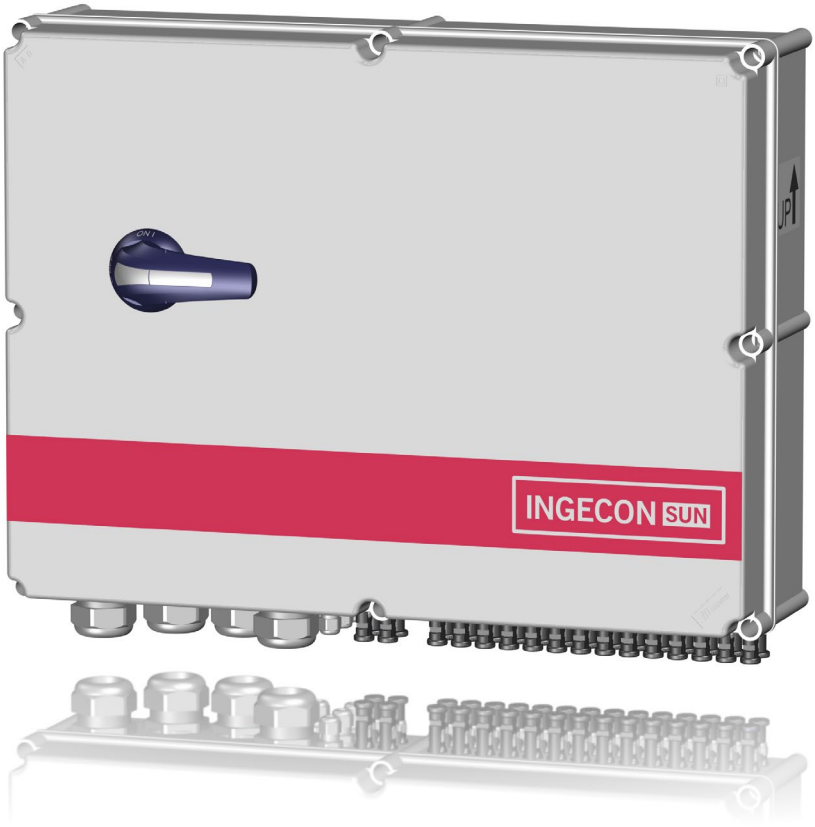
Ingeteam



INGECON SUN String Control

Installation and usage manual

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Contents

1. About this manual

The purpose of this manual is to describe the INGECON SUN String Control units and to provide appropriate information for their correct reception, installation, start-up, maintenance and operation.

1.1. Scope

This manual is valid for the different configurations of the INGECON SUN String Control 160 and INGECON SUN String Control 320.

1.2. Recipients

This document is intended for qualified personnel.

The status of qualified personnel referred to in this manual will be, as a minimum, that which meets all the standards, regulations and laws regarding safety applicable to the tasks of installing and operating this unit.

The responsibility for designating qualified personnel will always be of the company to which the personnel belong. It is necessary to decide which workers are suitable or not for carrying out specific work to preserve their safety at the same time as complying with occupational safety legislation.

These companies are responsible for providing appropriate training in electrical equipment to their personnel and for familiarising them with the contents of this manual.

1.3. Symbols

This manual uses various symbols to emphasize and highlight certain texts. The general meanings are discussed below.

General warning.

General information.

Electrical danger.

Read the section indicated.

Prohibition.

2. Unit description

2.1. Overview

The INGECON SUN String Control has various functions.

Firstly it acts as a grouping box for strings, in which up to 16 strings from the PV array are placed in parallel.

Secondly it includes a series of fuses and fuse holders, which protect the installation and enable the switching of the PV array (the fuse holders must never be opened when powered).

Finally, this unit carries out readings of the currents carried by each string, triggering an alarm in the event that a string has an anomalous current and sending information on the production of each string.

When the inverter starts up and injects power into the grid, the PV array current crosses the INGECON SUN String Control. This then starts to measure the currents that pass along each string, comparing them, and detecting any currents that are out of range.

Detection of an anomalous current

Periodically the unit measures each string and calculates the average current of all the strings weighting them by their rated current. Then a calculation is made of the deviation of each string with respect to the weighted average. If the deviation of any of the strings exceeds the percentage defined in the configurable parameter *average deviation %*, then it is considered that the string has an anomalous current. If the current of this string stays above the *average deviation %* over a time greater than the *Time before alarm* the unit generates an *Anomalous current* alarm.

The process of detecting anomalous flows begins when the average current exceeds the larger of two values: 0.5 A or 10% of the rated current of the strings. This is done to filter alarms in periods of very low radiation or at sunrise and sunset.

Detection of blown fuse

This unit does not have hardware for blown-fuse detection, but it evaluates the currents and under certain conditions deems there to be a possibility that the fuse is blown.

The unit deems a string to have a blown fuse when this does not exceed 200 mA while the average for the rest of the unit exceeds the larger of two values: 1 A or 20% of the rated current of the installation.

As can be inferred from these conditions, the unit deems a fuse to be blown when the string has zero-current (with a safety margin) and the rest of the installation is in production. For this reason this fault may not be a blown fuse but a connector without good contact, or a cable cut in the installation, etc.

2.2. Optional accessories

Isolating switch

Optionally the INGECON SUN String Control can be equipped with a DC isolating switch.

Isolating switch with communication-assisted tripping

Optionally the INGECON SUN String Control can be equipped with a DC isolating switch with communication-assisted tripping.

DC surge arresters

These units have the option of incorporating surge arresters that, in the event of voltages higher than 1000 VDC, route the voltage to ground as a protection measure.

Communication accessories

There are two distinct options for communicating the units.

RS-485.

Ethernet.

GSM/GPRS.

See the corresponding *Communication accessories* manual for more information on the different possibilities.

2.3. Compliance with regulations

2.3.1. CE marking

CE marking is mandatory for the sale of any product within the European Union, without prejudice to standards or laws. These units have CE marking by reason of their compliance with the following directives:

- *Low Voltage Directive 2006/95/EC.*
- *Electromagnetic Compatibility Directive 2004/108/EC.*

Low Voltage Directive

These units comply with this directive by means of compliance with the applicable parts of standards:

- *EN 62109-1 Safety of power converters for use in photovoltaic power systems.* Part 1: general requirements.
- *EN 62109-2 Safety of power converters for use in photovoltaic power systems.* Part 2: Specific requirements for inverters.

Electromagnetic Compatibility Directive

These units comply with this directive by means of compliance with the applicable parts of harmonised standards:

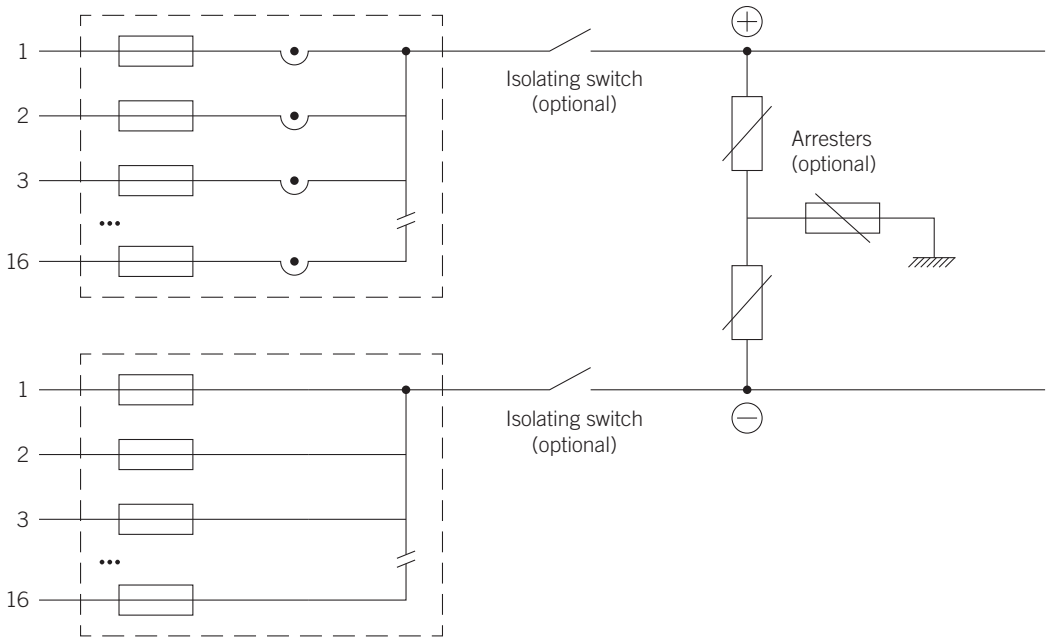
- *EN 61000-6-2 Electromagnetic Compatibility*. Part 6-2: Generic standards - Immunity for industrial environments.
- *EN 61000-6-4 Electromagnetic Compatibility*. Part 6-4: Generic standards - Emission for industrial environments.

Compliance with these standards calls for compliance with limits and procedures in other standards of the same series.

2.4. Protection class

These units meet IP65 protection class against external agents.

2.5. System wiring diagram

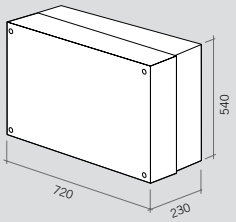


2.6. Specification table

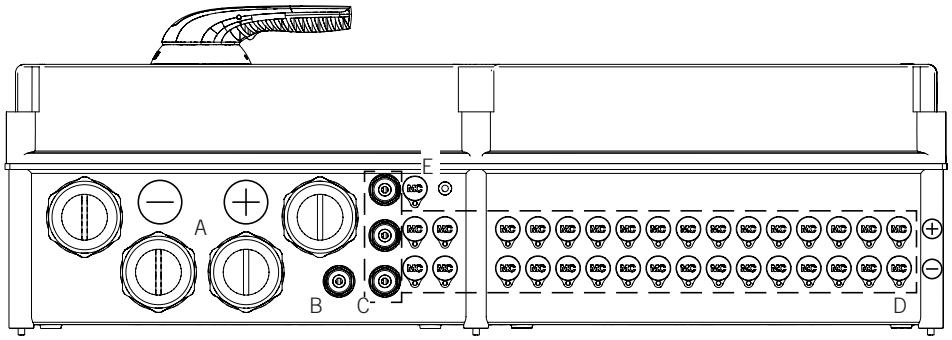
	String Control 160	String Control 320
Maximum number of connectable strings	16	
Maximum number of measurable channels	16	
Maximum current per string	10 ADC	20 ADC
Maximum total current	160 ADC	320 ADC
Number of protection fuses	16	
Maximum voltage	1000 VDC	
Input connectors	Type-4 photovoltaic connectors	
Output connectors	M55 packing gland (up to 55 mm²)	
Communication connections	RS-485, Ethernet, GSM/GPRS	
Operating temperature	-20 ºC ~ 65 ºC	
Protection class	IP65	
Ground connector	M16 packing gland (up to 35 mm²)	

Size and weight (mm)

15 kg.



2.7. Description of cable inlets



A. DC Output toward the inverter.

B. Ground.

C. Multipurpose / communications.

D. DC input from the PV array.

E. Tester.

3. Safety

This section describes the safety warnings and the Personal Protective Equipment or the symbols used in the unit.

3.1. Safety conditions

General warnings

The operations described in the manual may be performed only by qualified personnel.

The status of qualified personnel referred to in this manual will be, as a minimum, that which meets all the standards, regulations and laws regarding safety applicable to the tasks of installing and operating this unit.

The responsibility for designating qualified personnel will always be of the company to which the personnel belong. It is necessary to decide which workers are suitable or not for carrying out specific work to preserve their safety at the same time as complying with occupational safety legislation.

These companies are responsible for providing appropriate training in electrical equipment to their personnel and for familiarising them with the contents of this manual.

All applicable safety-related legislation for electrical work must be complied with. Danger of electric shock.

Compliance with the safety instructions set out in this manual or in the suggested legislation does not imply exemption from other specific standards for the installation, place, country or other circumstances that affect the inverter.

The set of conditions listed throughout this document should be considered as minimum requirements. It is always preferable to cut the general power supply. There may be faults in the installation that cause the unwanted return of voltage. Danger of electric shock.

Opening the door of the housing does not imply there is no voltage inside.

There is a danger of electrical shock even after disconnecting the grid, the PV array and the auxiliary power.

Only qualified personnel may open it, following the instructions in this manual.

According to basic safety standards, all the equipment must be suitable to protect exposed workers against the risk of direct and indirect contact. In any case the electrical parts of the work equipment must comply with the provisions of the corresponding specific regulations.

According to basic safety standards, the electrical installation shall not entail a fire or explosion risk. Workers must be duly protected against the risk of accidents caused by direct or indirect contact. The electrical installation and protection devices must take into account the voltage, the external conditions and the competence of persons who have access to parts of the installation.

Class II *NEC NFPA 70E* measuring instruments must be used for checking for the absence of voltage.

Ingeteam accepts no liability for any damages caused by improper use of its equipment.

Carry out all control and handling without voltage.

As a minimum security measure in this operation, the so-called **five golden rules** should always be followed:

1. Disconnect.
2. Prevent any possible feedback.
3. Check there is no voltage.
4. Ground and short circuit.
5. Protect from live elements, if any, and put up safety signs around the work area.

Until these five steps are completed, the work area cannot be considered voltage-free and any work performed will be considered to be work on live equipment.

Ingeteam accepts no liability for any damages caused by improper use of the equipment. Any work carried out on any equipment which implies a modification of the original electrical arrangements must be proposed in advance to Ingeteam. These must be studied and approved by Ingeteam.

It is obligatory to provide the necessary measures to prevent any person from outside the installation from coming close to, or handling the equipment.

