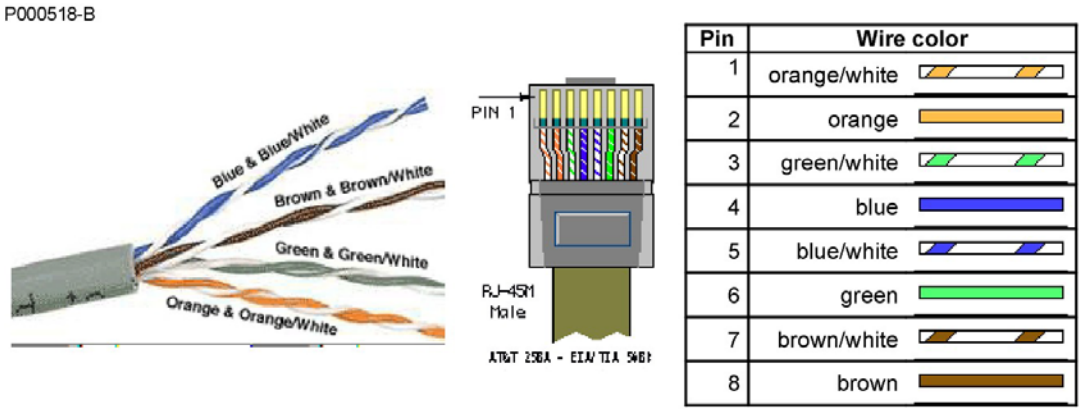
The Data Logger board can be connected through the Ethernet interface to an Ethernet control device with Modbus/TCP Master (PC) protocol in one of the following ways:

- Through a LAN (e.g. Ethernet business network)
- Through a direct point-to-point connection.

The Internet connection through a LAN obtained by connecting the Data Logger to the Switch or the Hub using a standard cable or a Straight-Through Cable TIA/EIA-568-B, cat. 5 UTP (Patch cable for LAN).

	The Ethernet interface board cannot be connected to old LANs using Thin Ethernet (10base2) coaxial cables. Connection to this type of LANs is possible using a Hub provided with both Thin Ethernet (10base2) connectors and 100Base-TX or 10Base-T connectors. The LAN topology is a star one, with each node connected to the Hub or the Switch through its cable.

The figure below shows the Cable of Cat. 5 for Ethernet and the standard colour arrangement in the connector.



Pin	Wire color
1	orange/white
2	orange
3	green/white
4	blue
5	blue/white
6	green
7	brown/white
8	brown

Figure 50: Pair layout in a 5 UTP cable

Direct point-to-point connection is obtained with a Cross-Over Cable TIA/EIA-568-B, cat. 5. This type of cable performs a cross-over of the pairs so that the TD+/TD- pair corresponds to the RD+/RD- pair, and vice versa. The table below shows the colour matching on the connector pins for the Cross-Over Cable and the crossover diagram of the two pairs used from 100Base-TX or 10Base-T connection.

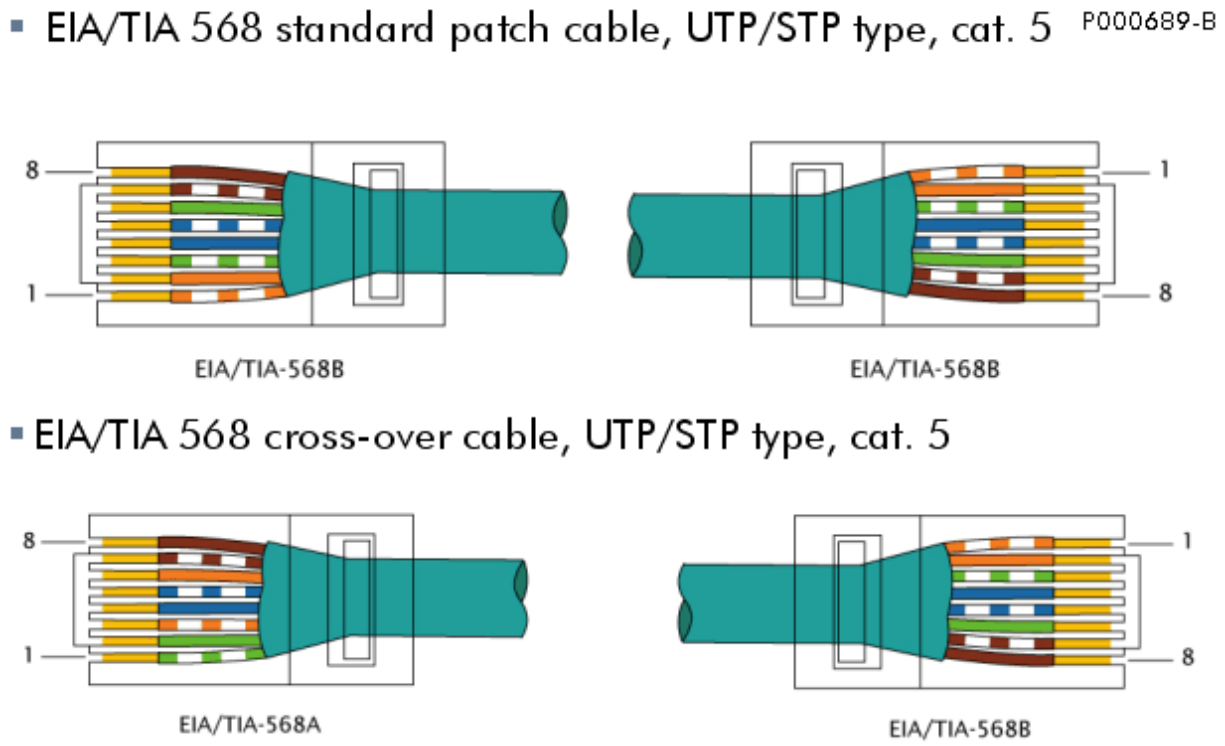


Figure 51: Standard patch cable and cross-over cable EIA/TIA 568 type UTP/STP cat. 5

	The inverter is typically installed with other electric/electronic devices inside a cubicle. Normally, the electromagnetic pollution inside the cubicle is remarkable and is due to both radiofrequency disturbance caused by the inverters and to bursts caused by the electromechanical devices. To avoid propagating disturbance to Ethernet cables, they must be segregated and kept as far as possible from the other power cables and signal cables in the cubicle. Disturbance propagated to Ethernet cables may affect the correct operation of the inverter and the other devices (computers, PLCs, Switches, Routers) connected to the same LAN.
	The maximum length of the LAN cable, cat. 5 UTP allowed by IEEE 802 standards results from the max. transit time allowed from the protocol and is equal to 100m. The longer the cable length, the higher the risk of communications failure..
	For Ethernet wiring, only use cables certified for LAN cables of 5 UTP category or higher. For standard wiring, avoid creating your own cables; Straight-Through or Cross-Over cables should be purchased from an authorised dealer.
	For a proper configuration and utilization of the communications board, the user should be familiar with the basics of the TCP/IP protocol and the MAC address, the IP address and the ARP (Address Resolution Protocol). The basic document on the Web is RFC1180 – "A TCP/IP Tutorial". The English version can be downloaded from: http://www.faqs.org/ftp/rfc/pdf/rfc1180.txt.pdf.

If serial communication failures occur, refer to the Alarm Code List in the Operating Instructions manual.