



Inverter for photovoltaic applications

INSTALLATION MANUAL SOLEIL DSPX TLH 1500



**KEEP FOR FUTURE REFERENCE
for the entire life of the appliance**

INDICE

1	AIM OF THE DOCUMENT	3
1.1	OVERVIEW	3
1.2	GRAPHIC SYMBOLS USED.....	3
2	POSITIONING.....	5
3	POWER CONNECTIONS AND AUXILIARIES	6
3.1	MECHANICAL LAYOUT	6
3.2	CABLE QUANTITY AND SECTION	9
3.3	GROUND CONDUCTOR SIZING	9
3.4	MAXIMUM TORQUE TIGHTENING CABLES	10
3.5	FAN CHARACTERISTIC	10
4	INSTALLATION.....	11
4.1	VISUAL INSPECTION	11
4.2	UNPACKING	11
4.3	SAFETY CONSIDERATIONS	13
4.4	ENVIRONMENTAL CONSIDERATIONS	14
4.4.1	<i>Load-bearing capacity of the floor.....</i>	<i>14</i>
4.4.2	<i>Temperature and humidity.....</i>	<i>14</i>
4.5	INSTALLATION LOCATION OF INVERTERS	14
4.6	INSTALLATION LOCATION OF OUTDOOR INVERTERS.....	15
4.7	POSITIONING AND VENTILATION	15
4.8	ELECTRICAL CONSIDERATIONS	16
4.9	MEDIUM TO LOW VOLTAGE TRANSFORMER FOR CONNECTION TO MV GRID: CRITERIA OF CHOICE.	16
4.10	PREVENTIVE MAINTENANCE	16
5	BASIC INSTALLATION HINTS	17
5.1	POSITIONING OF THE INVERTERS AND VENTILATION	17
6	SYNCHRONIZATION CABLE AND CAN-BUS (MULTI-INVERTER SYSTEMS)	18
7	CONNECTION OF THE EPO CIRCUIT (EMERGENCY POWER OFF)	20
7.1	CONNECTION OF THE MODULES' TEMPERATURE SENSOR	20
8	SERIAL COMMUNICATION CONNECTIONS.....	21
8.1	TYPE OF CABLES TO BE USED	21
8.2	MONITORING SYSTEM AND POWER PLANT CONTROLLER (PPC) RS485 MODBUS COMMUNICATION	21
8.3	CONNECTION OF THE MODBUS SERIAL PORT SHIELD	21
8.4	CONNECTION OF THE SAC BUS SERIAL SHIELD	21
8.5	RULES FOR THE LAYING OF RS485 SERIAL CABLES	21
9	USER SETTINGS.....	24
9.1	CONNECTING AN INPUT POLE TO THE PHOTOVOLTAIC FIELD EARTH	24
9.2	CONTROL FEATURES – NETWORK SERVICES.....	25

1 AIM OF THE DOCUMENT

1.1 Overview

This document constitutes a rapid guide for the installation of the product in the operating room and provides summary and schematic instructions for the positioning and network connection of the product and signal connections.



In no way can this document be considered a substitute for the *IV346 Instruction Manual* to which reference is made particularly for the recommendations contained in it on the issue of safety regarding the handling and electrical connection of the equipment.







The failure to follow the recommendations contained in the *IV346 Instruction Manual* may have serious consequences, such as the destruction of the apparatus, injury to persons and death due to electrocution.








The information and technical features contained in this manual refer to the date of the drafting of the document. SIEL SPA reserves the right to modify such technical features at any moment and without warning.

1.2 Graphic symbols used

The following symbols are used in this manual to warn and inform users of particular situations of special importance. The symbols used and their meanings are explained below.

Simbolo	Descrizione
	INFORMATION Supplementary description to be taken into due consideration. Used for important notes and/or recommendations
	CAUTION Danger (situation which may cause severe injuries to persons and/or damage to equipment)
	ELECTRICAL DANGER Serious risk of electrocution. These warnings signal compulsory behaviour.
	UNPACKING INSTRUCTIONS Describe how to unpack equipment.

	<p>INSTALLATION INSTRUCTIONS Describe the inverter installation process step by step.</p>
	<p>MANDATORY INSTRUCTIONS Read and understand the instruction manual before working on the inverter.</p>
	<p>DISPOSAL Contains information useful for disposal of the equipment.</p>
 	<p>THE WARNING TRIANGLES INDICATE INSTRUCTIONS REGARDING SAFETY FOR STAFF. FOLLOW THEM CAREFULLY TO AVOID DAMAGES TO PERSONS OR OBJECTS.</p>

2 POSITIONING



In the installation of the Soleil product, it is recommended that the distance between the inverter and any walls or other objects be respected, as shown in the following diagrams.

