Inverter for photovoltaic applications

INSTRUCTION MANUAL
SOLEIL DSPX

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for the entire life of the appliance

CONTENTS

1 SYMBOLS USED IN THE MANUAL

The following symbols are used in this manual to both warn and advise users of particular situations that warrant attention. The symbols and their meanings are as follows.

Symbol	Description
	**INFORMATION** Additional information to be borne in mind. To be used for making notices and/or recommendations.
	**ATTENTION** This symbol is used to draw the attention of the user on situations that could cause serious injuries to people and/or serious damage to the system.
	**ELECTRICAL DANGER** This symbol is used to draw the attention of the user on the risk of electrical shocks. These warnings signal compulsory behaviour.
	**UNPACKING INSTRUCTIONS** These instructions explain how to remove the system from the packaging.
	**INSTALLATION INSTRUCTIONS** These step-by-step instructions describe how to install the inverter.
	**MANDATORY INSTRUCTIONS** Before carrying out any work on the appliance, read the operation and installation manual carefully.
	**DISPOSAL** Provides useful information on the disposal of the system.
 	**THE WARNING TRIANGLES ARE USED TO INDICATE WARNINGS ABOUT PERSONAL SAFETY. FOLLOW THESE INSTRUCTIONS VERY CAREFULLY TO PREVENT PERSONAL INJURY OR DAMAGE TO THE APPLIANCE.**

2 SAFETY INSTRUCTIONS

Failure to observe the following instructions can lead to serious consequences, like, among others, the destruction of the system, injuries to people and death due to electrical shocks.

If the appliance is not used according to the manufacturer's instructions, the protection provided by the device may no longer apply.

It is therefore very important to read and understand all the safety instructions contained in this manual before using the inverter. In case of doubts or for additional information, please contact SIEL SPA customer service.

2.1 General precautions

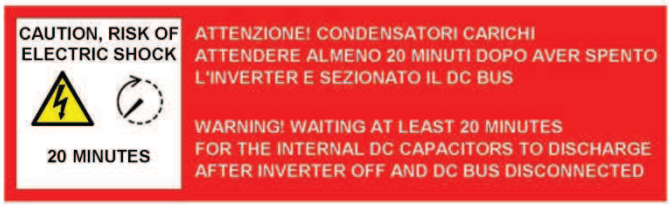
Dangerous voltages

- The system uses very high internal voltages that could potentially cause injury.
- All components with potentially dangerous voltages are grouped in special areas that can be accessed only with tools that are not supplied with the inverter.
- All maintenance or repair work which requires access to those areas of the inverter may only be carried out by technical personnel specially trained by SIEL SPA.
- Before opening the inverter, it is essential to disconnect the AC and DC power supplies.

- To disconnect the DC side, open the main switch making sure that the inverter is turned off and that the AC side switch is open.

- Do not use the DC side switch unless the current has been cut off. These signs are placed on the front panel of the inverter.

- Once the appliance has been turned off, components inside the inverter and all the DC terminals can still give off dangerous electrical discharges due to the presence of electrolytic condensers that hold dangerous voltages for at least 20 minutes. Before carrying out any work on the appliance, make sure that the voltage at the DC bars has dropped to a safe level (< 60vDC).



Introduction of objects

- Do not introduce objects into the ventilation inlets and avoid using liquids to clean the system. Cleaning operations should only be performed using a dry cloth. These warnings should be observed even when the machine is off.

Trampling

- Roofs of inverters are not designed to withstand heavy weights. Never climb on the top of the device or place service platforms or other similar objects on it and do not use it as a support for further structures (cable raceways, brackets, etc...).

Section of the cables

- Always verify that the section of power and/or output cables is adequate. This requirement also applies to the other cables used for the system.
- The connections, cable cross sections and inverter installation must all meet the standards regulating the use of low voltage electrical currents.

Ground connection

- The first cable to be connected should always be the ground cable. When disconnecting the appliance, always leave the earth cable to last.

Initial start-up

- Always power the system after it has been thoroughly inspected by qualified personnel.

Subsequent start-ups

- Verify that all the disconnecting switches of the system and installation are open before performing the start-up procedure.

Handling

- Inverters are heavy and should only be handled by qualified personnel.
- Before positioning the inverter, it is also important to make sure that the floor and overhead platforms can bear the weight of the appliance.
- Do not store or transport the system in tilted position or placed on one side.

Installation site

- Apparatus not suited to bathrooms or similar wet areas (see paragraph “Environmental considerations”) and exclusively suited for indoor operation.
- The inverter is not designed to be installed in areas where it could be exposed to impacts or vibrations; for example: means of transport for road, rail, rope, air, ship transportation or similar equipment (for example cranes, hoists, parts of the machine tools that are exposed to movements or vibrations, etc.).
- Do not install the inverter in explosive, corrosive, abrasive or saline environments.

Positioning

- Never position the invert near sources of heat.
- Never install the unit in an area with poor ventilation.
- Never position the inverter in an area that is not well protected. Inverters have not been designed for outdoor installation.
- Position the inverter in a dust free environment, as dust may enter the equipment and prevent it from cooling properly.
- The inverter must be installed on a stable, level surface that is longer and wider than the base of the appliance.
- See the appliance dimensions and warnings shown in the table in this manual in the “Installation” section.

Cleanliness of the site of installation

- The inverter installation site must be kept clean and dry at all times so as to prevent foreign material or liquids from entering the appliance. Besides affecting the operation of the appliance, dirt and dampness could greatly increase the risk of fire.

Reparations

- Do not attempt to repair the system directly, but have it serviced by the manufacturer or by an authorised support centre.
- Any repair work made to the equipment not explicitly authorized in written form or not carried out by SIEL SPA, beside involving actual danger, immediately voids the warranty. SIEL SPA shall not be liable for any consequent malfunction and for any arising loss or damages.

Technical support

- The Technical Support team must always be contacted if the system has been damaged, for example if liquid has penetrated the system, if objects have fallen on top of or inside the appliance, if it has been exposed to rain or humidity (outside the specifications range), if it is not working correctly, if it is performing poorly or if it has been dropped.

Accessories

- Only use accessories recommended by the manufacturer. The use of unauthorised accessories may seriously affect how the appliance operates. The use of non-original accessories will result in the warranty being invalidated and will exempt the manufacturer from any responsibility whatsoever for malfunctions and any consequences that might stem from them.

MTBF (Mean Time Between Failures)

- SIEL SPA inverters are designed and manufactured with a view to assuring remarkably high MTBF for the appliance. It is useful to remember that the MTBF is a statistical parameter and therefore has both conceptual and practical limitations.
- The MTBF specification applies only if the equipment has been correctly installed and serviced and therefore specifically excludes all conceptual or practical errors installation errors, negligence or improper use.
- According to their specific function, SOLEIL DSPX inverters are designed only for professional users and must not be used by untrained personnel

Maintenance

- To ensure that an appliance completes its expected life cycle, it is essential to strictly adhere to the maintenance schedule shown in this manual.
- Maintenance must always be carried out by SIEL, to ensure that only new and genuine spare parts are used and that the inverter (depending upon the service contract that is stipulated) is updated to incorporate any technical improvements that may have been introduced in the meantime (according to the status of the art).

- In addition, any appliance that has been fitted with non-original, used or not up-to-date spare parts, will be deemed “modified” with the consequences as outlined in “modifications to the appliance”

Product nameplate

- The product ID plate which bears the appliance code number, serial number and technical data is situated on the rear of the inverter.
- The serial number shown on this ID plate must be quoted in all communications regarding the appliance.

Inverter in the electrical installation

- Always use an electrical supply that complies with the technical specifications and data shown on the ID plate.

Protection and disconnection devices

- Always check that the mains supply is fitted with suitable protective devices and switches and that they are in good working order.

Ventilation

- The temperature of the power stage heat sinks may increase to a maximum of 80°C. Never block or obstruct the inverter air vents in any way.
- The type and the implementation of any air distribution line must be approved by SIEL SPA.

Changes made to the system

- Any change made to the equipment not explicitly and formally authorized by SIEL SPA implies the immediate cancellation of warranty. SIEL shall not be liable for any consequent malfunction and for any arising loss.

User warning systems

- All warning signals to users made by means of relay contacts are thoroughly insulated from dangerous voltages.
- The insulation between these contacts is only suitable for voltages of less than 48V AC (60 VDC). These contacts should never be used as switches.

User warning systems

- Always keep the original packaging.
- Inverters should always be returned, if required, in their original packaging.
- Appliances returned for repair work in unsuitable packaging or that have not been transported horizontally will not be accepted or repaired under warranty.

Limitation of responsibility

- SIEL SPA shall not be liable for any direct or indirect damages (including loss of profits or revenues) deriving from the malfunction of the device, even if SIEL SPA was warned in advance of the possibility of such damages.

Disposal

- This product should not be disposed of as domestic waste and must instead be handed over to the nearest collection point specialised in the recycling of used electric or electronic equipment.

2.2 Lightening and overvoltage

In areas where storms are frequent, electrical discharges can occur through the mains.

It may therefore be advisable to install lighting conductors to protect the appliance control circuits from any damage that might occur due to high voltages in the surrounding atmosphere.

To protect the inverter from voltage peaks caused by atmospheric discharges, it is advisable to install varistors on the input connection lines (modules) and on the output lines (alternate current) of the system.

To protect the appliance from direct lighting strikes, both lightning rods and special protective devices should be installed.

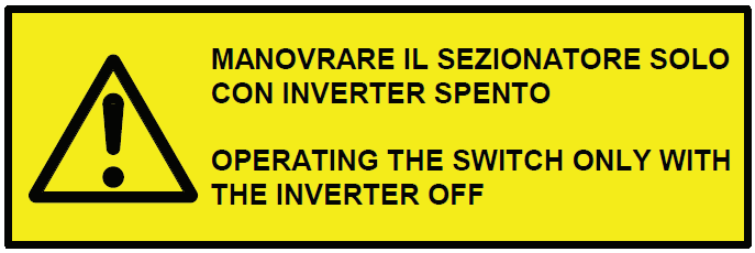
2.3 Ground connection

The inverter must be grounded for compliance and as required by current regulations concerning low voltage. All the components of the installation must be grounded to the same system.

The first cable to be connected should always be the ground cable. When disconnecting the appliance, always leave the earth cable to last.

2.4 DC disconnector

The DC dicsocnnector, cannot be operated (neither opened or closed) when the inverter is in generation mode (‘on load’ condition).



3 DESCRIPTION OF THE EQUIPMENT

3.1 Introduction

The SOLEIL DSPX range of inverters provides the ideal solution for connecting photovoltaic power production systems to three-phase power grids.

The series is composed of inverters with an isolation transformer (SOLEIL DSPX: TRL, TRH and TRW) and transformerless inverters (SOLEIL DSPX: TLW and TLH).

The inverters of the SOLEIL DSPX series are in compliance with the resolution AEEG 84/2012/R/ENEL (attachment A70 of TERNA, CEI-021, and CEI-016)

All inverters use a system which tracks the maximum power point of the photovoltaic generator (MPPT) thus achieving the maximum power efficiency in any operating status.

SOLEIL DSPX inverters permit both automatic and manual operation. In automatic mode, maximum power point tracking is enabled, while in manual mode it is the user who sets system operation (mode used for specific test requirements) at a specific point.

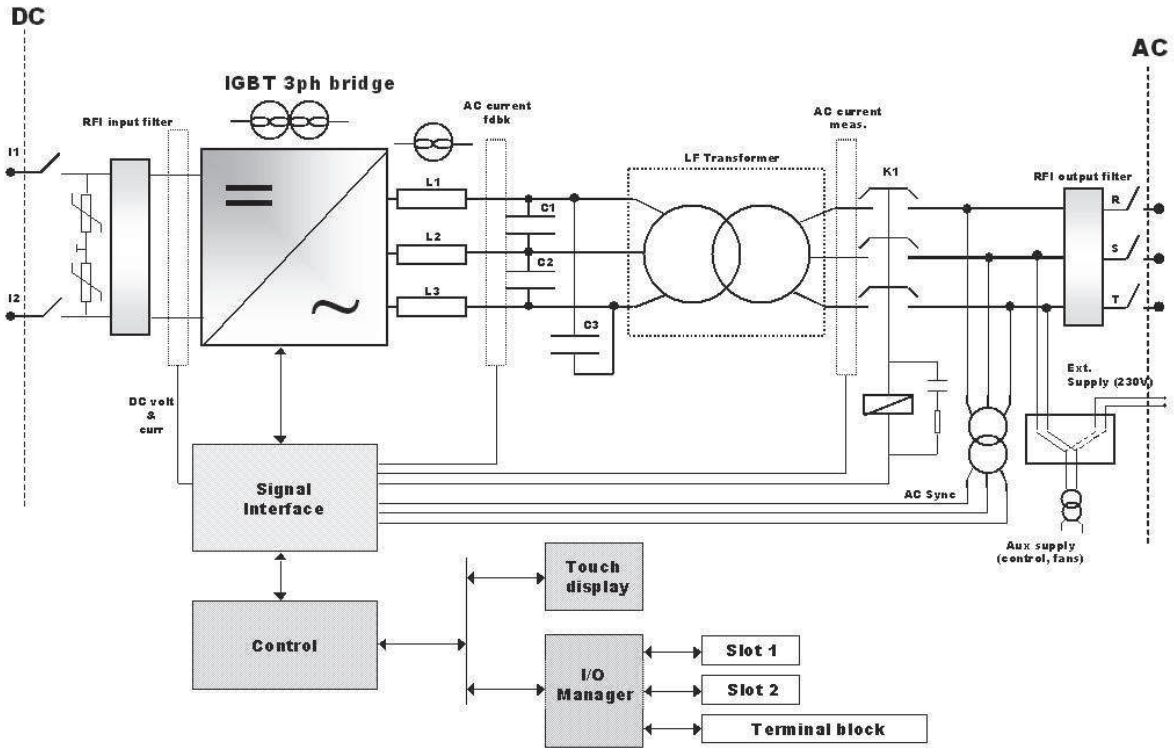
The waveform of the current injected in the electricity distribution grid is identical to that of the voltage with a power factor that can be regulated in accordance with standard CEI-021.

The inverter has a “touch screen” control panel allowing to view all system operating parameters (electrical values, status and alarms) and to input all basic commands.

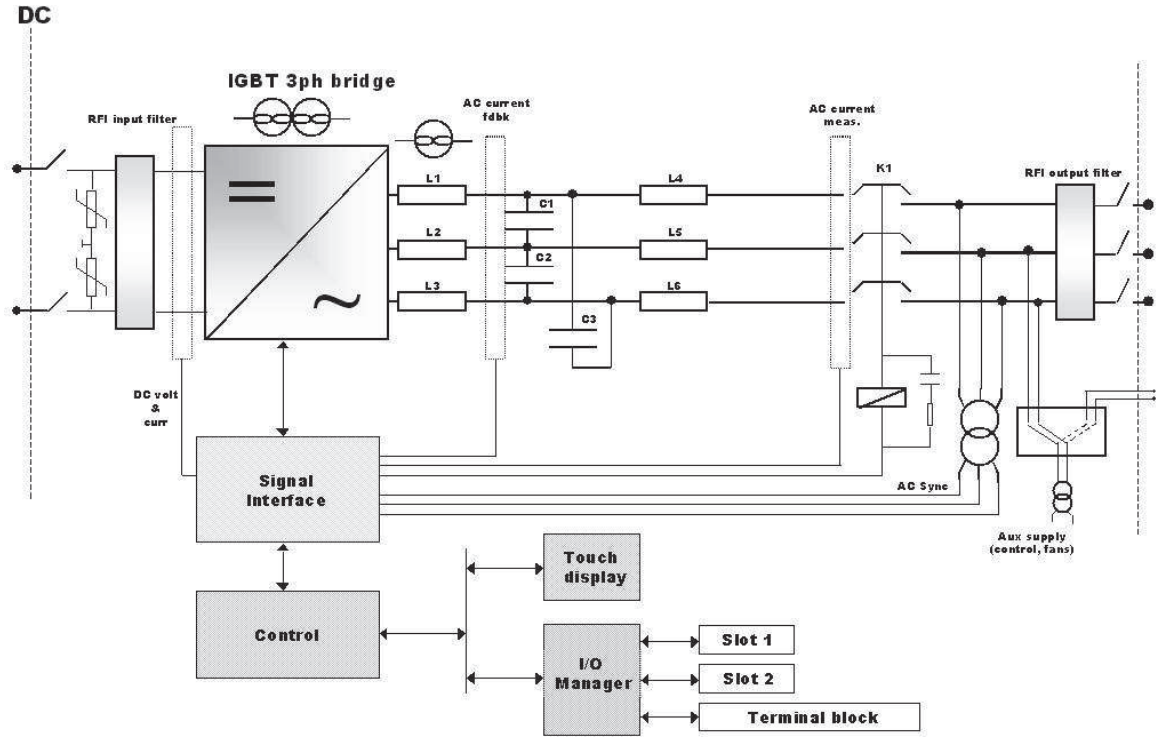
The device is also equipped with two communication ports, which can be configured according to different serial transmission standards, and with a “volt free” contact terminal board for the remote signalling of the status and most important machine alarms as well as for receiving remote commands.

Pulse width modulation (PWM) control technology and IGBT power devices are used on SOLEIL DSPX inverters, which permit the switching of significant levels of power with a high degree of sturdiness and reliability.

3.2 Equipment block diagram



SOLEIL DSPX TRL, TRH and TRW inverter flowchart with isolation transformer



SOLEIL DSPX TLW and TLH inverter flowchart

3.3 Operating principles

When the inverter is energized, the control system checks the power grid, voltage and frequency parameters. If these parameters are within the correct range, the inverter checks the voltage of the photovoltaic generator and when this reading is sufficiently high, the conversion process begins.

When the photovoltaic field voltage reaches the right level, the grid contactor closes and the inverter begins delivering power to the three-phase power grid.

At this point, the control system starts varying the photovoltaic generator's operating point to track the maximum power point. This tracking takes place at intervals of about 2 seconds.

If the grid voltage and frequency values are within the range of acceptance established by legislation, in conditions of low irradiation (DC voltage below the minimum threshold, see chapters 7 and 8, or the power injected into the grid is below a certain threshold), the inverter enters into standby mode for 6 minutes. After this pause, if the photovoltaic generator and grid parameters are correct, the inverter starts up automatically recovering the conversion process.

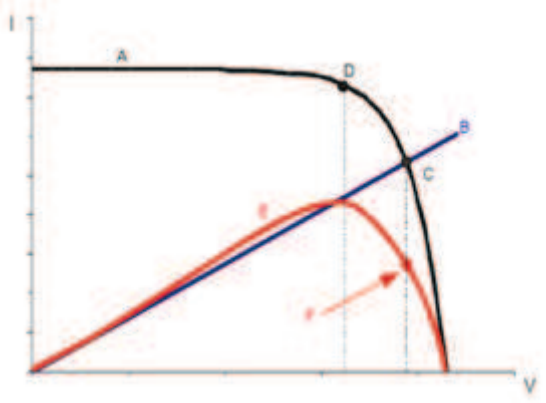
If the test detects abnormal operating conditions which can jeopardize machine reliability, adequate protections are activated. After the activation of a protection, the control system waits 10 seconds and, according to the "severity" level of the protection, it may decide to restart the inverter or to stop it until a repair is carried out by the SIEL technical service. For more details about alarms and protections, see paragraph 4.5.2.

3.4 Maximum power point tracking (MPPT)

When a photovoltaic cell receives solar radiation, it generates an electrical voltage which depends on the incident radiation and on the temperature of the cell itself.

When a load is connected to the photovoltaic cell, a current will start to circulate through the load and the voltage of the cell will decrease according to the voltage-current characteristics (V-I).

The figure below shows the typical V-I characteristic curve of a cell (A), which by analogy is identical to that of a photovoltaic module, or to that of a photovoltaic generator (or field) made up of several suitably connected modules. The same figure shows the load characteristic curve (B) which will be resistive. The intersection of the curve of the photovoltaic generator with the characteristic curve of the charge is called the operating point (C).



A: Characteristic of the photovoltaic generator

B: Load characteristic

C: Operating point

D: Maximum power point

E: Photovoltaic generator power curve

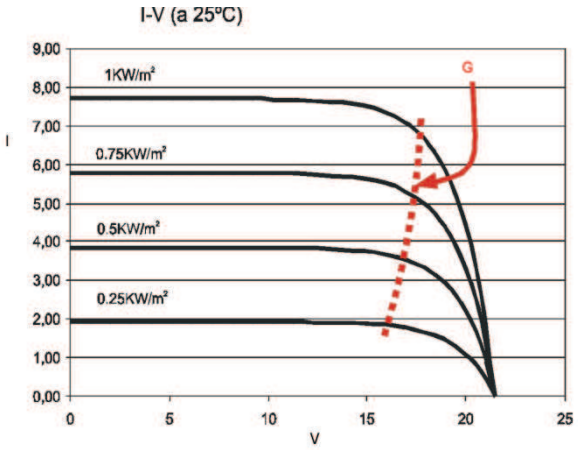
F: Operating point power

Response V-I of the photovoltaic generator implies a much more precise output power characteristic (F), which will vary when the operating point changes (as shown in the graph below).

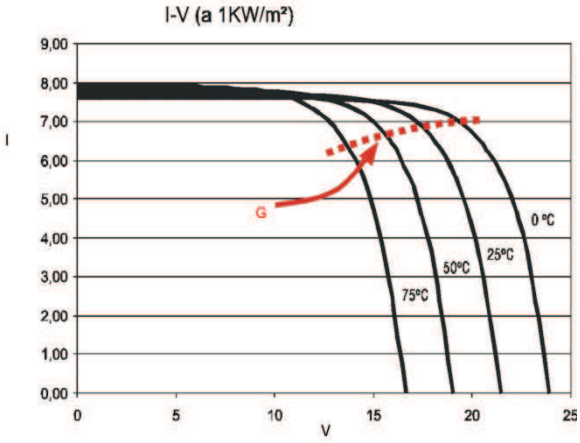
The operating point corresponding to the highest possible power is called the Maximum Power Point (D).

Additionally, the photovoltaic generator curve is not fixed, but changes according to the temperature and incident solar radiation. The following figure shows:

- the typical curve of a photovoltaic module as a function of the radiation (picture A);
- the typical curve of a photovoltaic module as a function of the temperature (picture B);



Pic. A



Pic. B

The evolution of the maximum power point (G) is also shown on the curves.

Therefore, the purpose of the maximum power tracking algorithm (Maximum Point Power Tracker) is to vary the device's load resistance to ensure the constant functioning of the photovoltaic system (panel + inverter) in the highest possible point of power; in this way the maximum level of power will be delivered to the power distribution grid.

In automatic mode, the inverter constantly tracks the maximum power point

The device can also be operated in Manual mode, during which the user determines a fixed operating point. Obviously, **the maximum level of power efficiency for the installation is not achieved in this mode**; for this reason, manual operation must only be used as a method of checking the device by trained technical personnel.

