



INGECON SUN PowerMax

TL U B 1500 Vdc

Installation and Operation Manual

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This document may be changed.

Important safety instructions

This section describes the safety warnings and the personal protective equipment and symbols used in the unit.

Safety conditions

General warnings

DANGER

Opening the enclosure does not imply there is no voltage inside.

The risk of electric shock exists even after disconnecting from the grid, the PV array and the auxiliary supply.

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

It is strictly forbidden to gain access to the inside of the electrical panel through any other point than the access cover provided for this purpose. Always gain access when the unit is voltage-free.

CAUTION

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 fall to 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 familiarizing 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.

You must consider the set of conditions listed throughout this document as minimum requirements. It is always preferable to shut off the main power supply. There may be faults in the installation that cause the unwanted return of voltage. Danger of electric shock.

According to basic safety standards, the complete unit 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.

Category IV - 1500-Volt measuring instruments must be used for checking for the absence of voltage.

INFO

These instructions must be easily accessible close to the unit and located within reach of all users.

Before installation and start-up, please read these safety instructions and warnings carefully as well as all the warning notices located on the unit. Ensure that all the warnings signs are perfectly legible and that those which are damaged or have disappeared are restored.

Protection against direct contact is by means of the enclosure.

The unit has been tested according to the applicable regulations to comply with the safety requirements, the values for insulation clearances and leakage paths for the voltages used.

Potential hazards for people

DANGER

Electric shock.

The equipment may remain charged after disconnecting the PV array, grid power and auxiliary power.

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

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.

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.

High temperature.

The flow of outlet air can reach high temperatures which can cause injury to anybody exposed to it.

Potential hazards for the equipment

DANGER

Cooling.

The unit requires particle-free 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.

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.

Personal Protective Equipment

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

Name	Explanation
Safety footwear	In compliance with standard <i>ASTM F2413-05</i>
Helmet with face shield	In compliance with standard <i>ANSI/ISEA Z89.1-2009</i> , wherever there are directly accessible live parts
Working clothes	Close-fitting, non-flammable, 100% cotton
Dielectric gloves	In compliance with standard <i>ANSI/ISEA 105-2011</i>
Hearing protection device	In compliance with standard <i>ANSI S12.6-1997</i>
Anti-impact glasses	Use of anti-impact glasses when accessing the fan area.

Tools and / or equipment used in live work must have at least class IV-1500 Volts insulation.

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

Symbols on the units

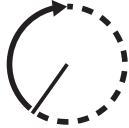
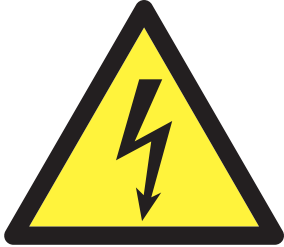
Ø 1	Connection from cable and phase 1 terminal.
Ø 2	Connection from cable and phase 2 terminal.
Ø 3	Connection from cable and phase 3 terminal.
	DC outlet.
	AC outlet.
	Ground terminal.
	Grounded points.
	ON
	OFF



**DANGER**

POTENTIAL RISK OF ARC FLASH

RISQUE D'ARC ÉLECTRIQUE

 DANGER		
 	RISK OF ELECTRIC SHOCK FROM ENERGY STORED IN CAPACITOR. Do not remove cover until 10 minutes after disconnecting all sources of supply.	RISQUE DE CHOC ÉLECTRIQUE DÙ À L'ÉNERGIE STOCKÉE DANS LE CONDENSATEUR Après avoir déconnecté toutes les sources d'alimentation, attendre 10 minutes avant de retirer la protection
 WARNING		
	RISK OF ELECTRIC SHOCK FROM ENERGY STORED IN CAPACITOR.	RISQUE DE CHOC ÉLECTRIQUE D'ENERGIE STOKEE DANS LE CONDENSATEUR
	RISK OF ELECTRIC SHOCK DO NOT REMOVE COVER.	RISQUE DE CHOC ÉLECTRIQUE NE PAS OUVRIR LE CAPOT
	No user serviceable parts inside. Refer servicing to qualified service personnel.	Cette unité ne contient pas de composants susceptibles d'être réparés par l'utilisateur. Confiez les travaux de service technique à du personnel qualifié.
	POWER FED FROM MORE THAN ONE SOURCE	PUISSANCE PROVENANT DE PLUSIEURS SOURCES
	RISK OF ELECTRIC SHOCK. Normally grounded conductors may be ungrounded and energized when a ground-fault is indicated	RISQUE DE CHOC ÉLECTRIQUE Conducteurs normalement mis à la terre, ils peuvent être encore sous tension lors d'un retrait de la mise à la terre en cas de défaut à la terre.

 DANGER	
HAZARDOUS VOLTAGE Contact may cause electric shock or burn. When the photovoltaic array is exposed to light, it supplies a DC voltage to this equipment.	TENSION DANGEREUSE Tout contact peut provoquer un choc électrique ou des brûlures. Lorsque le champ photovoltaïque est exposé à l'irradiation solaire, il génère une tension DC dans cet appareil.
 WARNING	
FOR CONTINUED PROTECTION AGAINST RISK OF FIRE Replace only with same type and ratings of fuse.	POUR RESTER PROTEGÉ CONTRE LE RISQUE D'INCENDIE Remplacer uniquement avec le même type et classe de fusible.

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1. About this manual

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

You can download the latest version of this Manual from the website www.ingeteam.com.

1.1. Scope of application

This manual is applicable to the following units:

Complete name	Abbreviation
INGECON SUN 1640TL U B630	1640TL U B630
INGECON SUN 1665TL U B640	1665TL U B640
INGECON SUN 1690TL U B650	1690TL U B650
INGECON SUN 1715TL U B660	1715TL U B660
INGECON SUN 1740TL U B670	1740TL U B670
INGECON SUN 1800TL U B690	1800TL U B690

Other variants of this family are possible.

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 fall to 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 familiarizing them with the contents of this manual.

1.3. Nomenclature

This document will refer to the various models of inverter of the INGECON SUN PowerMax B family by both their full name and their abbreviation. They will also be referred to generically as *inverter* or *unit*.

The lengths indicated in this manual, except unless indicated, appear in millimeters.

1.4. Warnings

Throughout this manual we include warnings to highlight certain information. Relative to the nature of the text, there are three types of warnings:



This indicates a hazard to personnel or the inverter.



Indicates importance.



Additional information or references to other parts of the document or documents.

2. Unit description

2.1. Overview

An inverter is an electronic unit used to convert direct current to alternating current. The function of these units is to convert the direct current generated by PV solar panels to alternating current and so enable it to be fed to the electricity grid.

i INFO

These units are designed to be used in an enclosed electric area.

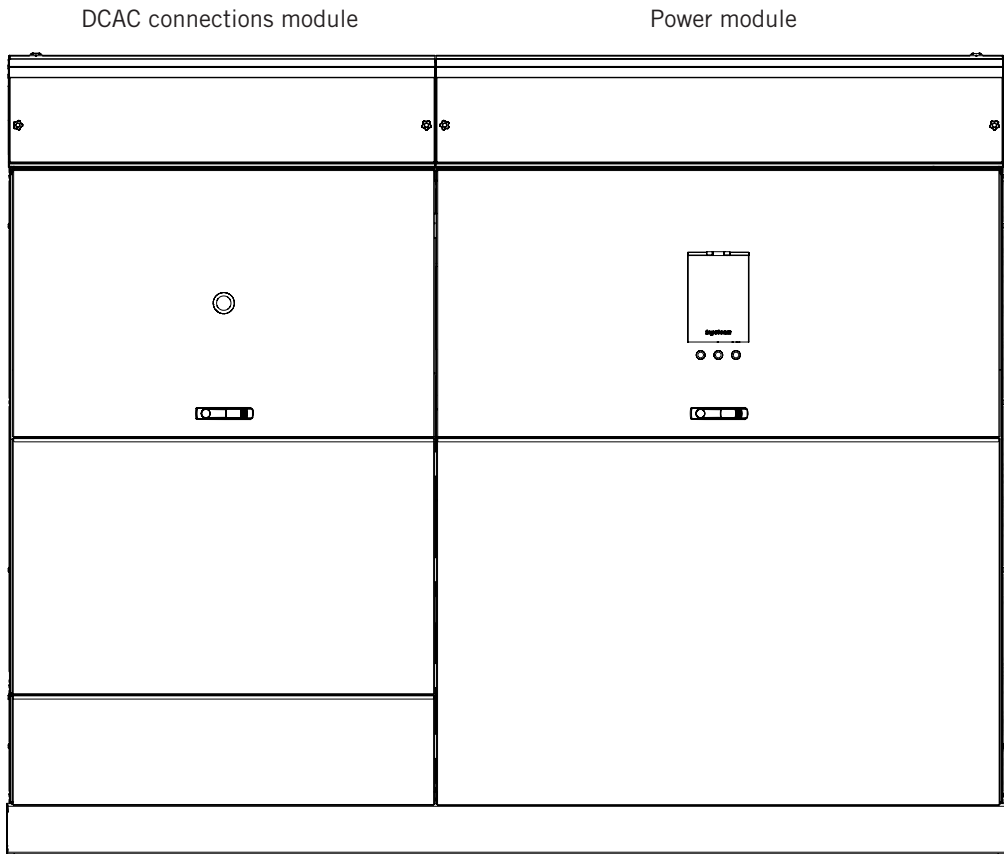
2.2. Electrical characteristics of the unit