SOLEIL DSPX xxxx TLH 1500

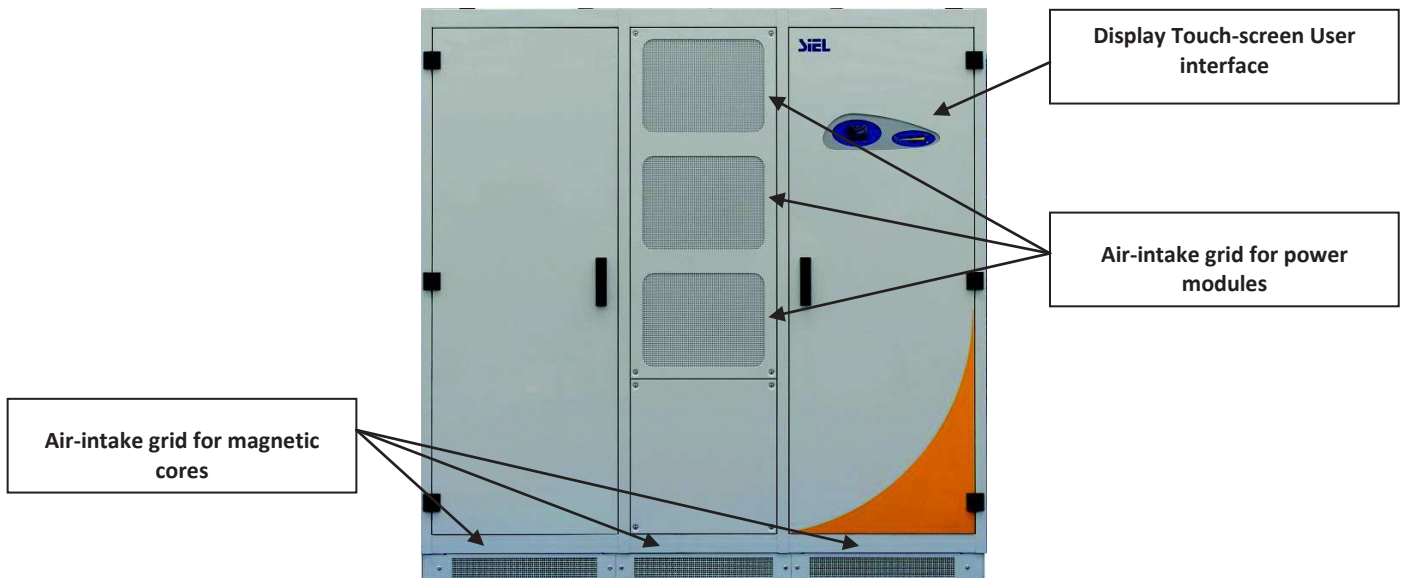


3 POWER CONNECTIONS AND AUXILIARIES

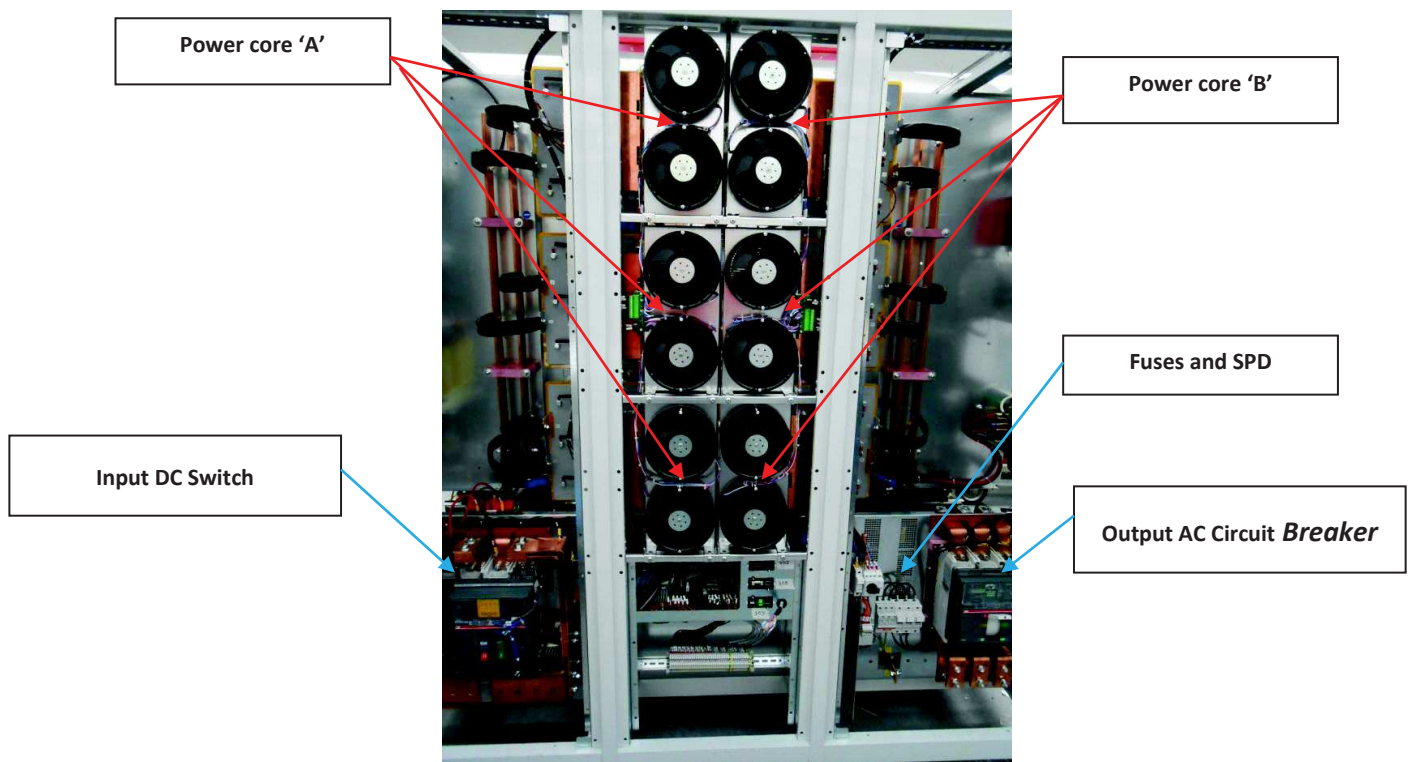
3.1 Mechanical layout

The following figures illustrate the power terminals of the DC (input) and AC (output) sections.