3.5 Master & Slave operation (available only for DSPX TLH 500M, DSPX TLH 660M, TLH 760M @380V output)

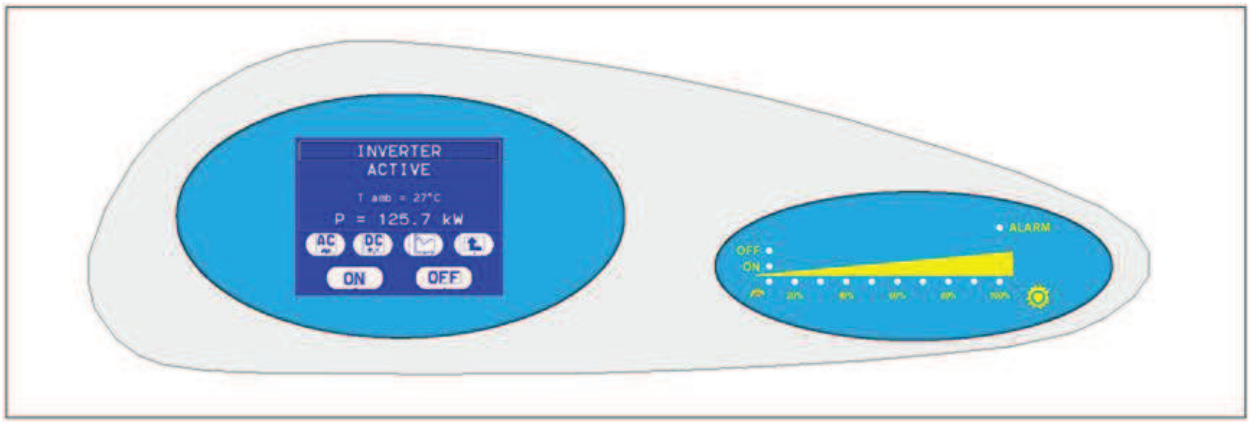
Master & Slave is a logic of operation available on some of the inverters 'M' type. It consists in a control mode performed by the DSP control, that, upon the availability of DC power at the input, enables only one or both power modules for operation. This logic allows achieving higher efficiencies at low power levels, because, below the 50% of the overall power of the inverter (sum of the rated power of the two modules composing it), one of the two modules (the 'Slave') is turned-off, so that the other one (the 'Master') operates at a higher power level, where its efficiency is higher. Therefore, the conversion efficiency of the system benefit of this logic. When the input power gets higher than 45% of the overall inverter rated power (90% of the single module), the 'Slave' is turned-on back again, to help the 'Master' sharing the generation.

4 INVERTER OPERATION

4.1 Inverter control panel

The control panel is made up of a monochromatic “touch screen” display and a LED signalling panel showing the generated power.

The “touch screen” display acts both as viewer and as an interface to input or change the machine parameters.



The LED lights mean as follows:

- ALARM it lights up when the machine has stopped because an alarm/a protection has activated
- OFF: it lights up when the machine is in the “disabled inverter status”
- ON: It lights up when the inverter switches to the operating status energising the power grid (“inverter generating power” status)
- ON and OFF flashing alternatively: it happens during the first start up and in the “enabled inverter” status as well as after an error has been detected, immediately before closing the contactor and starting the generation process
- LED power bar the amount of lit up LEDs is proportional to the instant power percentage delivered to the grid

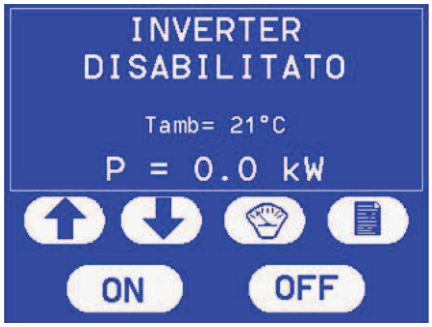
4.2 Quick Start

To start the inverter:

- the input DC and output AC cables must be properly connected.
- the EPO contacts (terminal contacts 13-14 – see section 0) and EXTERNAL START INVERTER must be closed (terminal contacts 11-12 – see section 0). As a default setting, both these contacts are short-circuited by the manufacturer.

  Closing the alternate current switch, voltage is fed to the control logic, the touch screen lights up showing a welcome screen and an acoustic “beep” is emitted.

Immediately after the welcome message, the main screen appears:



The top two lines show status messages and any alarm conditions in rotation. Immediately after the controller has been powered on under suitable grid and voltage conditions, the sequence of messages to appear is as follows:

- Inverter disabled
- Remote switch open
- Mains voltage OK
- Mains frequency OK

If you press the ON key on the “touch screen” and confirm by pressing the ENTER key as displayed in the following screenshot, the inverter will switch to “Enabled inverter” mode while the ON and OFF LEDs will flash alternately.

Under this condition, the following messages can appear on the display:

- Inverter enabled
- Remote switch open
- Mains voltage OK
- Mains frequency OK

The inverter waits for the grid parameters (voltage and frequency) to come into the pre-established range for at least 5 minutes (modifiable, see the appendix “Features Regarding Grid Services”, section 9.2.1), after which the generation of grid power can begin.

At this point the ON LED stays lit. The messages shown on the display are as follows:

- 'Inverter generating'
- "Remote switch closed"
- "Mains voltage OK"
- "Mains frequency" OK

The default inverter operating mode is AUTOMATIC, i.e. with maximum power point tracking enabled.

During standard operation, if the photovoltaic field voltage drops below the minimum level (see "Technical information") or the available power from the power grid is below a given threshold (1,5% of the rated input power), the inverter switches to "Inverter enabled" mode and starts a 6-minute countdown.

The sequence of the messages displayed is as follows:

- "Inverter enabled"
- "Remote switch open"
- "Mains voltage OK"
- "Mains frequency" OK
- "Insufficient radiation"

When the countdown is over, if the mains and cell voltage conditions are correct, the inverter starts up again, closes the contactor and resumes the power generation to grid.

If the electrical grid is not suitable (voltage or frequency outside specification), the inverter remains in "inverter enabled" status, the ON and OFF LEDs flash alternatively and the sequence of messages displayed is as follows:

- "Inverter enabled"
- "Remote switch open"
- "Mains frequency outside specification" or "Mains voltage outside specification"

When correct conditions of the power grid are restored, the inverter starts up again, closes the contactor and resumes the power generation to grid.

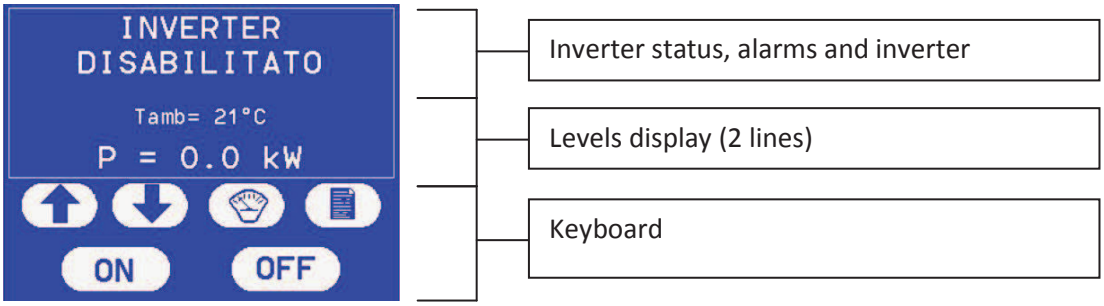
To disable the inverter, all that is needed is to press OFF without having to confirm the command with other buttons. Confirmation of switching off the inverter is given by the yellow OFF LED that stays lit.

Users should take note of the fact that under such conditions, the inverter does NOT generate electricity and this condition should only be employed for maintenance work.

4.3 Touch screen display

4.3.1 Introduction

The following picture shows the touch screen main window, displayed immediately after the control system is energized.



Every screen display is subdivided into three sections as shown in the diagram:

- Section for status messages, alarms, inverter protection
- Section for measurement values
- Section for keyboard

The messages are shown in rotation in all the screens at about one message a second. The status of the inverter (see section 4.5) is shown in this section along with any alarm or active protection messages.

The levels, subdivided into AC and DC, are always shown in the format:

Secondary display (lower case, first line)

MAIN DISPLAY (upper case, second line)

The section relating to buttons varies in line with the selection made by the user.

The combination of buttons present depends on the screen being shown. For safety purposes, the only key present on all the screens is the OFF button.

The touch screen fades after not being used for 3 minutes. If you touch the panel again, the display lighting is restored.

4.3.2 Navigation display

To navigate around the display, just touch the screen in the designated areas.

The touch functions on the main screen are as follows:

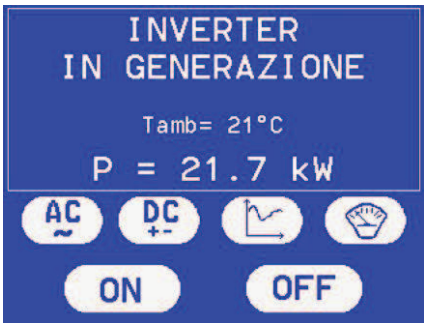
Arrow buttons: to scroll through all active status/alarm messages

Level access button: give you access to the measurements screen.

Menu set-up access button: give you access to the set-up menu.

4.3.3 Measurements menu

Pressing the AC and DC keys, it is possible to access the machine measurement value screens on the alternate current side (output to mains) and the direct current side (photovoltaic field input).



To move from the AC measurement screen to another, just press “AC”.

To move from the DC measurement screen to another, just press “DC”.

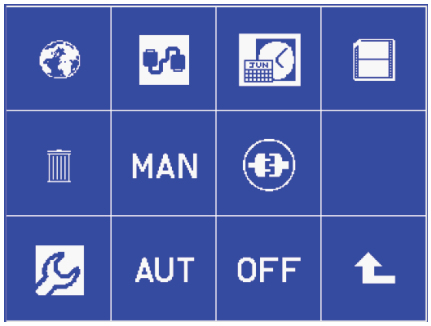
From the AC measurement screen, you can move to the DC screen by pressing the DC button.

Similarly, from any DC measurement screen, you can move to the AC screen by pressing the AC button.

To go back to the main screen, just press the ‘return’ button  .

For more information about the electrical values of the machine to be displayed, see paragraph 4.4.

4.3.4 Set-up menu



This menu lets you access the following appliance functions:


Language selection (section 4.3.4.4)


Setting serial ports (section 4.3.4.3)


Setting the date and time (section 4.3.4.5)


Events log display (par. 4.3.4.2)


Reset history


Advanced appliance settings (section 4.3.4.6)

Selecting Automatic/Manual modes (section 4.3.4.1)


Selection of grid connection protocol (section 4.3.4.7)


Return to main screen

4.3.4.1 Selecting AUTOMATIC/MANUAL modes

To select MANUAL or AUTOMATIC mode, use the AUT/MAN buttons.

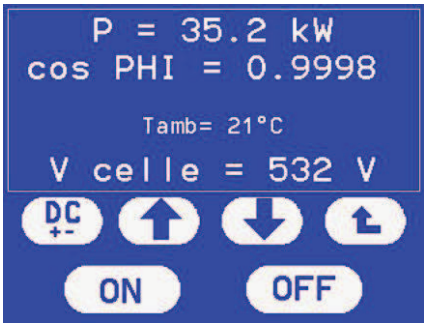
The following screen will appear to let you confirm your choice of **AUT** or **MAN**:

Press the white button to confirm.

After selecting **AUTOMATIC** mode, the main screen will appear. In this operating mode, using the maximum power point tracker (MPPT) system, the inverter will maximises the quantity of power taken from the photovoltaic field.

If you select the **MANUAL** mode, the maximum power point tracker algorithm is disabled and you may set the desired power level (according to actual radiation condition). For this reason, MAN mode should only be used by qualified personnel for diagnostic purposes.

In this case, the following screen appears:



Using the arrow keys  , you can change the delivered power (the arrow direction shows the increase or decrease of power).

To disable MANUAL mode and to return to AUTOMATIC, just press the “return” button  .

The set-up menu will then appear. Selecting **AUT** restores **AUTOMATIC** mode.

To return to the main screen from the set-up menu, press the ‘return’ button  .

The inverter default setting is in **AUTOMATIC**.

If you try to select an already active mode, nothing happens

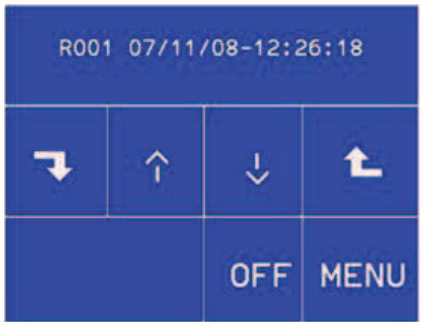
4.3.4.2 Display and navigation of history

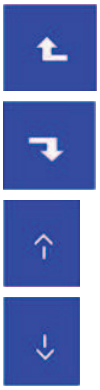
The inverter is fitted with a system that saves events (alarms, malfunctions, protection) to its memory bank. As soon as it occurs, an “event” is saved to a progressive list along with details of time and date it occurred. Every record also contains details of the appliance status (AC and DC measurements).

To access the appliance history section, once you are in the set-up menu (section 4.3.2) :

- Press the key with icon 

  The records list will appear:





Back key

Record details access key

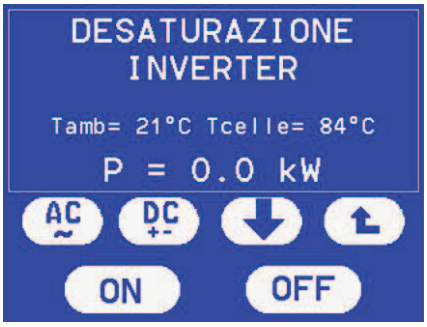
Previous record display key

Next record display key

  Each history record has a progressive number (R001 in the diagram) from the date and time that the event took place.

- Press the  ,  keys to display the different log records (R002, R003, etc).

- If you press the  key, you access the record details, i.e. all the information regarding device operations stored when the event occurred.



  The diagram shows one of the conditions applicable to alarm R001 dated 7 November 2008 (‘Inverter desaturation’).

  The other indications scroll automatically in the first two lines of the display.

  If you press the  keys, you enter the machine measurement values which were stored when the event occurred.

  For a more detailed description of the electrical measurements that the appliance can display, see section 4.4.

If you press  , the status message of the inverter is displayed, including the message regarding the originating alarm/error of the record (“Inverter desaturation” in this example).

- Press  to go back to the record list display, from which you can return to the main window by pressing  twice.

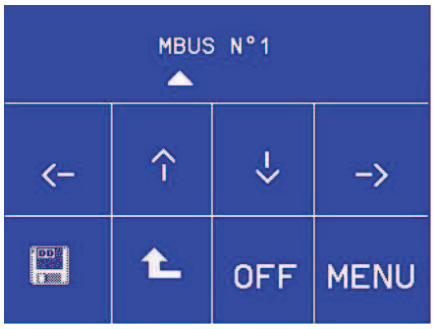
4.3.4.3 Serial settings

The inverter uses serial settings (RS-232, RS-485) to export two communication protocols (Modbus, OCS3). Before connecting the serial port, select the protocol and inverter node address.

From the set-up menu:

- Press the key with icon 

  The following screen will appear:



- Using  and  move to the field you wish to change (protocol or address) indicated by the cursor  .
- Press the key and the  keys to change the field value.
- Press “Save”  to confirm settings.
- Press  to go back to the set-up menu screen.

4.3.4.4 Language selection

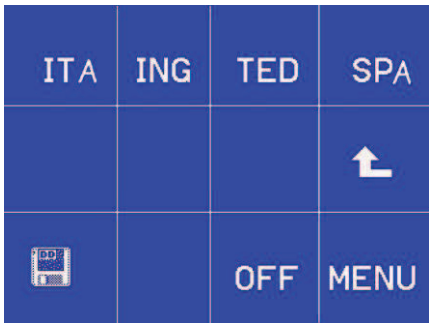
Messages can be displayed in the following languages:

- Italian (default)
- English
- German
- Spanish
- French

To set the language from the set-up menu:

- Press the key with icon 

  The following screen appears:



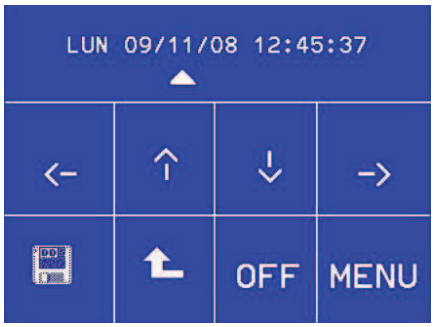
- Press the icon of the language you want to select.
- Press “Save”  to confirm settings.
- Press  to go back to the set-up menu screen.

4.3.4.5 Date and time settings

To set the date and time from the set-up menu:

- Press the key with icon 

  The following screen will appear:



- Using  and  move to the field you wish to change (date or time) indicated by the cursor  .
- Press the key and the  keys to change the field value.
- Press “Save”  to confirm settings.
- Press  to go back to the set-up menu screen.

4.3.4.6 Advanced machine settings

Some inverter operating parameters are password protected but can be edited to enable/set up particular features, by entering the value of an accessible parameter through the relevant address.

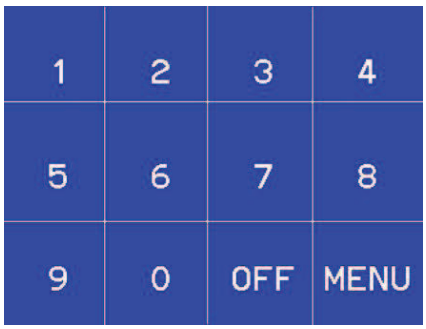
Parameters can be edited with the machine in a DISABLED status, following the procedure described as follows.

THIS MANUAL CONTAINS ALL AND ONLY THE PARAMETERS ACCESSIBLE TO THE USER, WITH THE RELATIVE ADMITTED VALUES; A VALUE THAT IS NOT PROVIDED FOR CAN COMPROMISE CONVERTER OPERATIONS.

From the set-up menu:

- Press the key with icon 

  The following screen will appear:



Enter the password **14914** to access the User parameters. If the password is recognised as valid the screen below will be shown; otherwise the set-up menu will be shown again

Reading parameters

Press the **READ** key to open the menu to read parameters.

Proceed as follows:

- Press **OK** to enter the address of the parameter of the value you wish to read.

  Press  to return to the previous menu (by pressing the **MENU** key you return to the set-up menu, or press **OFF** to immediately turn off the inverter and immediately return to the main screen).

- A numerical keyboard will appear; set up the address always using four digits. If the value of the address is less than 1000, enter a sufficient number of zeroes before it to have four digits (Example: address 99 is entered as 0099).

- On pressing the fourth digit a confirmation screen will appear with the address just entered. If its value is correct press **OK** to confirm.
  The display shows the value of the selected parameter.

The **Value** field represents the value of the parameter in the “a byte” format (in the example illustration the byte with the address 1239 has the value 1), while the field **Word Value** is the value in the “a word” format (in the example the word formed from byte 1239 and 1240 has the total value of 260).

If the entered address is not valid, the error message “Reading error with DSP board” will be shown.

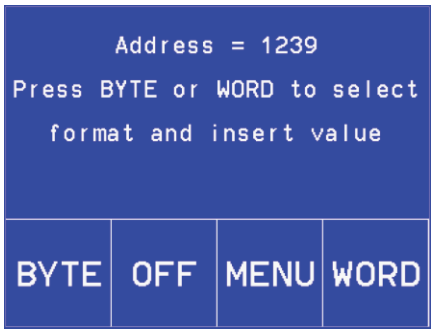
Verify the value of the address and possibly retry by pressing OK.

Entering parameters

Press the **WRITE** key to open the parameter entry menu.

Proceed as follows:

- Press **OK** to enter the address of the parameter of the value you wish to read.
- The screen will appear to enter the address. Proceed exactly as in the case of reading parameters.
- Once the address of the parameter that you wish to change has been confirmed, the following screen will appear:



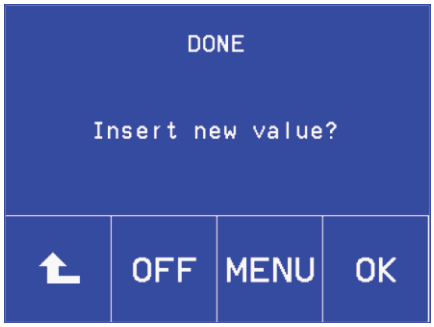
- Press **BYTE** if you intend to enter the new value in the “a byte” format; press **WORD** if you intend to enter the new value in the “a word” format.
- A numerical keyboard will appear. Enter the new value considering that: the “a byte” format is three digits long (from 0 a 255), while the “a word” format is five (from 0 to 65535). If the value to be entered is composed of a number of digits that is less that that required, place a sufficient number of zeroes before it to complete the format (Example: the value 99 will be entered in the “a byte” format as 099, while in the “a word” format as 00099).

- Once the last number has been entered, a confirmation window will appear. Press **OK** to confirm the value to be changed.

- If the written value is accepted by the inverter, a screen will appear with the word “Wait…” at the end of which the message “DONE” will be shown for confirmation.

If the value-address is not available to the user, the message “ACCESS DENIED. Address Not Available” will be shown, and you will return to the initial WRITE menu screen.

- Once the writing operation is completed it is possible to choose whether to set a new parameter, or end the edit phase and save the new machine set-up.



Press **OK** to enter a new value.

By pressing **OFF** to exit the mode you change parameters WITHOUT saving the changes. **To completely cancel the changes it is necessary to reboot the machine.**

Press **MENU** and then YES to confirm changes and save them in the non-volatile memory.

4.3.4.7 Grid connection protocol selection

From the main menu, press the  key to access the grid connection protocol selection menu.

The protocol currently set is indicated in round brackets. To modify the preference, use the “arrow” key to scroll through the possible choices, and then the “OK” key to confirm the choice.

The following Connection Protocols can be selected:

- DK5940 and 2.2
- VDE 0126-1-1
- REAL DECRETO
- G83
- CEI 0-16 0-21 A70

4.4 Machine values

The appliance measurements displayed are summarised in the following table:

Acronym	Measurement	Unit of measurement	AC/DC	Main or secondary display
Vrs	RS Linked voltage	V (rms)	AC	S
Vst	ST Linked voltage	V (rms)	AC	S
Vtr	TR Linked voltage	V (rms)	AC	S
Ir	R Phase current	A (rms)	AC	S
Is	S Phase current	A (rms)	AC	S
It	T Phase current	A (rms)	AC	S
P	Active power	KW	AC	P
Q	Reactive power	KVA	AC	P
Cos phi	Power factor		AC	S
Tamb	Ambient temperature	°C		S
Energy	Energy produced	kWh/MWh	AC	P
Hours	Running hours	h	AC	S
Vcel	Cell voltage	V	DC	S
Icel	Cell current	A	DC	S
Pcel	Cell power	KW	DC	P
Irry	Vertical radiation	W/sq mt	DC	S
Tcel	Cell temperature	°C	DC	S
Riso	Isolation resistance	kΩ	DC	S

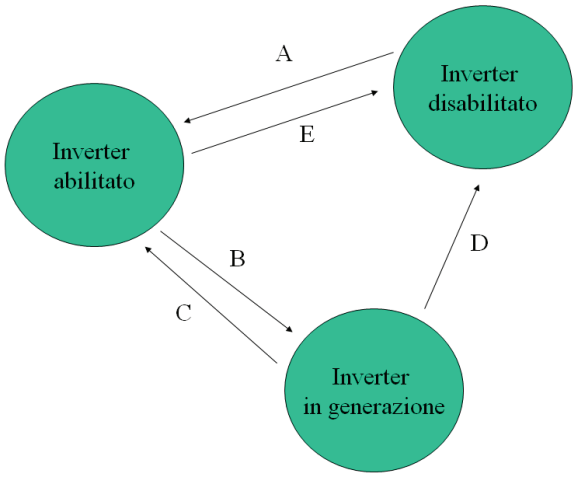
As previously explained in section 4.3.3, press AC to view the alternate current value display (AC); to view the direct current value display press DC.

The measurements are always shown in the ‘main display” format (upper case letters, second line) – secondary display (lower case letters, first line).

4.5 Status, alarms and inverter protection

4.5.1 Details about status and operating conditions

The inverter features three operating conditions:



The status of the inverter is shown in the two rows at the top of each window.