The units in this manual have been designed in accordance to standards *UL 1741SA, Rule 21 & Rule 14-H*. They particularly respond to the following characteristics:

- They are designed to follow at least *Overcurrent Category 2* in the continuous current cycle and *Overcurrent Category 3* in the alternating current cycle.
- This is a *Class I* protection device.
- The power factor range is 0 ± 1 .
- The maximum start-up current is 350 A and with a duration of 8 ms.
- The maximum admissible DC short circuit current is 2700 A.

2.3. Structure of the unit

These units feature a DCAC connections module and a power module.



2.4. Available optional kits

These units can incorporate the following optional, by order, kits:

- DC fuses
- DC type I + II natural surge arrester
- Monitoring of DC input currents
- Ground connection of the PV array
- Low temperature operating kit
- Reactive power regulation with no PV array power (night reactive)
- Auxiliary services
- PV array depolarizer
- Integrated DC combiner box
- Sand trap
- Bottom cover
- Ancillary services feeder
- Communications accessories

DC fuses

Depending on the inverter's configuration, this may come with between six and fifteen fuses in the positive pole or both poles.

DC type I + II natural surge arrester

The equipment has DC type II natural surge arresters. Optionally type I + II surge arresters can be equipped for greater protection against natural surges.

Monitoring of DC input currents

The DC input currents monitoring kit is offered as an option. The aim of this kit is to monitor each of the equipment's input strings. This device implements the following functions:

- Detection of anomalous currents by string or by fault.
- Detection of blown PV input fuses.
- Data storage.

Monitoring of this item can be accessed through the unit's communications.

Ground connection of the PV array

This kit enables the grounding of the negative pole of the PV array, depending on the technology of the panels used or the applicable standard. The ground connection of the PV array is made via a 5 A fuse in accordance to the standard UL1741.

Low temperature operating kit

In places where the inverter may be subject to temperatures lower than -4 °F (-20 °C) the low temperature operating kit is required.

This kit allows the installation of units in minimum ambient temperatures of -22 °F (-30 °C).

Reactive power regulation with no PV array power (night reactive)

This kit is for installations in which the applicable standard requires the injection of reactive nocturnal power or when there is no power in the PV array.

Ancillary services

In order for the unit to operate, they require a 230 Vac 50/60 Hz single-phase auxiliary power supply, which must be supplied by the installer.

The function of this kit is to generate the necessary power supply for the inverter's auxiliary services to operate, thus avoiding the need to externally power the unit.

This kit is made up of a transformer with the suitable transformation for each of the INGECON SUN PowerMax B model families.

The maximum consumption is 4250 W (25 A).

PV array depolarizer

The polarization of the photovoltaic panels may become degraded (*Potential Induced Degradation, PID*). Ingeteam offers an optional PV array depolarizer that induces the necessary voltage to revert these effects.

⚠ DANGER

When the PV array generates low voltage (nighttime or other situations) this kit generates a voltage of 500 Vdc between the negative pole of the PV panel and ground. Take into account this feature for the different tasks that are to be carried out on the inverter.

To prevent the kit from generating voltage, the emergency stop button must be interlocked.

Communication accessories

There is various technology to communicate between units. For further information consult Section "12. Connection of the communication accessories".

Integrated DC combiner box

Its purpose is to disconnect the PV array before the DC fuses. This solution is completely integrated in the DCAC connections module.

Sand trap

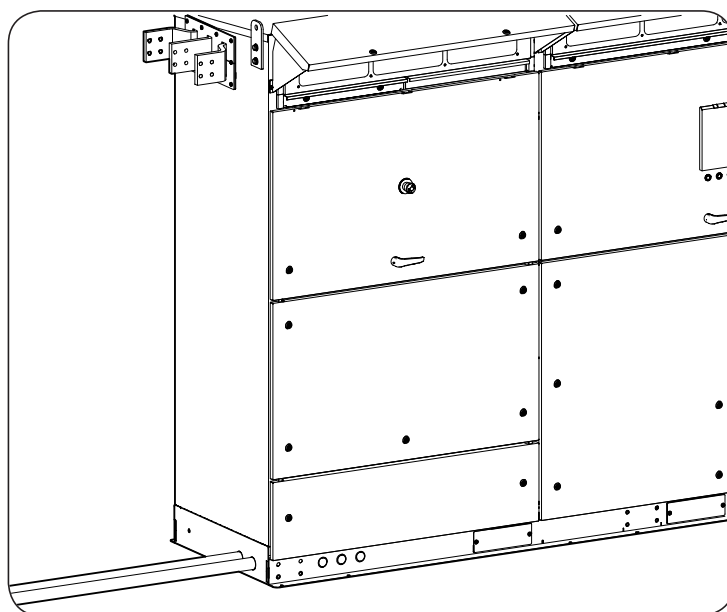
For locations where environmental and terrain conditions require additional protection against sand entering through the ventilation system.

This kit consists of a sand trap system in the front ventilation grilles.

Bottom cover

The bottom cover is a system designed to separate the DC supply from the ancillary and communication cable entry. The ancillary and communication cables are inserted in the unit through the lower side hole in the inverter.

A 48 mm conduit must be connected.