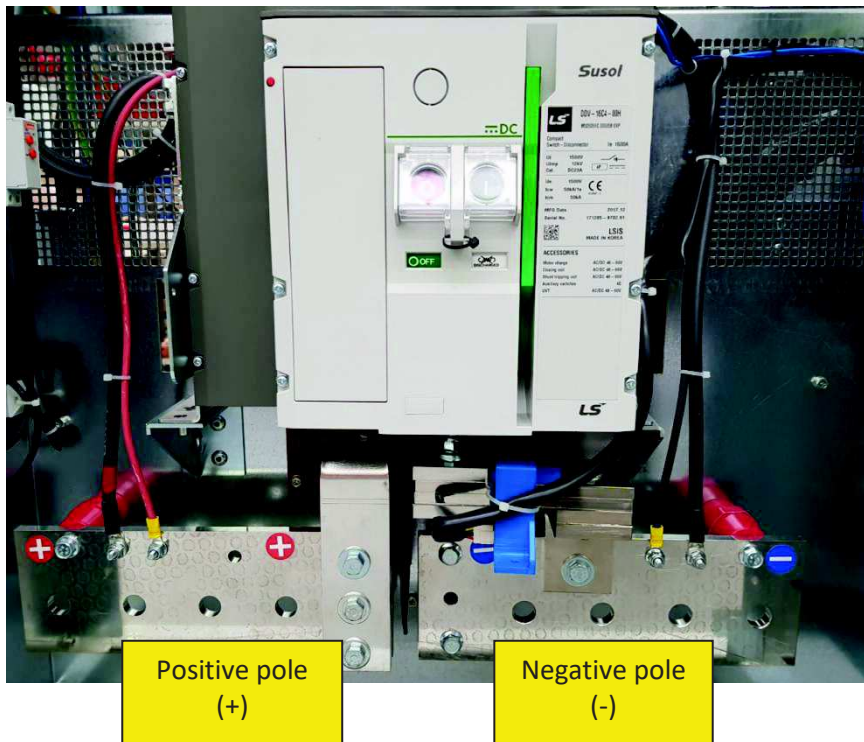
Frontal view of the inverter:



Internal view of the inverter:



DC Terminal side:



AC terminal side:



Connecting AC side cables are dimensioned taking into account the electrical parameters of the circuit breakers, summarised in the following table:

Current(A)-Curve	Magnetic curve	Breaking capacity [kA]
1600A	10 In (Programmable)	50kA



The characteristics (curve type, magnetic current) of the switch on the electrical board connected to the inverter must be compatible with the characteristics of the machine switch.

3.2 Cable quantity and section

The following tables indicate **the maximum quantity and the maximum section of copper-made cables** that can be connected to the DC input and the AC output.

Inverter soleil DSPX xxxx TLH 1500						
Model	550	665	708	1100M	1330M	1415M
AC Cables (cables number x section in mmq)						
Suggestito	2 x 300	2 x 300	2 x 300	4 x 300	4 x 300	4 x 300
Massimo consentito	2 x 300	2 x 300	2 x 300	4 x 300	4 x 300	4 x 300
DC Cables (cables number x section in mmq)						
Suggestito	2 x 300	2 x 300	2 x 300	4 x 300	4 x 300	4 x 300
Massimo consentito	2 x 300	2 x 300	2 x 300	4 x 300	4 x 300	4 x 300
Ground Conductor (PE) (cables number x section in mmq)						
Suggestito	Max 2 cavi (nota 1)	Max 2 cavi (nota 1)	Max 2 cavi (nota 1)	Max 2 cavi (nota 1)	Max 2 cavi (nota 1)	Max 2 cavi (nota 1)

Note 1: Refer to the table for the sizing of the earth wires for the calculation of the total cable section

The type of cable and its cross section to be used must be determined at the design stage by the designer or installer

3.3 Ground conductor Sizing

The size of the ground conductor must be made according to the following table, extracted from the product Safety standard CEI EN 62109-1.

The cross section of the phase conductors connected to the inverter, 'S' mm ²	Relevant minimum cross section of the protective conductor to the ground, Sp
S ≤ 16	S
16 < S ≤ 35	16
35 < S	S/2
NOTE: The values shown in the previous table are valid only if the protective earthing conductor is made of the same material used for the phase conductors AC. If not, the cross section of the protective conductor to ground must be determined in order to get the same conductance value equivalent.	

3.4 Maximum torque tightening cables

Coppia massima di serraggio		
Ingresso DC	Uscita AC	Cavo di Terra
30 N m		

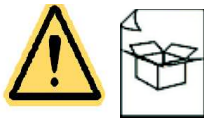
3.5 FAN characteristic

The following table includes the air flow volume and the power dissipation values.

Model	Air capacity aria [m ³ /h] Inverter FAN	Air capacity aria [m ³ /h] Magnetics FAN	Inverter FAN consumption [W]	Magnetics FAN consumption [W]	Dissipated power [kW]
SOLEIL DSPX 1415M TLH 1500	7000	4000	1200	420	17,5
SOLEIL DSPX 1330M TLH 1500					16,5
SOLEIL DSPX 1100M TLH 1500					13,5

4 INSTALLATION

4.1 Visual inspection



All inverter components (electrical and mechanical) are carefully inspected before the unit is delivered to the customer and must be integral even after delivery. Always visually check a UPS after delivery for any transit damage, and immediately inform Siel SPA if such damage is evident.

4.2 Unpacking

The inverter packaging is usually constituted by a plastic ground cloth, put on from the top part of the equipment and lowered till the lower limit of the equipment. Above the ground cloth, a carton box is secured with plastic strips.