Inverter disabled

The inverter is still (“OFF” Led lit up). PWM impulses are off and the inverter is offline. The inverter is in this status:

- As soon as logic control is turned on for the first time.
- After pressing the OFF key.
- After the EPO triggers.
- After appliance protections repeatedly trigger.
- To enable the inverter, press the ON key and confirm on the display.

Inverter enabled

In these conditions the inverter is always offline (contact open) and does not generate power although PWM impulses to the bridge can be on. Once in this condition, the controller checks:

- For the presence of network synchronism in the voltage and frequency acceptance interval.
- For cell voltage (and, eventually, solar radiation) in the acceptance interval.
- For protections off (the countdown triggered by a protection has elapsed).
- The contact “EXTERNAL START INVERTER”(terminals 11-12, see par. 0) is closed.

If all these conditions are met, the inverter releases PWM impulses and accelerates the voltage ramp output to the bridge.

In these conditions, the ON and OFF leds blink alternatively.

When output voltage reaches a set value, the control closes the contact and switches to *'inverter in generation*' conditions.

Inverter generating

In these conditions, the inverter is online (contact closed) and generates power ('ON' led on). If one of the following events occurs during operations:

- Radiation conditions are not enough to keep the inverter operating (cell voltage or input power below the respective threshold, see par. 4.5.2), or the voltage and mains synchronism values are not in the allowable range (see par. 4.5.2), or
- If a machine protection triggers (other than EPO),

  the contact is opened, PWM impulses are immediately turned off, a countdown starts (depending on the type of protection triggered) and the inverter returns to *'inverter on'* conditions.

  If the EPO triggers, the inverter switches to *'inverter disabled*'.

  If a protection triggers, the 'ALARM' led turns on and beeps.

If you press the OFF button, no matter what the condition is, the inverter immediately switches to the "disabled inverter" status.

If a protection triggers, the 'ALARM' led turns on and beep sounds. Touching any button on the touch screen silences the beep.

The triggering of a protection causes the inverter to disconnect from the mains and the immediate cancellation of impulses. The inverter is programmed to start again after the activation of a protection (with the exception of EPO), after a specific countdown is over (the amount of the countdown depends on the protection type). The continuous triggering of a protection is however a sign of a "serious" appliance malfunction. For this reason, if the protection activity occurs fairly frequently and lasts a long time, the controller can decide not to restart the inverter. In this event, the controller will change the status from 'inverter generating' to 'inverter disabled' until specialised technical assistance from SIEL is provided.

EPO: if the EPO activates the inverter switches to the "disabled inverter" status. The protection system is restored by reclosing the EPO switch. To re-enable the inverter, press the ON button on the keyboard then confirm.

Below is a table with detailed descriptions of appliance statuses and of events that activate various changes of status.

The input "External start inverter" functions as a go-ahead signal to start the inverter. If the inverter has already been started and stopped by a contact opening, on the re-closure of the contact "External start inverter", the inverter will immediate restart.

Current status	Previous status	Event	Subsequent status	Graphic change	Actions
Inverter disabled	Any	Press button ON+confirm	Inverter enabled	A	• PWM pulses off • Switch open
	Inverter generating	EPO closes, press button ON+confirm	Inverter enabled		
Inverter enabled	Any	OFF button pressed	Inverter disabled	E	• PWM pulses off • Switch open
		10 sec countdown expired with closed "EXTERNAL START INVERTER" contact	Inverter generating	B	• PWM pulses on • Switch open • Voltage ramp
	Inverter generating	Minimum radiation 6-minute countdown expired	Inverter generating	B	• PWM pulses on • Switch open • Voltage ramp
		Grid parameters verified in the range of acceptance			
		10-second countdown for desaturation protection has expired			
		10 sec countdown time passed for maximum current			
		Inverter module temperature reset below 75°C			

Current status	Previous status	Event	Subsequent status	Graphic change	Actions
Inverter generating	Inverter enabled	-	-	-	• PWM pulses on • Closed contactor • Generation of power in the grid
	Any	OFF button pressed	Inverter disabled	C	-
	Inverter generating	Insufficient irradiation	Inverter enabled	C	6-minute countdown start
		Grid parameters (voltage and frequency) outside of the limits			Awaiting re-entry into the range of acceptance (see par. 9.2.1)
		Desaturation protection triggered			• 10-second countdown starts. • ALARM LED lights up on control panel • Beep sounds
		Protection is activated against maximum current			
		Protection is activated against inverter overtemperature			• ALARM LED lights up on control panel • Beep sounds
	Any	IMPULSE ENABLING contact opens	Inverter enabled	C	10-second countdown starts.
		EPO contact opens	Inverter disabled	D	• ALARM LED lights up on control panel • Beep sounds

4.5.2 Faults, alarms and protections

The events that can occur during inverter operation can be subdivided into:

Faults These are events that occur outside the appliance that affect normal operating mode and the appliance to temporarily stop working (transition from 'inverter generating' to 'inverter enabled' and the start of a countdown).

Alarms Events signalling an incorrect operating condition, which do not jeopardize the proper operation of the inverter.

Protection devices These are events that indicate a 'serious' fault in the appliance and cause the appliance to temporarily stop working (transition from 'inverter generating' to 'inverter on' and a countdown starts). Protections triggered with a certain frequency may cause the inverter to shut down (transition from 'inverter generating' to 'inverter off') and require operator intervention to manually reset the inverter.

As previously mentioned, EPO tripping cause the complete shutdown of the inverter (transition from "Inverter generating power" to "disabled inverter").

Each of these events is reported on the touch screen display as a text message.

Displayed message	AN - Fault AL - Alarm PR - Protection	Cause	Effect
INSUFFICIENT RADIATION	AN	Cell voltage below minimum threshold (note 1) Input power from photovoltaic field is below minimum level (note 2)	• If conditions are 'inverter on', it remains in these conditions. • If conditions are 'inverter in generation', it switches to 'inverter on'. • the 6-minute countdown starts.
NETWORK VOLTAGE OUTSIDE SPECIFICATION	AN	The rms voltage value of mains synchronisms is not in the allowable range (note 3)	Note 3
NETWORK FREQUENCY OUT OF LIMITS	AN	Network synchronism frequency outside acceptance parameters (note 3)	
INVERTER STOPPED EXTERNALLY	AN	'EXTERNAL START INVERTER' contact opened	• If conditions are 'inverter on', it remains in these conditions. • If conditions are 'inverter in generation', it switches to 'inverter on'.
INSULATION LOSS	AL	One of the two DC poles is short-circuited to earth (note 4)	Depending on the set behaviour (Note 4), the inverter may remain in the status in which it is found or move to the status of "disabled inverter".
POLE-TO-EARTH FUSE BLOWN	AL	The electrical connection between the DC pole and earth was interrupted (note 4)	

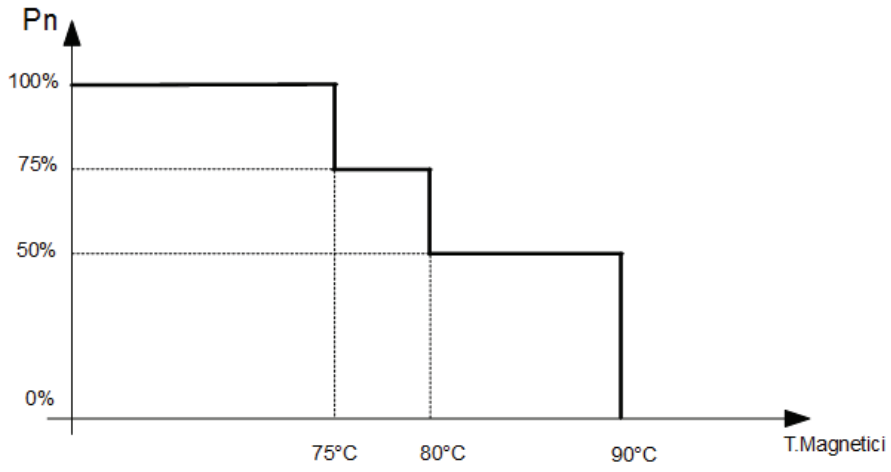
NO COM. DSP-SIGNALLING	AL	Connections between the control board and touch-screen board are down	The inverter does not change its current status.
EEPROM COMMUNICATIONS ERROR	AL	Configuration loading error at start-up	The inverter is in the “Inverter disabled” status and requires an intervention by a SIEL SPA qualified technician.
OVERCURRENT	PR	Rms or peak value of the current generated in the grid outside allowable range (note 5)	• Conditions switch from 'inverter in generation' to 'inverter on'. • The 10-second countdown starts.
INVERTER DESATURATION	PR	Power semi-conductor fault	• Conditions switch from 'inverter in generation' to 'inverter on'. • The 10-second countdown starts.
OVERVOLTAGE BUS DC	PR	Cell voltage over maximum threshold (note 6)	• If conditions are 'inverter on', it remains in these conditions. • If conditions are 'inverter in generation', it switches to 'inverter on'. • Wait until bus voltage returns under the safety value.
INVERTER OVER TEMPERATURE	PR	Inverter heat sink above 80°C (note 7).	• Conditions switch from 'inverter in generation' to 'inverter on'. • The 10-second countdown starts.
EPO TRIGGERED	PR	EPO switch opened	Conditions switch to 'inverter off'.
AC CONTACTOR FAULT	PR	AC Contactor fault	The inverter is in the “Inverter disabled” status and requires an intervention by a SIEL SPA qualified technician.
AC CONTACTOR A FAULT	PR	AC Contactor A fault (note 8)	The inverter is in the “Inverter disabled” status and requires an intervention by a SIEL SPA qualified technician.
AC CONTACTOR B FAULT	PR	AC Contactor B fault (note 8)	The inverter is in the “Inverter disabled” status and requires an intervention by a SIEL SPA qualified technician.
UNBALANCE CURRENT	PR	Unbalance Current between module A and module B (note 8)	The inverter is in the “Inverter disabled” status and requires an intervention by a SIEL SPA qualified technician.

1. Minimum cell voltage: see the tables shown in chapter 8 “Technical information”.
2. Minimum power: 1,5% of nominal power (at DC side input).
3. Behaviour complies with the requirements of the CEI-021 regulations and the attachment A70, regarding “voltage dips and frequency variations”, as approved by resolution AEEG/84/2012/R/ENEL, Art.4, paragraph 1.
4. The inverter is equipped with the control of the isolation of the DC side. The same device also permits the detection of the opening of the fuse of the earthing pole, if panels that provide for it are inserted. The two features are complementary. As a default, the inverter measures the insulation resistance with the activation of an alarm if the measurement is less than a set value. Should the earthing pole control feature be implemented, contact the SIEL SPA customer support service. It is possible to choose whether the insulation defect or the operation of the fuse of the earthing pole must only give an alarm or stop the inverter (Protection), also in this case it will be necessary to contact the SIEL SPA customer support service. The implementations described in the above lines can also be carried out in the factory if requested in the ordering phase.
5. The intervention threshold of the maximum current protection is equal to 200% of the rms value of the rated inverter current (see the tables reported in chapter 8 “Technical Information”).
6. The maximum voltage protection system cuts in when DC BUS voltage exceeds the value shown in the ‘Technical data’ tables in section 8. The protection is reset if the direct voltage drops below the safety value (90% of maximum voltage).
7. The inverter control system implements an automatic power limitation function depending on the inverter module temperature, according to the following criteria:
   - 0 - 70°C: maximum power = rated power (ratings plate).
   - 70 - 75°C: maximum power = 70% of nominal power.
   - 75 - 80°C: maximum power = 50% of nominal power.
   - Above 80°C: Inverter overheating protection activated.
8. Contactor A, Contactor B and Unbalance Current faults concern inverters with dual module and single control **(*SOLEIL DSPX TLW 440 … 500 and SOLEIL DSPX TLH 440 … 800*)** that have two distinct contactors, one per module.

4.5.3 Power derating as a function of power module temperature

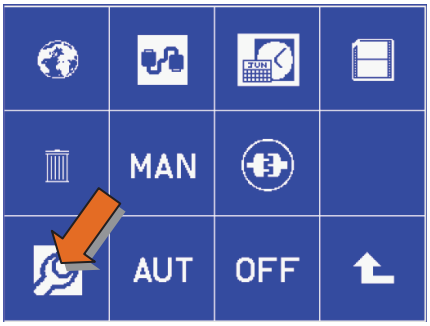
The control CPU of the inverter,automatically performs a power limitation, depending on the measured value of the temperature of the inverter power module, according to following logic:

- From 0 to 75°C: Max generated power = Rated power (data reported on the inverter technical plate)
- From 75°C to 80°C: Max generated power = 75% of rated power.
- From 80°C to 90°C: Max generated power = 50% of rated power.
- Above 90°C: over-temperature protection trip.

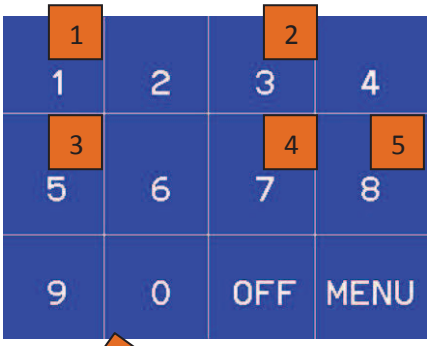


4.6 Identification of code revision firmware installed on solar converters

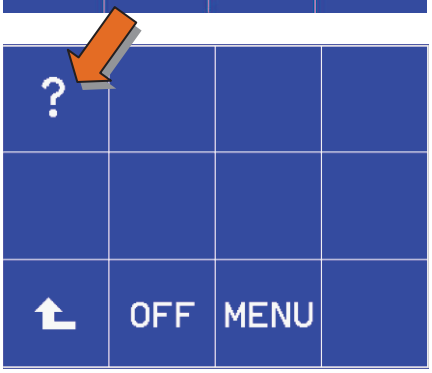
From the main screen of the display of the machine, press the **Menu** key to access the corresponding page.



Access the **Advanced setup** menu by pressing the key on.



Enter the code number **13578**.



Go to the screen **firmware** revision code of the machine using the appropriate button.

Using the arrow keys, scroll the display to the DSP BOARD to read the regulation firmware version installed in the inverter.

For the converter construction date, the firmware identification code can be viewed in one of the following formats:

MCxxxx . yy . zz for example MC0162.00.01

MCxxxx yy REV zz for example MC010900 REV 24

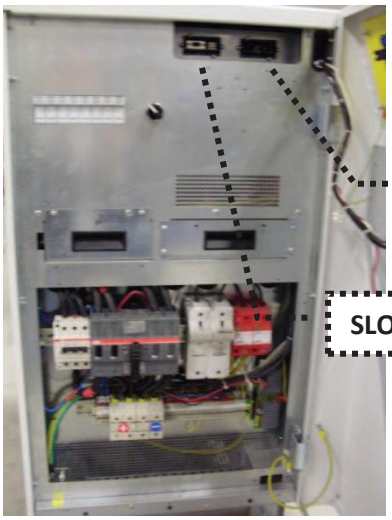
For all display formats, the field must be interpreted in accord to the following table:

Field	Meaning
MCxxxx	Identification code of the firmware. *MC0109 Identification code for SOLEIL DSP inverters* *MC0162 Identification code for new generation SOLEIL inverters*
yy	Major Revision Code, indicates changes with the addition of new features
zz	Minor Revision Code, indicates changes related to bugfix and anomalies *Firmware with different minor revision code, from the point of view of functionality for Network Services are equivalent*

5 COMMUNICATIONS AND I/O

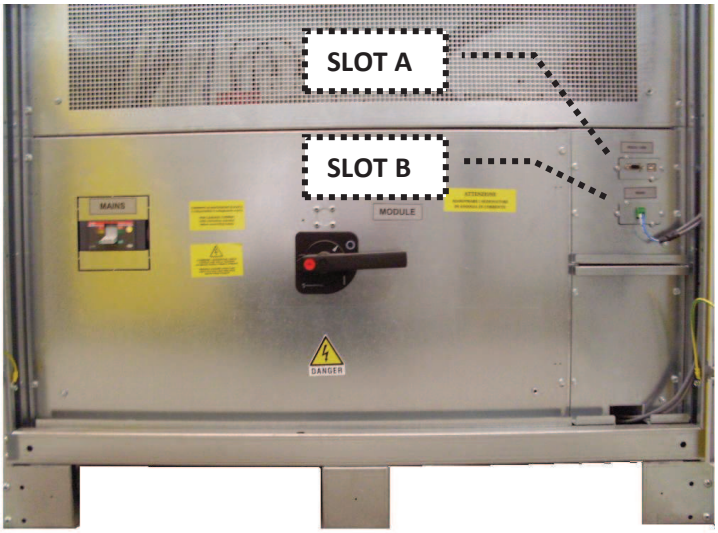
5.1 Ports and protocols

Soleil DSPX inverters are equipped with a communication platform based on two ports, which can accommodate different interface devices for the remote transmission of values, status and alarms.



SOLEIL DSPX TRL 10 .. 30

SOLEIL DSPX TRL 45 55

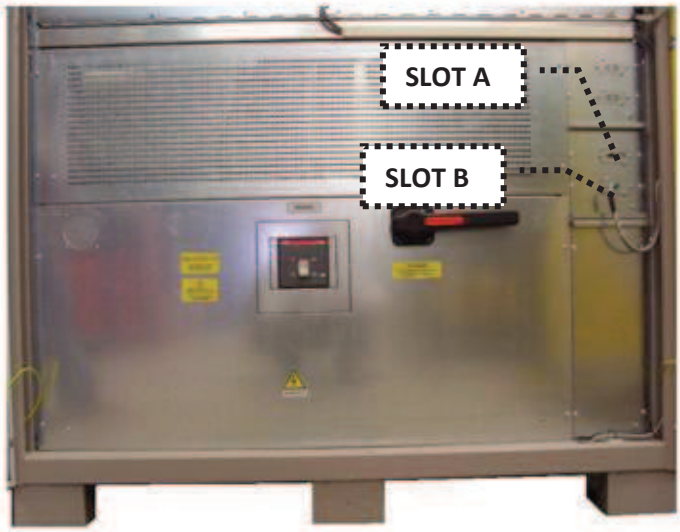


SOLEIL DSPX TRL 80 .. 110

SOLEIL DSPX TRH 80 .. 110

SOLEIL DSPX TLW 90 .. 110

SOLEIL DSPX TLH 90 .. 110

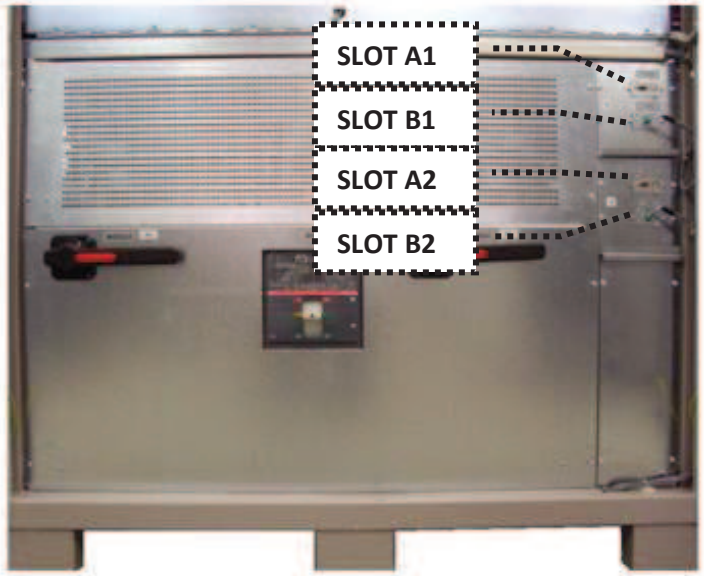


SOLEIL DSPX TRL 220 .. 250

SOLEIL DSPX TRH 220 .. 250

SOLEIL DSPX TLW 220 .. 250

SOLEIL DSPX TLH 220 .. 400



SOLEIL DSPX TLW 440 ... 500

SOLEIL DSPX TLH 440 .. 800

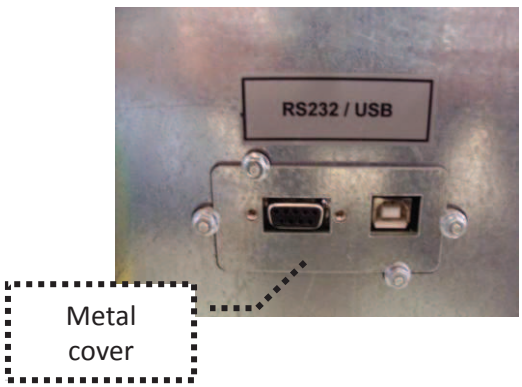
Each of the slots supports differing types of peripherals and communication protocols as can be seen in the following table:

CARD	SLOT A	SLOT B
RS-232/USB	OCS3 protocol	OCS3 and Modbus protocols
RS-485	Not available	OCS3 and Modbus protocols
Fibre optic interface (optional)	OCS3 protocol	OCS3 and Modbus protocols
Network adapter (optional)	SNMP protocol	SNMP protocol

By default, the appliance is fitted with an RS-232/USB interface board (type B) for point-to-point type connections and with an RS-485 interface board for field bus connections.

To replace one type of board with another, you need to:

- Set the communication protocol parameters by touch as explained in section 4.3.4.3.
- Unscrew the nuts (1 to 4) as shown in the picture and remove the metal cover.
- Remove the card (an empty slot appears as shown in the right section of the picture) and insert the new card pushing it until you notice a resistance.
- Replace the metal cover (supplied with the board) then refit the four nuts.
- Plug the communications cable into the board connector.



A board can be replaced even while the inverter is running.

For more information about other cards (not RS-232 and RS-485) and about communication protocol, contact SIEL SPA Commercial Office.

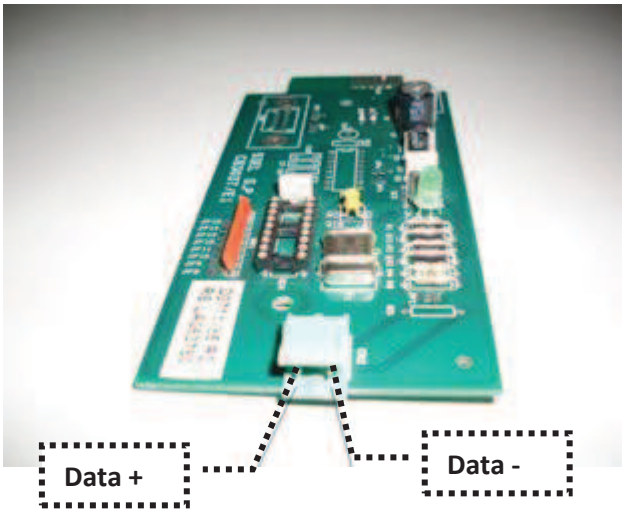
5.2 Communication boards

5.2.1 RS-232/USB serial interface card

The use of this board is combined with point-to-point communication software for PC OCSystem MDB that integrates display functionality, event recording (alarms, faults, protection systems) and graphics of the main appliance measurements.

The installation of a dedicated communication driver is required in order to use the USB port for interfacing with this software (the driver is included in the OCSystem MDB software package).

5.2.2 Serial RS-485 interface board



This board allows you to connect the inverter to a RS-485 field bus serial with the Modbus protocol. The connection of each inverter to the RS-485 bus must take place according to a “chain” type (avoiding “star” connections).

The connection diagrams are found in “Installation Manual” document IV347.

5.2.3 Concentrator card for CSP12 smart string boxes

Each inverter is equipped with a card which ensures interfacing with up to 8 CSP12 string monitoring boxes, by means of either datalogger or TGS monitoring system.

This card can communicate with the CSP boxes (up to 8) through a dedicated serial port (terminals 25-26 on terminal board, see par. 0). It collects data from the CSP boxes and make them available on an “auxiliary” RS-485 (terminals 27-28 on terminal board) to which the datalogger for CSP is connected.