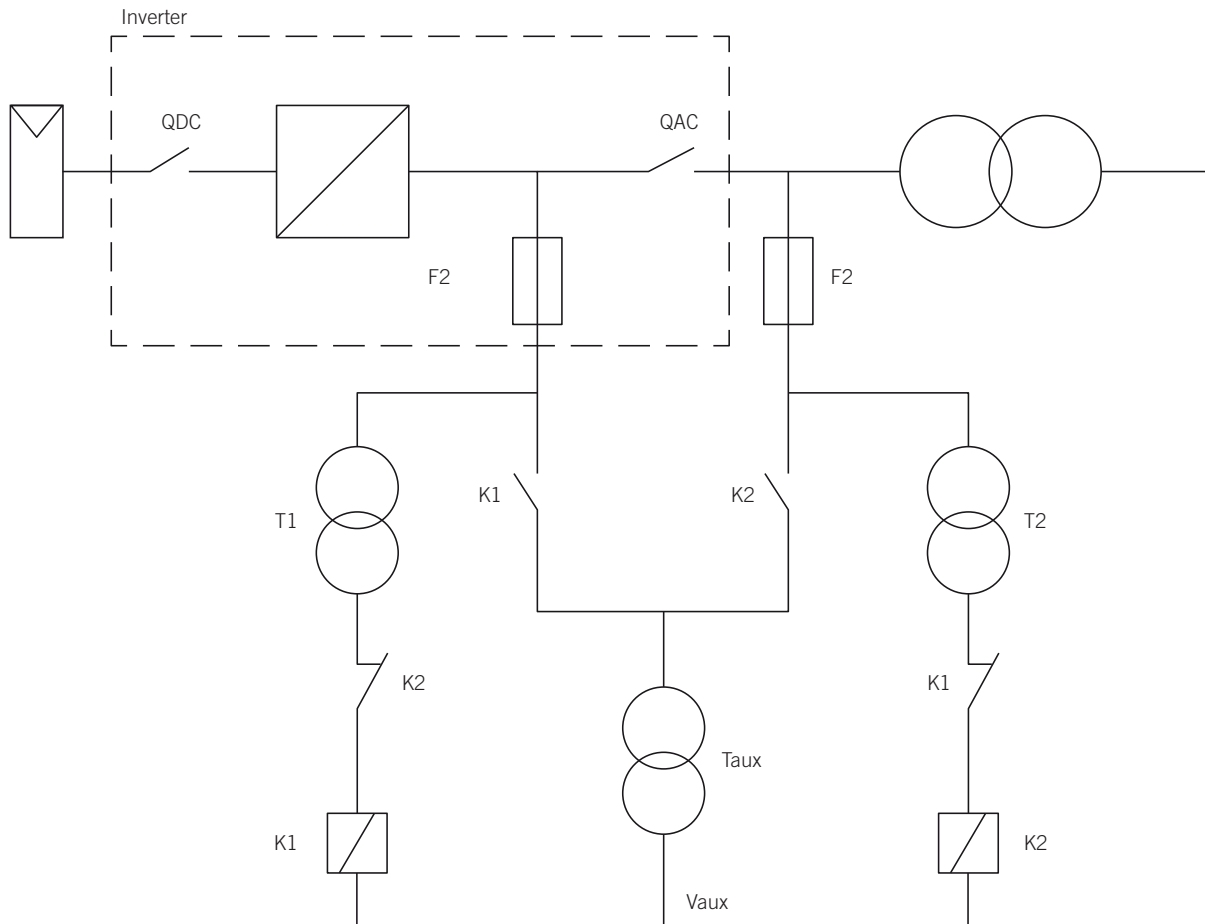


Lower conduits for ancillary and communication cables.

Ancillary services feeder

In the event of absence of plant grid power, this kit allows to supply the Low Voltage system, so that the inverter will supply the ancillary services as long as there is voltage in the photovoltaic panels and the inverter firmware has been configured for this.

An example of the use of this kit is to supply the photovoltaic panel trackers in order to place them in safety position.



Ancillary services feeder kit diagram

2.5. Options

The standard units provide the ability to set various standard options. The installer can decide to use them or not depending on the requirements of each installation.

i INFO

For more information about the connections see section “14. Connection options”.

2.5.1. Monitoring components external to the unit

This option allows you, via a connection terminal on the equipment, to supervise the proper performance of its external elements.

This monitoring is carried out using normally closed voltage-free contacts. Should one of the contacts be open (due to a fault in the monitored item) the inverter will generate an alarm and shut down.

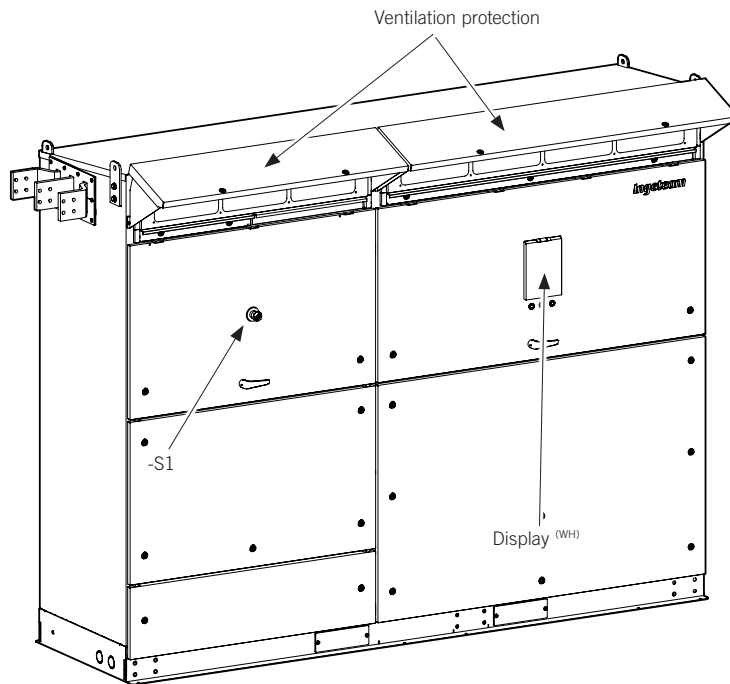
2.5.2. Remote control for DC switch and AC thermomagnetic circuit breaker

It enables remote manual stop (opening) of the DC switch and the AC thermomagnetic circuit breaker via a normally closed voltage-free contact. When the contact is opened it changes the unit's status to manual stop and remotely trips the DC switch and the AC thermomagnetic circuit breaker.

Closing a normally closed contact closes the DC switch and starts up the unit.

2.6. Location of components

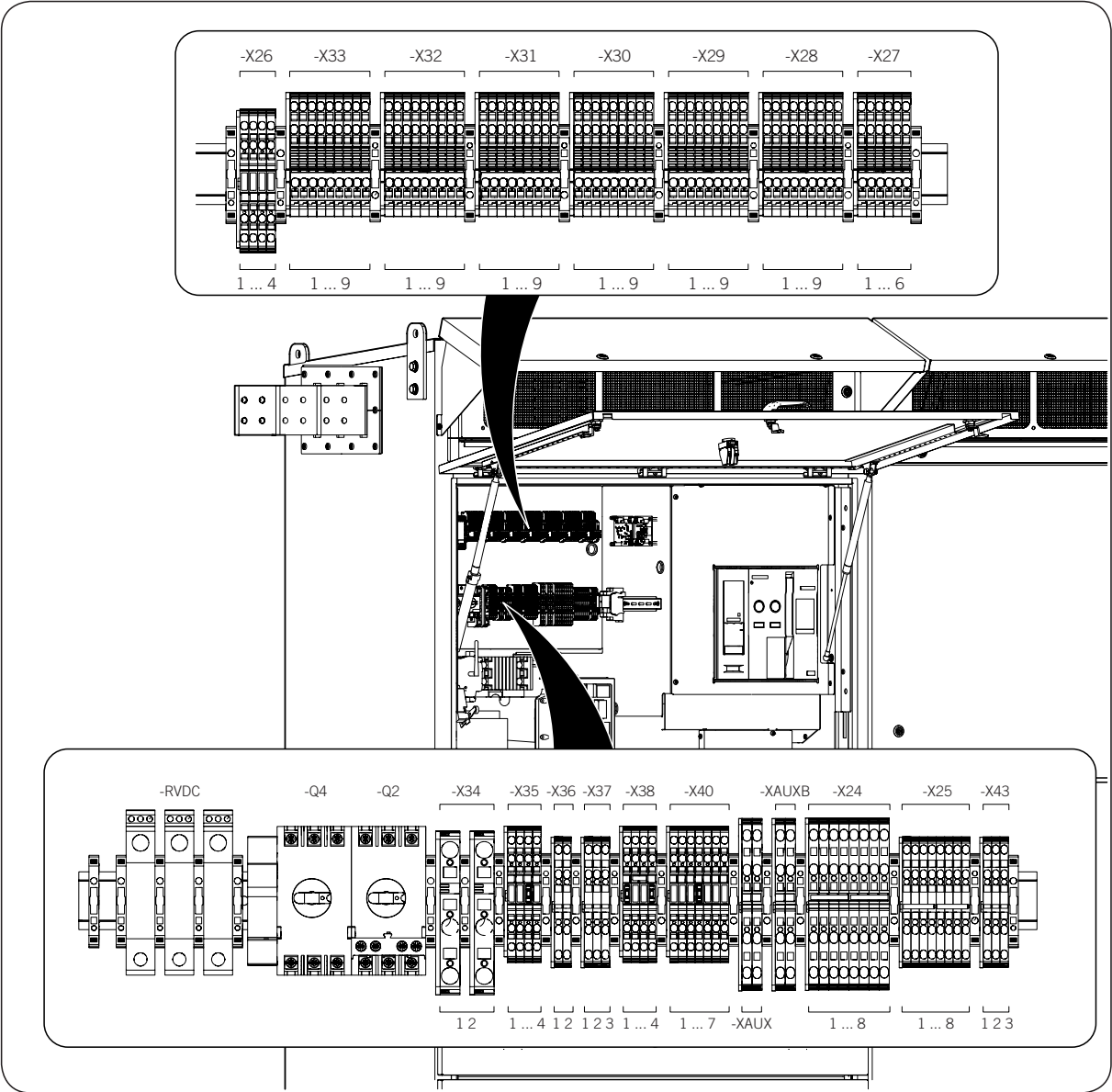
This section graphically describes the location of the main components of the unit. Throughout the document reference is made to this section repeatedly in order to facilitate the location of these elements.