In order to unpack the inverter, it firstly required to cut the plastic strips and push the carton toward the top of the unit, until the equipment is totally out of the box. Once this operation is done, it is possible to get the inverter out of its plastic ground cloth.

Removal from the pallet: please use a forklift (with proper capacity for weight). Please refer to chapter (TECHNICAL INFORMATION) of this manual to retrieve the weight information.

Forks of the forklift have to be inserted either from the front or from the rear of the cabinet (never from the lateral side of it).

Due to the weight of the equipment, it is strongly recommended the use of all the safety tools as prescribed by the safety regulation in force in any specific country where the equipment is installed.

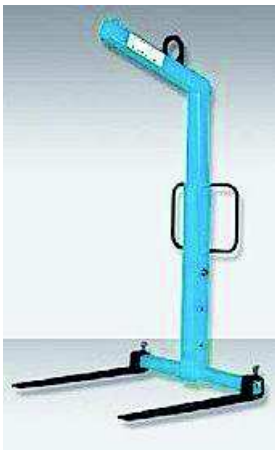


The drive comes with plinths which close the base of the equipment. When the apparatus comes from the factory skirtings are not mounted so that it can be lifted from the bottom with a forklift.

Please do not tilt or lay down the inverter on either lateral side.

Following tools can be used for transport:

- Crane Forks
- Forklift
- Transpallets



Please use only tools designed to stand the weight of the inverter to be lifted.

In case of a pre-installed inverter removal, please remove the grid at the bottom of the equipment.

For weights and dimensions refer to the chapter "TECHNICAL INFORMATION" section of the instruction manual.

Due to the order of magnitude of the weights, it is strongly recommended to use all the safety devices required by current safety-related standards for movement and placement.

4.3 Safety considerations



Accidents can be prevented by simply following a few precautions:

- Walls, ceilings, floors and any other item placed next to the converter should not be made of inflammable materials.
- The floor on which the inverter is installed should always be kept clean to prevent metal particles or scraps of iron or metal from being sucked inside the unit and causing short circuits.
- A dry powder fire extinguisher should be positioned at the installation site.
- For units of 100kW or higher, an automatic fire-fighting system should be installed (as explained in the section “choice of installation site”).
- Access to the inverter installation site should only be given to service staff and maintenance personnel; inward opening doors (with handles) to the room where the inverter is sited and to the inverter itself) should be kept closed at all times (limited access area).
- All service and electrical maintenance personnel must be trained and able to perform both ordinary and emergency procedures. New personnel must be given suitable training before being allowed to work on inverters.

4.4 Environmental considerations



The environmental factors that need to be taken into account are detailed in the paragraphs that follow.

4.4.1 Load-bearing capacity of the floor



The weight of the inverter (specified in the Technical specifications in the instruction manual) is taken by a small floor area. Therefore, it is important to make sure that the area selected for installation can bear the weight of the appliance.

If the UPS is installed on a raised floor, it is important to use a base with pedestals (this base can be provided by Siel SPA upon request).

All cables should be routed from below the floor.

4.4.2 Temperature and humidity



The premises where the inverter is to be installed must be able to disperse the Kw that the device gives off during operation to keep the temperature between -5°C and 45°C; with a humidity percentage between 0 and 95% as shown on the technical specifications table.

The type and the implementation of any air distribution line must be checked and approved by Siel SPA. The manufacturer is not in any way liable for inverter malfunctions due to the failure to observe the rules of Installation, particularly the permitted temperature and humidity requirements. It is recommended therefore to adopt design features (for example air-conditioning, heating or dehumidification of the premises), suitable to guarantee the maintenance of the permitted temperature and humidity conditions.

4.5 Installation Location of inverters



The inverter must be installed on a stable, level surface that is longer and wider than the base of the appliance.



The inverter is not designed to be installed in areas where it could be exposed to impacts or vibration: being transported by road, rail, sling, air or ship or by similar equipment (e.g. cranes, moving parts of the appliance etc.).



The room intended for installation of the inverter must be a access-restricted only, such as containers, electrical substations or suitable technical rooms suited to accommodate electrical power, where no risk of items falling from above is present. The requirement of security to prevent falling objects from that area is IP3X.



For indoor-type inverters, the installation site must be kept clean and dry at all times so as to prevent foreign material or liquids from entering the equipment.

1 m clearance, at least, must be kept in front of the inverter to allow all routine and maintenance operations to be carried out.



The top of the equipment should be positioned at least 1m from the ceiling in order to ensure good ventilation.



As these appliances can reach significant power levels, the site where an inverter is positioned should be fitted with an automatic smoke detector that has a remote alarm system that stops the unit and cuts off the power supply. The detector should also be able to set off a fire-fighting system suitable for an electrical device.

4.6 Installation Location of outdoor inverters



The inverter must be installed on **concrete reinforced basement**, such to stand the weight of the inverter. The basement has to be prepared with cable conduits and fixation holes before the installation. The inverter has to be secured to the basement through dedicated screws inserted into the fixation holes.



The inverter is not designed to be installed in areas where it could be exposed to impacts or vibration.

4.7 POSITIONING AND VENTILATION



Although “SOLEIL DSPX” series inverters are highly efficient, be aware that during normal operation a certain amount of heat is generated. If this heat is not properly dissipated, it can lead to an increase in temperature in the room where the inverter is located and so the inverter itself can start to overheat.

4.8 Electrical considerations

Please refer to document IT0068 “Guidelines for the creation of photovoltaic plants” for the design recommendations for the creation of LV and MV plants based on SOLEIL DSPX inverters.

4.9 Medium to Low voltage transformer for connection to MV grid: criteria of choice.

The choice and the sizing of MV/LV transformer for connection to MV grid, has to be done paying attention to the hints provided by document IT0068 ‘Guidelines for the creation of photovoltaic plants’.