The CSPs are interconnected by means of a “cascade” set-up according to the diagrams shown the “Installation Manual” document IV347.

5.3 Supervision platforms

Four supervision platforms are available and these are listed below in ascending order of complexity:

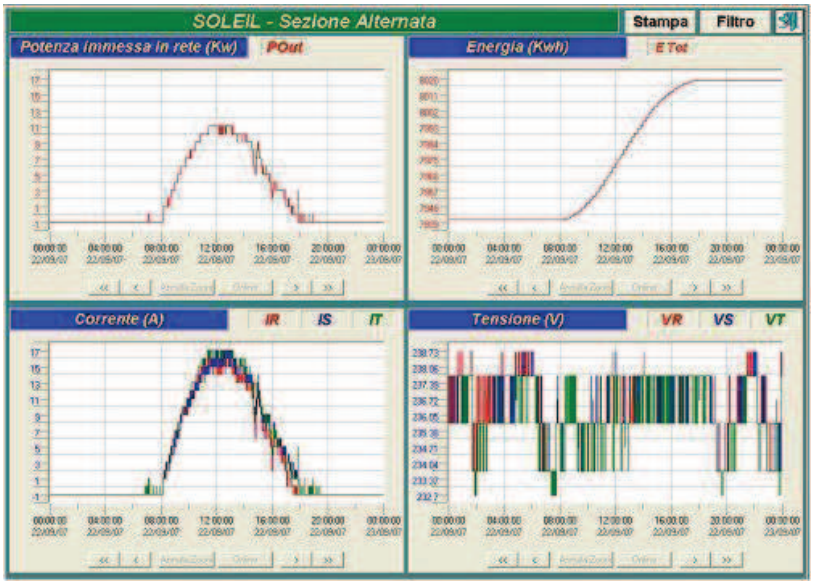
- ‘Light’ platform for point-to-point connections.
- Datalogger platform and LAN connection
- SNMP adaptor network platform.
- TGS (TeleGlobalService) platform and LAN or GPRS/ADSL modem connection.

5.3.1 Light platform

The inverter can be connected directly to a PC using the RS232 USB slot and inverter functioning can be monitored using the OCSystem MDB software.

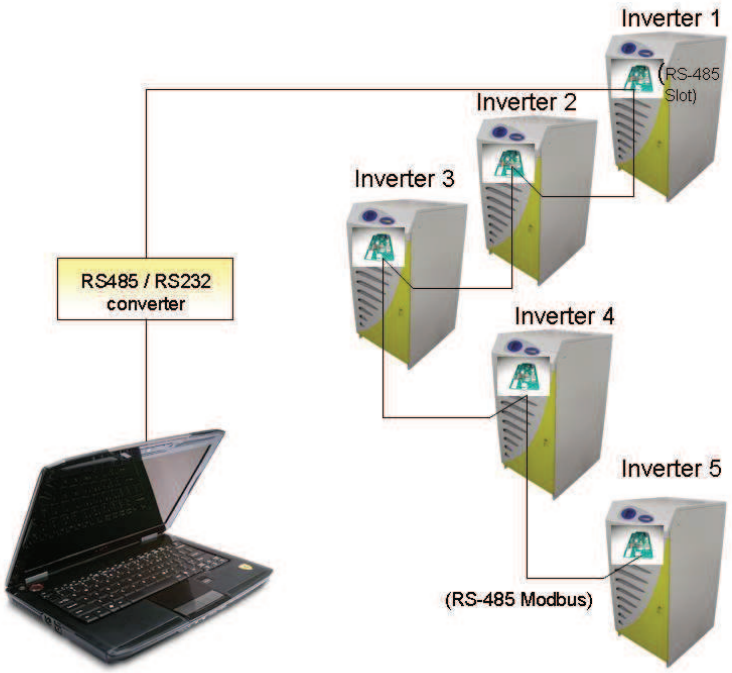
Using the Modbus protocol, this SW allows the acquisition of measurements, appliance alarm statuses and all the history of such measurements can be saved to the PC hard disc.

Below is a diagram showing the main measurement graphics that can be displayed using the OCSsytem.



The PC can be connected via USB (B type) or serial RS232. The USB connection requires installing the specific driver included in the setup package of the software.

The maximum length of the serial cable that can be used is 10 metres therefore this monitoring system is suited to small units where the distance between the inverter and the control centre is no more than a few metres.



The OCSystem MDB software can also be used with the RS485 slot and in such case allows the acquisition and monitoring of up to 5 inverters connected in series. In this case however you will need to use an RS485-RS232 converter (see section 0) to make connection with the PC possible.

The maximum length of the distance between serial and RS485 must not exceed 1200m.

5.3.2 Platform based on SoleilLog with LAN connection

This platform is based on an RS-485 Modbus local network, referring to a datalogger called SoleilLog, which is the communication master.

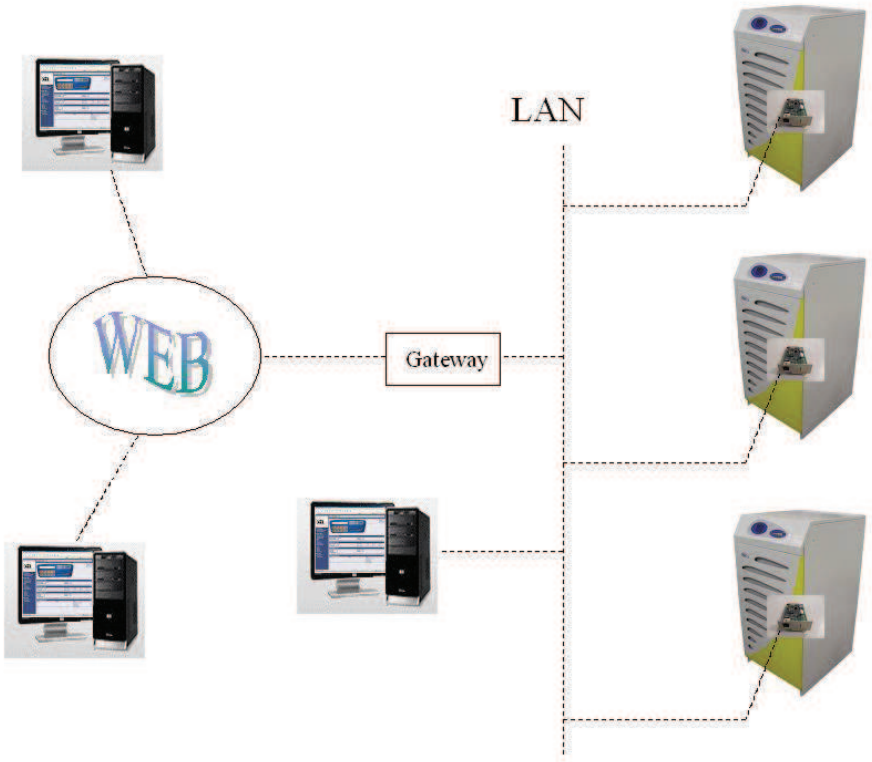
The RS-485 Modbus network referring to the SoleilLog inverter is created by interconnecting the inverters in a “cascade” set-up through their terminal board as described in the diagrams of the following pages.

The parallel boards of each inverter are interconnected by a local bus (SAC to CSP) terminating on terminals 25 (+) and 26 (-) of the respective inverter, while the cable shield shall be connected to terminal 29. Each inverter supports up to 8 field boards. If the amount of boards per inverter is more than 8, a “concentrator” must be added allowing an expansion up to 16 parallel boards (see par. 0).

For a complete description of the terminal board, see par. 0.

For the correct installation refer to the SoleilLog manual.

5.3.3 Platform based on SNMP card



This configuration allows the inverter to be connected to an existing LAN network with an SNMP slot adapter that is available as accessory (see section 7). Insert the SNMP card in one of the slots (A or B) replacing one of two default cards (RS232 or RS485). Consult par. 5 for details regarding the installation of the card.

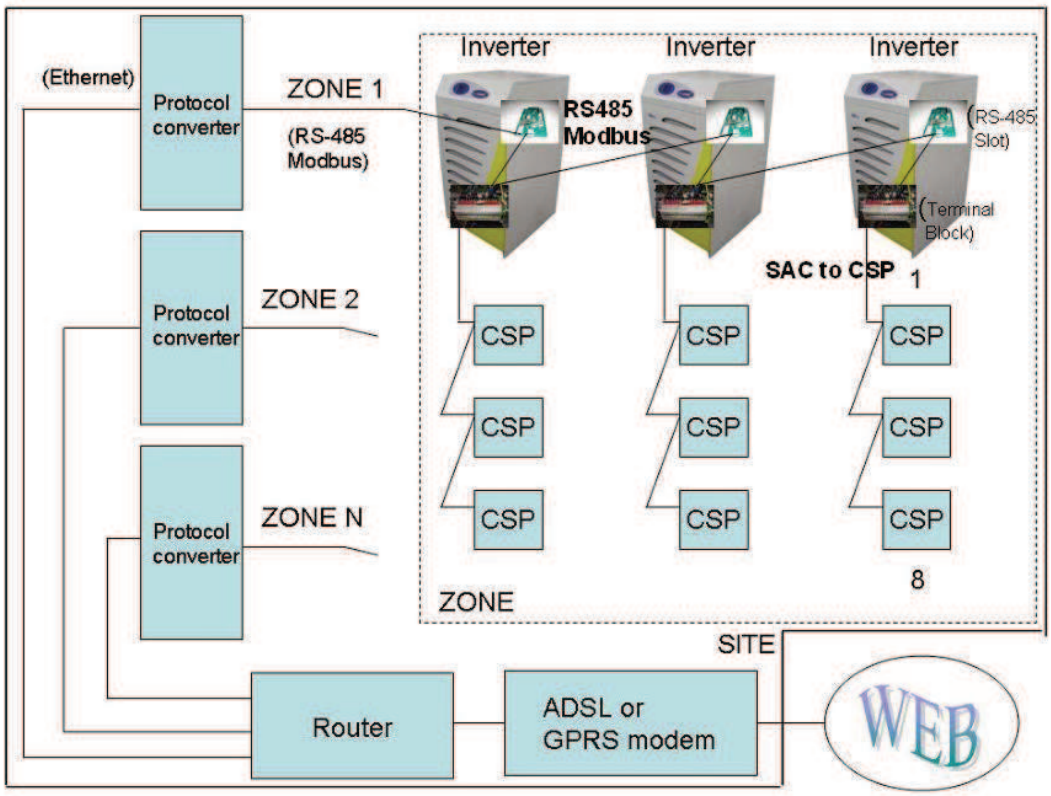
This adapter allows to monitor the basic values and status of the inverter in the network using a simple web browser (MS Explorer, Mozilla Firefox, etc.).

This board acts as a web server using the SNMP network protocol, incorporates remote access functions (telnet and ftp) and also lets you send messages to configurable addresses to remotely signal possible alarms, faults or appliance protection system interventions.

Once the suitable driver (included in the software package) has been installed, it also lets you send trap to a PC for the purposes of checking configurable events and for the display of pop-up messages on the PC.

In this configuration, any inverter on the LAN network can be communicated with by means of a unique IP address.

5.3.4 TGS platform (Tele Global Service)



The TGS platform is based on a network that has three distinct levels:

- One bus network bus (SAC to CSP) connecting each inverter to the respective parallel boards. The group made up of the inverter and parallel board is called “PHOTOVOLTAIC GENERATOR”.
- A second RS-485 Modbus network cascade interconnects the existing photovoltaic generators. The N photovoltaic generators cascade is called “ZONE”.
- An Ethernet network controls various ‘ZONES’. This network can consist of an existing LAN system or can be connected to a public network with an ADSL or GPRS modem. A combination of zones makes up the ‘SITE’.

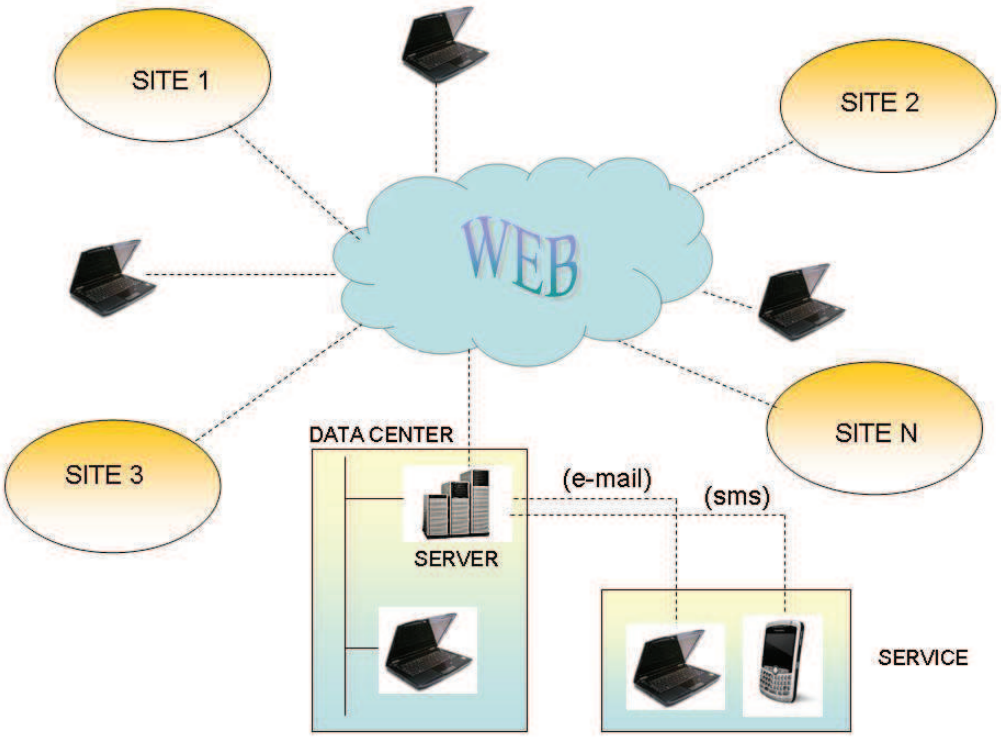
The “PHOTOVOLTAIC GENERATOR” network is established by:

1. cascade connecting all the parallel boards on a RS485 bus (SAC to CSP) and terminating this cascade on terminals 25 (+) and 26 (-) of the respective inverter. the board is connected to terminal 29.
2. connecting terminals 27 (+) and 28 (-) of the RS-485 AUX bus respectively to the + and - terminals of the RS-485 slot card, using the shielded cable provided with the machine. the board is connected to terminal 30.

The ZONE network (the dotted line in the diagram) is created by connecting the + and – terminals of the RS-485 Modbus board slot of an inverter to terminals 27 (+ terminal) and 28 (- terminal) of the next inverter where on the latter, terminals 27 and 28 are connected to the + and – terminals of the RS-485 Modbus board slot of the same inverter. The board of this cable is connected directly to the board of the next cable.

The last section of the zone RS-485 bus terminates on RS-485 – Ethernet protocol converter (see par. 7.7). The board of this section of cable is to be earthed as near as possible to the RS485 – Ethernet protocol converter.

The SITE network is created by connecting all the various RS485-Ethernet protocol converters that control the ZONE by means of an existing LAN or a router. If LAN access is not available, it can be set up using a GPRS/ADSL modem (with a SIM card).



A dedicated WEB application for monitoring purposes, installed on a server located in the management centre (of the customer or of SIEL itself), manages the queries from the different sites, collecting their values, status and alarms and administering the log of all data and of all sites. This data can be seen from any PC work station (that has internet access) by connecting (via a w.w.w. address) to the appropriate server and requesting access (with authentication) to the relevant site information.

The monitoring application can solve problems which occurred in the field (for example, alarms or protections on one or more inverters), notifying the Service in real time (via email) about the problem type, in which site, zone and photovoltaic generator. It can also send text messages directly to maintenance personnel who are contactable at that moment thus ensuring rapid intervention at the site where the problem has taken place.

5.3.5 Connection diagrams of the various communication platforms

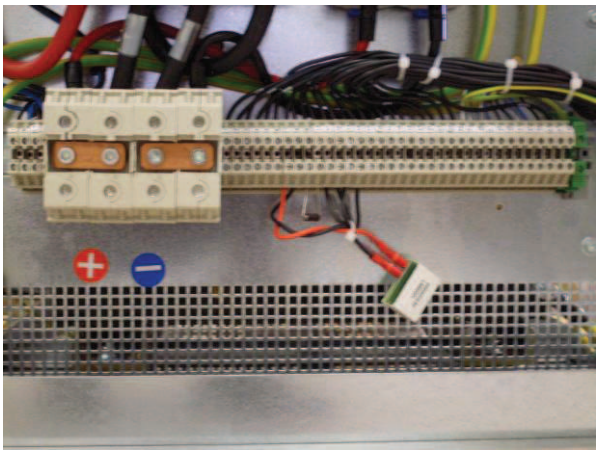
For the detailed diagrams regarding the plant design construction of each of the communication platforms, refer to the "Installation Manual" document IV347.

5.4 Terminal board I/O (terminal block)

The inverter has a terminal block for cables that lets the user:

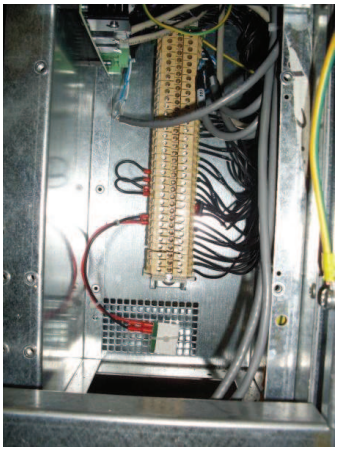
- Acquire detailed digital information about inverter status (volt free).

- Send commands to the inverter (using relays).
- Send analogue signals (voltage 0-5V) to the inverter (measurements or references).



SOLEIL DSPX TRL 10 .. 30

SOLEIL DSPX TRL 45 .. 55



SOLEIL DSPX TRL 80 .. 110

SOLEIL DSPX TRH 80 .. 110

SOLEIL DSPX TLW 90 .. 110

SOLEIL DSPX TLH 90 .. 110

SOLEIL DSPX TRL 220 .. 250

SOLEIL DSPX TLW 220 .. 250

SOLEIL DSPX TRH 220 .. 250

SOLEIL DSPX TLH 220 .. 400

SOLEIL DSPX TLW 440 .. 500

SOLEIL DSPX TLH 440 .. 800

For the SOLEIL DSPX TRL 45-55 types, to get access to the auxiliary terminal board yon need to remove the protective grid panel in the lower front part of the device; remove the screws fixing the panel in position. For all other sizes, the auxiliary terminal board is located in the disconnection switch compartment. The terminal board is always protected by a metal panel.

Terminal	Signal name	I/O	Type	Meaning	
1-2	ENABLE/DISABLE	O	Contact	Open	Enabled inverter not generating power
				Closed	Inverter disabled
3-4	PROTECTION	O	Contact	Open	Protection present
				Closed	No protection present
5-6	START/STOP	O	Contact	Open	Inverter connected to the mains and generating
				Closed	Inverter not generating
7(+)-8(-)	CELL TEMPERATURE	I	Analogue	Temperature module probe input	
9(+)–10(-)	RADIATION	I	Analogue	Radiation sensor input	
11-12	EXTERNAL START INVERTER	I	Contact	Open	External inverter stop command
				Closed	External inverter start command
13-14	EPO	I	Contact	Open	Inverter remote emergency stop
				Closed	
15–16	CONF. DIG INPUT1	I	Contact	Open	Digital input configurable for expansion
				Closed	
17-18	EARTHED FUSE BOX STATUS	I	Contact	Open	Condition of the fuse on the pole directly connected to earth
				Closed	
19-20	CONF. DIG. OUTPUT	O	Contact	Open	Digital output configurable for expansion
				Closed	
21(+)-22(-)	CONF. AN. INPUT1	I	Analogue	Analog expansion input	21(+)-22(-)
23(+)-24(-)	CONF. AN. INPUT2	I	Analogue	Analog expansion input	23(+)-24(-)
25(+)-26(-)	SAC TO CSP BUS	I/O	Serial	Bus communication for CSP	25(+)-26(-)
27(+)-28(-)	RS-485 MODBUS IN	I/O	Serial	RS 485 MODBUS input (Inverter and datalogger for CSP)	27(+)-28(-)
29	SAC BOARD TO CSP BUS		Serial	Cable shield connection SAC TO CSP BUS	29
30	MODBUS IN BOARD		Serial	Cable shield connection RS-485 MODBUS IN	30
31(+)-32(-)	RS-485 MODBUS OUT	I/O	Serial	RS 485 MODBUS output (Inverter and datalogger for CSP)	31(+)-32(-)
33	MODBUS OUT SCREEN		Serial	Cable shield connection RS-485 MODBUS OUT	33
34	(-) Power supply SAC	I/O	Serial	Negative power RS485 SAC TO CSP BUS	34
35	(+) Power supply SAC	I/O	Serial	Positive power RS485 SAC TO CSP BUS	35

Notes

1. The volt-free contacts have the following characteristics:
   a. Maximum commutable voltage: 48Vac, 60Vdc.
   b. Maximum commutable current: 6A
2. The analog input are signalled at 0-5V.
3. The serials are differential +5 / -5V.
4. **For the correct connection of the machine serial ports, it is recommended that the "Installation Manual" document IV347 be consulted.**

6 INSTALLATION

6.1 Visual inspection

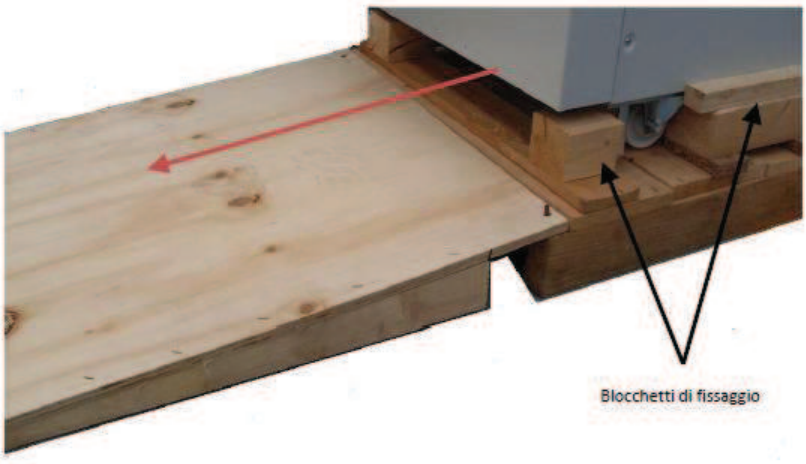
All inverter components (electrical and mechanical) are carefully inspected before the unit is delivered to the customer and must be integral even after delivery. Always visually check a UPS after delivery for any transit damage, and immediately inform Siel SPA if such damage is evident.

6.2 Unpacking

The inverter packaging is usually consitituted 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 (only for inverters up to 30 kVA): secure the dedicated slide (wood-made, included in the packaging), remove the fastening blocks and leave the unit to go down the slide on its wheels. Please take care that the wheels be always moving onto the slide.



Removal from the pallet (for inverters above 30 kVA): 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.

Please do not tilt or lay down the inverter on either lateral side.
Following tools can be used for tran sport:
- 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.

6.3 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 extinguished 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 inverted 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.

6.4 Environmental considerations

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

6.4.1 Load-bearing capacity of the floor

The weight of the inverter (specified in the Technical specifications section) 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.

6.4.2 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.

6.5 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.).

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

A free space of about 1 m must be kept in front of the inverter to allow all

routine and maintenance operations to be carried out.

The top of the appliance should be positioned at least 1 metre 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.

6.6 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: being transported by road, rail, sling, air or ship or by similar equipment (e.g. cranes, moving parts of the appliance etc.).