Any work carried out that implies a modification of the original electrical arrangements must be proposed and accepted in advance to and by Ingeteam.

These instructions must be readily available near to the unit and located within easy reach of all users.

Before carrying out the installation and start-up, please carefully read these safety instructions and warnings as well as all the warning signs on the unit. Make sure that all the warning signs remain perfectly legible and those that are damaged or missing are restored.

Protection against direct contact is made by way of creating an enclosure.

The unit has been tested according to applicable regulations in order to meet the safety requirements, and the isolation and creepage distance values for operating voltages.

Potential hazards for people

HAZARD: electric shock.

The unit may remain charged after disconnecting the PV array, the mains supply and the auxiliary power supplies.

Carefully follow the mandatory steps in the manual for removing the voltage.

HAZARD: explosion.

There is a very low risk of explosion in very specific cases of malfunction.

The casing will protect people and property from the explosion only if it is correctly closed.

HAZARD: crushing and joint injuries.

Always follow the indications in the manual on moving and placing the unit.

The weight of this unit can cause serious injury and even death if not handled correctly.

Potential hazards for the unit

WARNING: cooling.

The unit requires quality air flow while it is operating.

Keeping the unit in the upright position and the inlets free of obstacles is essential for this air flow to reach the inside.

WARNING: connections.

After all duly authorised handling, check that the unit is ready to start operating. Only after this can it be connected following the instructions in the manual.

Do not touch boards or electronic components. The more sensitive components can be damaged or destroyed by static electricity.

Do not disconnect or connect any terminal while the unit is operating. Disconnect and check for absence of voltage first.

3.2. Personal Protective Equipment (PPE)

When working on the unit, use the following safety equipment recommended by Ingeteam as a minimum.

Name	Explanation
Safety footwear	In compliance with Standard *UNE-EN-ISO 20345:2012*
Helmet	In compliance with Standard *EN 397:1995*
Helmet with face shield	In compliance with Standard *UNE-EN 166:2002*, wherever there are directly accessible live parts.
Working clothes	Close-fitting, non-flammable, 100% cotton
Dielectric gloves	In compliance with Standard *EN 60903:2005*

Tools and/or equipment used in live work must have at least Category III-1000 Volts insulation.

Should the country's regulations demand another kind of personal protection, the equipment recommended by Ingeteam should be appropriately supplemented.

4. Receipt of the unit and storage

4.1. Reception

Keep the unit in its packaging until immediately before installation.

4.2. Unit identification

The serial number (S/N) of the unit is its unique identifier. This number must be quoted in any communication with Ingeteam.

The unit's serial number is also marked both on the packaging and on the nameplate:

4.3. Transport Damage

If the unit has been damaged during transport, proceed as follows:

1. Do not proceed with the installation.
2. Notify the distributor immediately within five days of receipt of the unit.

If ultimately the unit has to be returned to the manufacturer, use the original packaging.

4.4. Storage

Failure to follow the instructions shown in this section may lead to damage to the unit.

Ingeteam accepts no liability for damage resulting from the failure to follow these instructions.

If the unit is not installed immediately after reception, the following points should be taken into account in order to avoid damage:

- Keep the unit free of dirt (dust, shavings, grease, etc.) and away from rodents.
- Keep away from water splashes, welding sparks, etc.
- Cover the unit with a breathable protective material in order to prevent condensation due to ambient humidity.
- Units in storage must not be subjected to weather conditions other than those indicated in Section *"2.6. Specification table"*.
- It is very important to protect the unit from chemical products which can cause corrosion, as well as from salty atmospheres.
- Do not store the unit outdoors.

4.5. Conservation

In order to ensure correct preservation of the units, they must not be removed from their original packaging until it is time to install them.

In case of prolonged storage, the use of dry places avoiding, as far as possible, sharp changes in temperature is recommended.

Deterioration of the packaging (tears, holes, etc.) prevents the units from being kept in optimum conditions before installation.

5. Equipment transport

The unit must be protected, during transport, from mechanical knocks, vibrations, water splashes (rain) and any other product or situation which may damage it or alter its behaviour. Failure to observe these instructions may lead to loss of warranty on the product, for which Ingeteam is not responsible.

5.1. Transport

Transport using a pallet truck

At least the following requirements should be observed:

1. Place the packaged units centred with respect to the forks.
2. Try to locate them as close as possible to the connection between the forks and the steering unit.
3. In all cases, observe the instructions in the pallet truck's user manual.

Transport using a forklift truck

At least the following requirements should be observed:

1. Place the packaged units centred with respect to the forks.
2. Try to locate them as close as possible to the connection between the forks and the steering unit.
3. Ensure that the forks are perfectly level to avoid overturning the unit.
4. In any case, observe the instructions in the forklift truck's user manual.

Once the unit has been transported to the place where it is to be located and only when it is to be installed, unpack the unit.

At this time, it can be transported vertically over a short distance without packaging. The guidelines in the next point should be followed both for the unit and for the transformer.

Transport of the unpackaged unit

At least the following requirements should be observed:

1. Attach the unit firmly.
2. Follow the necessary ergonomic advice for lifting weights.
3. Do not release the unit until it is perfectly secured or placed.
4. Ask someone else to guide the movements to be made.

5.2. Unpacking

Correct handling of the units is vitally important in order to:

- Prevent damage to the packaging which enables them to be kept in optimum condition from shipping until they are installed.
- Avoid knocks and/or falls which may harm the mechanical characteristics of the units, e.g. cause incorrect closure of doors, loss of IP rating, etc.
- Avoid, as far as possible, vibrations which may cause subsequent malfunction.

If you observe any anomaly, please contact Ingeteam immediately.

Separating the packaging

All the packaging can be delivered to a non-hazardous waste management company.

6. Preparation for installing the unit

When deciding the location of the unit and planning your installation, you must follow a set of guidelines based on the specifications of the unit. These guidelines are summarised in this chapter.

6.1. Environment

- Place the units in a place that is accessible for installation and maintenance work.
- Avoid corrosive environments that may affect the proper operation of the unit.
- Never place any object on top of the unit.
- Ingeteam recommends protecting the units from direct sunlight.

6.2. Environmental conditions

Environmental conditions must be taken into account when choosing the location of the unit.

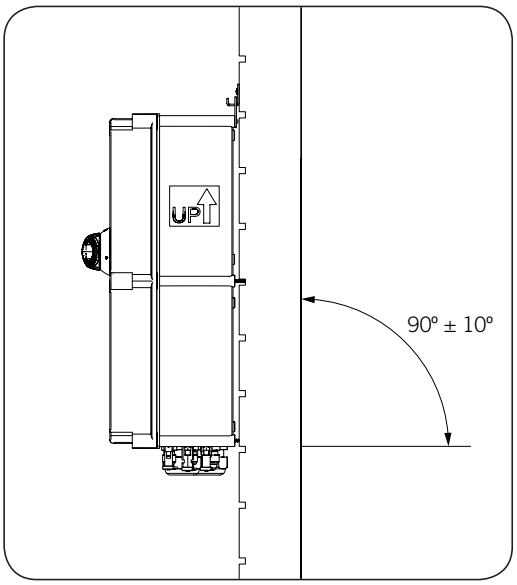
Environmental conditions	
Minimum temperature	-20 ºC
Minimum surrounding air temperature	-20 ºC
Maximum surrounding air temperature	65 ºC
Maximum relative humidity without condensation	95%

It should be borne in mind that moderate condensation may occasionally occur as a consequence of temperature variations. For this reason, apart from the unit's own protection, vigilance of these units is necessary once they have been started up on sites where the conditions described above are not expected to be present.

In the event of condensation, never apply voltage to the unit.

6.3. Supporting Surface and Fastening

To guarantee good heat evacuation and promote sealing, the units must be placed on a perfectly vertical wall or, failing this, with a slight slope of a maximum of ± 10º from vertical.



Reserve a solid wall to which to attach the unit. It must be possible to drill the wall and fit suitable fixing elements to support the unit's weight.

7. Installing the Unit

Before installing the unit, the packaging must be removed, taking special care not to damage the housing.

Check that there is no condensation inside the packaging. If there are signs of condensation, the unit must not be installed until you are sure it is completely dry.

All installation operations must comply with current regulations.

7.1. General requirements for installation

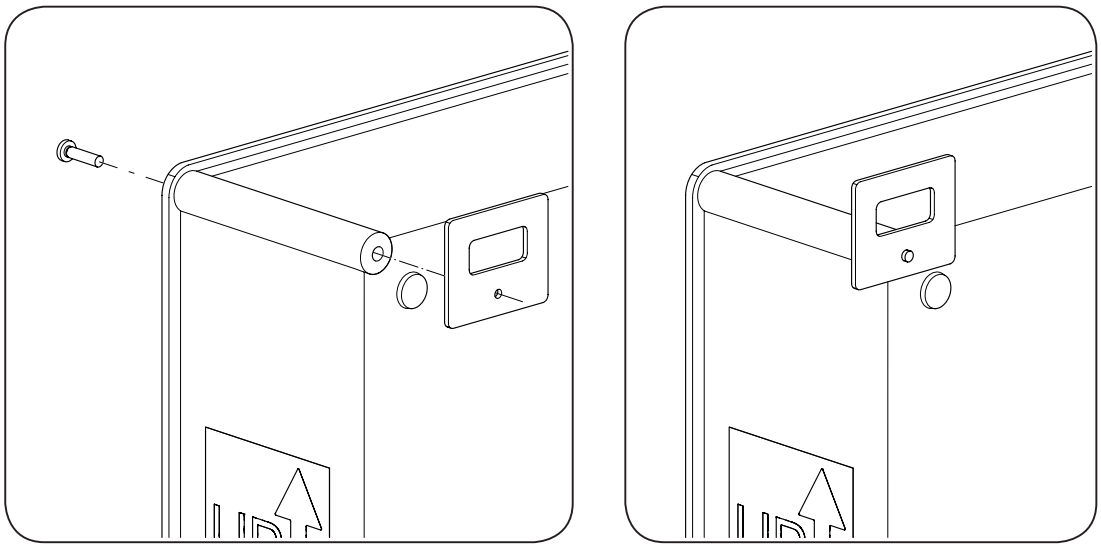
- The environment of the unit must be appropriate and meet the guidelines described in Chapter *"6. Preparation for installing the unit"*. Additionally, the parts used in the rest of the installation must be compatible with the unit and comply with the applicable legislation.
- Ventilation and the space for work, which must be suitable for maintenance tasks according to the applicable regulations in force.
- The external connection devices, which must be suitable and sufficiently close as set forth in current regulations.
- The feed cables must be of the appropriate gauge for the maximum current.
- Special care must be taken to ensure that there are no external elements near the air inlets and outlets to obstruct proper cooling of the unit.

7.2. Attaching the unit to the wall

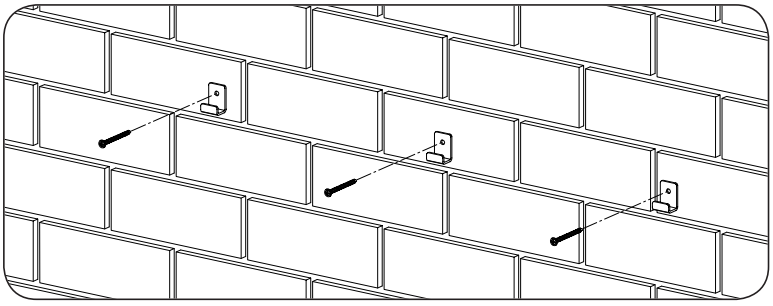
These units have a system for securing them to the wall using plates. The steps for fixing the unit properly are as follows.

The weight of the unit must be taken into account (see section *"2.6. Specification table"*).

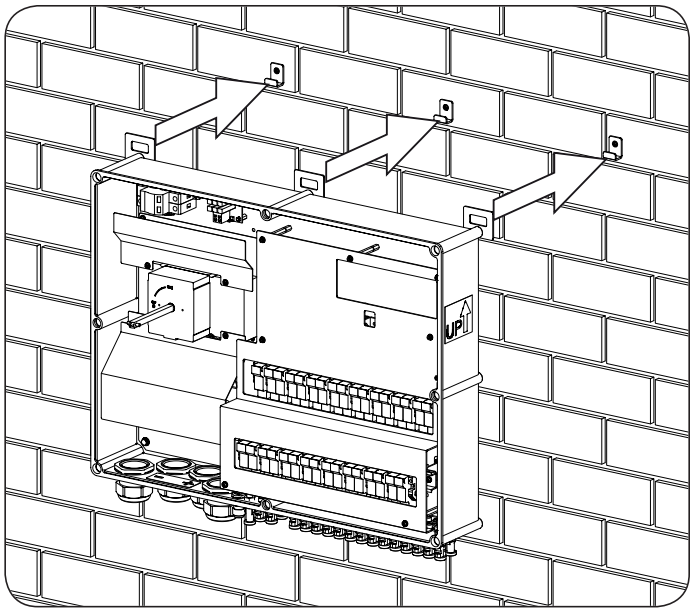
1. Attach the three fastening plates at the top using the screws supplied.