Component	Description	Component	Description
-S1	Emergency push-button	Display ^(WH)	Display for interacting with the inverter
Circuit breaker access	AC thermomagnetic switch access	Ventilation protection	Ventilation system protection for extreme weather conditions

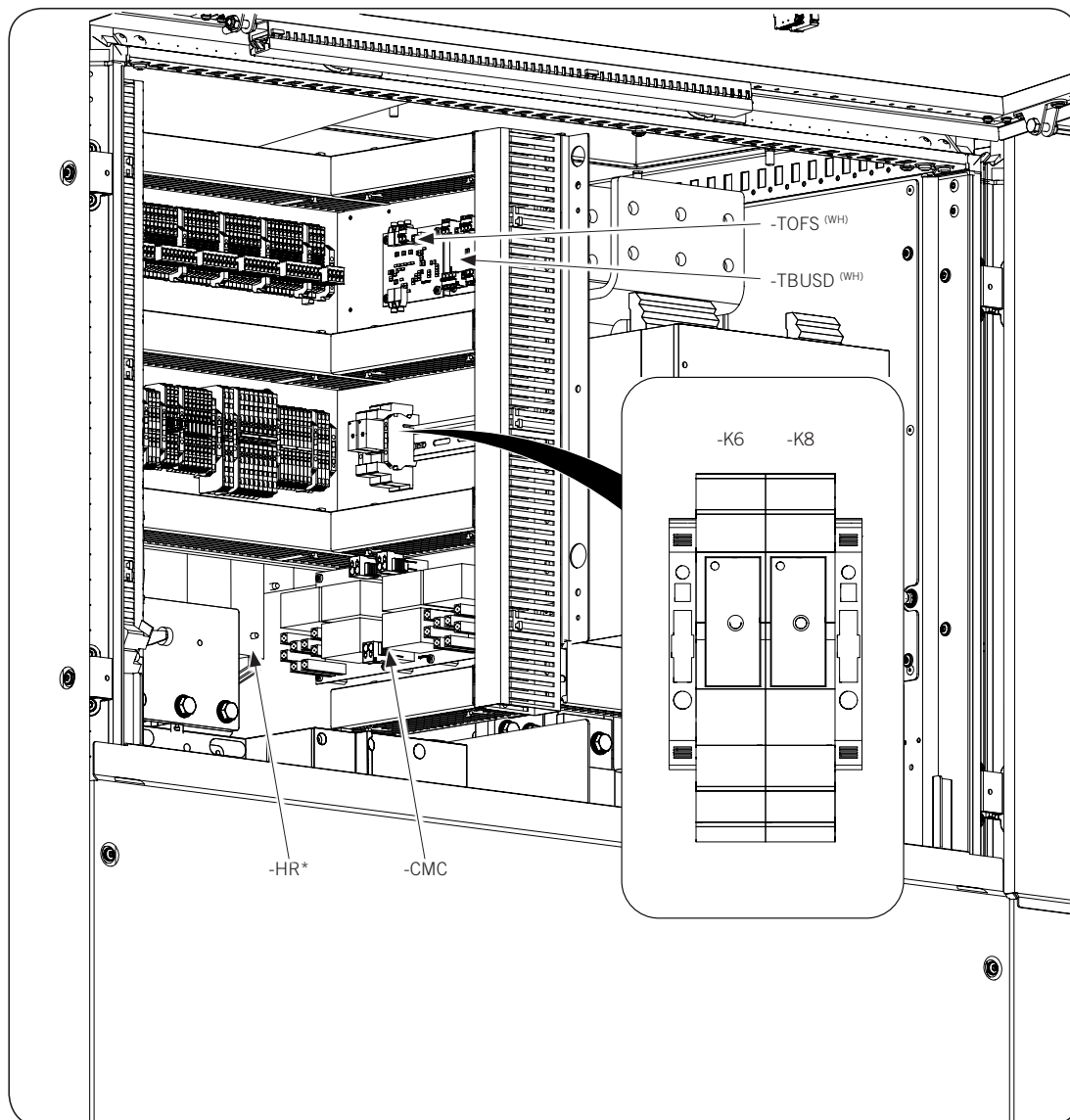
^(WH) Individual waste handling (for more information see section “23. Waste handling”)

2.6.1. DCAC connections module



Component	Description
-XAUX	Auxiliary services connection terminal strip
-Q4	Grid voltage sensor protection
-Q2	Auxiliary services protection

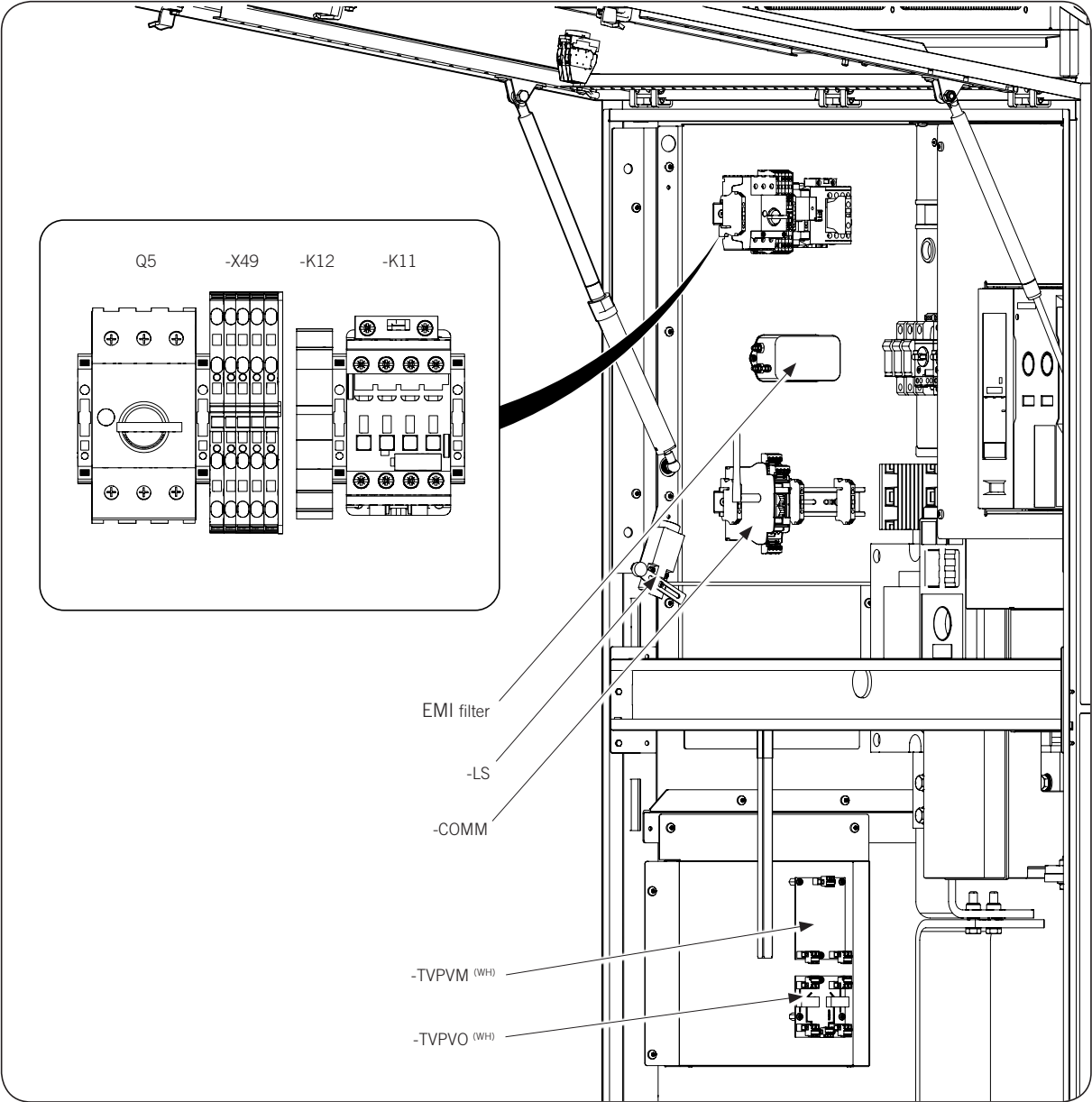
Component	Description
-RVDC	DC surge arresters
-X38	Monitoring strip of external elements, grid connection / insulation fault / alarm, remote control of the motorized DC switch