6.7 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.

For information regarding technical room ventilation positioning and dimensions, refer to the “Installation Manual” document IV347

6.8 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.

6.9 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 ‘Linee Guida per la realizzazione di impianti fotovoltaici’.

6.10Power supply and auxiliary connections

For the following information:

- Features of switches
- Cable quantity and section
- AC and DC power connection
- Auxiliary power supply for inverter fans
- Inverter fan consumption
- Connection of (optional) external fans
- Connection of EPO circuit
- Connection of the modules' temperature sensor
- Connection of Current Transducers to energy meters (outdoor inverters)

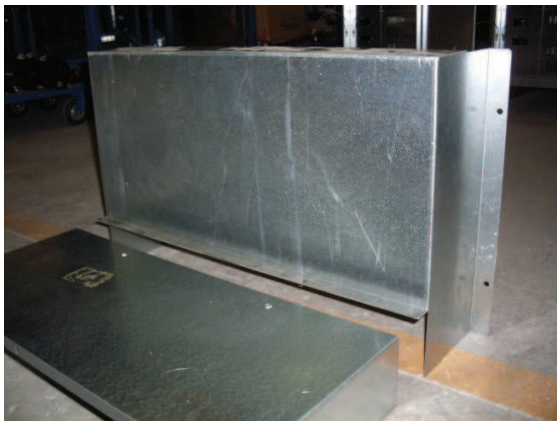
Please see "Installation Manual" document IV347

6.11Connection of external fans (optional for SOLEIL DSPX TRL 45-55)

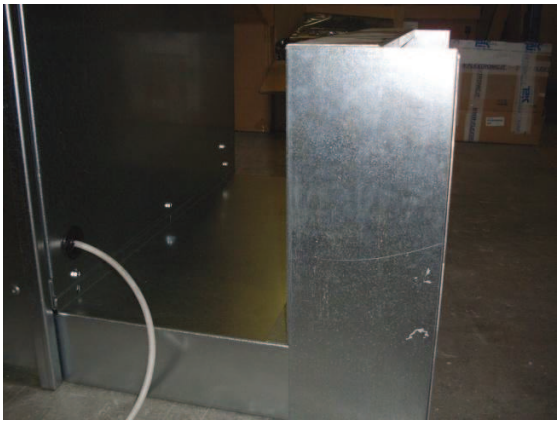
A set of 3 additional fans is available on request to increase the machine cooling in severe environmental conditions.

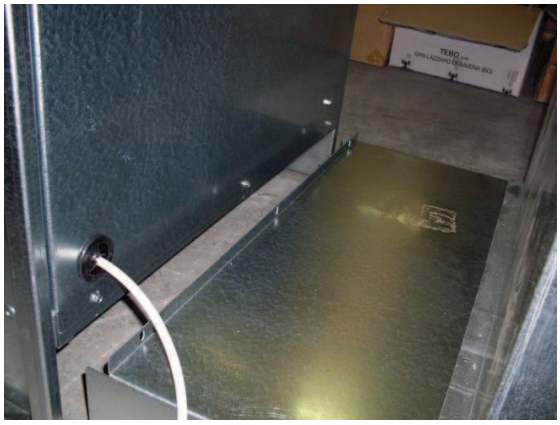
The installation of this set requires the connection of a dedicated 230Vac, 50Hz line with the L, N terminals of the inverter. The cables for the external fan power are included in the set. The mounting instructions for the set are as follows.

1. Assemble the two galvanised sheet iron sections as shown in the following pictures.

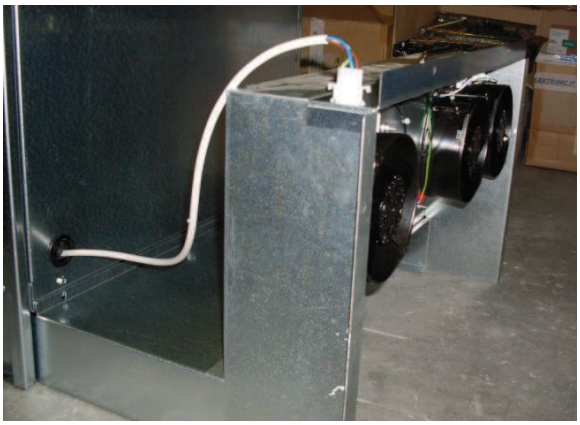


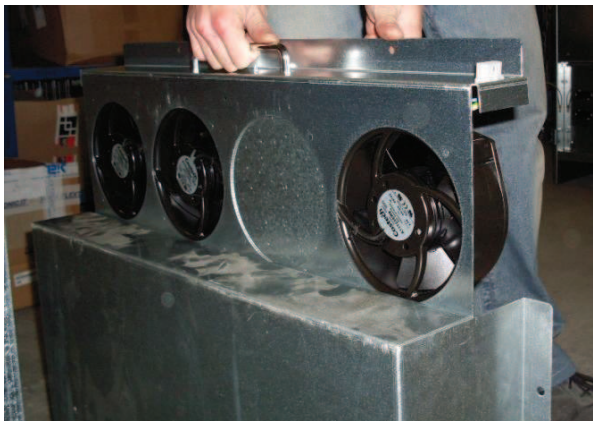
2. Fix the assembly to the wall and after placing the equipment in the correct position, fix it to the lower part of the inverter cubicle.





Place the fan box in the correct position and insert the power supply connector.

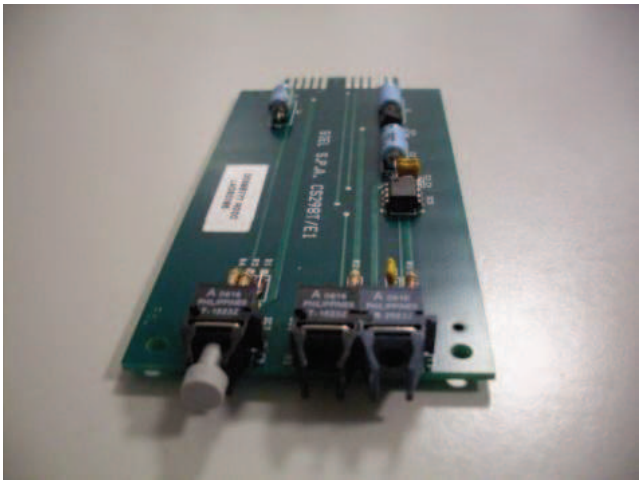




7 ACCESSORIES (OPTIONAL)

Only use accessories recommended by the manufacturer. The use of unauthorised accessories may seriously affect how the appliance operates. The use of non-original accessories will result in the warranty being invalidated and will exempt the manufacturer from any responsibility whatsoever for malfunctions and any consequences that might stem from them.

7.1 Fibre optic serial interface card (optional)



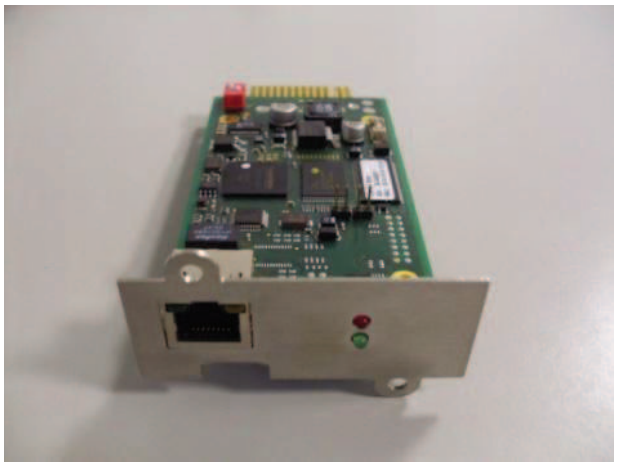
This slot card permits communications between PC and inverter with a fibre optics connection, which is immune to electromagnetic disturbances and is particularly suitable for noisy environment, where signals may be subject to external interference.

This board can be used in both the slots as shown in the following table:

CARD	SLOT A	SLOT B
Fibre optic interface (optional)	OCS3 protocol	OCS3 and Modbus protocols

A fibre-optic converter/RS232 is also supplied to enable connection to a PC.

7.2 Network SNMP adapter



The network adapter board enables direct LAN connection on any individual inverter. To install this card, see paragraph 5.

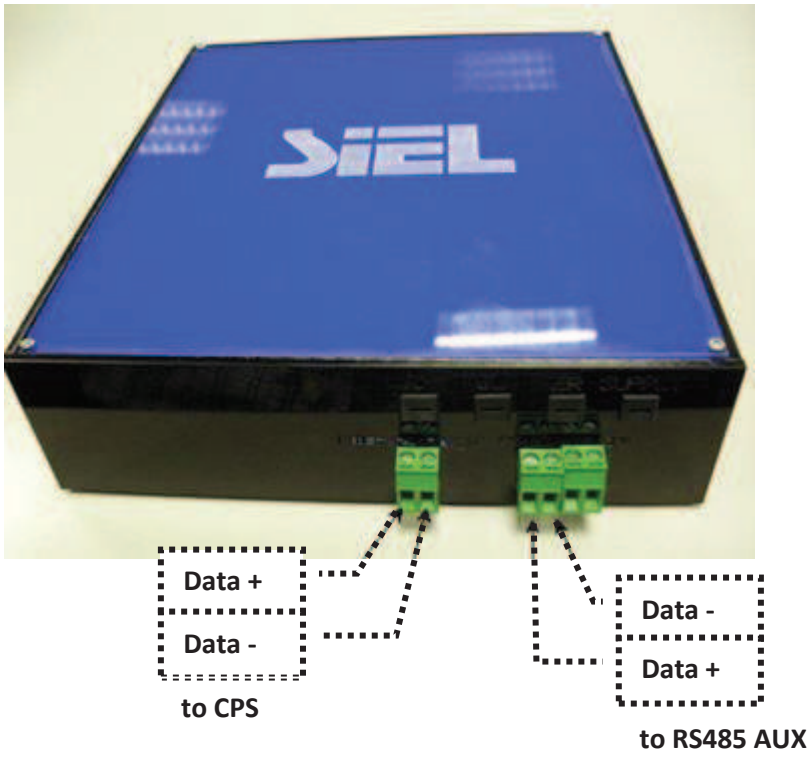
See par. 0 for more details regarding the exported functions.

7.3 Datalogger for inverter

For information on the operation of the SoleilLog Datalogger, refer to the “SoleilLog Instruction Manual” document IV326.

7.4 Concentrator for CSP12

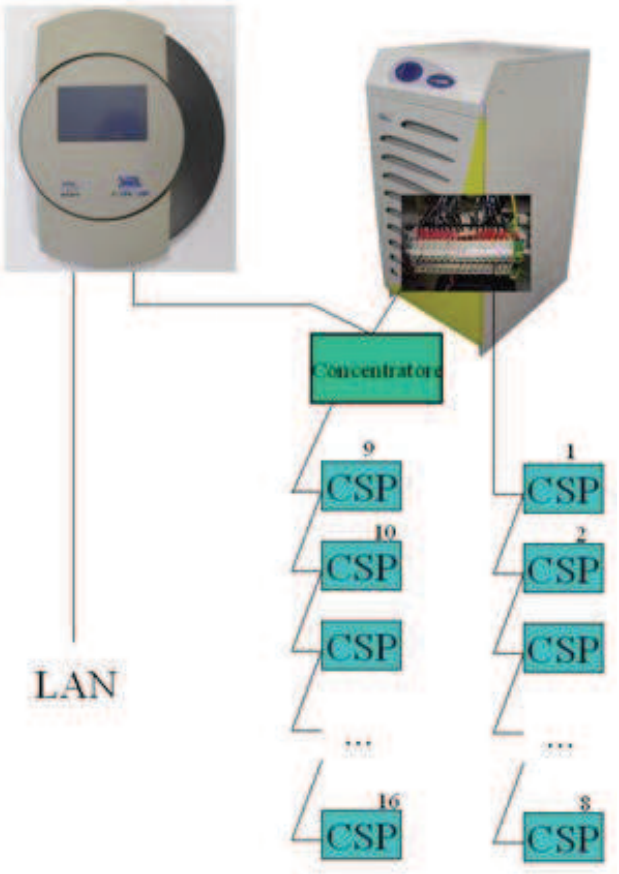
If the DC smart string boxes (CSP12) for each inverter are more than 8, a concentrator shall be added on the RS-485 AUX chain (terminals 27-28, see par. 0), allowing to expand the amount of CSP12 units to 16.



The concentrator features the following terminals:

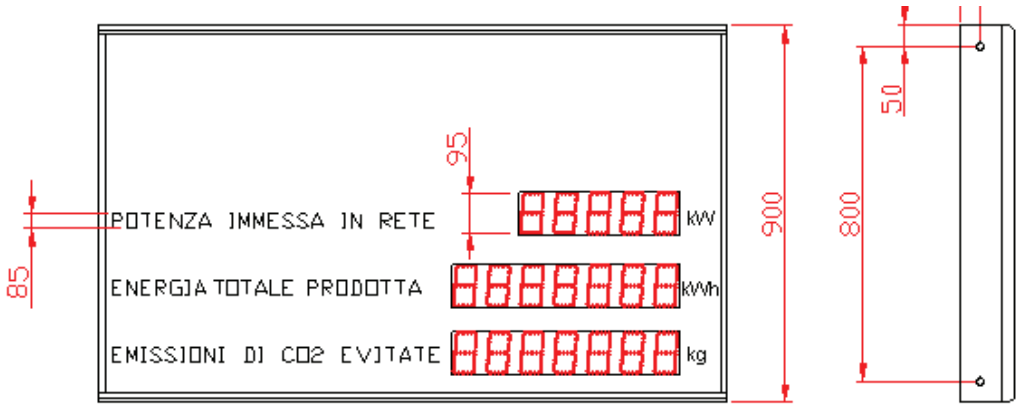
- Data+ and Data- for the CSP communication bus. The CSP are connected “in cascade” and terminate on these two connectors.
- Data+ and Data- for the RS485 AUX bus. According to the communication platform, these two terminals are used for:
    - TGS platform: to connect the concentrator with the RS-485 slot (TGS platform). “Data +” pin shall be connected with the “Data +” pin of the slot, etc...
    - Platform based on Datalogger:
        - to connect the concentrator to an inverter on terminal board by a RS485 AUX (Data + of the concentrator with terminal 27 on terminal board,, Data- of the concentrator with terminal 28 of terminal board).
        - To connect the concentrator to the datalogger when the concentrator is the last element of the chain.

The following diagram shows how to connect the concentrator for a platform based on SoleilLog.



The concentrator is delivered with a 230Vac/9Vdc power supply.

7.5 Public display



A public display is available which can be connected to the SoleilLog or to the modem used for the TGS2 system by means of an RS485 serial port, in two different versions: 3 and 4 line systems.

The main display characteristics are as follows:

- Dimensions: 1500x130x900
- Text relative to the size of the display, character height 85mm.
- Red LED, character height 95mm
- Size displayed:
    - Powered delivered to grid, 5 figures, in kW
    - Total energy produced, 7 figures, in kW
    - Avoided CO2 emissions, 7 figures, in Kg
    - T.E.P. not used in t (only on the 4 line version), 7 characters

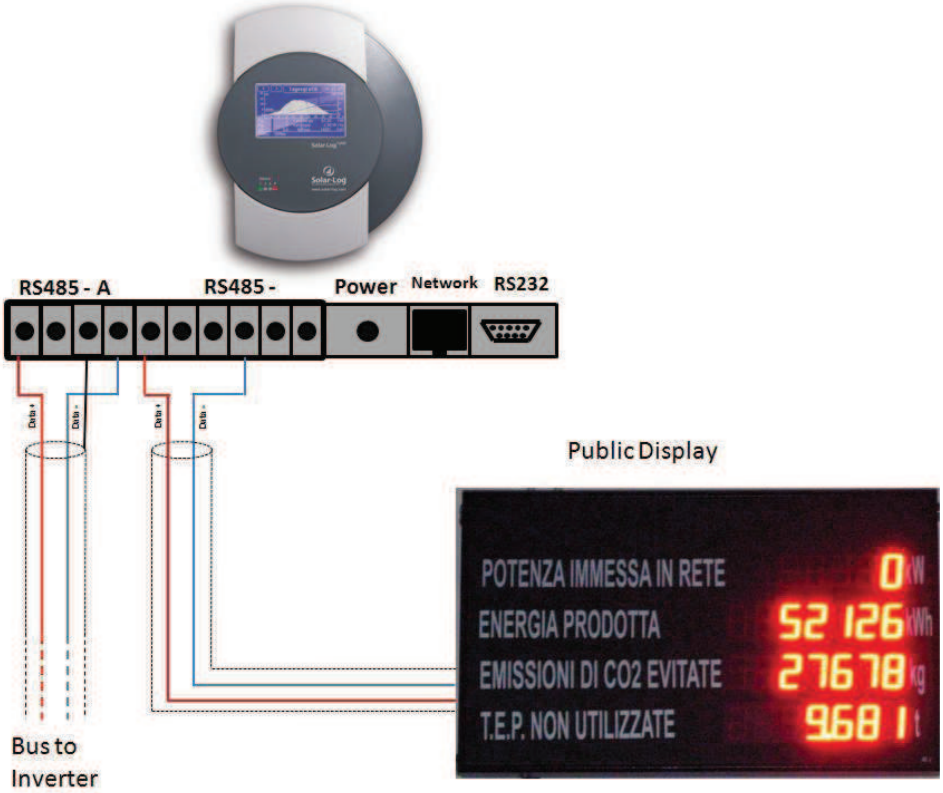
The display has its own 230V power supply.

The connection between the datalogger and the display is made by means of an RS485.

The display is supplied with a cable fitted with a RJ45 connector, that must be stripped so that it is possible to extract the pair of blue (data +) and white/blue (data-) wires.

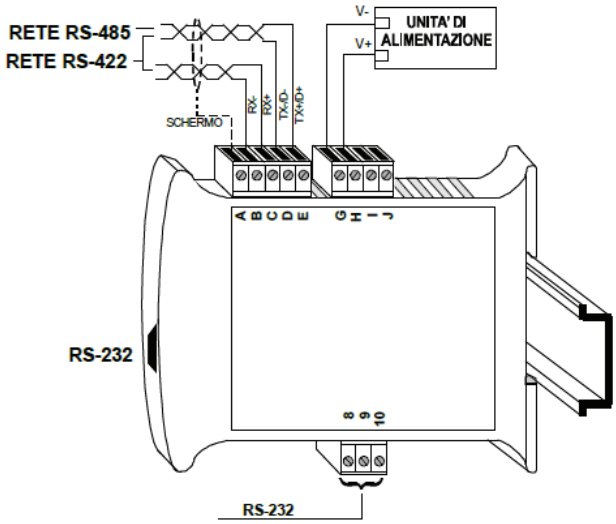
Strip the two wires extracted. Connect the wires to the terminals shown in the diagram to (**to public display**) Data+ on the display (blue wire) on the connector bearing Data + in the datalogger and similarly, connect Data- on the display (white/blue) to the connector bearing Data- in the datalogger.

After having powered up the display, it is necessary to wait about one minute before it lights up.



To check the correct display connection and functioning, consult the document IV326 “SoleilLog instruction manual”, and document IV308 “Instruction manual public display”.

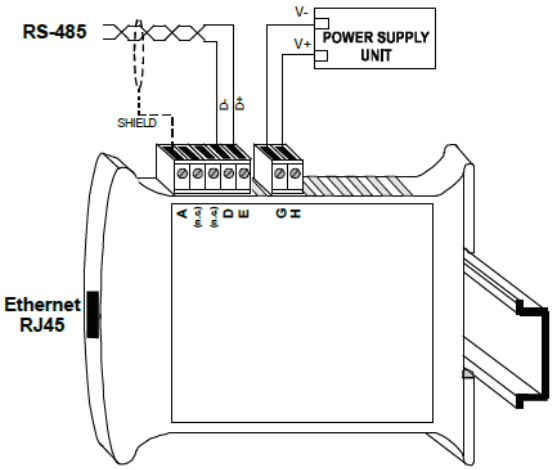
7.6 RS232 / RS485 adapter



This adapter is used in the 'light' monitoring platform (section 5.3.1) or along with the serial board fibre-optic interface (section 7.1) for the connection with the PC.

The RS232/RS485 converter runs on a 24V AC power supply.

7.7 RS485 to Ethernet converter



This converter is used in the TGS communication platform (see par. 5.3.4).
One side of the converter connects to the 'zone' network based on the RS485-Modbus bus and converts it to the Ethernet (TCP/IP) protocol. Each converter is assigned its own IP address during network configuration by means of a PC.
The converter needs a 24V DC power supply.

7.8 GPRS-ADSL Modem

Whatever the location, the user can access a public or private network (Internet/Intranet) with a excellent security (VPN). Connections made using GPRS links are optimal from the points of view of traffic costs and transmission quality thanks to the transmission of control messages, inactivity timers and external aerials to improve signal quality.

Main characteristics:

- Ethernet: 1 or 5 ports RJ45 10/100Mbps
- GPRS/GSM connection: dual band EGSM 900 and GSM 800
    - Max upload speed: 21.4Kbps
    - Max download speed: 85.6Kbps
- Power supply: 240V AC (internal power supply)

7.9 Radiation sensor

An instantaneous radiation sensor is available on request.

The radiation value reading (in W/sq mt) can be viewed on the touch screen display and via Modbus.

The sensor is a 405x355x35mm photovoltaic module and it shall be installed as coplanar as possible to the actual photovoltaic field (same tilt and azimuth angles).

The following table lists the electrical data:

Pmax	Imp	Vmp	Isc	Voc
15W ±3%	0,85 A	17,7 V	0,92 A	21,6 V

The module shall be connected to terminals **9**(Irr+) and **10**(Irr-) of the inverter with two 0.5/1.5 sq mm wires (par. 0). The load resistance of the module is setup at factory on the external machine side of terminals 9 and 10 (connect the wires from the parallel module to the resistance).

8 TECHNICAL DATA

The following tables[1] contain the SOLEIL DSPX inverter series technical data:

SOLEIL DSPX: TRL

- **with isolation transformer**

  Inverter in compliance with Resolution **AEEG 84/2012/R/EEL art. 4.1b**, and for LV and MV connections, with crystalline modules

SOLEIL DSPX: TRH, TRW, TLH & TLW

- **with isolation transformer**, divided into:
  - Inverter in compliance with Resolution **AEEG 84/2012/R/EEL art. 4.1b**, and for LV and MV connections, with crystalline modules
  - Inverter in compliance with Resolution **AEEG 84/2012/R/EEL art. 4.1a**, and for LV and MV connections, with amorphous modules (low dynamic)
- **without isolation transformer**
  - Inverter in compliance with Resolution **AEEG 84/2012/R/EEL art. 4.1b**, for MV connections, with crystalline modules
  - Inverter in compliance with Resolution **AEEG 84/2012/R/EEL art. 4.1a**, for MV connections, with amorphous modules (low dynamic)

Please refer to **Notes** at the end of all the TECHNICAL SPECIFICATION Tables, for definitions and conditions in which the technical data are expressed.

[1] The data included in the tables refers to the issue date of this document. SIEL reserves the right to change the technical specification at any time.