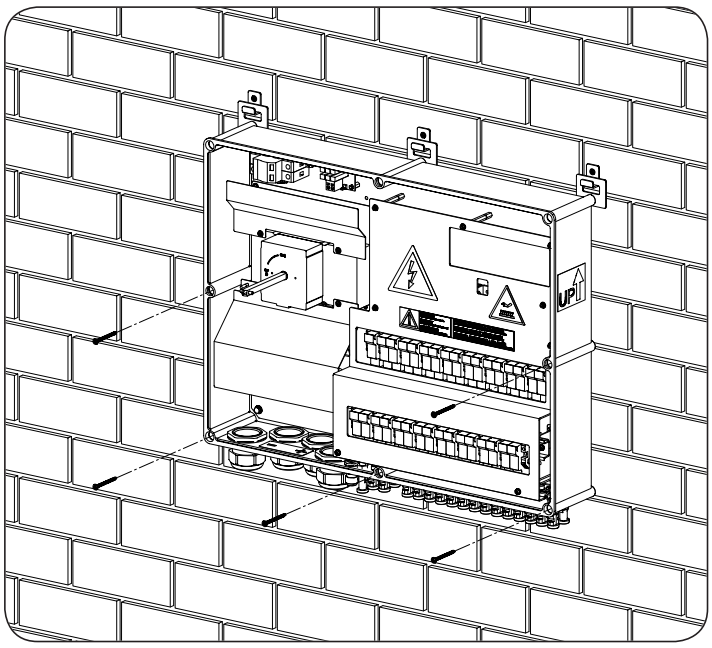
2. Attach the hooks to the wall using stainless steel fasteners that are appropriate for its material.



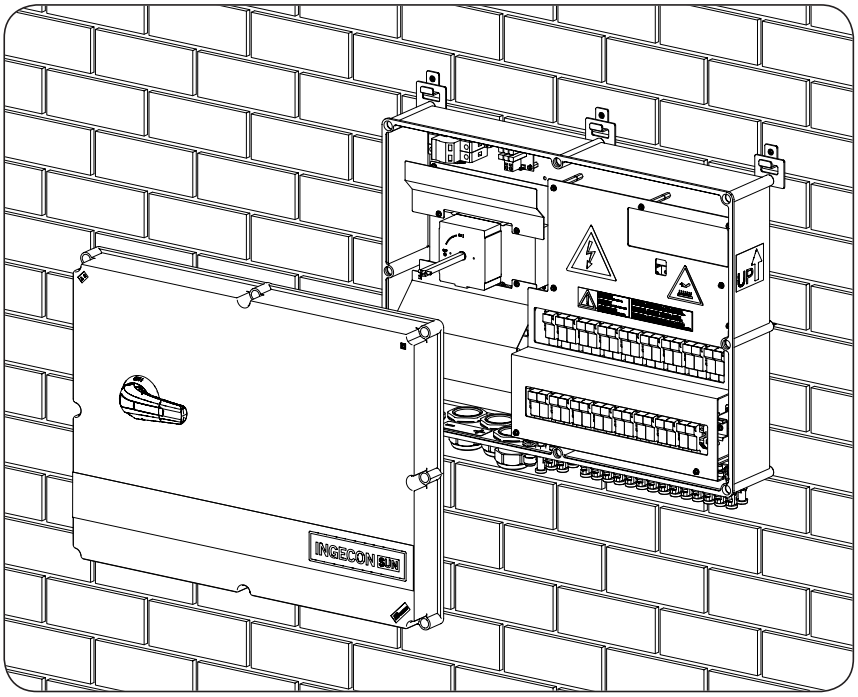
3. Hang the unit from the plates.



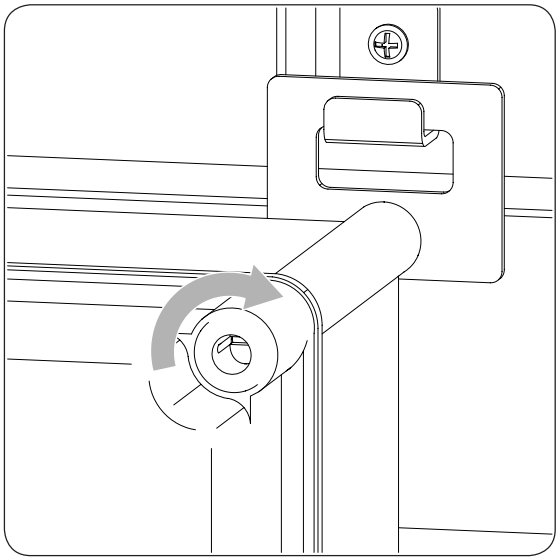
4. Insert the fastening elements in the wall, as shown in the following figure.



5. Put the cover in place.



6. Attach the plastic fasteners that are inserted in the cover.



7. Check that the unit is properly secured.

Once the unit has been installed correctly, a node number must be allocated.

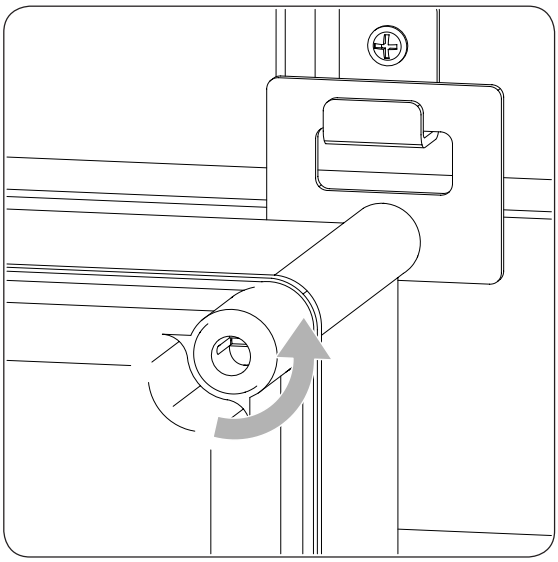
After said configuration, it should be connected in the following order of connection.

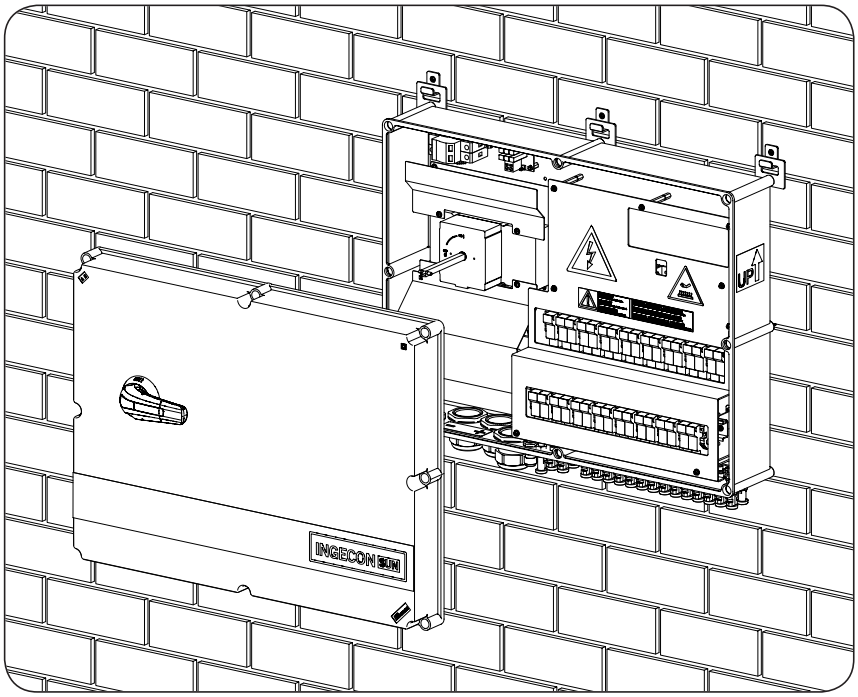
1. Ground connection.
2. Connection of the communication accessories.
3. DC connection.
4. AC connection.

It is mandatory to follow the order described above. Do not switch on the power until you have made all the connections and the unit is closed.

7.3. Opening the housing

Loosen the front screws to open the housing cover.

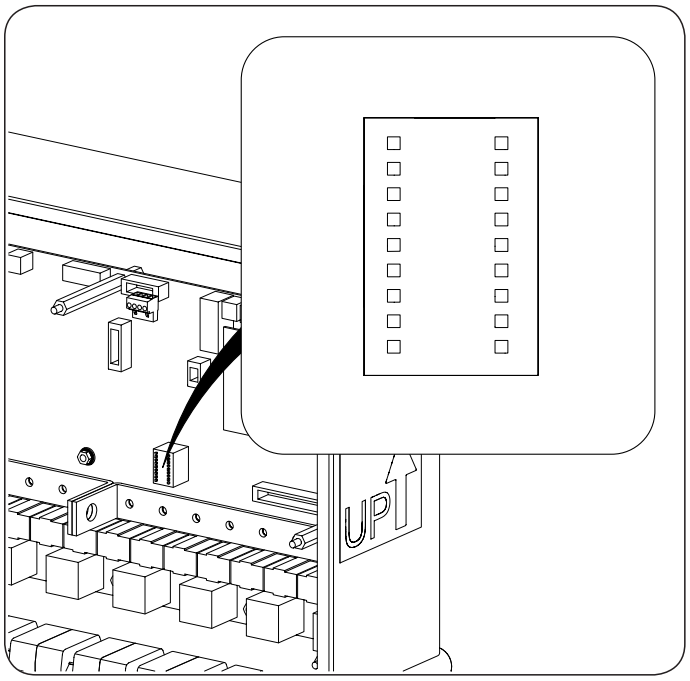




8. Node number allocation

Before starting the process of connecting the INGECON SUN String Control, the node number must be allocated. This number **can never match the node number of the inverter**.

The connection is made using switch 1 (SW 1). It consists of a switch with 8 channels with which the numbering of the node will be set up (see *"7.2. Attaching the unit to the wall"*).



Node number configuration switch

There should never be nodes with the same number (either inverters or other INGECON SUN String Controls) within the same communication bus.

The INGECON SUN String Control unit must be configured using the INGECON SUN Manager software.

The most important settings parameters are:

- Number of strings installed: the number of strings connected to your unit. The strings must be connected to the lowest-numbered connectors (from left to right). The number of strings is 16 by default.
- Rated current of each string: Insert in this field the nominal value of the current of each string in amps. This is set to 10 A by default.
- Average Percentage deviation: the percentage of deviation between the current of each string and the average of the currents of the unit for which we want an alarm to trigger.
- Time before alarm: the time that the string must provide a current above the percentage of average deviation before the unit triggers an alarm. It is defined in seconds.
- Light detection: a function that can be enabled or disabled. When this feature is enabled, in the event that light is detected inside your unit (e.g. an incorrectly closed cover) the system triggers an alarm and closes a potential-free relay.
- Send stop-command data: a function that can be enabled or disabled. If both this function and the *light detection* function are enabled, a request to stop is generated through communication for the inverter associated with the INGECON SUN String Control, when light is detected inside the unit.
- Inverter node associated with the INGECON SUN String Control: the inverter communication node to which the INGECON SUN String Control is connected. The default value is zero, thus when light is detected in the interior of the box, a stop command is sent to all the inverters connected to the communication network.

9. Ground connection

This chapter explains the requirements and process for connecting the ground wiring to the unit.

Read carefully before starting the connection process.

To ensure the safety of persons, the unit must be connected to the ground of the installation.

9.1. Safety instructions for connecting to ground

See section *"3. Safety"* and the section on security in this section before you operate on the unit.

Make sure there is no voltage present on the unit before carrying out any connections. Once the inverter is switched off, wait at least 10 minutes until internal capabilities are fully discharged.

Ingeteam accepts no liability for any damages caused by incorrect connection.

Failing to apply the correct tightening torques to the connection terminals causes a risk of overheating and fire.

In order to keep the nuts and bolts of the unit in good condition it is important to make sure there is no dirt or wood chips in the threads when screwing them in and apply a suitable lubricant.

After connecting the ground wiring, **do not switch on the power** until you have made all other connections and the unit has been closed.

Use the Personal Protective Equipment specified in the section *"3.2. Personal Protective Equipment (PPE)"*.

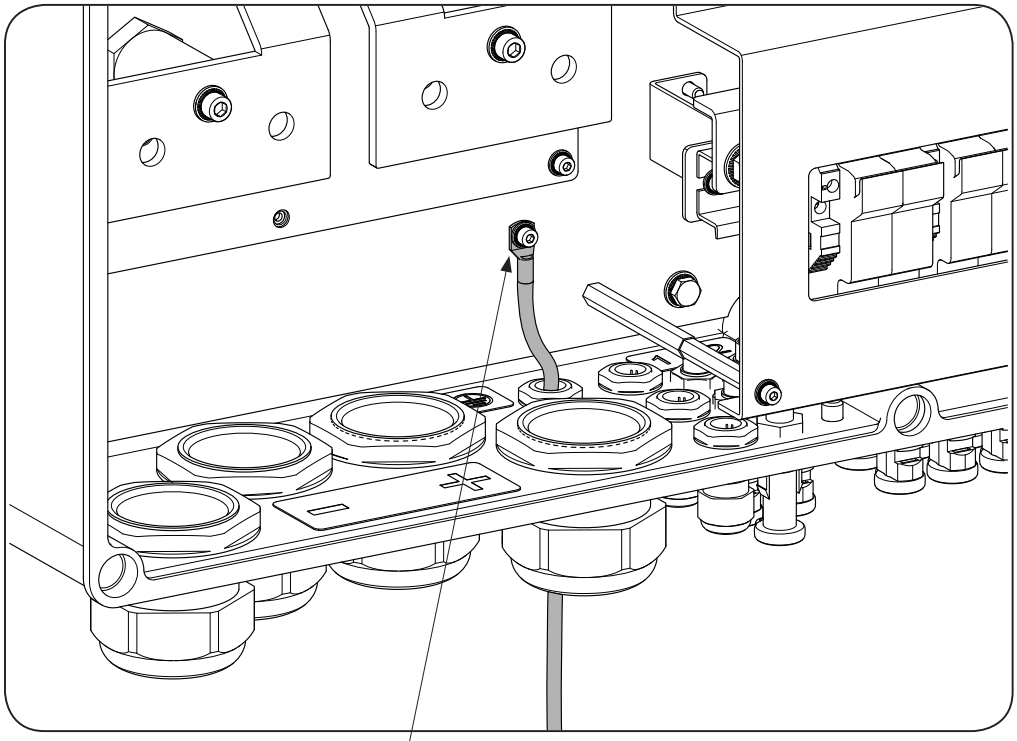
9.2. Wiring requirements for the ground connection

The dimensioning of the wiring for the ground connection is the responsibility of the installer.