4.10 Preventive Maintenance

To ensure the functionality of the inverter over time, it is necessary to carry out some checks periodically:

- Check status connections (any oxidation) - Annual
- Check tightening of power connections - Annual
- Check tightening signal connections (terminals) - Annual
- Check correct operation of the cooling fans – Every 6 months
- Check integrity of fuses – Every 6 months

The equipment must also internally and externally cleaned-up, at least every six months.

It is strongly recommended to replace capacitors AC side and DC before the end of life expectancy (10 years). This activity, due to its complexity, requires being done by qualified personnel.

Replacement of fans is better done at intervals of five years, to prevent their failure or performance degrading due to the aging of its components (rotor, winding, bearings, etc.)

All the above operations and access to the internal components have to be carried out by trained technicians.

During operation the inverter must be switched off and secured, opening the switches / disconnectors side AC and DC side,

Particularly, for access to the upper compartment and the rear part of the unit:

- 1- disconnect the DC input**
- 2- disconnect the AC output**
- 3- if the fans are powered by an external source, please make sure that the external switch for selecting the source of the aux circuits, is open.**

To access the lower compartment, where the connection terminals and bars are located, in addition to the steps described above, it is necessary to disconnect the incoming DC source from the photovoltaic field and open the AC switch downstream the inverter.

Before accessing any part of the inverter, make sure that the capacitors are completely discharged and that the fans are not operating.

5 BASIC INSTALLATION HINTS

This Chapter contains a brief summary of the criteria for a correct installation of a multi-inverter system, in order to get it into operation in the quickest and most reliable way.

5.1 Positioning of the inverters and ventilation

The positioning of the inverter has to take into account the type of installation:

- **Dedicated concrete-made technical room** : the inverter can be positioned either on a floating floor or on a concrete soil (in this case, power cables have to be routed to the inverter's power connection through underground dedicated conduits). In both cases, a dedicated mounting kit provided by SIEL has to be used to secure the inverter to the hosting surface.
- **Containerized Metal Conversion Unit**: the best practice to position the inverter, is placing it on a metal frame of crossbeams, covering the perimeter of the inverter itself.

A dedicated mounting kit provided by SIEL has to be used to secure the inverter to the metal frame.

Regardless of the type of installation, the inverter has to lie on a horizontal surface, able to carry at least 1000kg/m².

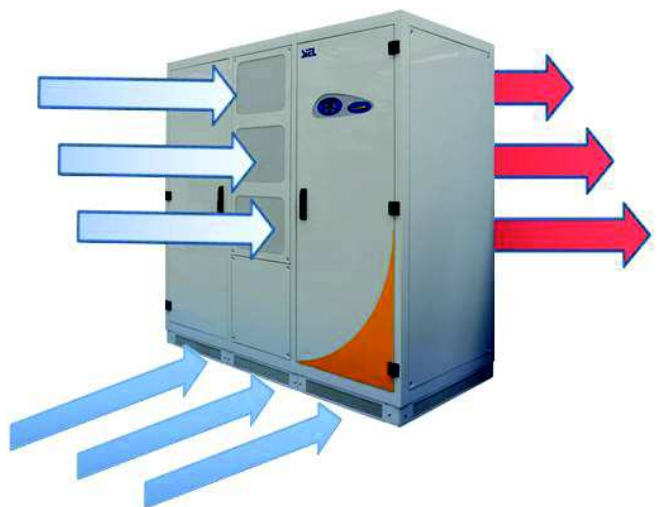
If the system is a multi-inverter system, all the inverters have to be placed one beside the other, all front-sided, as per following figure (example: DSPX TLH 5660M TLH 1500):



Fresh air intake is from the front , hot air exhaust from the rear of the unit. Proper clearance (1m from the front, 1m from the rear side) must be left respect to walls and possible obstacles, in order to ensure proper ventilation to the inverter.

Following table shows the required minimum air flow:

Model	Air flow (m ³ /h)
550, 665, 708	5500
1100M, 1330M, 1415M	11000
2200M, 2660M, 2830M	22000
3300M, 4000M, 4245M	33000
4400M, 5330M, 5660M	44000