8.1 SOLEIL DSPX. TRL

8.1.1 Inverter with isolation transformer

8.1.1.1 Inverter for LV and MV connections for crystalline modules

SOLEIL DSPX TRL	10	15	20	25	30	45	55	80	100	110	220*	250*
DC input side– Recommended power of the modules												
Rated [kWp]	10	15	20	25	30	45	55	80	100	110	220	250
Maximum [kWp]	12,8	21,2	25,3	35,0	37,9	55,2	69,0	100,0	123,4	137,0	274,6	309,2
DC input side– Electrical specifications												
Operating voltage range [V] 7	330 – 760											
MPPT voltage [V]7	330 – 700											
Max. voltage [V]@-10°C	780											
Min. voltage [V] @+70°C 7	330											
Modules max.[A]	33	54	64	89	96	140	175	254	313	348	697	785
N. DC inputs	1					2		8				
N. MPPT inputs	1											
AC output side												
Active power Nominal Pn [kW] 1	10	16.7	20	27.7	30	44	55	80	100	111	222	250
Maximum power Smax [kVA] 1	10	16.7	20	27.7	30	44	55	80	100	111	222	250
Connection	3Ph											
Nominal voltage [V]	400											
Rated current [A] 2	14.4	24.1	28.9	40.0	43.3	63.5	79.4	115.5	144.3	160.2	320.4	360.8
Maximum current [A] 3	16.0	26.8	32.1	44.4	48.1	70.6	88.2	128.3	160.4	178.0	356.0	400.9
Min Smax operating voltage [V]4	90% Vn											
Min operating voltage [V] 4	85% Vn											
Maximum operating voltage [V]	115% Vn											
Nominal frequency [Hz]	50											
Frequency interval [Hz] 5	47,5 - 51,5											
Max. efficiency[%] 6	93	93.8	94.2	94.4	94.5	95.1	95.1	95.5	96.7	96.7	96.5	96.5
Euro efficiency [%] 6	92	92.2	92.7	93	93.1	93.7	93.7	94.1	95.4	95.4	95.2	95.4
THD% I @Pnom	3											
Power factor 1	0.9 … 1.0 leading-lagging											
Short circuit current contribution [A]	21.7	36.2	43.4	60.0	65.0	95.3	119.1	173.3	173.3	240.4	480.7	541.3
Other data												
Ventilation system	Forced air											
Dissipated power without load [W]	32	32	32	32	32	32	32	56	56	56	64	64
Control	DSP											
Output wave form	Pure Sine wave											
Operating temperature (full power)[°C]	-5°C / +45°C											
Operating temperature range [°C]	-5°C / +50°C											
Storage temperature range [°C]	-20°C / +50°C											
Operating humidity range	5%/95% no condensing											
Maximum altitude	1.000 m a.s.l.											
Environment category	Indoor non conditioned											
Pollution Degree	PD3											
Overvoltage category (DC input)	Class II											

SOLEIL DSPX TRL	10	15	20	25	30	45	55	80	100	110	220*	250*
Overvoltage class (output AC)	Class III											
Mechanical characteristics												
dBA	60	60	60	60	60	60	60	64	64	64	68	68
Class of protection	IP20											
Dimensions LxDxH [mm]	550x850x1055					700x865x141		1100x820x1950				
Weight [kg]	280	300	330	390	420	560	580	700	980	980	1500	1600

*MV connection only

8.2 SOLEIL DSPX: TRH, TRW, TLH e TLW

8.2.1 Inverter with isolation transformer

8.2.1.1 Inverter for LV and MV connections for crystalline crystalline modules

SOLEIL DSPX TRH	80	110	220*	250*
DC input side– Recommended power of the modules				
Rated [kWp]	80	110	220	250
Maximum [kWp]	99,4	136,6	272,6	307,0
DC input side– Electrical specifications				
Operating voltage range [V] 7	460 - 930			
MPPT voltage [V]7	460 - 780			
Max. voltage [V]@-10°C	1000			
Min. voltage [V] @+70°C 7	460			
Modules max. current [A]	181	249	497	559
N. DC inputs	8			
N. MPPT inputs	1			
AC output side				
Active power Nominal Pn [kW] 1	80	111	222	250
Maximum power Smax [kVA] 1	80	111	222	250
Connection	3Ph			
Nominal voltage [V]	400			
Rated current [A] 2	115.5	160.2	320.4	360.8
Maximum current [A] 3	128.3	178.0	356.0	400.9
Min Smax operating voltage [V]4	90% Vn			
Minimum operating voltage [V]4	85% Vn			
Maximum operating voltage [V]4	115% Vn			
Nominal frequency [Hz]	50			
Frequency interval [Hz] 5	47.5 – 51.5			
Max. efficiency[%] 6	96.1	97	97.2	97.2
Euro efficiency [%] 6	94.8	95.8	95.8	95.8
THD% I @Pnom	3			
Power factor 1	0,9 … 1,0 leading-lagging			
Short circuit current contribution [A]	173.3	240.4	480.7	541.3
Other data				
Ventilation system	Forced air			
Dissipated power without load [W]	56	56	64	64
Control	DSP			
Output wave form	Pure sine wave			
Operating temperature (full power)[°C]	-5°C / +45°C			
Operating temperature range [°C]	-5°C / +50°C			
Storage temperature range [°C]	-20°C / +50°C			
Operating humidity range	5%/95% no condensing			
Maximum altitude	1,000 m a.s.l.			
Environment category	Indoor non conditioned			
Pollution Degree	PD3			
Overvoltage class (input DC)	Class II			
Overvoltage class (output AC)	Class III			
Mechanical characteristics				
dBA	64	64	68	68
Class of protection	IP20			
Dimensions LxDxH [mm]	1100x820x1950		1500x1000x2000	
Weight [kg]	750	900	1500	1600

*MV connection only

8.2.1.2 Inverter for LV and MV connections for amorphous modules (low dynamic)

SOLEIL DSPX TRW	80	110	220*	250*
DC input side– Recommended power of the modules				
Rated [kWp]	80	110	220	250
Maximum [kWp]	95.5	130.8	262.1	295.2
DC input side– Electrical specifications				
Operating voltage range [V] 7	330 - 930			
MPPT voltage [V]7	330 - 780			
Max. voltage [V]@-10°C	1000			
Min. voltage [V] @+70°C 7	330			
Modules max.[A]	254	348	697	785
N. DC inputs	8			
N. MPPT inputs	1			
AC output side				
Active power Nominal Pn [kW] 1	80	111	222	250
Maximum power Smax [kVA] 1	80	111	222	250
Connection	3Ph			
Rated voltage Vn [V]	400			
Rated current [A] 2	115	160	320	361
Maximum current [A] 3	128	178	356	401
Min Smax operating voltage [V]4	90% Vn			
Minimum operating voltage [V]4	85% Vn			
Maximum operating voltage [V]4	115% Vn			
Nominal frequency [Hz]	50			
Frequency interval [Hz] 5	47,5 - 51,5			
Max. efficiency[%] 6	95,5	96,7	96,5	96,5
Euro efficiency [%] 6	94,1	95,4	95,2	95,4
THD% I @Pnom	3			
Power factor 1	0.9 … 1.0 leading-lagging			
Short circuit current contribution [A]	173.3	240.4	480.7	541.3
Other data				
Ventilation system	Forced air			
Dissipated power without load [W]	56	56	64	64
Control	DSP			
Output wave form	Pre sine wave			
Operating temperature (full power)[°C]	-5°C / +45°C			
Operating temperature range [°C]	-5°C / +50°C			
Storage temperature range [°C]	-20 °C / +50°C			
Operating humidity range	5%/95% no condensing			
Maximum altitude	1,000 m a.s.l.			
Environment category	Indoor unconditioned			
Pollution Degree	PD3			
Overvoltage class (input DC)	Class II			
Overvoltage class (output AC)	Class III			
Mechanical characteristics				
dBA	64	64	68	68
Class of protection	IP20			
Dimensions LxDxH [mm]	1100x820x1950			
Weight [kg]	750	900	1500	1600

*MV connection only

8.2.2 Transformerless inverter

8.2.2.1 Inverter 280VAC output for MV connections for crystalline modules

SOLEIL DSPX TLH	90	110	220	250	330	440M	500M	660	660M
DC input side– Recommended power of the modules									
Rated [kWp]	90	110	220	250	330	440	500	660	660
Maximum [kWp]	109	136	270	304	401	541	608	803	803
DC input side– Electrical specifications									
Operating voltage range [V]7	460 - 930								
MPPT voltage [V]7	460 - 780								
Max. voltage [V]@-10°C	1000								
Min. voltage [V] @+70°C 7	460								
Modules max.[A]	199	248	492	554	731	986	1108	1463	1463
N. DC inputs	8					16		8 x 2	16
N. MPPT inputs	1					1		2	1
AC output side									
Pmax rated power [kW] 1	89	111	222	250	330	445	500	660	660
Maximum power Smax [kVA] 1	89	111	222	250	330	445	500	660	660
Connection	3Ph								
Nominal voltage [V]	280								
Rated current [A] 2	184	229	458	515	680	918	1031	1361	1361
Maximum current [A] 3	204	254	509	573	756	1020	1146	1512	1512
Min Smax operating voltage [V]4	90% Vn								
Minimum operating voltage [V]4	85% Vn								
Maximum operating voltage [V]4	115% Vn								
Nominal frequency [Hz]	50								
Frequency interval [Hz] 5	47,5 - 51,5								
Max. efficiency[%] 6	97,3	97,3	98,1	98,1	98,1	98,1	98,1	98,1	98,1
Euro efficiency [%] 6	96,45	96,45	97,3	97,3	97,3	97,3	97,3	97,3	97,3
THD% I @Pnom	3								
Power factor 1	0.9 … 1.0 inductive-capacitive								
Short circuit current contribution [A]	275	343	687	773	1021	1376	1547	2041	2041
Other data									
Ventilation system	Aria forzata								
Dissipated power without load [W]	56	56	64	64	64	64	128	128	128
Control	DSP								
Output wave form	Pure sine wave								
Operating temperature (full power)[°C]	-5°C / +45°C								
Operating temperature range [°C]	-5°C / +50°C								
Storage temperature range [°C]	-20 °C / +50°C								
Operating humidity range	5%/95% no condensing								
Maximum altitude	1,000 m a.s.l.								
Environment category	Indoor non conditioned								
Pollution Degree	PD3								
Overvoltage class (input DC)	Class II								
Overvoltage class (output AC)	Class III								
Mechanical characteristics									
dBA	64	64	68	68	68	68	68	68	68
Class of protection	IP20								
Dimensions LxDxH [mm]	1100x820x1950		1500x1000x2000						
Weight [kg]	350	450	750	800	850	1450	1520	1600	1600

8.2.2.2 Inverter 330VAC output for MV connections for crystalline modules

SOLEIL DSPX TLH	330	380	400	416	660	760	800	833	660M	760M	800M	833M
DC input side– Recommended power of the modules												
Rated [kWp]	330	380	400	416	660	760	800	833	660	760	800	833
Maximum [kWp]	400	459	483	503	800	918	966	1006	800	918	966	1006
DC input side– Electrical specifications												
Operating voltage range [V]7	500 - 930											
MPPT voltage [V]7	500 - 720											
Max. voltage [V]@-10°C	1000											
Min. voltage [V] @+70°C 7	500											
Modules max. Isc [A]	670	769	810	842	1340	1538	1619	1686	1340	1538	1619	1686
N. DC inputs	12				12X2				24			
N. MPPT inputs	1				2				1			
AC output side												
Pmax rated power [kW] 1	330	380	400	416	660	760	800	833	660	760	800	833
Maximum power Smax [kVA] 1	330	380	400	416	660	760	800	833	660	760	800	833
Connection	3Ph											
Nominal voltage [V]	330											
Rated current [A] 2	577	665	700	728	1155	1330	1400	1457	1155	1330	1400	1457
Maximum current [A] 3	642	739	778	809	1283	1477	1555	1619	1283	1477	1555	1619
Min Smax operating voltage [V]4	90% Vn											
Minimum operating voltage [V]4	85% Vn											
Maximum operating voltage [V]4	115% Vn											
Nominal frequency [Hz]	50											
Frequency interval [Hz] 5	47,5 - 51,5											
Max. efficiency[%] 6	98,5	98,8	98,8	98,8	98,5	98,8	98,8	98,8	98,5	98,8	98,8	98,8
Euro efficiency [%] 6	98,1	98,35	98,35	98,35	98,1	98,35	98,35	98,35	98,1	98,35	98,35	98,35
THD% I @Pnom	3											
Power factor 1	0.9 … 1.0 leading-lagging											
Short circuit current contribution [A]	866	997	1050	1092	1732	1995	2100	2186	1732	1995	2100	2186
Other data												
Ventilation system	Forced air											
Dissipated power without load [W]	64	64	64	64	128	128	128	128	128	128	128	128
Control	DSP											
Output wave form	Pure sine wave											
Operating temperature (full power)[°C]	-5°C / +45°C											
Operating temperature range [°C]	-5°C / +50°C											
Storage temperature range [°C]	-20°C / +50°C											
Operating humidity range	5% /95% no condensing											
Maximum altitude	1000m (s.l.m.)											
Environment category	Indoor non conditioned											
Pollution Degree	PD3											
Overvoltage class (input DC)	Classe II											
Overvoltage class (output AC)	Classe III											
Mechanical characteristics												

dBA	68	68	68	68	68	68	68	68	68	68	68	68
Class of protection	IP20											
Dimensions LxDxH [mm]	1500x1000x2000											
Weight [kg]	850	850	850	850	1600	1600	1600	1600	1600	1600	1600	1600

8.2.2.3 Inverter 380VAC output for MV connections for crystalline modules

SOLEIL DSPX TLH	330	380	400	416	660	760	800	833	500M (*)	660M (*)	760M (*)	800M	833M
DC input side– Recommended power of the modules													
Rated [kWp]	330	380	400	416	660	760	800	833	562	660	760	800	833
Maximum [kWp]	400	459	483	503	800	918	966	1006	672	800	918	966	1006
DC input side– Electrical specifications													
Operating voltage range [V][7]	560 - 930												
MPPT voltage [V][7]	560 - 780												
Max. voltage [V]@-10°C	1000												
Min. voltage [V] @+70°C [7]	560												
Modules max. Isc [A]	598	687	723	752	1197	1374	1446	1506	1008	1197	1374	1446	1506
N. DC inputs	12				12X2				24	24			
N. MPPT inputs	1				2				1				
AC output side													
Pmax rated power [kW] [1]	330	375	400	416	660	760	800	833	562	660	750	800	833
Maximum power Smax [kVA] [1]	330	380	400	416	660	760	800	833	562	660	760	800	833
Connection	3Ph												
Nominal voltage [V]	380												
Rated current [A] 2	501	577	608	632	1003	1155	1215	1266	855	1003	1155	1215	1266
Maximum current [A] [3]	557	642	675	702	1114	1283	1351	1406	950	1114	1283	1351	1406
Min Smax operating voltage [V][4]	90% Vn												
Minimum operating voltage [V][4]	85% Vn												
Maximum operating voltage [V][4]	115% Vn												
Nominal frequency [Hz]	50												
Frequency interval [Hz] [5]	47,5 - 51,5												
Max. efficiency[%] [6]	98,5	99,17	98,8	99.02	98,5	99,17	98,8	99.02	**99,17 (**)**	**99,19 (**)**	**99,22 (**)**	98,8	**99,02 (**)**
Euro efficiency [%] [6]	98,1	98,35	98,35	98,35	98,1	98,35	98,35	98,35	**98,73 (**)**	**98,76 (**)**	**98,77 (**)**	98,35	**98,75 (**)**
THD% I @Pnom	3												
Power factor [1]	0.9 … 1.0 leading-lagging												
Short circuit current contribution [A]	752	866	912	948	1504	1732	1823	1899	1283	1504	1732	1823	1899
Other data													
Ventilation system	Forced Air												
Dissipated power without load [W]	64	64	64	64	128	128	128	128	128	128	128	128	128
Control	DSP												
Output wave form	Pure sine wave												
Operating temperature (full power)[°C]	-20°C / +50°C												
Operating temperature range [°C]	-20°C / +50°C												
Storage temperature range [°C]	-25°C / +70°C												
Operating humidity range	5% / 95% (non condensing)												
Maximum altitude	1000m (s.l.m.)												
Environment category	Indoor, not conditioned												
Pollution Degree	PD3												

Overvoltage class (input DC)	Classe II												
Overvoltage class (output AC)	Classe III												

Mechanical characteristics

dBA	68	68	68	68	68	68	68	68	68	68	68	68	68
Class of protection	IP20												
Dimensions LxDxH [mm]	1500x1000x2000												
Weight [kg]	850	850	850	850	1600	1600	1600	1600	1600	1600	1600	1600	1600

Note

(*): DSPX TLH 500M, DSPXTLH 660M and DSPX TLH 760M operate with **Master & Slave logic** (see Paragraph 3.5 for details)

(**): Efficiency values measured by a **third-party independent lab**. Report available on request.

8.2.2.4 Inverter 380VAC for MV connections and outdoor operation

SOLEIL DSPX TLH	500M (*)	660M (*)	760M (*)
DC input side– Recommended power of the modules			
Rated [kWp]	562	660	760
Maximum [kWp]	672	800	
DC input side– Electrical specifications			
Operating voltage range [V][7]	560 - 930		
MPPT voltage [V][7]	560 - 780		
Max. voltage [V]@-10°C	1000		
Min. voltage [V] @+70°C [7]	560		
Modules max. Isc [A]	1008	1197	1374
N. DC inputs	24		
N. MPPT inputs	1		
AC output side			
Pmax rated power [kW] [1]	562	660	750
Maximum power Smax [kVA] [1]	562	660	760
Connection	3ph		
Nominal voltage [V]	380		
Rated current [A] 2	855	1003	1155
Maximum current [A] [3]	950	1114	1283
Min Smax operating voltage [V][4]	90% Vn		
Minimum operating voltage [V][4]	85% Vn		
Maximum operating voltage [V][4]	115% Vn		
Nominal frequency [Hz]	50		
Frequency interval [Hz] [5]	47,5 - 51,5		
Max. efficiency[%] [6]	**99,17 (**)**	**99,19 (**)**	**99,22 (**)**
Euro efficiency [%] [6]	**98,73 (**)**	**98,76(**)**	**98,77 (**)**
THD% I @Pnom	3		
Power factor [1]	0.9 … 1.0 leading-lagging		
Short circuit current contribution [A]	1283	1504	1732
Other data			
Ventilation system	Forced Air		
Dissipated power without load [W]	128	128	128
Control	DSP		
Output wave form	Pure sine wave		
Operating temperature (full power)[°C]	-20°C / +50°C		
Operating temperature range [°C]	-20°C / +50°C		
Storage temperature range [°C]	-25°C / +70°C		
Operating humidity range	5% / 95% no condensing		
Maximum altitude	1000m (s.l.m.)		
Environment category	OUTDOOR		
Pollution Degree	PD3		

Overvoltage class (input DC)	Class II		
Overvoltage class (output AC)	Class III		
Mechanical characteristics			
dBA	68	68	68
Class of protection	IP54		
Footprint size for basement (LxD) [mm]	1500x1000		
Overall Dimensions (LxDxH) [mm] (including roof)	2000/1500/2400		
Weight [kg]	1700	1700	1700

(*): DSPX TLH 500M, DSPXTLH 660M and DSPX TLH 760M operate with **Master & Slave logic** (see Paragraph 3.5 for details)

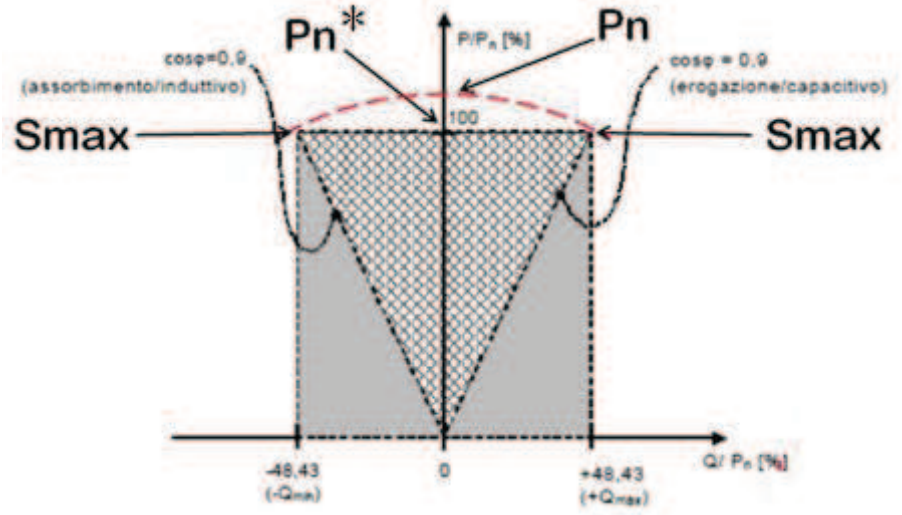
(**): Efficiency values measured by a **third-party independent lab**. Report available on request.

8.2.2.5 Inverter for MV connections for amorphous modules (low dynamic)

SOLEIL DSPX TLW	90	100	110	220	250	440M	500M
DC input side– Recommended power of the modules							
Rated [kWp]	90	100	110	220	250	440	500
Maximum [kWp]	104,9	117,1	130,0	259,5	292,2	520,1	584,4
DC input side– Electrical specifications							
Operating voltage range [V]7	330 - 930						
MPPT voltage [V]7	330 - 780						
Max. voltage [V]@-10°C	1000						
Min. voltage [V] @+70°C 7	330						
Modules max.[A]	279	311	346	690	777	1383	1554
N. DC inputs	8					16	
N. MPPT inputs	1					1	
AC output side							
Pmax rated power [kW] 1	89	100	111	222	250	445	500
Maximum power Smax [kVA] 1	89	100	111	222	250	445	500
Connection	Three-phase						
Nominal volatge [V]	200						
Nominal current [A] [2]	256,9	288,7	320,4	640,9	721,7	1284,6	1443,4
Maximum current [A] [3]	285,5	320,8	356,0	712,1	801,9	1427,3	1603,8
Max Smax operating voltage [V] [4]	90% Vn						
Minimum operating voltage [V] [4]	85% Vn						
Maximum operating voltage [V] [4]	115% Vn						
Nominal frequency [Hz]	50						
Frequency interval [Hz] [5]	47,5 - 51,5						
Max. efficiency [%] [6]	96,7	97,3	97,3	97,5	97,5	97,5	97,5
Euro efficiency [%] [6]	95,6	96	96	96,3	96,3	96,3	96,3
THD% I @Pnom	3						
Power factor 1	0.9 … 1.0 inductive-capacitive						
Short circuit current contribution [A]	385,4	433,1	480,7	961,3	1082,6	1927,0	2165,1
Other data							
Ventilation system	Aria forzata						
Dissipated power without load [W]	56	56	56	64	64	64	64
Control	Digital with DSP						
Output wave form	Sinusoidal						
Operating temperature (full power)[°C]	-5°C / +45°C						
Operating temperature range [°C]	-5°C / +50°C						
Storage temperature range [°C]	-20°C / +50°C						
Operating humidity range	5%/95% with no condensing						
Maximum altitude	1,000 m a.s.l.						
Environment category	Indoor unconditioned						
Pollution Degree	PD3						
Overvoltage class (input DC)	Class II						
Overvoltage class (output AC)	Class III						
Mechanical characteristics							
dBA	64	64	64	68	68	68	68
Class of protection	IP20						
Dimensions LxDxH [mm]	1100x820x1950			1500x1000x2000			
Weight [kg]	390	490	490	750	800	1450	1520

Notes

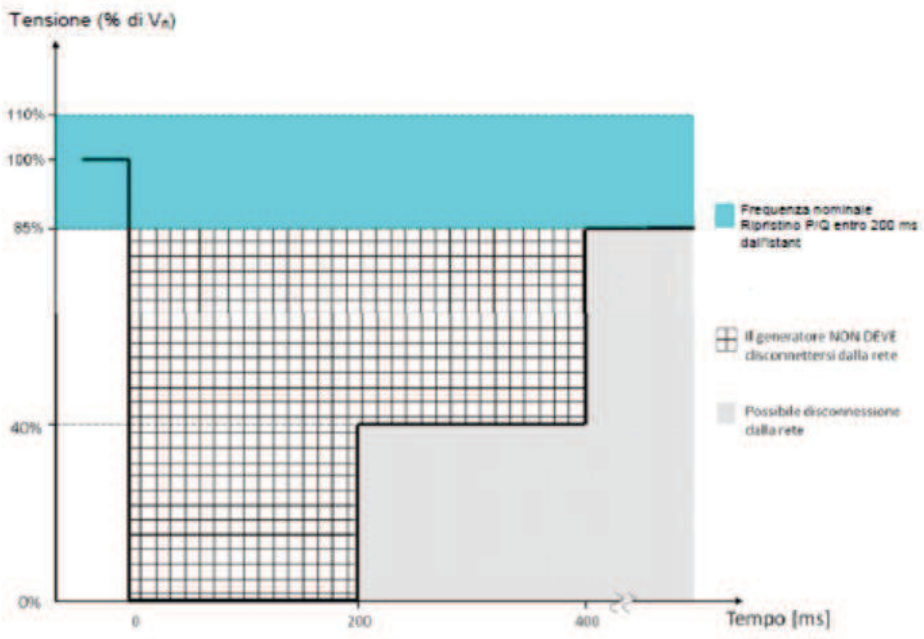
1. Power definitions
   - **PN Rated power**: maximum active power distributable on conditions of nominal grid voltage and generation of reactive power disabled (p.f. equal to 1).
   - **Rated power at p.f. = 0,9P***: maximum active power distributable on conditions of nominal grid voltage and generation of reactive power enabled (p.f. between 0,9 and 1).
   - **Power maximum Smax**: maximum power apparent distributable on conditions of maximum active power, maximum reactive power (p.f. equal to 0,9).