9.3. Ground connection process

1. Strip the wire according to the measurement of the terminal used.
2. Crimp the terminal at the cable.
3. Clean the contact surfaces, both of the terminal and at the connection point, with a clean cloth and ethanol.
4. Insert the cable through the packing gland.

5. Connect the terminal to the ground connection point using the screws (pre-lubricated) and washers and observing the tightening torque.



Ground connection

6. Make sure that the cable and the terminal are properly connected.
7. Close the packing gland, leaving a margin of excess in the wiring for accidental pulling.

10. Connecting the communication accessories

This chapter explains the process for wiring the communications accessories to the unit.

There are several ways to achieve this communication with these units.

- RS-485.
- Ethernet TCP.
- GSM/GPRS.

See the corresponding communications accessories manual for further information.

Read carefully before starting the connection process.

10.1. Safety instructions for connecting the communications accessories

See section *"3. Safety"* and the section on security in this section before you operate on the unit.

Make sure there is no voltage present on the unit before carrying out any connections. Once the inverter is switched off, wait at least 10 minutes until internal capabilities are fully discharged.

Ingeteam accepts no liability for any damages caused by incorrect connection.

In order to keep the nuts and bolts of the unit in good condition it is important to make sure there is no dirt or wood chips in the threads when screwing them in and apply a suitable lubricant.

After connecting the ground wiring, **do not switch on the power** until you have made all other connections and the unit has been closed.

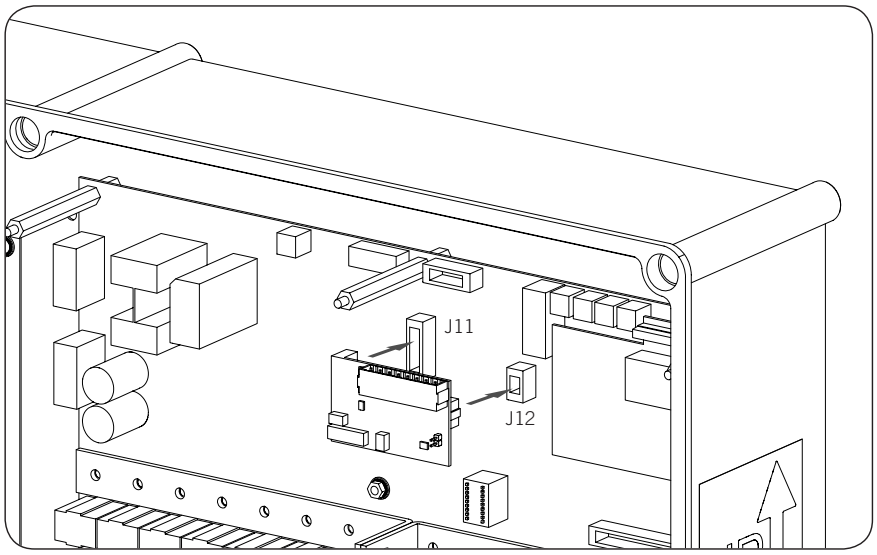
Use the Personal Protective Equipment specified in the section *"3.2. Personal Protective Equipment (PPE)"*.

10.2. Communication via RS-485

In order to connect the communications card using RS-485, observe the following instructions.

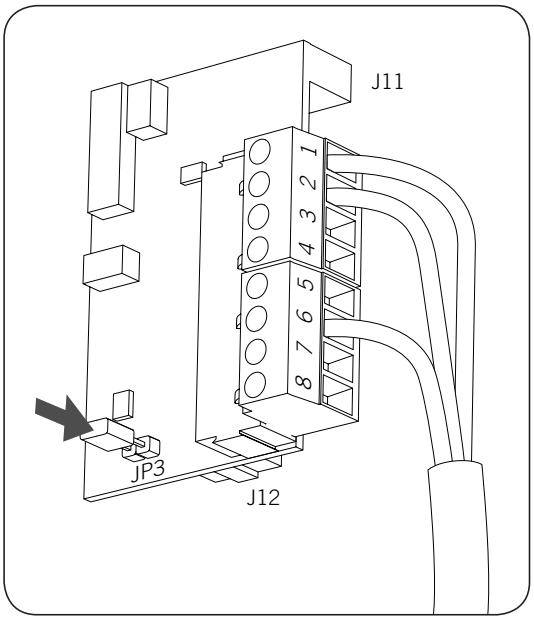
1. Insert the communications cabling through ducts provided at the bottom of the unit (see section *"2.7. Description of cable inlets"*).

2. Fit the communications card to connectors J11 and J12 of the control card as shown in the figure below.



3. Connect the communications cabling to the card following the indicated polarities, and also inserting the jumper JP3 (see the figure below).

Pin	Signal
1	RS-485 B (+)
2	RS-485A (-)
6	GND

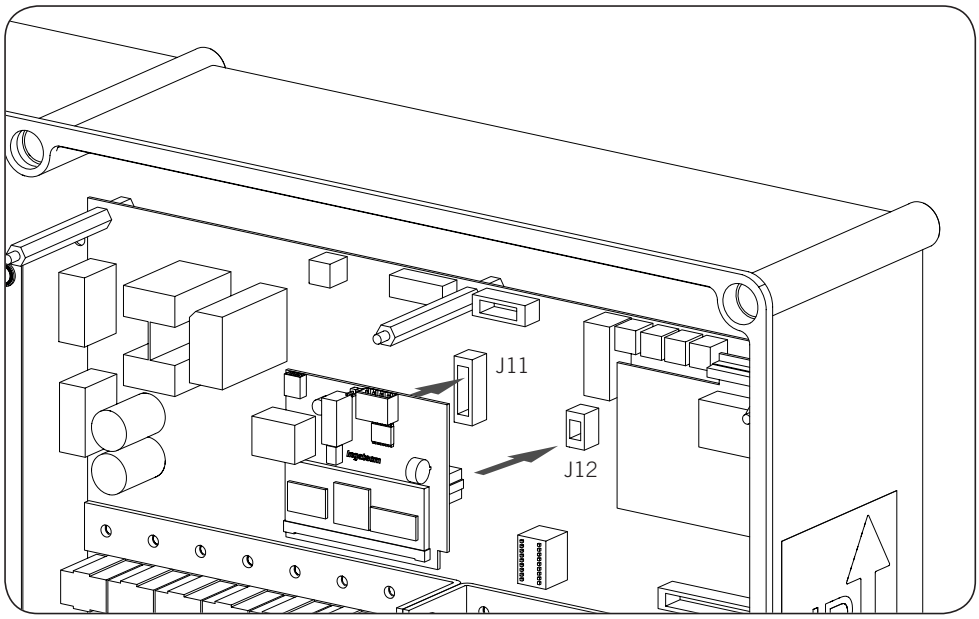


10.3. Communication via Ethernet TCP

In order to connect the communications card using Ethernet TCP, observe the following instructions.

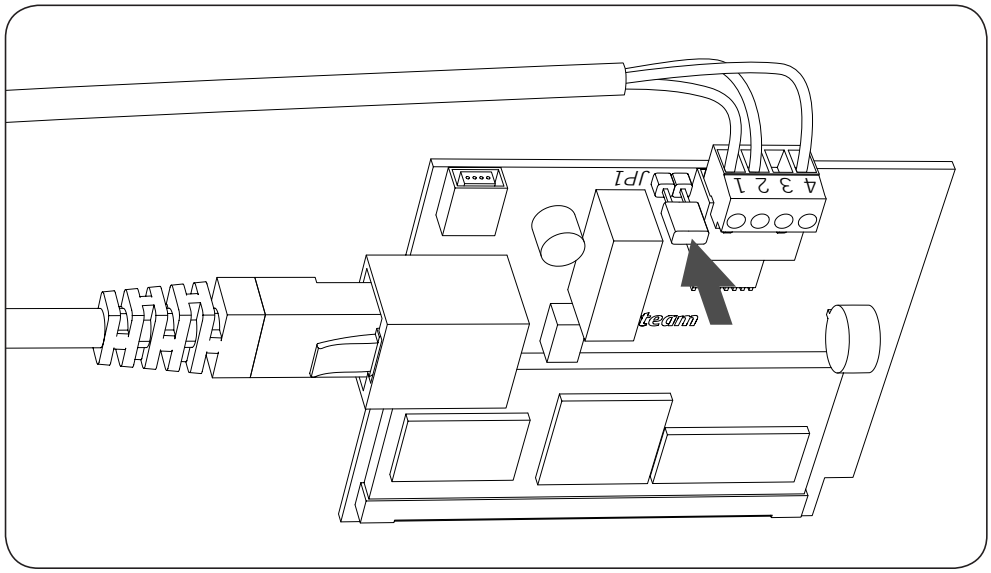
1. Insert the communications cabling through ducts provided at the bottom of the unit (see section *"2.7. Description of cable inlets"*).

2. Fit the communications card to connectors J11 and J12 of the control card as shown in the figures below.



3. Connect the Ethernet cabling to the communications card. Additionally, if you want to communicate via RS-485, connect the wiring for this purpose (see figure below).

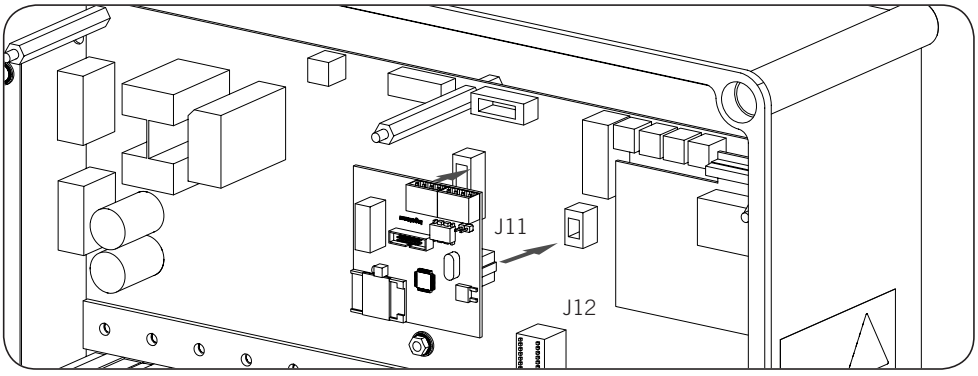
Pin	Signal
1	RS-485 B (+)
2	RS-485A (-)
4	GND



10.4. Communication via GSM/GPRS

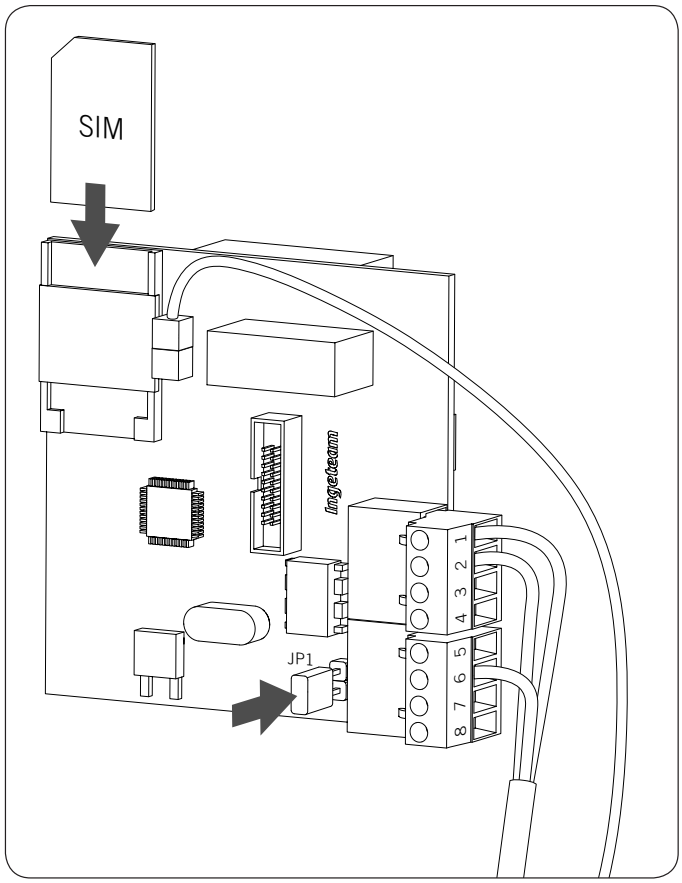
1. Insert the communications cabling through ducts provided at the bottom of the unit (see section *"2.7. Description of cable inlets"*).

2. Fit the communications card to connectors J11 and J12 of the control card as shown in the figure below.



3. Connect the antenna to the communications card. Additionally, if you want to communicate via RS-485, connect the wiring for this purpose (see figure below).