Component	Description	Component	Description
-TOFS ^(WH)	Synchronization card	-K6	Motorized DC switch remote control
-HR*	Optional <i>Low temperature operating kit.</i>	-K8	Grid connection relay / insulation fault / alarm

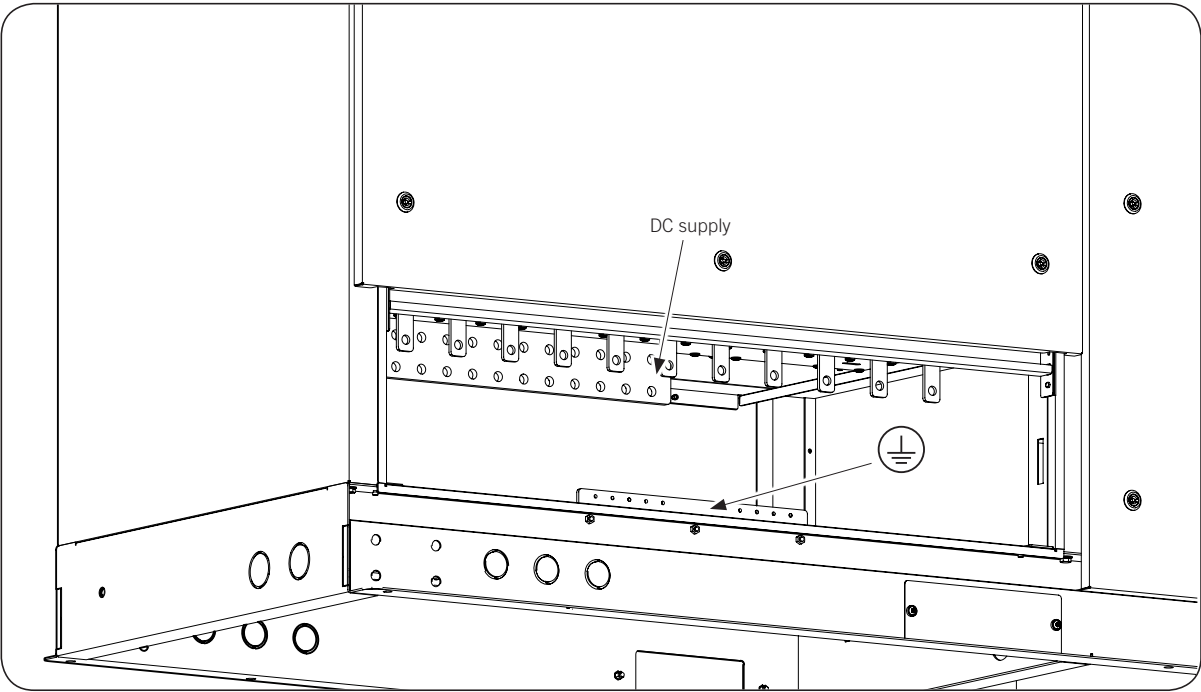
* Optional

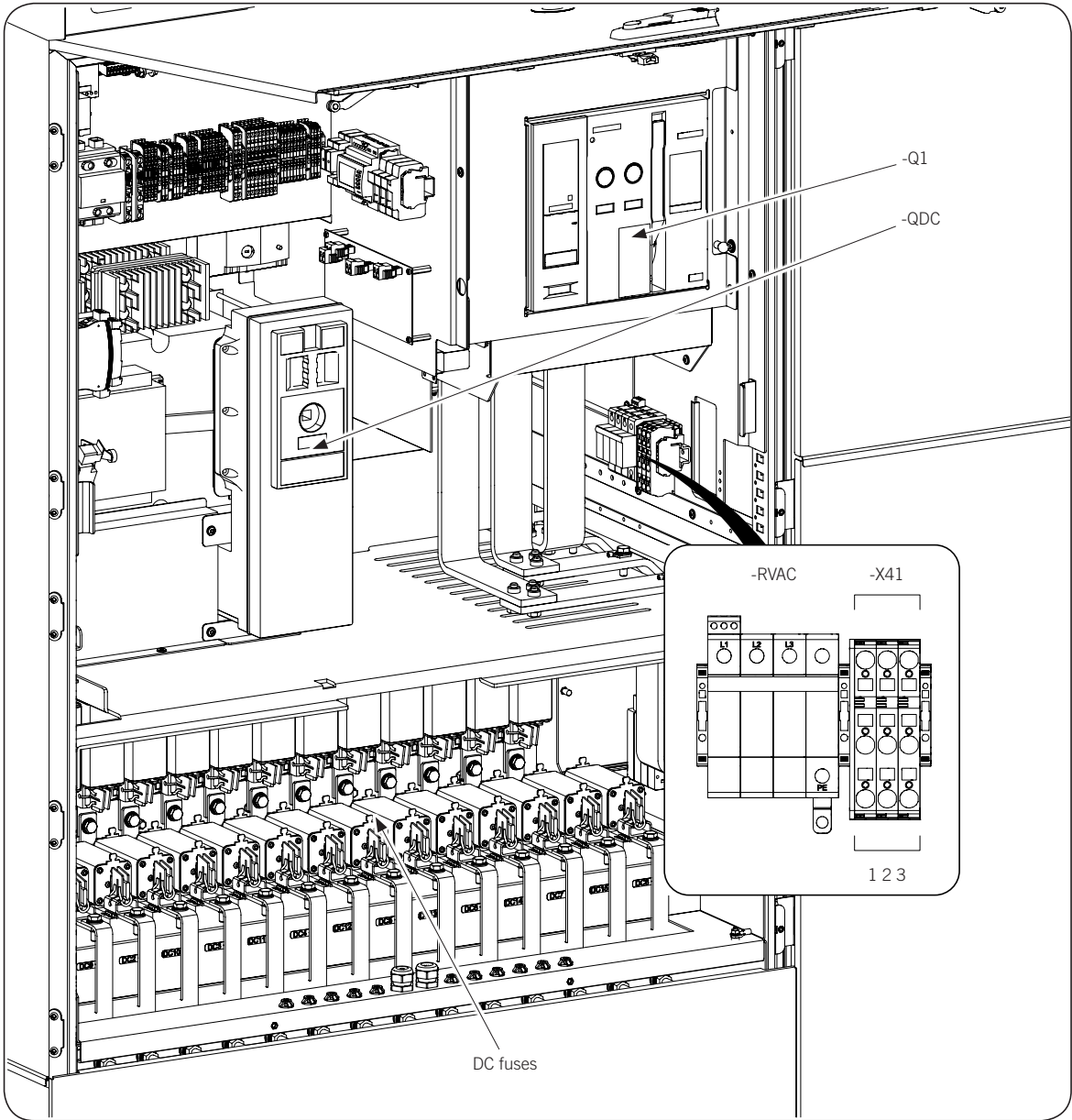
^(WH) Individual waste handling (for more information see section “23. Waste handling”)



Component	Description	Component	Description
-COMM	Communication accessories	-TVPVM ^(WH)	PV array voltage meter card
-LS	End switch	-TVPVO ^(WH)	PV array opening voltage meter card

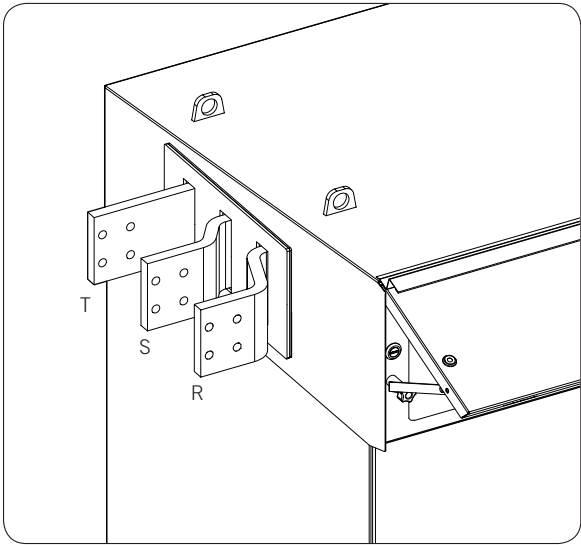
^(WH) Individual waste handling (for more information see section “23. Waste handling”)