2. Current in operating conditions with maximum apparent power Smax.

3. Current in operating conditions with maximum apparent power Smax and AC voltage at the minimum value compatible with Smax.

4. Voltage definitions
   - **Min Smax operating voltage**: minimum voltage at which the Smax generation of the maximum power is possible.
   - **Min operating voltage**: from 90%Vn to 85%Vn the inverter operates within the limitation of the current, for voltages inferior to 85%Vn, the inverter can remain connected to the grid without generating power (LVFRT function enabled, see graphic) or disconnect itself.
   - **Max operating voltage**: for voltage values above 115%Vn, the inverter disconnects from the grid.



5. Configurable according to the type of connection
6. Efficiency measured at the DC voltage of 400V for TRL TRW and TLW models
   Efficiency measured at the DC voltage of 520V for TRH and TLH 280V output models
   Efficiency measured at the DC voltage of 600V for and TLH 380V output models
7. AT nominal AC voltage

8.2.2.6 Electrical power consumption for ventilation fans

Model SOLEIL	Supply Voltage [V]	Frequency [Hz]	Max current [A]	Fans Power consumption [W]
TRL 10	230	50	0.5	90
TRL 15	230	50	0.5	90
TRL 20	230	50	0.5	90
TRL 25	230	50	0.65	120
TRL 30	230	50	0.65	120
TRL 45	230	50	0.8	150
TRL 55	230	50	1.6	300
TRL 80 – TRH 80	230	50	2.7	490
TRW 80	230	50	2.7	490
TRL 100	230	50	2.7	490
TRL 110 – TRH 110	230	50	2.7	490
TRW 110	230	50	2.7	490
TRL 220 – TRH 220	230	50	3.5	630
TRW 220	230	50	4.5	840
TRL 250 – TRH 250	230	50	3.5	630
TRW 250	230	50	4.5	840
TLW 90 – TLH 90	230	50	2.2	420
TLW 100	230	50	2.2	420
TLW 110 – TLH 110	230	50	2.2	420
TLW220 – TLH 220	230	50	2.2	420
TLW250 – TLH 250	230	50	2.2	420
TLH 330… TLH 416	230	50	2.7	490
TLW 440 – TLH 440	230	50	4.5	840
TLW 500 – TLH 500	230	50	4.5	840
TLH 660… TLH 833	230	50	5	980

9 APPENDIX: FEATURES REGARDING GRID SERVICES (CEI 0-21 CEI 0-16 AND ATTACHMENT A70)

9.1 Introduction

SOLEIL DSPX inverters comply with CEI 0-21/CEI 0-16 regulations and with Terna attachment A70.

The features regarding “Grid services”, summarised below, can be configured by the installer through the use of the inverter touch screen control panel, according to the procedure described below.

The functions implemented, in accord with section 8.5 of the CEI 0-21 regulations, paragraph 8.8.5 and 8.8.6 of the CEI 016 regulations and chapter 7 of Attachment A70 are:

- Start and gradual increase of the power fed into the grid
- Immunity to brownouts (LVFRT Low Voltage Fault Ride Through)
- Limitation of the active power generated in the presence of transients on the transmission grid
- Active generated power limitation according to a set power limit
- Participation in the control of the grid voltage, in the following ways:
    - Reactive power distribution/absorption according to a set Q reference
    - Automatic supply of reactive power according to a pf = f(P) characteristic curve
    - Automatic supply/absorption of reactive power according to a Q = f(V) characteristic curve

SOLEIL DSPX inverters are configured as follows by default:

Start and gradual increase of the power supplied to the grid	f=49.9…50.1 Hz, V=85…110% Vn (present for 5 continuous minutes) Power ramp lasting 5 minutes
Immunity to LVFRT brownouts	Function disabled, enabled
Limitation of the Active Power in the presence of frequency transients	Enabled with the following parameters : • Frequency thresholds = 50.3 and 51.5 Hz • droop = 2.4% • frequency thresholds for restoration of power = 49.9 and 50.1 Hz • slope of transfer after over frequency = 5 minutes
Participation in the control of the voltage (reactive supply)	Function disabled, enabled

If it is necessary to modify the standard setting, follow the procedure described as follows which lists the parameters regarding the different features available in detail.

9.2 Set-up of inverter parameters for Grid Services

In relation to the type of installation (Connection to the LV or MV grid), it may be necessary to modify some parameters to enable the Grid services provided for by the regulations, on the request of the Distributor.

FOR ANY MACHINE SET-UP MODIFICATION PLEASE REFER TO THE PARAMETER READ-WRITE PROCEDURE DESCRIBED IN SECTION 4.3.4.6.

9.2.1 Start and gradual increase of the power supplied to the grid

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1530	W	Upper limit of the grid frequency to define the range of acceptance for the start of the power generation phase.	5010	5000 … 5500
1532	W	Lower limit of the grid frequency to define the range of acceptance for the start of the power generation phase.	4990	4500 … 5000

The two thresholds together represent the range within which the grid frequency must terminate for a continuous defined time, before being able to start the power generation phase.
The two thresholds can be set in centi-Hz.

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1283	W	Lower limit of the grid (phase) voltage to define the range of acceptance for the start of the power generation phase (cei 016 → 90% Vn – cei 021 85% Vn)	-	90 … 360
1285	W	Upper limit of the grid (phase) voltage to define the range of acceptance for the start of the power generation phase.	-	90 … 360

The two thresholds together represent the range within which the grid (phase) voltage must terminate for a continuous defined time, before being able to start the power generation phase.
The two thresholds can be set in Volts.

In relation to the inverter nominal input voltage, the two default values are defined as follows:

INVERTER MODEL	W1283	W1285	Note
TLW Transformerless	104	127	CEI-016
TLH Transformerless 280VAC Output	145	177	CEI-016
TLH Transformerless 380VAC Output	197	241	CEI-016
TRL with Transformer on board	196 (CEI-021) 208 (CEI-016)	254	CEI-021 or CEI016
TRH with Transformer on board			
TRW with Transformer on board			

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1266	w	Time of acceptance of the Grid parameters (Voltage and frequency) for the start of the phase of power generation.	300	1 … 900

Time of acceptance of the Grid parameters (voltage and frequency) for the start of the phase of power generation.
The data is expressed in seconds.

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1540	B	Enabling of power ramp start-up.	170	15, 170

Enabling-disabling power ramp.

Value = 15 Ramp disabled
Value = 170 Ramp enabled

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1541	B	Duration of the ramp to go from 0 to 100% of the nominal power.	5	1 … 10

Duration of the power ramp to go from 0% to 100% of the nominal power Pn.
The data is expressed in minutes.

9.2.2 Immunity to LVFRT brownouts

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1563	B	Enabling of the management of Grid power failures.	170	15, 170

Enabling-disabling of the management of LVFRT grid power failures. By enabling the feature the inverter is able to not disconnect from the Grid when dealing with a voltage transient, as required by the regulations (Attachment A70 for the MV connection).

Value = 15 function disabled
Value = 170 function enabled

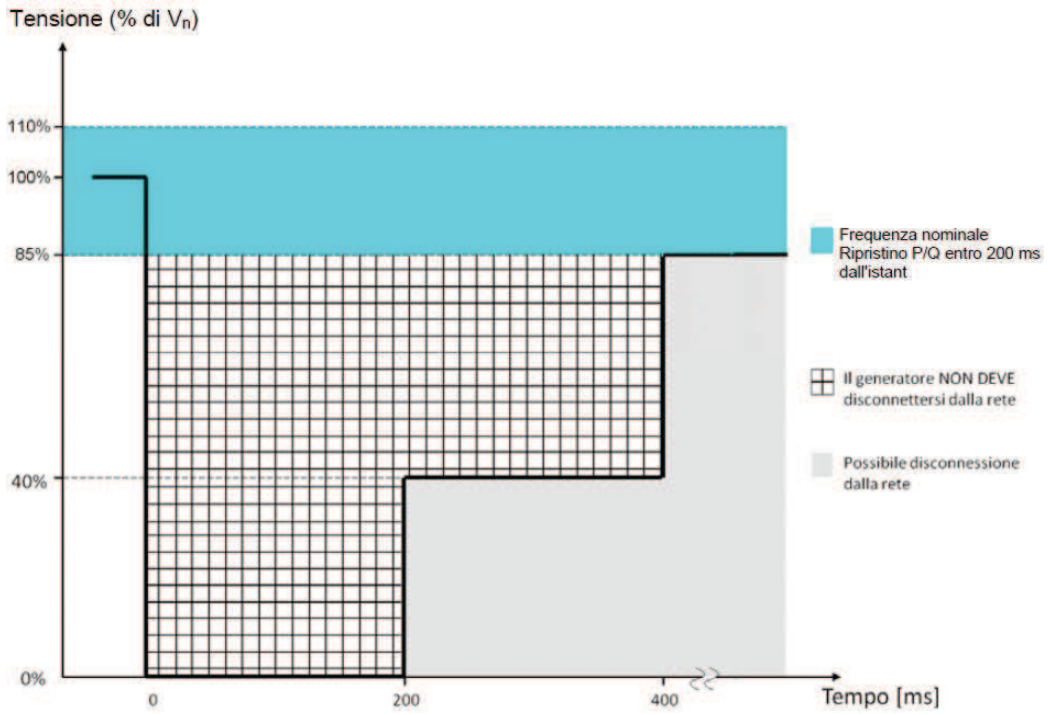
PARAMETER		DESCRIPTION	DEFAULT	RANGE
1561	w	Immunity time to LVRT grid power failures	….	400/1500/2000

It is the immunity time to grid power failures, beyond which the inverter switches to “Grid voltage out of limits” protection status. The time can be set in msec and varies according to the selected connection type:

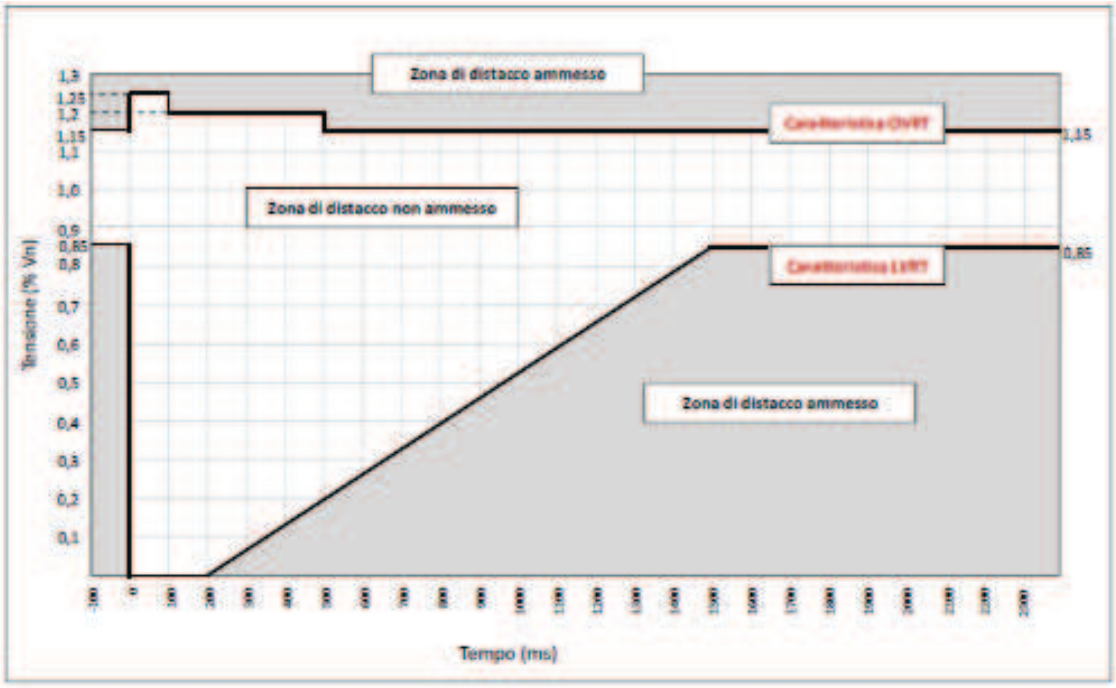
CEI 0-21 = 400 → 400msec
CEI 0-16 = 1500 → 1.5 sec

If the connection type is changed, this parameter must also be updated to a value consistent with the selected connection type as described above.
Where HV/HHV grid connection rules described in attachment A68 are required, CEI 0-16 connection type must be set and 2sec grid power failure immunity time (1561.w = 2000).
For the connection type, see paragraph: ***“9.2.5 Grid Code set up (CEI 021 – CEI 016)”***

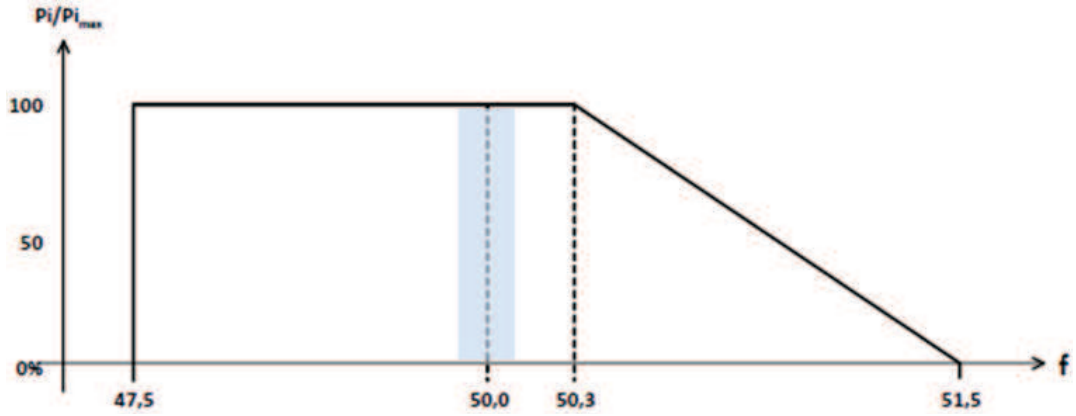
9.2.2.1 CEI 021 profile



9.2.2.2 CEI 016 profile



9.2.3 Limitation of the Active Power in the presence of frequency transients



PARAMETER		DESCRIPTION	DEFAULT	RANGE
1536	B	Enabling feature for the reduction of power due to over frequency.	170	15, 170

Enabling-disabling of the mode of reduction of active power supplied in accordance with the grid over frequency.

Value = 15 Mode disabled
Value = 170 Mode enabled

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1522	W	Initial frequency threshold for the reduction of the power emitted into the grid due to over frequency.	5030	5000 … 5100
1524	W	Final frequency threshold (function of the droop chosen) for the reduction of the power emitted into the grid due to over frequency. **The value set must be larger than the parameter 1522.**	5150	5000 … 5300

The two thresholds represent the range of frequency to be used for the calculation of the percentage of reduction of the power. The initial reference threshold is normally set at 50.3Hz; the final threshold must be calculated based on the required droop. The power is reduced in a linear manner starting from 0% at the initial frequency threshold, to arrive at 100% in conjunction with the final frequency threshold.
The two thresholds can be set in centi-Hz

Example
Initial threshold : 50.3 Hz → 50.3 * 100 = 5030 bit
Droop = 2.4 % → Final threshold = 50.3 + (50 * droop) = 51.5 Hz → 5150 bit

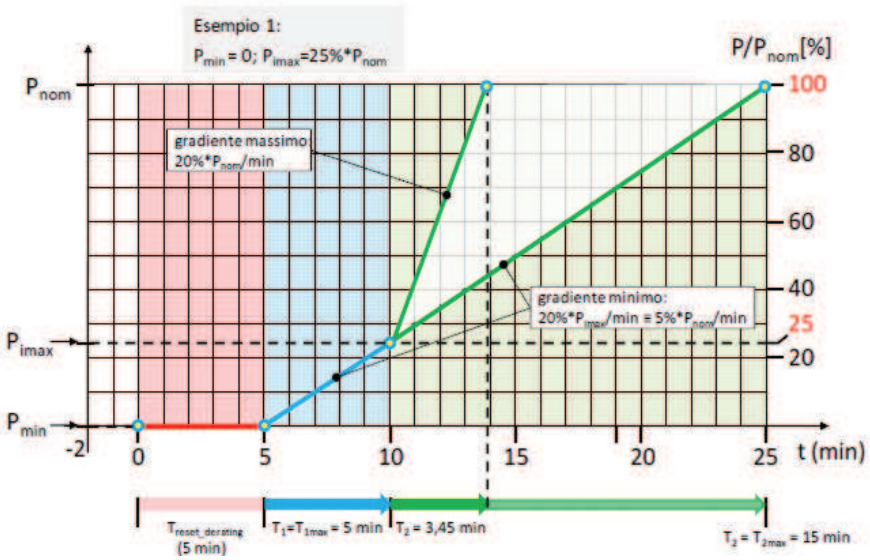
PARAMETER		DESCRIPTION	DEFAULT	RANGE
1526	W	Frequency threshold (HIGH) for the restoration of the power supplied before an episode of reduction due to over frequency.	5010	5000 … 5200
1528	W	Frequency threshold (LOW) for the restoration of the power supplied before an episode of reduction due to over frequency.	4990	4800 … 5000

The two thresholds represent the range within which the grid frequency must be terminated for a definite continuous period, before being able to carry out the restoration of the power previously reduced due to an episode of over frequency.

The two thresholds can be set in centi-Hz.

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1538	B	Waiting time within the correct range of frequency before carrying out the restoration of the power supplied before the fault	5	1 … 10

After an episode of over frequency, this parameter defines the waiting time within the correct range of frequency before being able to start the phase of restoration of the pre-fault power.
The data is expressed in minutes.



PARAMETER		DESCRIPTION	DEFAULT	RANGE
1537	B	Time for determining the gradient of restoration of the power supplied before an episode of over frequency equal to Gradient = Pre-fault / Time	5	1 … 10

This parameter determines the time for returning to the value of power before an episode of over frequency which previously caused its reduction, assuming that it begins at a level of power equal to 0.
The data is expressed in minutes. Grid parameters (voltage and frequency) outside of the limits

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1335	W	Upper grid voltage limit (phase) over which the grid outside limits voltage protection triggers (1.2 Vn)	-	90 … 360
1337	W	Lower grid voltage limit (phase) over which the grid outside limits voltage protection triggers (0.8 Vn)	-	90 … 360

The two thresholds together represent the range within which the grid (phase) voltage must terminate to avoid the grid outside limits voltage protection from triggering.
The two thresholds can be set in Volts.

In relation to the inverter nominal input voltage, the two default values are defined as follows:

MODELLO INVERTER	W1335	W1337
TLW Transformerless	138	92
TLH Transformerless 280VAC output	194	129
TLH Transformerless 380VAC output	263	175
TRL with Transformer on board	277	185
TRH with Transformer on board		
TRW with Transformer on board		

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1331	W	Upper grid voltage limit (phase) over which the grid outside limits frequency protection triggers	-	4000….7000
1333	W	Lower grid voltage limit (phase) over which the grid outside limits frequency protection triggers	-	4000….7000

The two thresholds together represent the range within which the grid (phase) frequency must terminate to avoid the grid outside limits frequency protection from triggering.
The two thresholds can be set in milli-hertz.

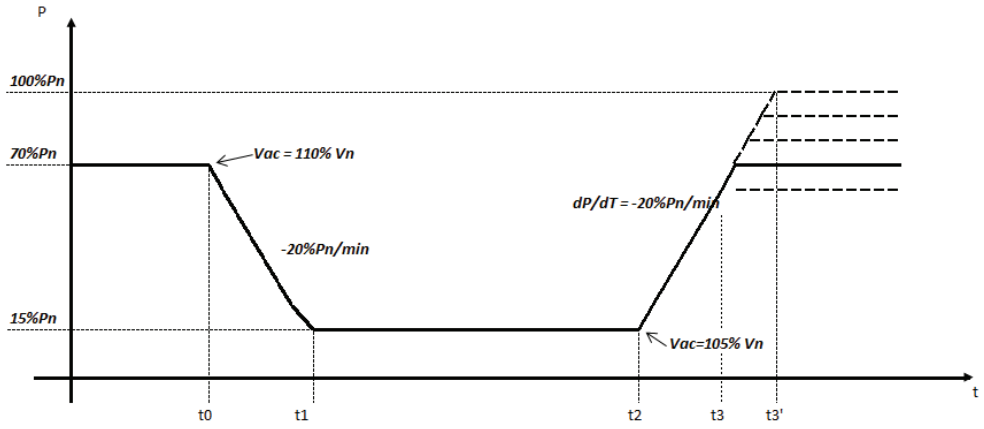
Default values are provided in the table below.

Parameter	Value	Frequency
W1331	5180	51.8Hz
W1333	4720	47.2Hz

9.2.4 Active Power limits for voltage values near 110%

When this function is enabled, the inverter, in local logic, limits power for voltage values near 110%.

When voltage exceeds 110% of the rated value “Vn” for more than two minutes, the inverter limits power with a negative gradient up to 15% of rated power Pn. When grid voltage returns to a value under 110%, generated power switches to the maximum generation power with a positive gradient equal to start up.



PARAMETER		DESCRIPTION	DEFAULT	RANGE
1254	B	Power limitation enabled P=f(Vac)	15	15.170

Enabling-disabling of the mode of reduction of active power supplied in accordance with the grid voltage Vac.

Value = 15 Mode disabled

Value = 170 Mode enabled

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1265	B	Vlock_in voltage threshold for power limitation function P=f(Vac)	110	100…110
1268	B	Vlock_out voltage threshold for power limitation function P=f(Vac)	105	100..110

Vlock_in and Vlock_out thresholds used to limit P power according to grid voltage Vac.
The lock-in and lock-out thresholds can vary from a minimum of 100% Vac up to a maximum of 110% Vac.

The data is expressed in percentage points with 1% resolution with respect to the supply VAC.

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1287	W	Time that determines the negative power gradient for power limit P=f(Vac)	300	10…900

It expresses the time it takes for P generated power to drop from 100% to 0% ratedP, determining the dP/dt gradient.

Data is expressed in seconds with 1 second resolution.