Pin	Signal
1	RS-485 B (+)
2	RS-485A (-)
6	GND

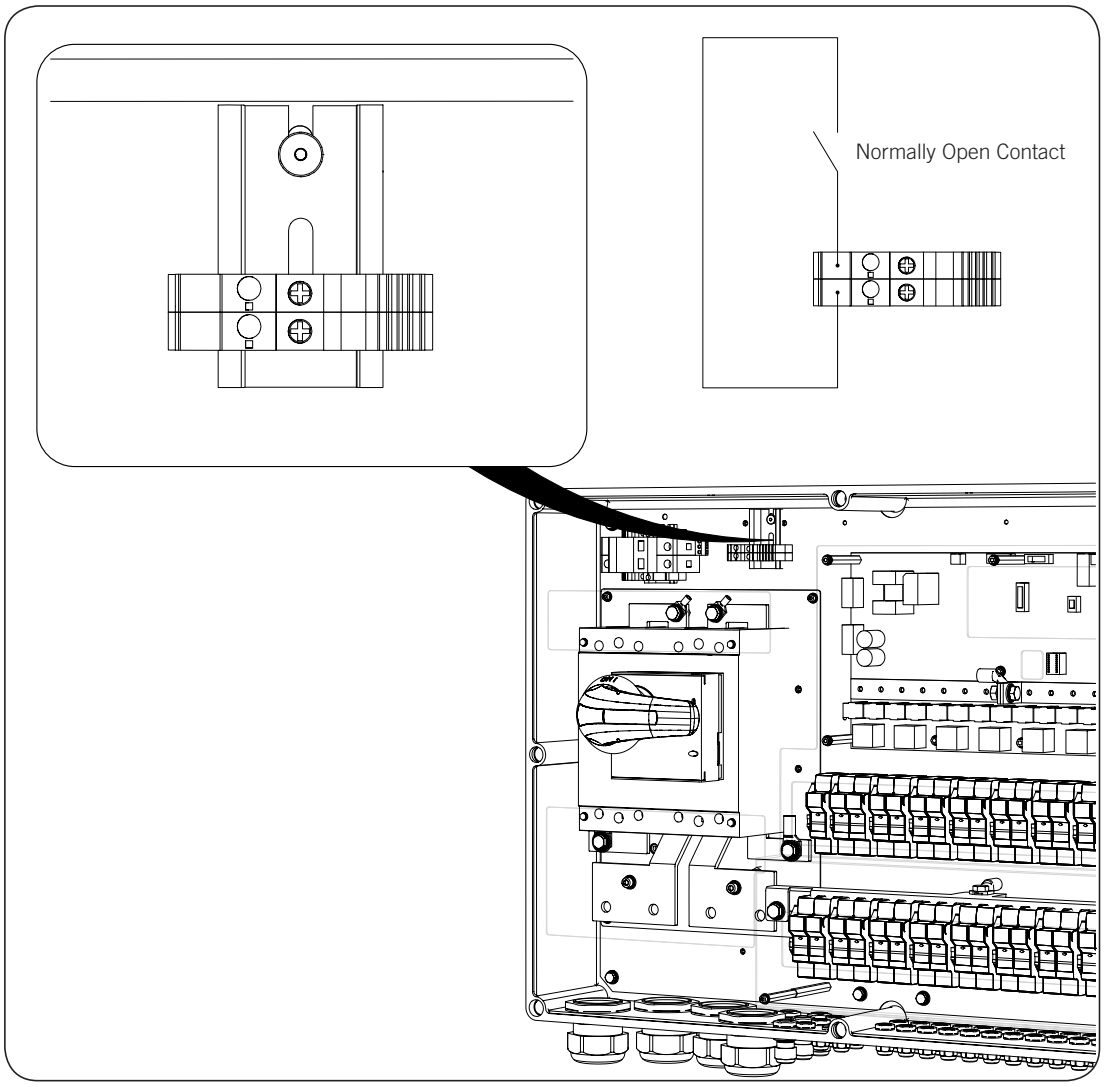


11. Connecting the communication-assisted trip of the isolating switch (optional)

As explained previously, optionally, these units can have an isolating switch or isolating switch with a communication-assisted trip.

To activate the coil that opens the isolator switch, make the connection shown in the following figure. The Normally Open contact must withstand 220//240 VAC.

Before you connect the wiring, set the isolator switch to OFF and, subsequently, open all the fuse holders.



The isolator switch must be reset manually.

12. Connecting the inverter

This chapter explains the requirements and process for connecting the inverter wiring to the unit.

Read carefully before starting the connection process.

12.1. Safety instructions for connecting the inverter

See section *"3. Safety"* and the section on security in this section before you operate on the unit.

Make sure there is no voltage present on the unit before carrying out any connections. Once the inverter is switched off, wait at least 10 minutes until internal capabilities are fully discharged.

When connecting the INGECON SUN String Control to the inverter, the PV array must be disconnected and the inverter isolator switch open.

Ingeteam accepts no liability for any damages caused by incorrect connection.

Failing to apply the correct tightening torques to the connection terminals causes a risk of overheating and fire.

In order to keep the nuts and bolts of the unit in good condition it is important to make sure there is no dirt or wood chips in the threads when screwing them in and apply a suitable lubricant.

After connecting the ground wiring, **do not switch on the power** until you have made all other connections and the unit has been closed.

Use the Personal Protective Equipment specified in the section *"3.2. Personal Protective Equipment (PPE)"*.

12.2. Wiring requirements for connecting the inverter

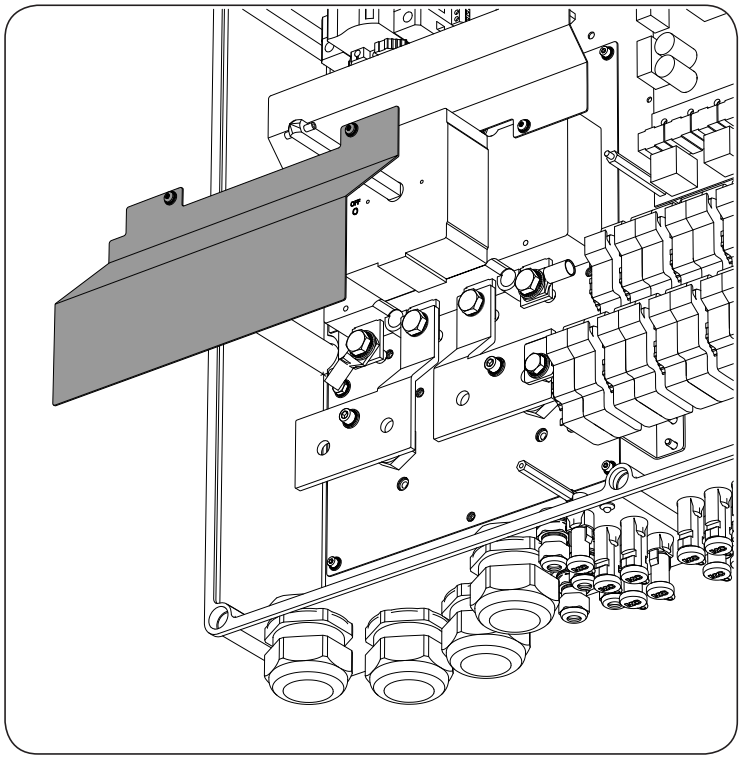
- Tinned copper compression terminals must be used for the inverter connection.
- Only copper or aluminium cable shall be used.
- The cables for the DC connection must withstand at least 1000 V between poles and between each pole and ground.

	INGECON SUN STRING CONTROL
Permitted wiring diameter	17 ~ 35 mm
Permitted wiring cross-section	240 ~ 300 mm^2
Terminal tightening torque	39 Nm

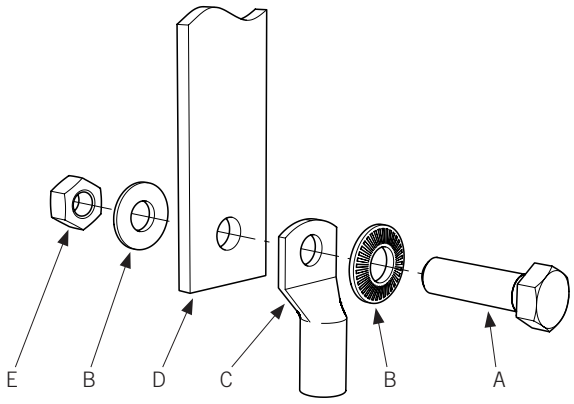
12.3. Inverter connection process

The terminals can be the threaded or cage-clamp type, depending on the model.

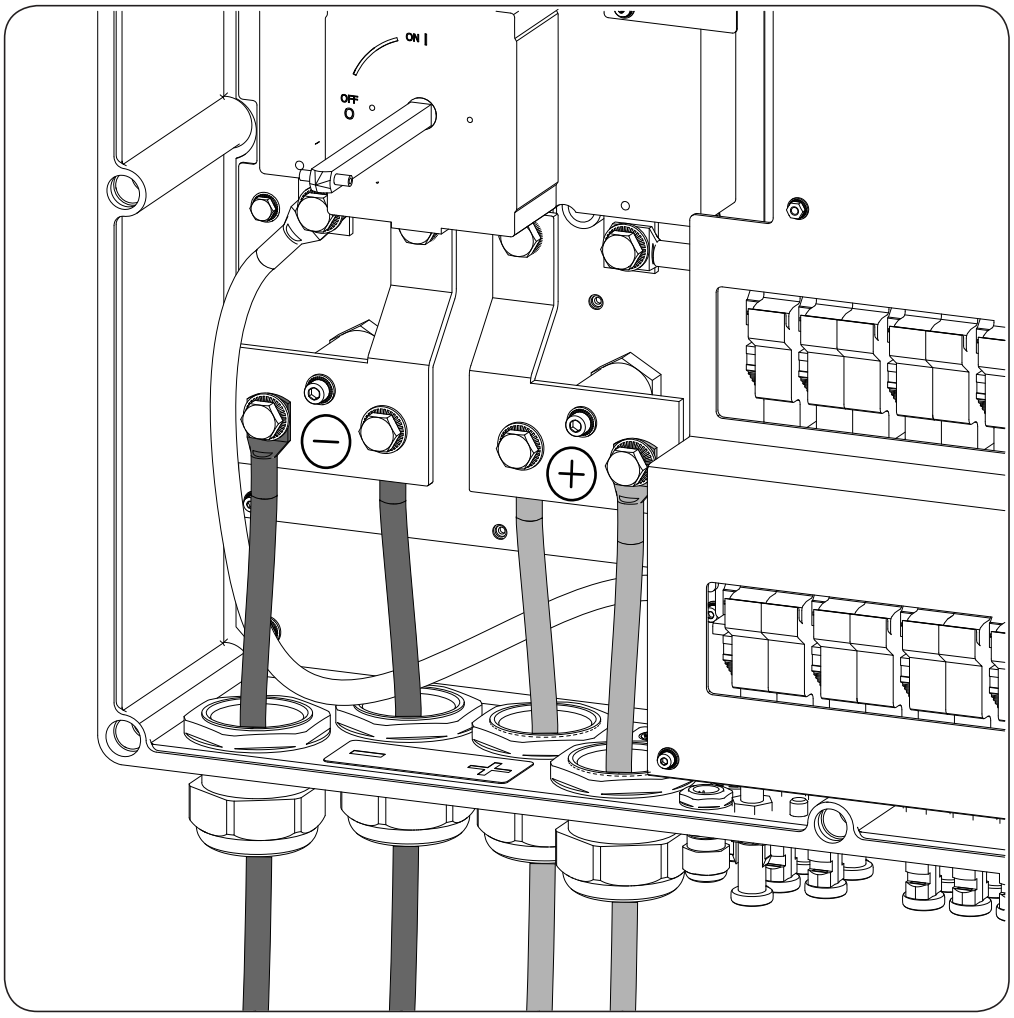
1. Remove the protective sheet of polycarbonate.



2. Insert the wiring through the packing glands for this connection.
3. Strip the wire according to the measurement of the terminal used.
4. Crimp the terminal at the cable.
5. Clean the contact surfaces, both of the terminal and at the connection bar, with a clean cloth and ethanol.
6. Connect the terminal to the connecting plate using the bolts (pre-lubricated) and washers supplied by Ingeteam on delivery of the unit, while respecting the indicated torque and polarities.



A. M10 hex cap screw.
B. M10 washer.
C. Terminal.
D. Connection plate.
E. M10 nut.



6. Tighten the packing glands to avoid loss of the protection rating. Check that the connection is tight.
7. Reinstall the protective sheet of polycarbonate.

13. Connecting the PV array

This chapter explains the requirements and process for DC wiring from the PV array to the unit.

Read carefully before starting the connection process.

13.1. Safety instructions for connecting the PV array

See section *"3. Safety"* and the section on security in this section before you operate on the unit.

Make sure there is no voltage present on the unit before carrying out any connections. Once the inverter is switched off, wait at least 10 minutes until internal capabilities are fully discharged.

Ingeteam accepts no liability for any damages caused by incorrect connection.

After connecting the ground wiring, **do not switch on the power** until you have made all other connections and the unit has been closed.

Use the Personal Protective Equipment specified in the section *"3.2. Personal Protective Equipment (PPE)"*.

13.2. Wiring requirements for connecting the PV array

- Only copper or aluminium cable shall be used.
- The cables for the DC connection must withstand at least 1000 V between poles and between each pole and ground.

	INGECON SUN STRING CONTROL
Permitted wiring diameter	3 ~ 9 mm
Permitted wiring cross-section	4 ~ 6 mm^2

13.3. Reverse connection of the PV array

Reverse connection of the PV array would have fatal consequences on the INGECON SUN String Control and could cause serious damage to persons close to the unit.

Reverse connection of a string of the PV array generates a short circuit, which causes a surge in the inversely connected string. The fuse associated with this string will clear the short circuit. The voltage that the fuse must open is double the open circuit voltage, as the string is connected in reverse.

Always check the polarity of PV arrays before making any connections.

Special attention should be paid in the first installation of the different strings of the PV array in the INGECON SUN String Control (diagram 1) and of the different INGECON SUN String Controls in the inverter (diagram 2).