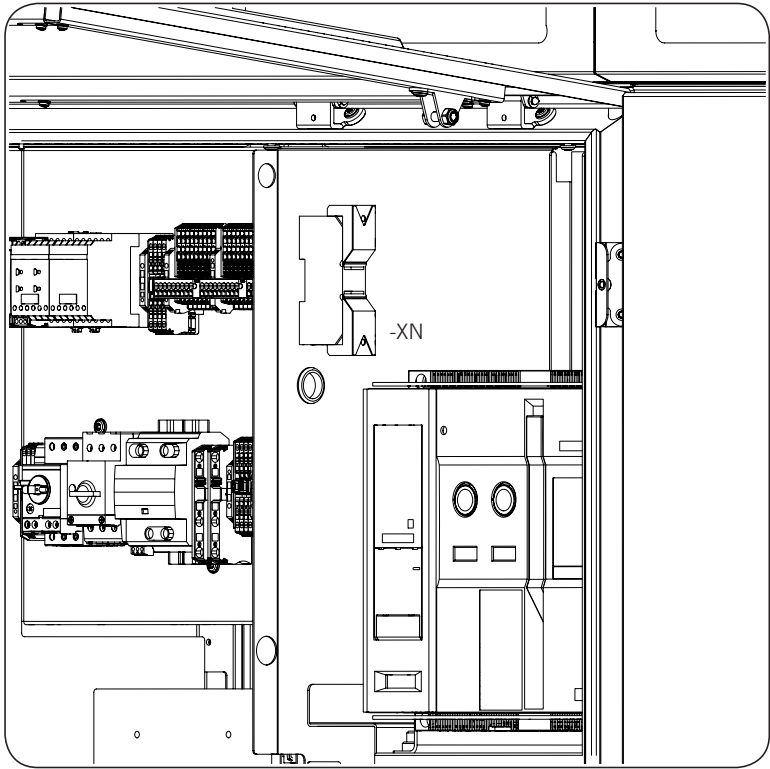
Component	Description
-QDC	Motorized DC switch
-Q1	AC thermomagnetic circuit breaker

Component	Description
-RVAC	AC surge arresters



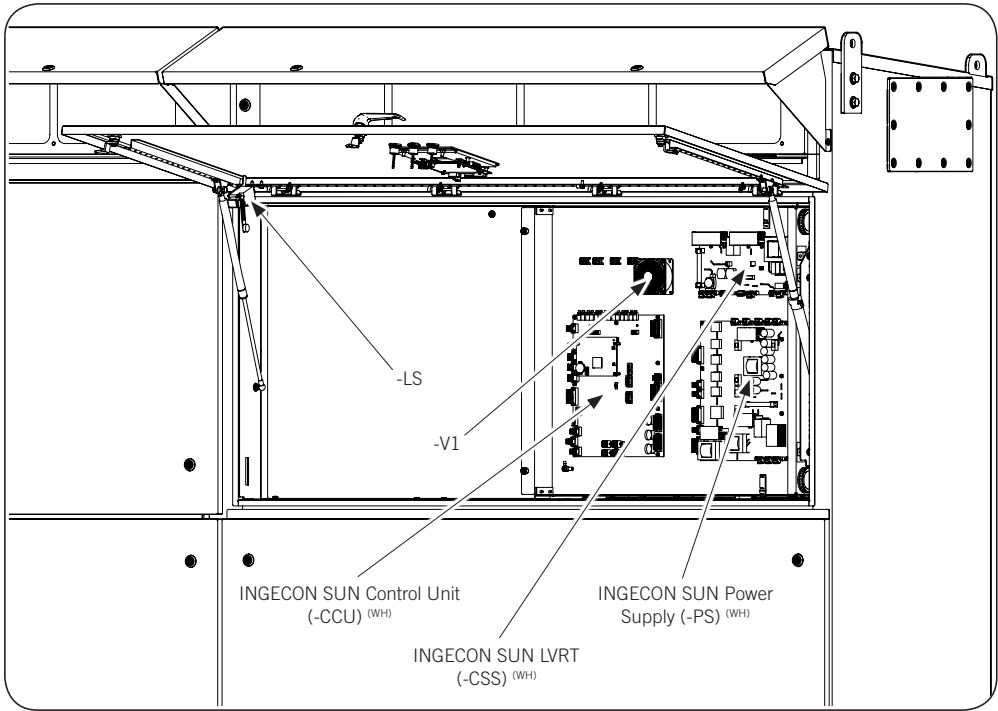
Component	Description
R	AC phase R plate connection
S	AC phase S plate connection

Component	Description
T	AC phase T plate connection



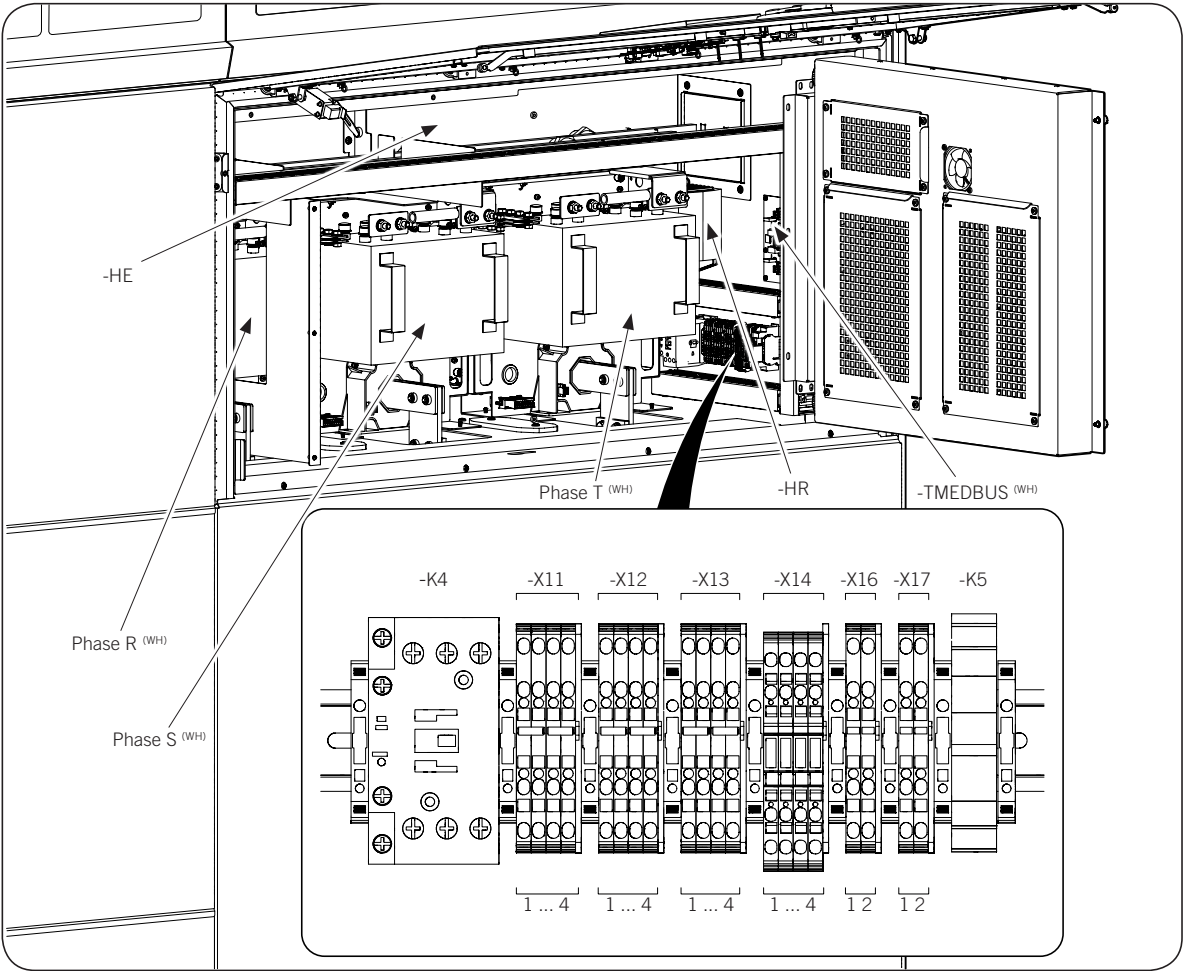
Component	Description
-XN	AC neutral connection terminal