9.2.5 Grid Code set up (CEI 021 – CEI 016)

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1512	B	GRID CODE mode selection	4 / 5	4, 5

This parameter allows you to select the reference standard for LV or MV/HV grid connection to enable some functions rather than others required by the standard.

Value = 04 Selected standard **CEI 021**
Value = 05 Selected standard **CEI 016**

By default, the parameter that selects a specific standard is tied to the machine type. Normally, machines with transformers under 200kW are set to CEI 021 by default while all machine without transformers and machines with transformers and power over 125 kW are set to CEI 016.

9.2.5.1 Editing parameters according to the Grid Code

Some operating parameters must be adjusted to the selected Grid Code. By default, machine parameter settings are consistent with the selected Grid Code. When the Grid Code is changed, make sure the following parameters are set as follows:

	Parametri			
Inverter Model	Grid Code	Minimum voltage connection (V)	Maximum time LVRT (msec)	Vnom Peak AC (V)
	1512.b	**1283.w**	**1561.w**	**1559.w**
CEI 016 - Inverter Transformerless 200VAC output	5	104	1500	163
CEI 016 - Inverter Transformerless 280VAC output	5	145	1500	229
CEI 016 - Inverter Transformerless 380VAC output	5	197	1500	311
CEI 016 - Inverter with Transformer on board	5	208	1500	327
CEI 021 - Inverter with Transformer on board	4	195	400	325

9.2.6 Q reactive power supply via Reference

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1260	B	Q reactive power reference enabled	15	15 , 170

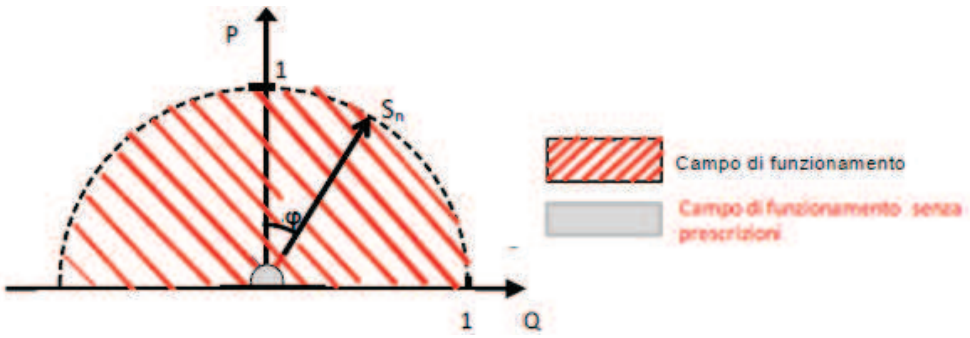
Value = 15 Mode disabled
Value = 170 Mode enabled

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1543	W	Q reactive power percentage	0	0 … 10000

The set value is the “Q” reactive power percentage of the inverter’s apparent rated power “Sn”.
If the selected standard is **CEI 021**, the maximum settable “Q” reactive power is +/-43.6% apparent “Sn” power (+/-4360.).

If the selected standard is **CEI 016**, the maximum settable “Q” reactive power is +/-100% apparent “Sn” power (+/-1000.). If the vector sum of “Q” reactive power and generated P active power exceeds the apparent “Sn” power, “Q” reactive power is automatically limited to a value where apparent “Sn” power is never exceeded.
This provides the semi-circular capability required by **CEI 016**.

The same reference



parameter (1543.w) can be used to generated a fixed “Q” reactive power percent of generated active power to thus obtain a fixed power factor.

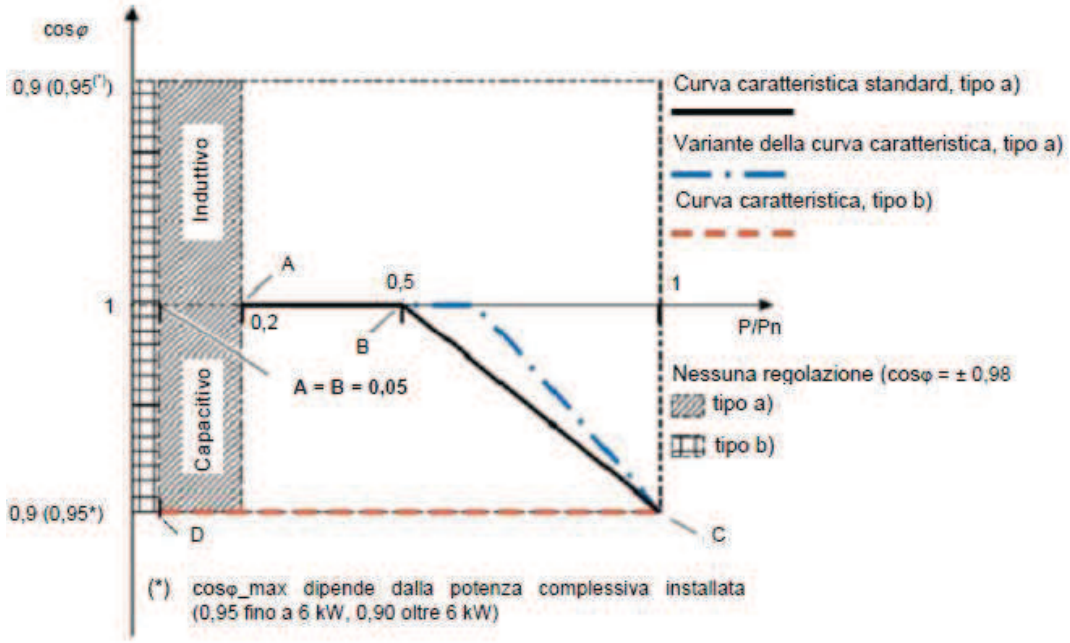
*See paragraph **“Participation in the control of the voltage - automatic supply of reactive power according to a pf = f(P) characteristic curve”***

9.2.6.1 Q reactive power reference sign

The sign used for reactive power generation from reference is the following:

- Positive reactive power: the generator supplies reactive power supplying current after voltage (over-excitation function).
- Negative reactive power: the generator absorbs reactive power supplying current before voltage (under-excitation function).

9.2.7 Participation in the control of the voltage - automatic supply of reactive power according to a pf = f(P) characteristic curve



PARAMETER		DESCRIPTION	DEFAULT	RANGE
1545	B	Enabling supply of reactive capacitive power according to the active power.	15	15, 160, 170

Enabling-disabling supply of the reactive (capacitive) power according to the active power supplied.

Value = 15 Supply disabled
Value = 160 Supply of reactive power in function of the active power according to the linear curve in parts (curve type A)
Value = 170 Q reactive power supply at rated fixed power factor (parameter 1546) when the lock-in power threshold (parameter 1549) is exceeded (curve type B)
Value = 180 Q reactive power supplied as a percent of P active power (variable power factor), used for remote Q control

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1546	W	Minimum power factor set.	900	900 … 1000

It represents the minimum power factor set which by default is equal to 0.9.
The resolution of this parameter is equal to 0.001.

Example
0.9 → 0.9/0.001 = 900 bit

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1548	B	Lock-in Power threshold for the calculation of the reactive power f(P) by using the linear curve A described by the regulation CEI-021	50	20 … 100

Active power threshold where the supply of reactive power Q starts in linear mode (point B of the diagram shown above).
The data is expressed in percentage points (referring to the data of the active nominal power of the converter) with 1% resolution.

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1549	B	Lock-in power threshold for the calculation of the reactive power f(P) by using the curve B (maximum Q reactive) described by the regulation CEI-021.	5	5 … 10

Active power threshold where the supply of reactive power Q starts (point D of the diagram shown above).
The data is expressed in percentage points (referring to the data of the active nominal power of the converter) with 1% resolution.

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1550	B	Lock-in voltage threshold of power for the calculation of the reactive power f(P)	105	100 … 110
1551	B	Lock-out voltage threshold of power for the calculation of the reactive power f(P)	100	90 … 100

Lock-in and lock-out voltage threshold used to enable or not the reference calculation Q reactive f(P).
The lock-in threshold may vary from a minimum of 100% nominal Vac up to a maximum of 110% nominal Vac.
The lock-out threshold may vary from a minimum of 90% up to a maximum of 100%.

The data is expressed in percentage points, referring to the nominal voltage (peak Vphase) of the inverter as described in the following table:

INVERTER MODEL	RATED VOLTAGE [V]
TLW Transformerless	163
TLH Transformerless 280VAC output	229
TLH Transformerless 380VAC output	311
TRL with Transformer on board	325 (CEI 021) 327 (CEI 016)
TRH with Transformer on board	
TRW with Transformer on board	

9.2.7.1 Fixed power factor operations

Parameter 1545.b is set to 180 to select fixed power factor operating mode.

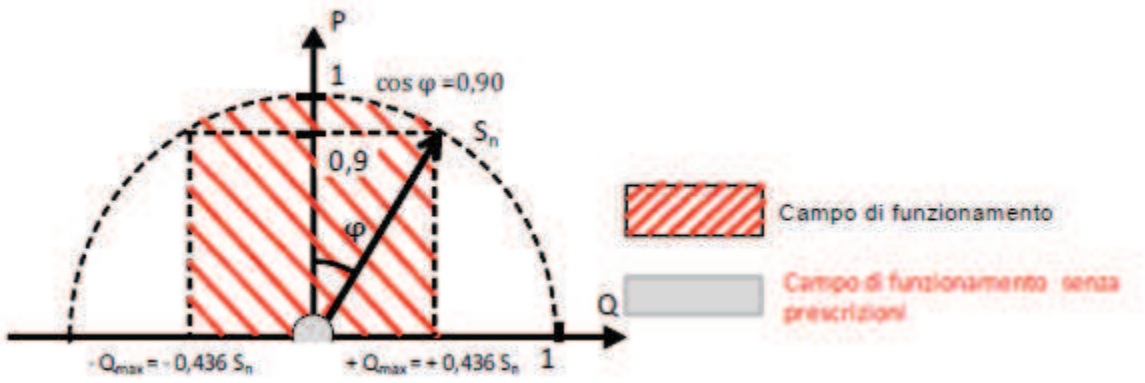
When this mode is selected, the Q reference (parameter 1543.w) is the fixed percent of Q compared to instantly generated P power.

This mode can achieve a fixed power factor between 1 and 0.7 both in over-excitation and under-excitation.

Q reference values for some desired “power factor” values are provided in the table.

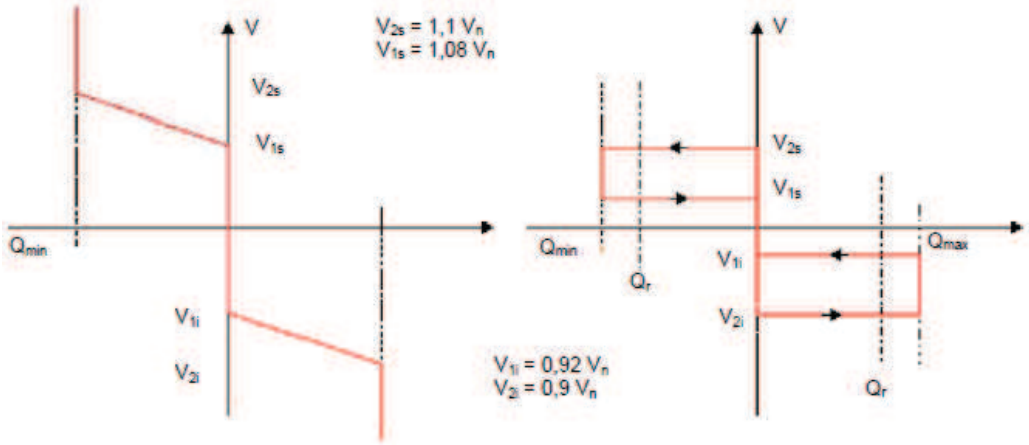
Desired power factor	Fixed power factor mode enabled (1545.b)	Q reference (1543.w) (over-excitation)	Q reference (1543.w) (under excitation)
1	170	0	0
0.95	170	3286	-3286
0.9	170	4843	-4843
0.85	170	6197	-6197
0.8	170	7500	-7500
0.75	170	8820	-8820
0.7	170	10000	-10000

The illustrated capability is obtained when the power factor is limited to 0.9.



For power values over 90% of Sn, reactive Q is limited to maintain the inverter’s maximum apparent Sn power.

9.2.8 Participation in the control of the voltage – Supply- automatic absorption of reactive powers according to a Q = f(V) characteristic curve



PARAMETER		DESCRIPTION	DEFAULT	RANGE
1552	B	Enabling supply of reactive power in function of the VAC supply voltage.	15	15, 160, 170

Enabling-disabling supply of the reactive power in function of the grid VAC voltage.

Value = 15 Supply disabled
Value = 160 Reactive power supply in VAC function with hysteresis
Value = 170 Reactive power supply in linear VAC function between V1s - V2s and V1i - V2i

Supply of reactive power in function of VAC with hysteresis

- If Q = 0
  Above V2s the maximum reactive capacitive power is supplied Q = MAX
- If Q = MAX
  Below V1s the supply of the reactive capacitive power is suspended Q = 0

- If Q = 0
  Above V2i the maximum reactive inductive power is supplied Q = MAX
- If Q = MAX
  Below V1i the supply of the reactive inductive power is suspended Q = 0

Supply of reactive power in function of linear VAC

- Between V1s and V2s the supply of the reactive capacitive power is carried out in linear mode respectively between 0% and 100% of the maximum reactive power deliverable (function of the pf).
- Between V1i and V2i the supply of the reactive inductive power is carried out in linear mode respectively between 0% and 100% of the maximum reactive power deliverable (function of the pf).

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1555	B	V1S voltage threshold for the calculation of the reactive power f(VAC).	108	100 … 110
1556	B	V2S voltage threshold for the calculation of the reactive power f(VAC) **The value set must be higher than the parameter 1555.**	110	100 … 110

V1S and V2S thresholds used for the supply the reactive capacitive power.
The lock-in and lock-out thresholds can vary from a minimum of 100% Vac up to a maximum of 110% Vac.
The data is expressed in percentage points with 1% resolution with respect to the supply VAC.

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1557	B	V1i voltage threshold for the calculation of the reactive power f(VAC).	92	90 … 100
1558	B	V2i voltage threshold for the calculation of the reactive power f(VAC) **The value set must be lower than the parameter 1557.**	90	90 … 100

V1i and V2i thresholds used for the supply of the reactive capacitive power.
The lock-in and lock-out thresholds can vary from a minimum of 90% Vac up to a maximum of 100% Vac.
The data is expressed in percentage points with 1% resolution with respect to the supply VAC.

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1553	B	Lock-in power threshold for the calculation of the reactive power f(VAC).	20	10 … 100
1554	B	Lock-out power threshold for the calculation of the reactive power f(VAC).	5	5 … 10

Lock-in and lock-out power thresholds which enable or not the supply of the reactive power.
The data is expressed in percentage points with 1% resolution.

10 APPENDIX: SET-UP OF INSULATION RESISTANCE MEASUREMENT FEATURE / FUSE TRIP POLE EARTHED

10.1 Introduction

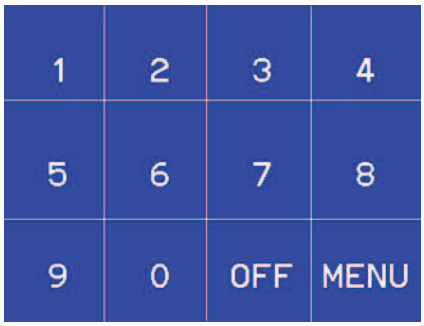
SOLEIL DSPX TRH, TLH and TRW inverters are equipped with a device for measuring the Insulation Resistance towards the ground (DC side), which, if necessary, can be set for diagnosing the FV field pole earthed fuse if the plant has been configured for this operation mode.

The configuration parameters of the feature are the following:

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1302	B	Enabling measurement of insulation resistance / Pole earthed 15 = Disabled 160 = Enabled measurement R Isol 170 = Enabled detect fuse earthed on positive pole interrupted 180 = Enabled detect fuse earthed on negative pole interrupted	160	15, 160, 170, 180
1305	B	Select Alarm or Fault in the case of Interruption Pole earthed or low R iso 15 = only alarm 170 = stop inverter	15	15, 170
1306	W	Minimum threshold for alarm-fault isolation resistance [kOhm]	100	10 … 500
1309	W	Delay in activation alarm-fault for R iso function / Pole earthed [sec]	60	10 … 1000

AS A DEFAULT, THE MACHINES ARE CONFIGURED FOR THE "MEASUREMENT OF INSULATION RESISTANCE" MODE.

FOR ANY MACHINE SET-UP MODIFICATION PLEASE REFER TO THE PARAMETER READ-WRITE PROCEDURE DESCRIBED IN SECTION . 4.3.4.6, FOLLOWING THE INSTRUCTIONS IN THE FOLLOWING PARAGRAPHS



10.2 Set-up of grounded pole mode

1. Prepare the connection towards a FV field pole, as required by the design constraints. See the “Installation Manual” IV347.
2. Enable the feature by means of parameter b1302, by paying attention to the required system (170 or 180 according to which pole is earthed).
3. If necessary, change the protection triggering system (parameter b1305 for the choice of the mode: ALARM or STOP) and the time delay (parameter b1309).

10.3 Set-up of method of measuring Insulation Resistance

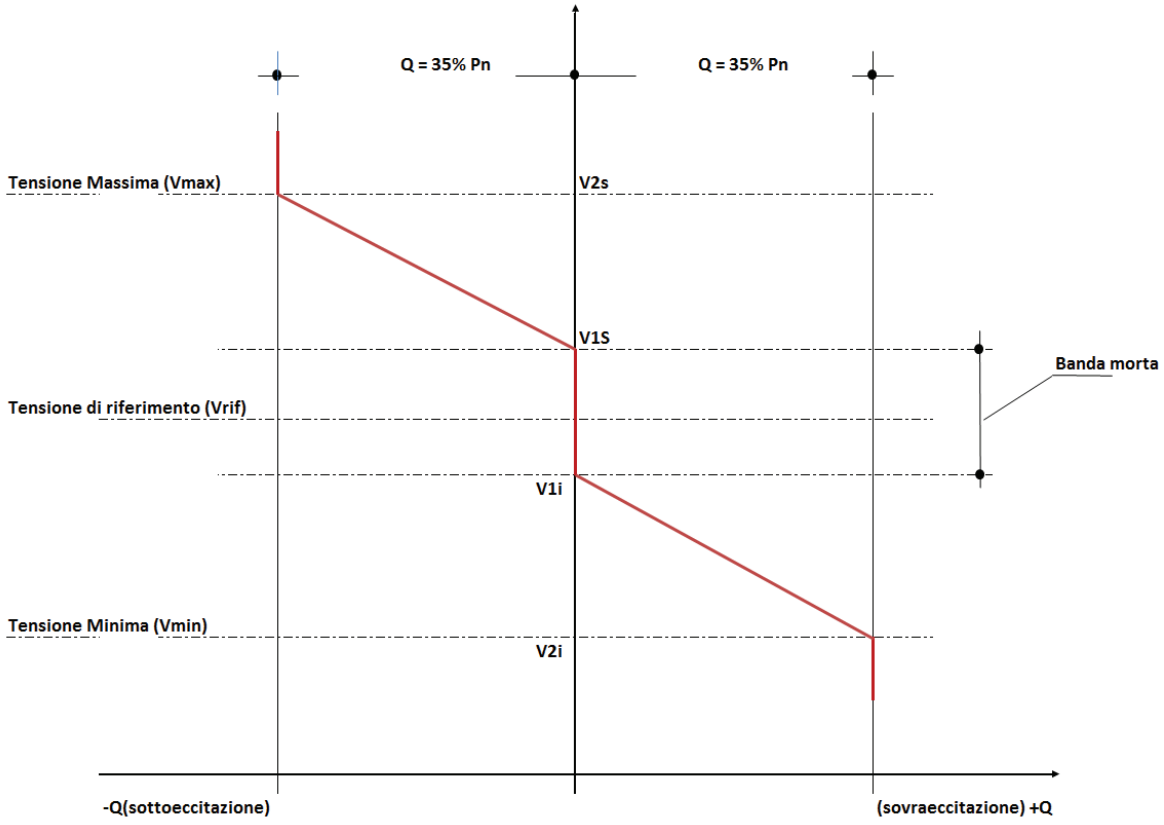
1. Ensure that there is no solidly earthed connection of a pole of the FV field on the plant
2. Verify the enabling of the feature (parameter b1302 = 160).
3. If necessary, change the protection triggering system (parameter b1305 for the choice of the mode: ALARM or STOP) and the time delay (parameter b1309).

11 APPENDIX: SET UP OF THE REACTIVE POWER GENERATION METHOD ACCORDING TO THE VOLTAGE READ AT THE DELIVERY POINT (FOR HV GRID CONNECTIONS)

11.1 Introduction

SOLEIL DSPX inverters that meet CEI 016 connection standards can be connected to the HV/HHV grid. This type of connection is regulated by appendix A68 that describes the "MINIMUM REQUIREMENTS FOR CONNECTION AND OPERATIONS IN PARALLEL WITH THE HV GRID".

The A68 appendix requires reactive power supply or absorption according to the Q=f(V) characteristic curve illustrated below:



11.2 Configuration

The characteristic curve is set by the following parameters:

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1257	B	Reactive power supply enabled Q=f(V) at delivery point or inverter output	15/170	15 … 170

Enabled-disabled reactive power supply according to VAC voltage read at the HV grid pdc delivery point or inverter output

Value = 15 Q reactive power supply according to Vac voltage read at inverter output
Value = 170 Q reactive power supply according to Vac voltage read at HV grid delivery point

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1401	W	HV grid rated voltage	15000	0 ….. 32767

Indicates the HV grid rated voltage with a resolution of 10 volts per unit. **(1bit=10V)**

I.e.: HV grid rated value: 150000V (150kV)
Parameter value: 15000

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1269	W	Vref voltage (% HV grid rated voltage)	10200	0 ….. 32767

Percent of rated grid voltage to calculate Vref reference voltage.
The data is expressed in hundredths of percent (1bit = 0.01%)

I.e.: Grid Vrated = 150Kv Vref = 153Kv --> Vref = 102% Vrated
Percent value: 102%
Parameter value: 10200

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1365	B	Dead band	30	0 ….. 255

Percent of Vref to determine +/- deltaV of Vref to obtain the two V1s and V1i values
The data is expressed in hundredths of percent (1bit = 0.01%)

I.e.: Required dead band = 3% --> V1s = Vref + (3%Vrif) V1i = Vref – (3%Vref)
Parameter value: 30

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1303	W	Maximum voltage (Vmax) (% HV grid Vrated)	10500	0 ….. 32767

Percent of rated grid voltage to calculate Vmax maximum voltage.
The data is expressed in hundredths of percent (1bit = 0.01%)

I.e.: Grid Vrated = 150Kv Vmax = 157,5Kv --> Vmax = 105% Vrated
Percent value: 105%
Parameter value: 10500

PARAMETER		DESCRIPTION	DEFAULT	RANGE
1296	W	Minimum voltage (Vmin) (% HV grid Vrated)	9900	0 ….. 32767

Percent of rated grid voltage to calculate Vmax maximum voltage.
The data is expressed in hundredths of percent (1bit = 0.01%)

I.e.: Grid Vrated = 150Kv Vmin = 148,5Kv --> Vmin = 99% Vrated
Percent value: 99%
Parameter value: 9900

Reactive power generation Q = f (Vac), according to that required by appendix A68, requires voltage reference be those directly read at the delivery point on the HV/HHV grid.

To run this function for HV/HHV connections, efficient phase voltage values must be acquired through another system independent of the inverter and communicated to the latter via RS485 communication using MODBUS protocol.

For information on mapping and acquisition scales, see the following document:

"SP104 REVxx Technical Specifications for Modbus Area Mapping"