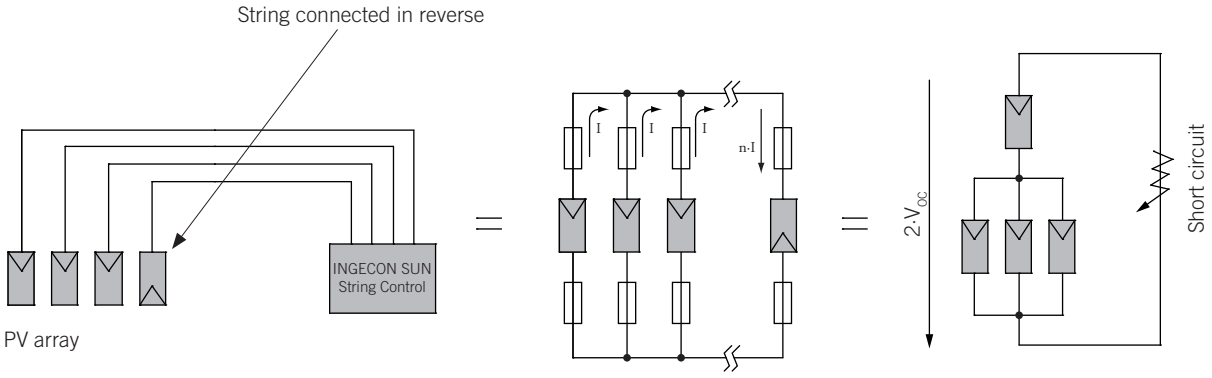


Diagram 1

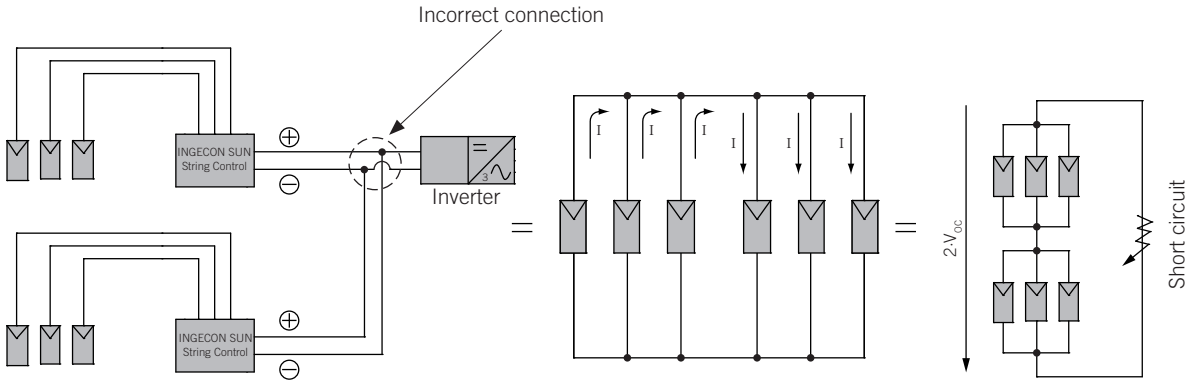
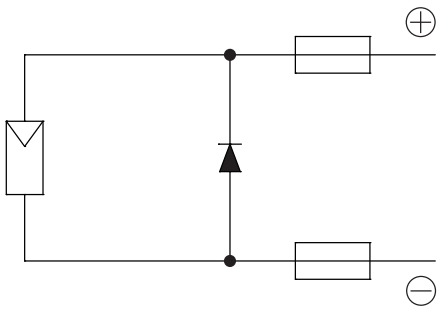


Diagram 2

In order to avoid surge problems that are generated when a string is connected in reverse, Ingeteam implements a patented system. When you connect a string in reverse, a protection diode ensures that the voltage within the box is within the safety margins.

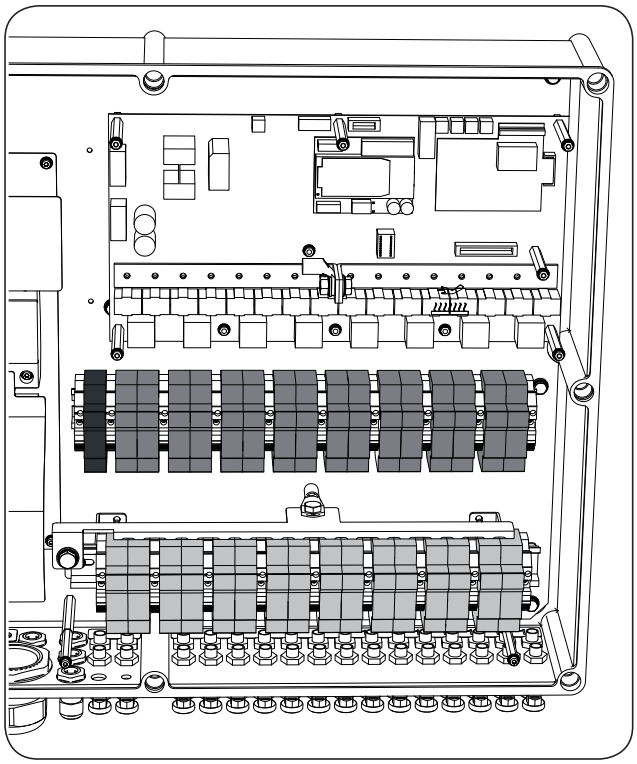


If the string is polarised in reverse the diode conducts the current generated by the string, short circuiting it. When installing the strings in the box, **all the fuse holders must be open, with the fuses uninstalled**. Each string must be joined one by one and checked with a multimeter to ensure that it has the open circuit voltage and if possible to measure the current flowing through it. If a current is present or if the voltage differs greatly from the open circuit voltage, safely disconnect the string from the INGECON SUN String Control.

This unit withstands a maximum of two strings connected in reverse. More than two strings attached in reverse will destroy the unit.

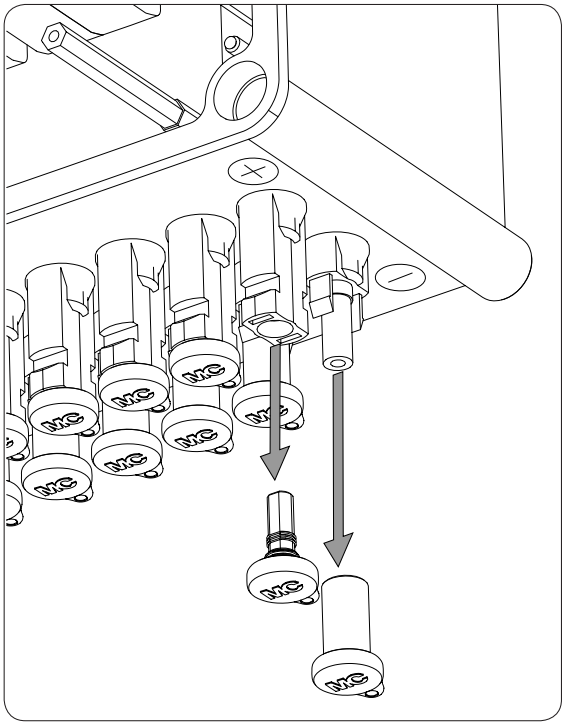
13.4. PV array connection process

1. Open all the fuse holders of the positive and negative poles and uninstall the fuses, keeping the fuse that protects electronics installed.

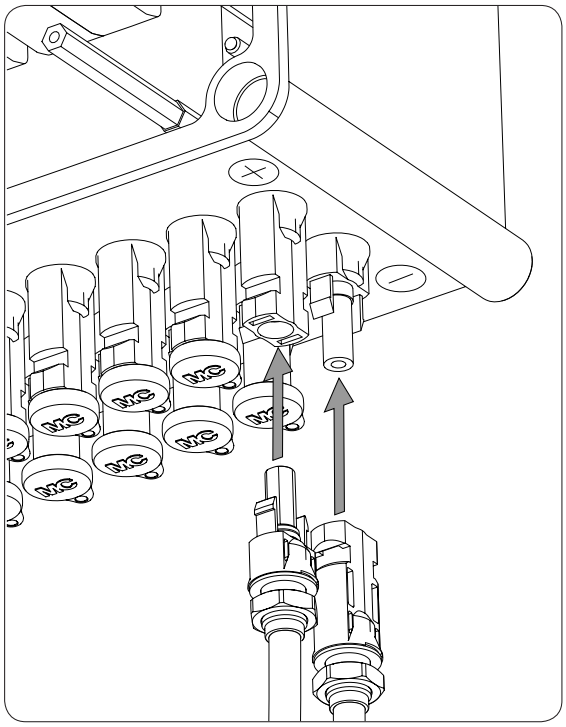


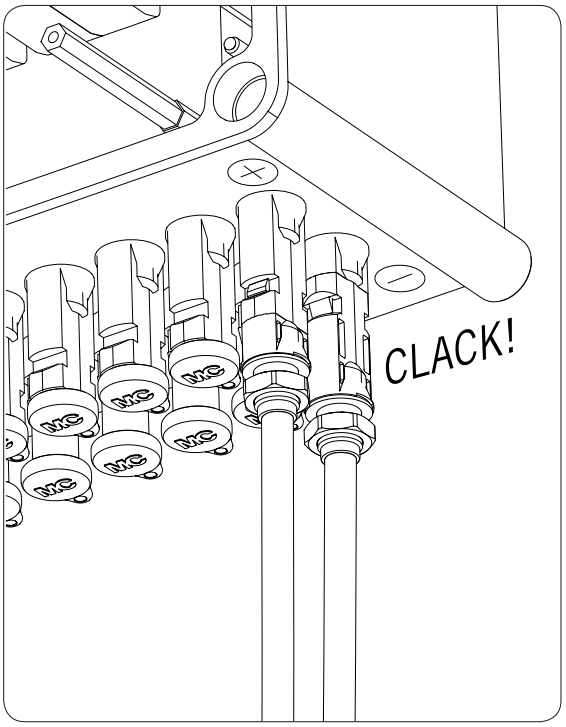
- Electronics Fuse
- Negative pole fuses
- Positive pole fuses

2. Remove the safety plugs from the connectors to be used. Do not remove the plugs from the connectors that will not be used.

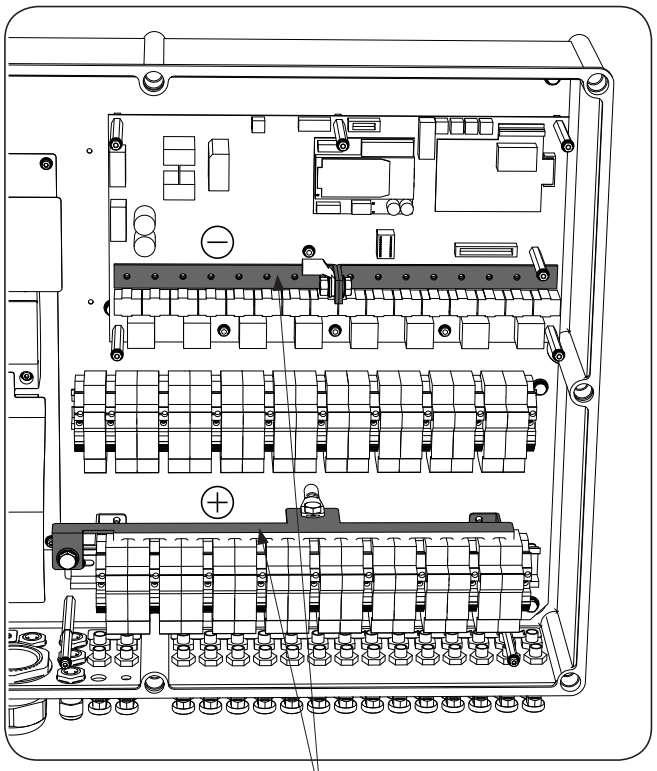


3. Insert the connectors with the fuse holders open. The safety tab must be correctly inserted to avoid involuntary disconnections.





4. Before connecting any more strings, use a multimeter suitable for measuring the VOC of the PV array to measure the voltage between the fuse holder inputs and check the polarity of the voltage ensuring its value is correct (according to the PV array connected).



Check points

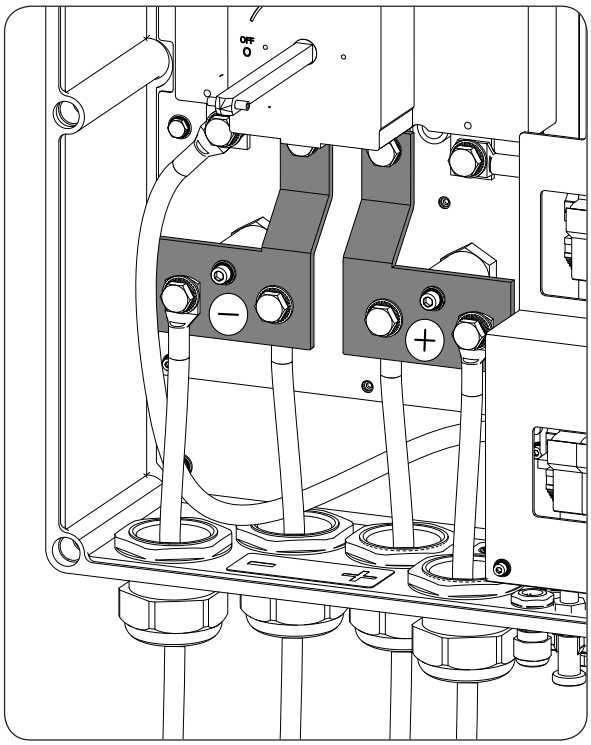
If the expected VOC shows, connect the next string.

If the voltage is close to zero, check that the string has been installed with the correct polarity, safely opening the string.

If an unexpected voltage shows, check the installation.