2.6.2. Power module



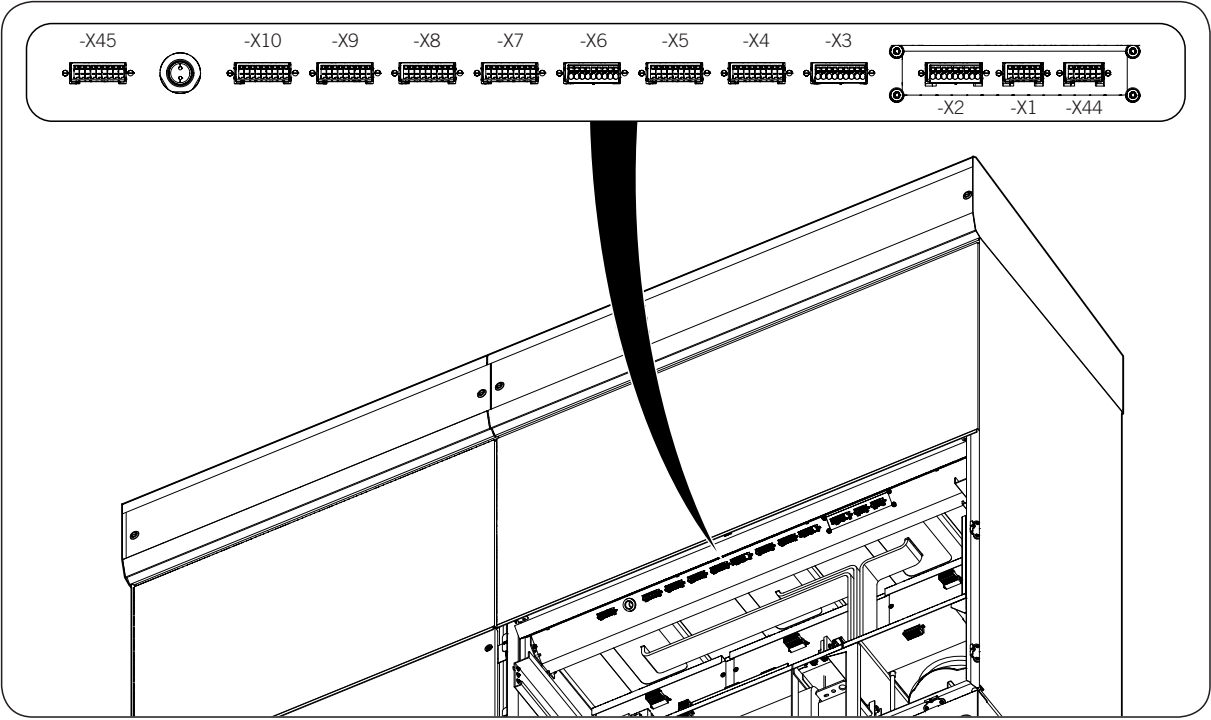
Component	Description	Component	Description
-V1	Fan.	-INGECON SUN Control Unit (-CCU) (WH)	Meter and Control system
-LS	End switch	-INGECON SUN LVRT (-CSS) (WH)	LVRT system
		-INGECON SUN Power Supply (-PS) (WH)	Power supply system

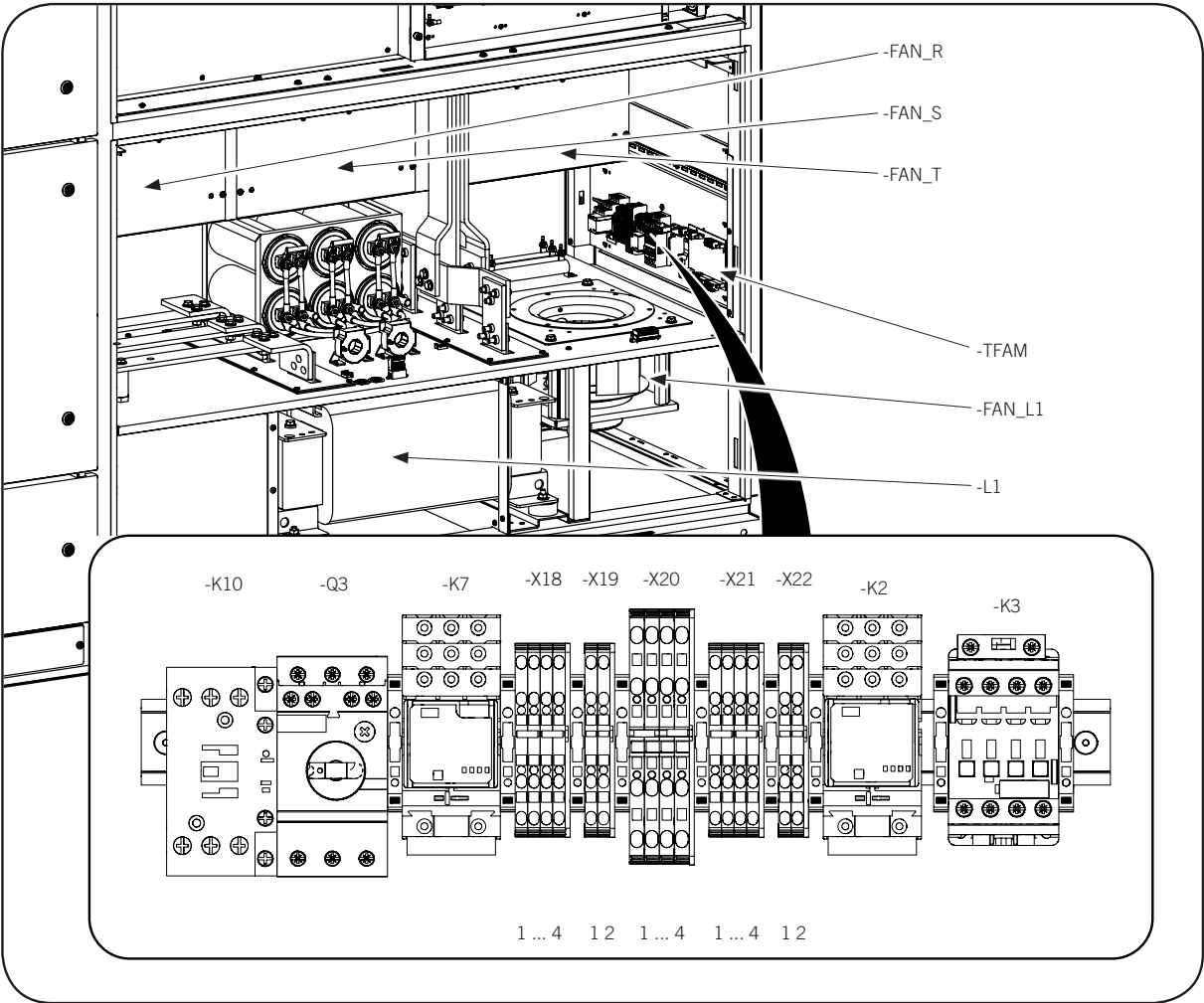
(WH) Individual waste handling (for more information see section “23. Waste handling”)



Component	Description	Component	Description
Phase R	Converter's Phase R	-HR	Heating element
Phase S	Phase S Converter	-HE	Air-air exchange
Phase T	Phase T Converter		