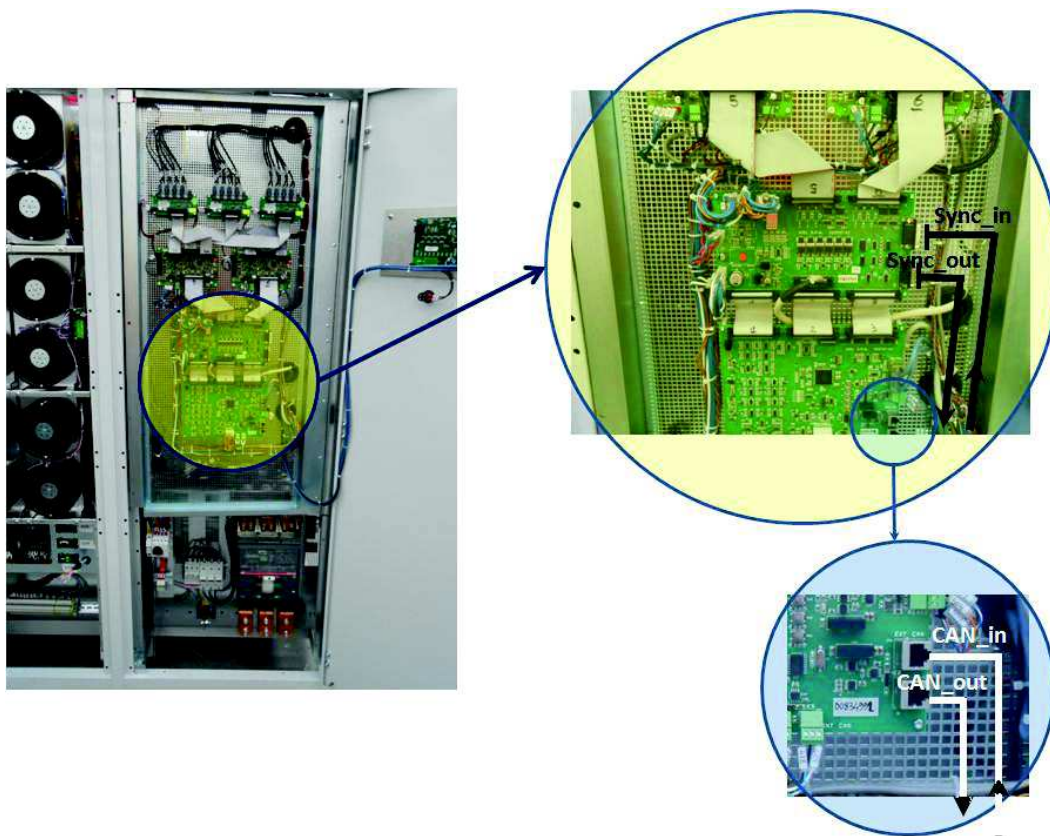


6 SYNCHRONIZATION CABLE AND CAN-BUS (MULTI-INVERTER SYSTEMS)

In multi-inverter models (2200M, 2660M, 2830M, 3300M, 4000M, 4245M, 4400M, 5330M, 5660M), every inverter is connected in a daisy-chain fashion with the next one and the previous one (except the Master and the last inverter of the system) as far as:

- **Synchronization channel:** the synchronized firing commands are received by one unit on the 'Interface Board' and retransmitted forward, by using a twisted multi-conductor, shielded cable, terminated with a multi-pole DIN connector (link 'Sync_in' & 'Sync_out' in the figure below).
- **CAN-bus channel:** the CAN link carrying the status information of every unit, is received by one unit on the 'DSP control board' and retransmitted forward, by using a twisted multi-conductor shielded cable for high frequency, terminated with a CAT5 – RJ45-like connector ('CAN-in' & 'CAN-out' in the figure below).

As anticipated, these two communication links are functional to the Master & Slave operation of the system.

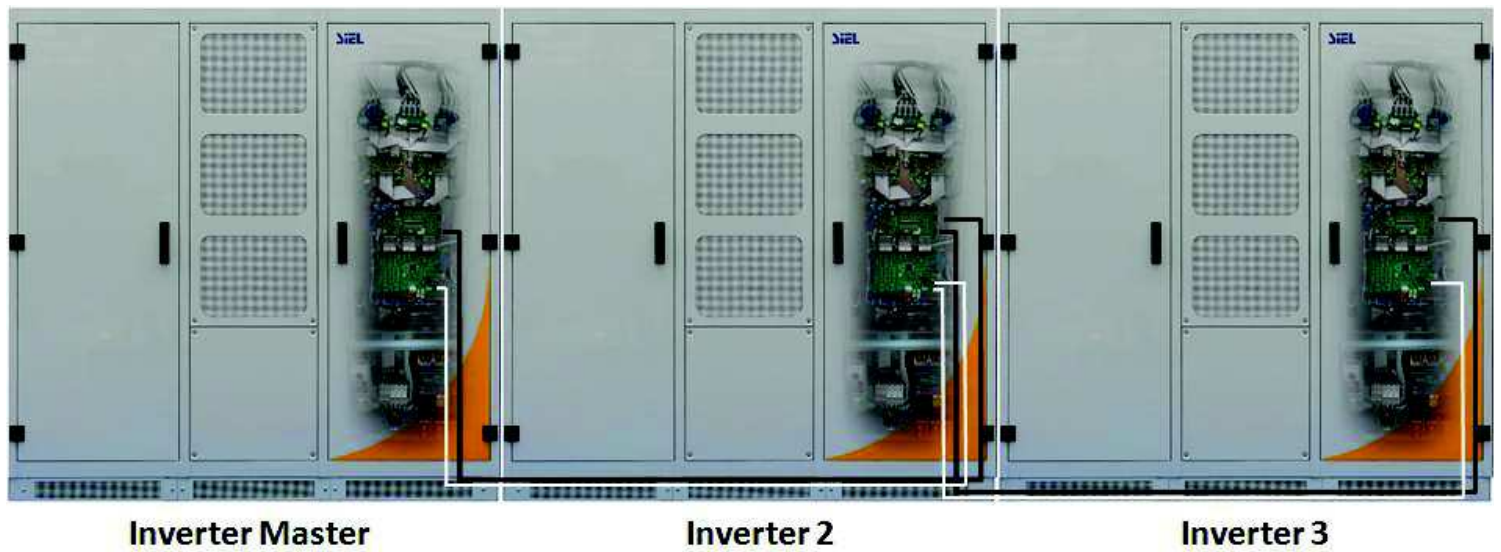


In a multi-inverter system, the overall length of these two connection has to be kept as low as possible and, however, less than 20m, for signal integrity and timing constraints.

This is the main reason why, as recommended in previous paragraph, it is essential to keep the inverters aligned to each other on the front side.

Next figure shows the path of both 'Sync' and 'CAN' connections among units:

SINCHRONIZATION AND CAN BUS CONNECTION EXAMPLE (DSPX 4000M TLH 1500)



- Synchronization connections: black lines
- CAN bus connections: white lines

7 CONNECTION OF THE EPO CIRCUIT (EMERGENCY POWER OFF)



The inverter includes an electronic device (EPO) which can stop the inverter and disconnect it from the distribution network.