5. Repeat steps 3 and 4 for all the strings connected to the INGECON SUN String Control.
6. Do not insert the fuses or close the fuse holder.
7. Repeat points 3, 4, 5 and 6 for all the INGECON SUN String Controls connected to the same inverter.

8. Insert a pair of fuses, positive and negative, in an INGECON SUN String Control. Close the fuse holder that corresponds to these fuses, and the isolator switch if present. There will be voltage in the inverter connection wiring. Check the polarity in the positive and negative plates connected to the inverter in the rest of the INGECON SUN String Control to prevent reverse connections between boxes.



Inverter connection plates

9. If the polarity is correct, repeat point 8 for each pair of fuses.
10. Close all the boxes and set the switches to on if it is equipped with this option.

14. Starting up

This chapter details the process for starting up the unit.

14.1. Equipment inspection

The correct condition of the installation must be checked before start-up.

Each installation is different, depending on its characteristics, the country in which it is located or other special conditions which may apply. In all cases, before starting up, it is necessary to ensure that the installation complies with the applicable legislation and regulations and that at least the part to be started up is complete.

14.1.1. Inspection

Before inverter start-up, a general inspection of the units must be carried out involving mainly:

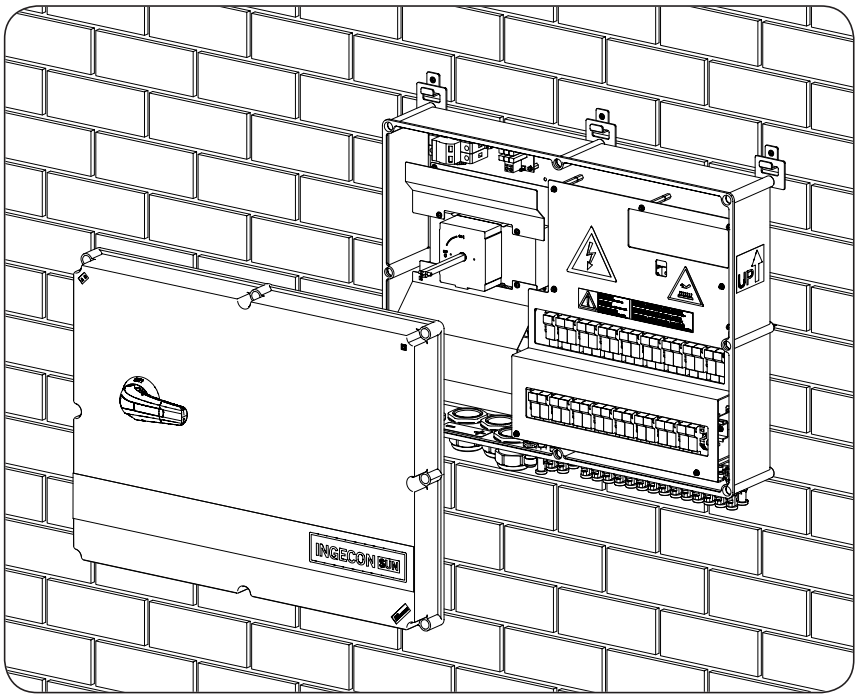
Wiring check

- Make sure that the cables are correctly connected to the connection terminals.
- Check that these cables are in a good condition and that there are no hazards in their environment which damage them, such as sources of intense heat, objects which could cut them or arrangements which put them at risk of impacts or pulling.

Check that the unit is properly secured

Check that the unit is secured firmly and is not at risk of falling.

14.1.2. Hermetic sealing of the unit



14.2. Start-up

The box of strings can only be started up after all the connections indicated in the preceding paragraphs are made and it is perfectly closed.

14.2.1. Electrical contact with the inverter and the PV array

Make the electrical connections following the instructions in the respective sections on connecting to the inverter and the PV array.

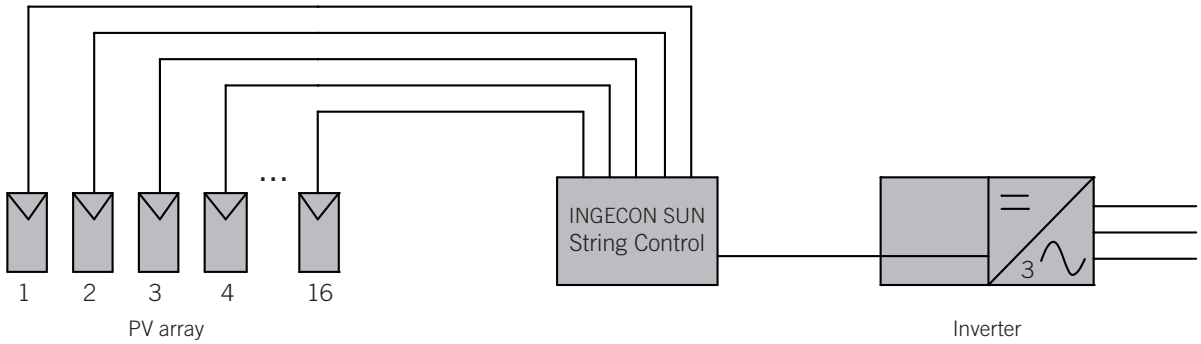
15. Shutting down the unit

This section describes the procedure to shut down the unit. If you wish to work inside the unit, these instructions must be carried out in the order shown here to remove the power.

15.1. Shutting down the unit

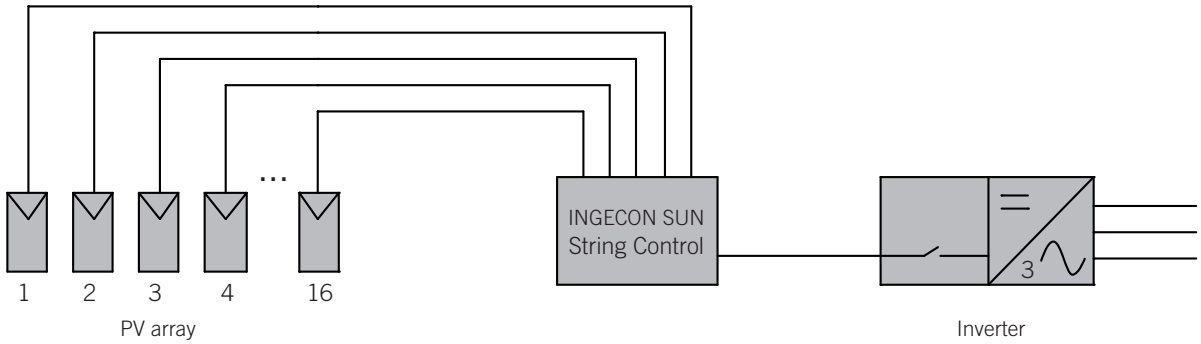
15.1.1. Inverter with one INGECON SUN String Control unit

The normal operation diagram is as follows:

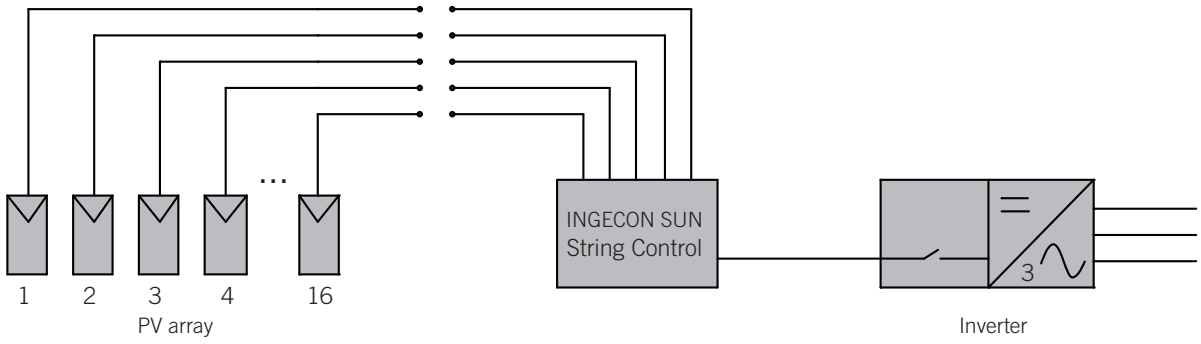


Follow these steps to shut down the unit:

1. Stop the inverter (using emergency push-button or manual stop) and open its DC and AC isolating switch.



2. Disconnect the PV array.

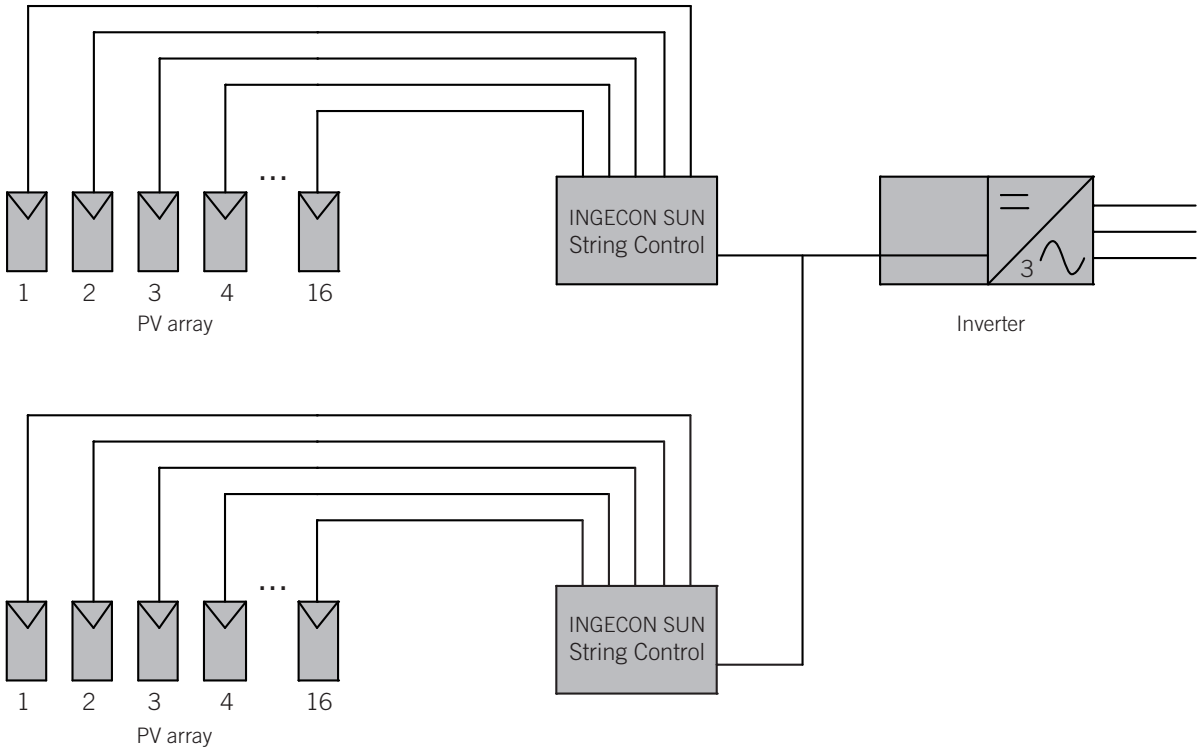


3. INGECON SUN String Control with no voltage. Disconnect the whole PV array associated with the unit.

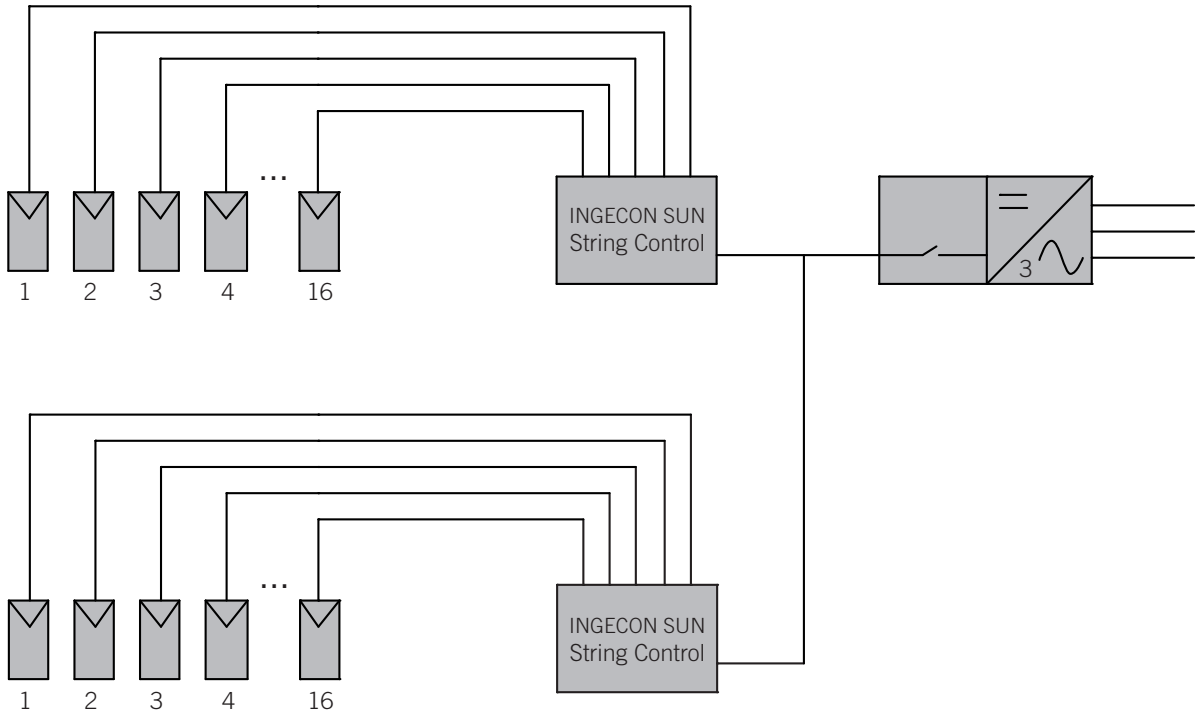
15.1.2. Inverter with more than one INGECON SUN String Control unit

The following example shows shutdown with two INGECON SUN String Control units. In the event that there are more than two INGECON SUN String Control units, the shutdown process is the same, carrying out the operations described below for each unit.