The connection between the external EPO contact and the inverter is established by 2 wires which shall be connected to terminal 3 and 4 on the terminal board.

This device must be remotely activated by an emergency pushbutton; to restore normal operation, first press the ON button and then the ENTER key on the touch screen.

It is important to ensure that the EPO circuit leads do not run close to the power cables.

Although the entire EPO circuit is without hazardous voltages and is metalically separated from the internal voltages of the inverter, **care must be taken since this circuit completely stops the inverter.**

7.1 Connection of the modules' temperature sensor

The inverter is equipped with a modules temperature sensor, which is temporary wired and is located in the terminal board I/O compartment.

This sensor is placed right behind the modules and connected to terminals **5** (Temp+) and **6** (Temp-) of the inverter terminal board with a 1.5/2.5 mm² wire pair (according to the distance: Max 250m).

The temperature value reading (°C) can be viewed on the touch screen display and via Modbus.

8 SERIAL COMMUNICATION CONNECTIONS

8.1 Type of cables to be used

The inverters of the Soleil DSPX xxxx TLH 1500 series, have two RS485 serial port available as a fieldbus, with a standard Modbus RTU protocol; they also have a RS485 serial port (SAC BUS) to collect data from the parallel string boxes.

On the Modbus serial port, information is made available to the user regarding the inverter.

For both serial ports, the use of a bipolar/tripolar EIA RS-485 shielded cable is advised, with typical impedance of 120 Ohms.

The shields of the different cable sections shall be interconnected. As a first level check, if communications are unstable, check the continuity between the various shield sections.

8.2 Monitoring system and Power Plant Controller (PPC) RS485 Modbus communication

Inverter Soleil DSPX xxxx TLH 1500, has two RS485 serial port and may be used independently one another. They can be connected to a monitoring system and/or to a power plant controller named PPC.

To optimize the communication and improve the PPC efficiency, both serial port are used as showed by the following example.

8.3 Connection of the Modbus serial port shield

The shield of the cable section that connects the inverter Modbus serial port to the Modbus converter – TCP/IP (terminal 32), is earthed on the converter side. If communications are unstable with this type of connection, this may be due to the fact that the earth is 'noisy'.

8.4 Connection of the SAC BUS serial shield

The shield of the RS485 cable that connects the inverter SAC BUS serial port to the parallel boxes (terminal 28), is not earthed on the box side because it is already earthed inside the inverter

8.5 Rules for the laying of RS485 serial cables

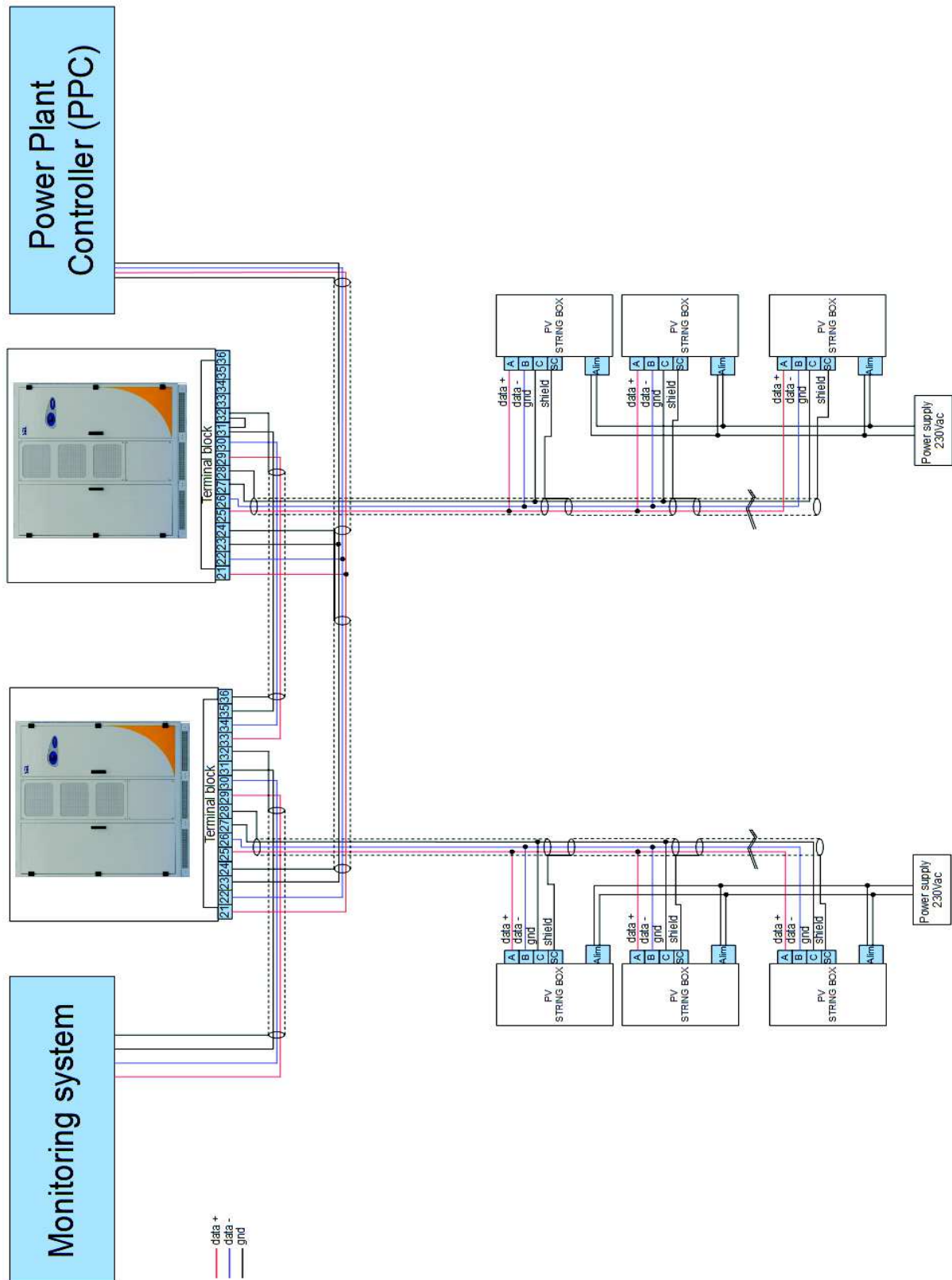


In order to minimise possible interference to serial data transmission/reception signals, it is recommended that the following rules be observed for the use and laying of the connecting cables.

- The total maximum length of the RS-485 chain shall not exceed 1200m.
- Separate, as far as possible, the signal from the power cables (particularly on the photovoltaic field side), utilising different channels..

- For SAC BUS use a shield cable with typical impedance of 120 Ohms (RS485) with four wires (nr2 for Data+ and Data- RS485 and Nr2 for the positive/negative 24Vdc power supply). Alternatively use a 120 Ohm (RS485) bipolar shielded cable for the transmission of information and a bipolar shielded cable for the 24Vdc power supply. Utilise the same cable route between the RS485 cable and the 24Vdc power supply cable.
- Maintain a minimum distance of at least 30cm between the signal cable and the power cable.
- If the signal cable and the power cable must be closer than the minimum distance, try as much as possible to minimise the length of the section along which they run parallel.

LAYOUT CONNECTION EXAMPLE MONITORING SYSTEM - POWER PLANT CONTROLLER – PV STRING BOX



9 USER SETTINGS

9.1 Connecting an input pole to the photovoltaic field earth

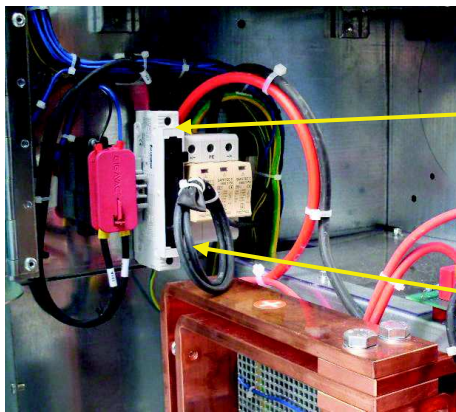
For some types of photovoltaic panels the earth connection of a pole is required.

Machines of the SOLEIL DSPX xxxx TLH 1500 series are designed for the easy earth connection of the positive or negative pole on input (depending on the requirements of the plant design), by means of a special fuse already installed inside the converter.

Once the settings have been appropriately configured (see chapter 10 of the IV347'Instruction Manual'), the machine is able to detect the opening of the fuse and activate the corresponding alarm.



SOLEIL default machines are configured in the factory WITHOUT any earth connection of the input poles.



Earthing fuse PV pole

Cabling of the machine supplied.



Connection point on the positive DC input bar

Connection point on the negative DC input bar

For the earthing connection of an input pole proceed as follows:

1. Identify the earthing connection fuse within the machine
2. Use the wire provided to connect the terminal of the fuse holder to the DC input bar (positive or negative as required by the plant constraints)
3. Set the software feature to detect the fuse opening by means of the touch screen, as described in chapter 10 of the IV407 'Instruction manual SOLEIL DSPX TLH 1500'

9.2 Control features – Network services

Soleil and Soleil HV Inverters comply with CEI-021 regulations and with Terna attachment A70.

The features regarding the 'Network services', summarised below, can be set by the installer through the use of the inverter touch screen operating panel, in accordance with the procedure described in the IV407 'Instruction manual'.

The supported features, in accordance with section 8.5 of the CEI-021 regulations and chapter 7 of the attachment A70 are:

- Launch and gradual increase of the power to the network
- Immunity to brownouts (LVFRT Low Voltage Fault Ride Through)
- Limitation of the active power generated in the presence of transients on the transmission network
- Participation in the voltage control, in the following ways:
 - Automatic supply of reactive power according to a characteristic curve $\cos\phi = f(P)$
 - Automatic supply/absorption of reactive power according to a characteristic curve $Q = f(V)$

SOLEIL inverters are configured by default as follows:

Launch and gradual increase of the power delivered to the grid	$f = 49.9...50.1 \text{ Hz} / 59.9...60.1 \text{ Hz}$, $V = 85...110\% V_n$ (present for 5 continuous minutes) Power ramp lasting 5 minutes
Immunity to LVFRT brownouts	Feature disabled, may be enabled
Limitation of the Active Power in the presence of frequency transients	Enabled with the following parameters : <ul style="list-style-type: none"> • frequency thresholds = 50,3 and 51.5 Hz or 60,3 and 61,5 Hz • droop = 2.4% • frequency thresholds for restoring power = 49.9 and 50.1 Hz or 59,9 and 60,1 Hz • slope of transfer after overfrequency = 5 minutes
Participation in the voltage control (reactive supply)	Feature disabled, may be enabled



FOR A DETAILED DESCRIPTION OF THE AVAILABLE FEATURES AND ANY CUSTOMISATION, REFER TO THE PROCEDURE DESCRIBED IN THE IV407 'INSTRUCTION MANUAL'.