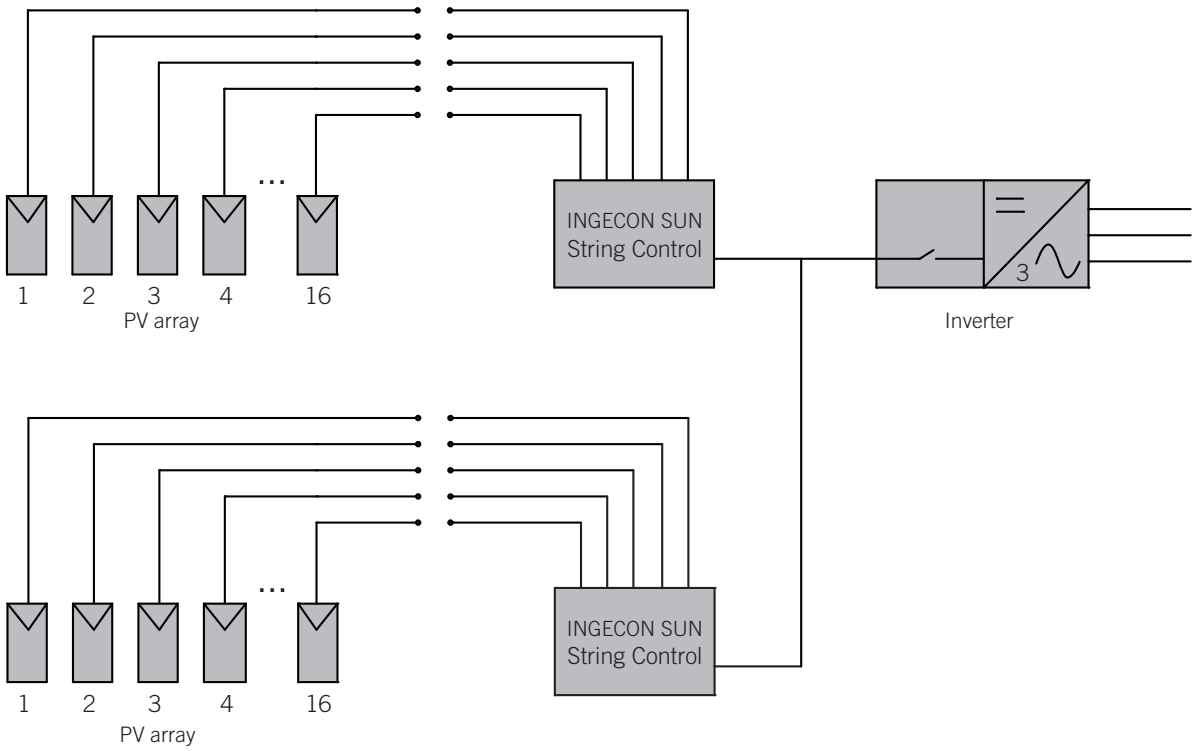
The normal operation diagram is as follows:



1. Stop the inverter (using emergency push-button or manual stop) and open its DC and AC isolating switch.



2. Disconnect the PV array of all of the boxes.



3. INGECON SUN String Control units with no voltage. Disconnect the whole PV array associated with the unit.

15.2. Uninstalling the unit

In the event that it is necessary to uninstall the unit in order to be sent to the factory or for other reasons, the instructions in section *"7.2. Attaching the unit to the wall"* must be followed in reverse order.

16. Preventive maintenance

The recommended preventive maintenance tasks must be carried out at least ANNUALLY, except where otherwise stated.

16.1. Safety conditions

Before opening the unit, you must remove the power (see Section *"15. Shutting down the unit"*).

The set of conditions listed below should be considered as minimum requirements.

An open housing never implies an absence of voltage in the unit, so only qualified personnel may access the unit, following the safe operation guidelines stipulated in this document.

Ingeteam accepts no liability for any damages caused by improper use of the equipment. Any work carried out on any equipment which implies a modification of the original electrical arrangements must be proposed in advance to Ingeteam. These must be studied and approved by Ingeteam.

All the maintenance checks included here must be carried out with the machine stopped, under safe conditions for handling, including those specified by the client for these types of operation.

When carrying out maintenance work on the unit, the Personal Protective Equipment specified in Section *"3.2. Personal Protective Equipment (PPE)"* of this document must be worn.

After completing the maintenance task, replace the front cover and secure it with the bolts supplied.

16.2. Status of the housing

A visual check of the condition of the housing must be carried out, confirming the condition of the seals and the covers, as well as the fixing of the units to their anchor points. In addition, the condition of the housing must be checked for dents or scratches that might degrade the housing or cause it to lose its protection classification. If these types of defect are noticed, the affected parts must be repaired or replaced.

Check that there is no moisture inside the housing. If moisture exists, dry it before making electrical connections.

Check the correct fixing of the housing components to their corresponding anchoring points.

16.3. Status of cables and terminals

- Check the correct path of the cables so they do not come into contact with live parts.
- Check the insulation deficiencies and hot spots by checking the colour of the insulation and terminals.
- Check that the connections are properly adjusted.

17. Troubleshooting

This is a help guide for problems that might arise when installing the INGECON SUN String Control.

Troubleshooting for the INGECON SUN String Control must be performed by qualified personnel in compliance with the general safety instructions in this manual.

INGECON SUN String Control does not communicate.

Communication failures in the INGECON SUN String Control can occur for different reasons. Check that:

- The wiring of the communication has been carried out properly.
- The communication node is correctly configured.
- Two or more devices with the same communication node are not present in the network.
- The communication card is correctly configured.
- The type of communication is the correct Modbus RTU 8 Bits with no parity, 1 start bit and 1 stop bit.
- The unit is correctly powered, and check if the protection fuse of the source is not blown.

Light alarm

If a light alarm shows on the INGECON SUN String Control, the installation must be reviewed to ensure its correct assembly. The box must be installed in a vertical position, with the connectors at the bottom.

Check that the cover is correctly closed, with the seals anchored into position.

Check the cable entry. They must all enter through the packing glands, and these must be properly closed to prevent the entry of water and light.

INGECON SUN String Control damaged in the diode area

If the strings are installed incorrectly, as shown in point *"13.3. Reverse connection of the PV array"* there is a risk of damage. The diodes bear a transient current in order to avoid hazardous electrical arcs. After installing the strings, a check must always be made to ensure no current circulates through the diodes.

Water entry

If water is detected in the INGECON SUN String Control enclosure in the maintenance work, it must be dried. The enclosure must be checked to determine the point of access of water, and then it must be sealed.

Battery alarm

If the battery alarm triggers in the INGECON SUN String Control, it is recommended to change the battery. The battery model is CR2032.

The emergence of the alarm does not mean that the unit data will be lost.

17.1. Relationship of alarms and reasons for stoppage

The reasons for stoppage are set out in the following tables, which can be related to each alarm:

General alarms

This variable indicates the general alarms of the string box.

Code	Alarm	Description
0x0001	Anomalous current alarm	Anomalous current in a string
0x0002	Alarm for arresters	Alarm in arresters
0x0004	Fuse alarm	Blown fuses
0x0010	PCB Temperature alarm	High PCB temperature
0x0040	Light detection alarm	IP protection loss
0x0080	Alarm battery low	RTC battery low
0x1000	Manual stop	Manual stop

18. Waste handling

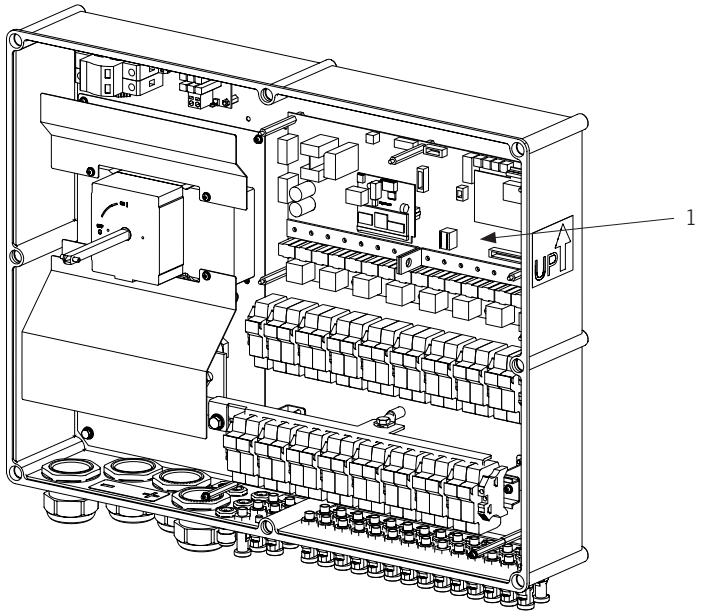
During the various processes for installation, start-up and maintenance, waste is generated which must be handled appropriately according to the regulations in the corresponding country.

At the end of the unit's life, the waste must be processed by an authorised waste management company.

Ingeteam, in accordance with its policy of respect for the environment, will inform the authorised manager, via this Section, of the location of components to be decontaminated.

The elements within the unit that must be handled individually are:

1. Printed circuit board cards.



Annex A: Encoding for Strings

The following pages show the encoding to use to designate the different possible node numbers.

Node no.	8	7	6	5	4	3	2	1
1	Off	Off	Off	Off	Off	Off	Off	On
2	Off	Off	Off	Off	Off	Off	On	Off
3	Off	Off	Off	Off	Off	Off	On	On
4	Off	Off	Off	Off	Off	On	Off	Off
5	Off	Off	Off	Off	Off	On	Off	On
6	Off	Off	Off	Off	Off	On	On	Off
7	Off	Off	Off	Off	Off	On	On	On
8	Off	Off	Off	Off	On	Off	Off	Off
9	Off	Off	Off	Off	On	Off	Off	On
10	Off	Off	Off	Off	On	Off	On	Off
11	Off	Off	Off	Off	On	Off	On	On
12	Off	Off	Off	Off	On	On	Off	Off
13	Off	Off	Off	Off	On	On	Off	On
14	Off	Off	Off	Off	On	On	On	Off
15	Off	Off	Off	Off	On	On	On	On
16	Off	Off	Off	On	Off	Off	Off	Off
17	Off	Off	Off	On	Off	Off	Off	On
18	Off	Off	Off	On	Off	Off	On	Off
19	Off	Off	Off	On	Off	Off	On	On
20	Off	Off	Off	On	Off	On	Off	Off
21	Off	Off	Off	On	Off	On	Off	On
22	Off	Off	Off	On	Off	On	On	Off
23	Off	Off	Off	On	Off	On	On	On
24	Off	Off	Off	On	On	Off	Off	Off
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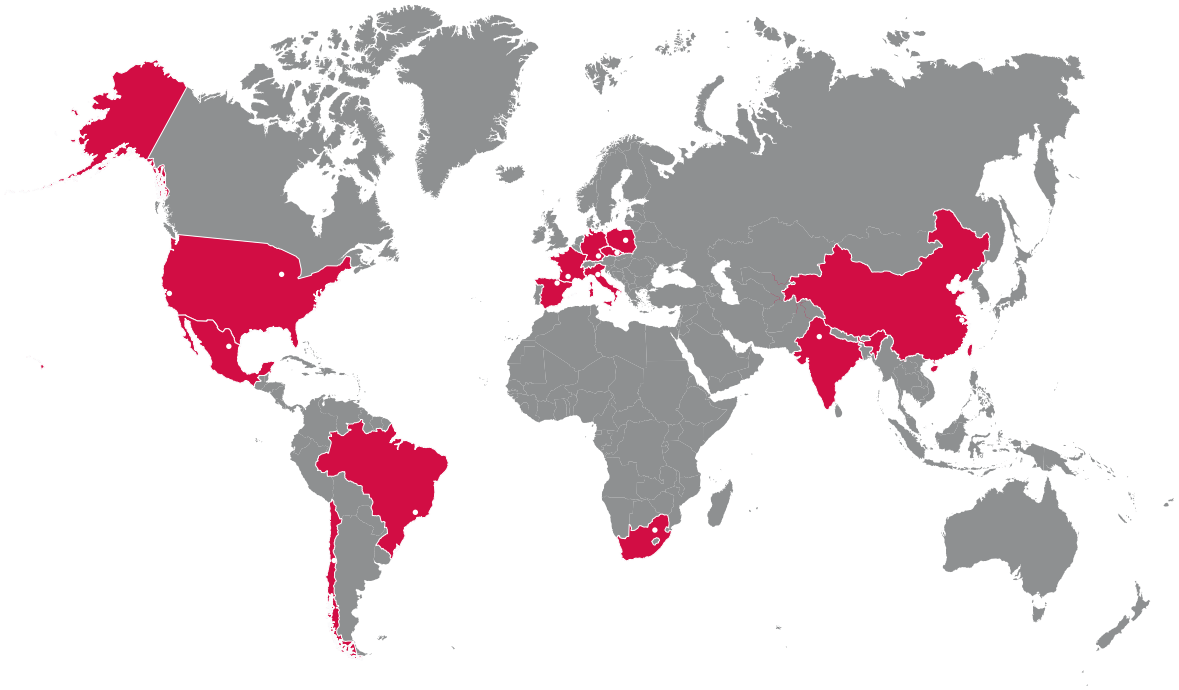

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