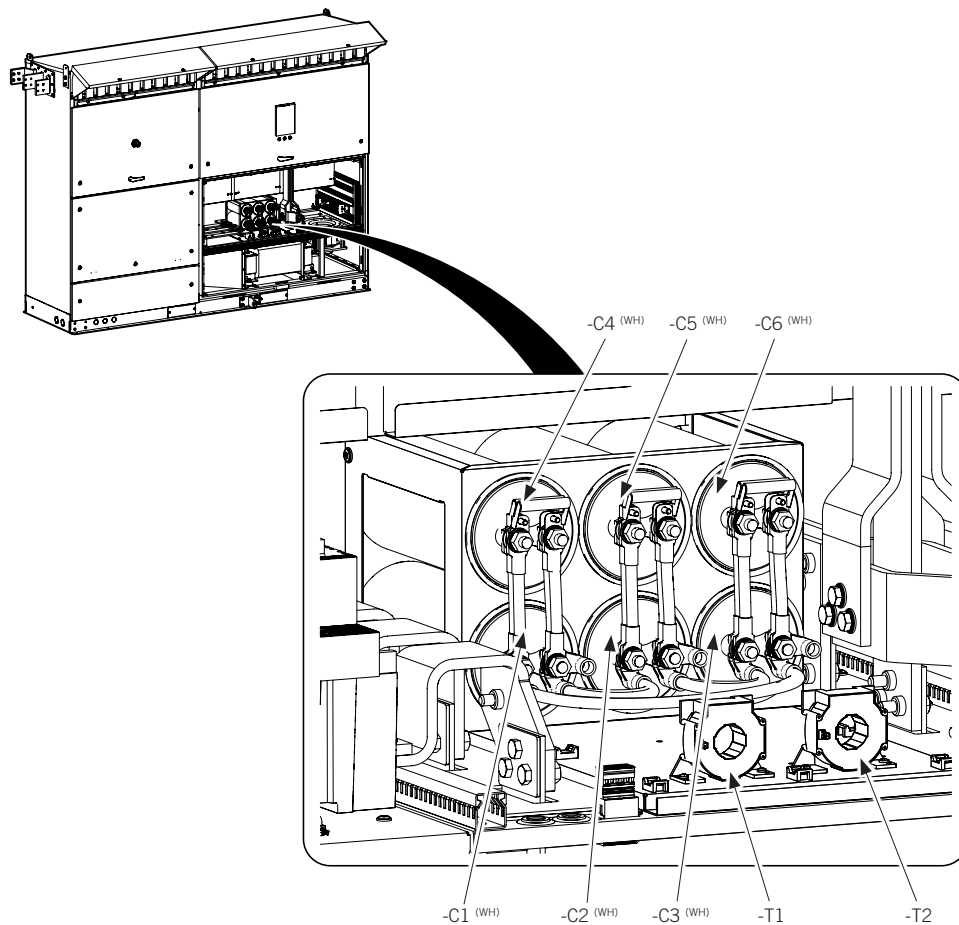
^(WH) Individual waste handling (for more information see section “23. Waste handling”)





Component	Description
-FAN_R	Phase R fan
-FAN_S	Phase S fan
-FAN_T	Phase T fan

Component	Description
-FAN_L1	Coil fan
-K2	AC thermomagnetic switch control
-L1	Coil



^(WH) Individual waste handling (for more information see section “23. Waste handling”)

2.7. Compliance with regulations

UL1741SA, Rule 21, Rule 14-H

Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, UL 1741 2nd Ed (January 28, 2010) including revisions through September 07, 2016

Source Requirement Documents per SUPPLEMENT SA:

- Rule 21, Section Hh. (Revisions through August 2nd, 2017).
- SRD-UL-1741-SA-V1.1 Updated: 9/26/2017.
- Compliance with UL 1741 Second Edition includes applicable requirements of IEEE 1547 and IEEE 1547.1. Optionally, IEEE 1547a & IEEE 1547a.1.

Reference Stds. ANSI/CAN/UL 9540:2016 (STORAGE).

UL 9540

UL Standard for Safety of Energy Storage Systems. First Edition, Dated June 28, 2014.

CSA

Power Conversion Equipment CSA C22.2 No. 107.1-16 (June 2016) - Canadian Electrical Code - Part II.

0.4-04 - Bonding of Electrical Equipment.

107.1-01 - General Use Power Supplies.

FCC Part 15 B (class A) EMC tests

IEEE 1547.1TM

IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.

2.8. EMC requirements

These units are equipped with the necessary filtering elements to comply with EMC requirements for industrial applications in order to prevent disturbances in other equipment outside the installation.

All of these units are connected to the grid through a low to medium voltage transformer. This transformer gives the unit galvanic isolation that affects its good performance in terms of noise emission (see Section “6.8.1. Grid connection transformer”). This is why:

CAUTION

Any auxiliary element must be connected to the low voltage network powering the units via a galvanic isolation transformer (see Section “6.8.2. Auxiliary transformer”).

The maximum distance between the units and the grid connection transformer must be less than 30 meters.

2.9. Protection class

These units meet NEMA 3R degree of protection against external agents, so can be installed outdoors.

They include standard protection covers for sand/dust storms for the front and rear grilles.

2.10. Pollution degree

The pollution degree for which the units have been designed is grade 3.

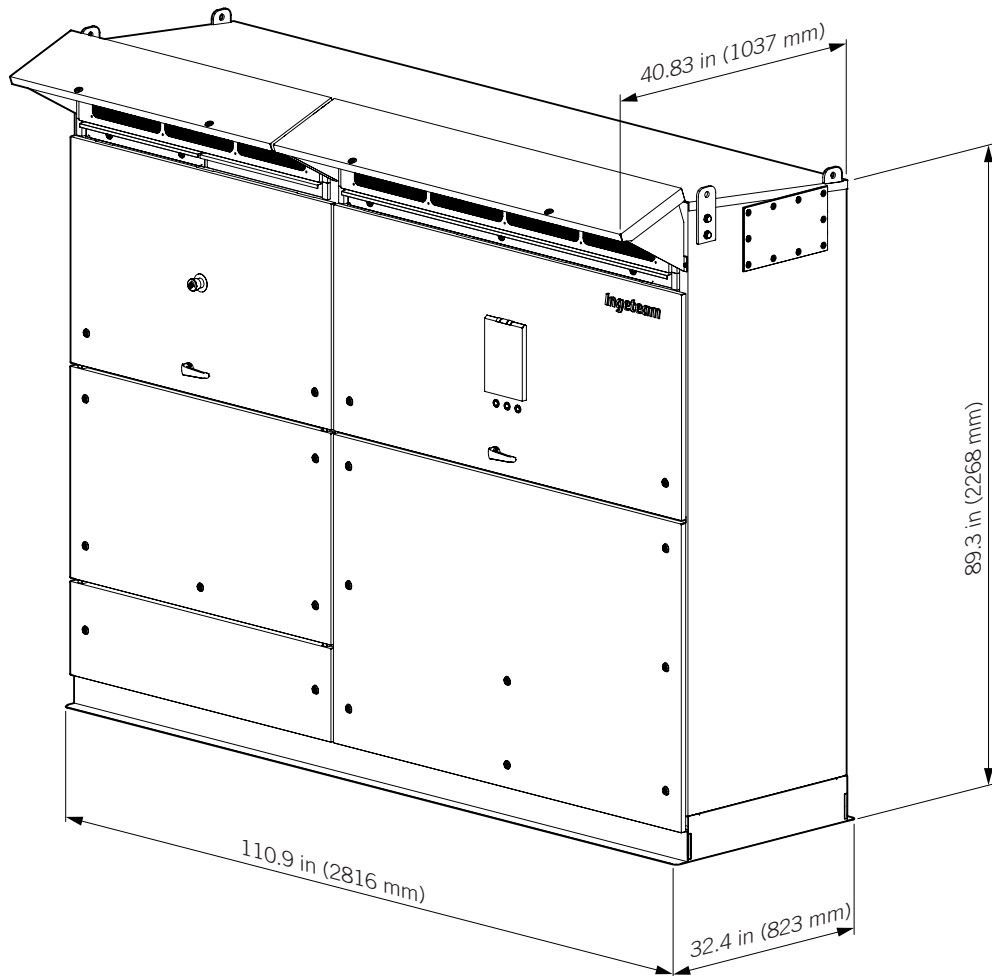
Suitable measures should be taken to provide dust-free air of sufficient quality in the vicinity of the inverter.

2.11. Acoustic contamination

When on, the inverter generates a buzzing sound.

Do not place it in an occupied room, or on light supports which might amplify this buzz. The mounting surface must be firm and appropriate for the weight of the unit.

2.12. Dimensions



2.13. Characteristics of the electrical installation

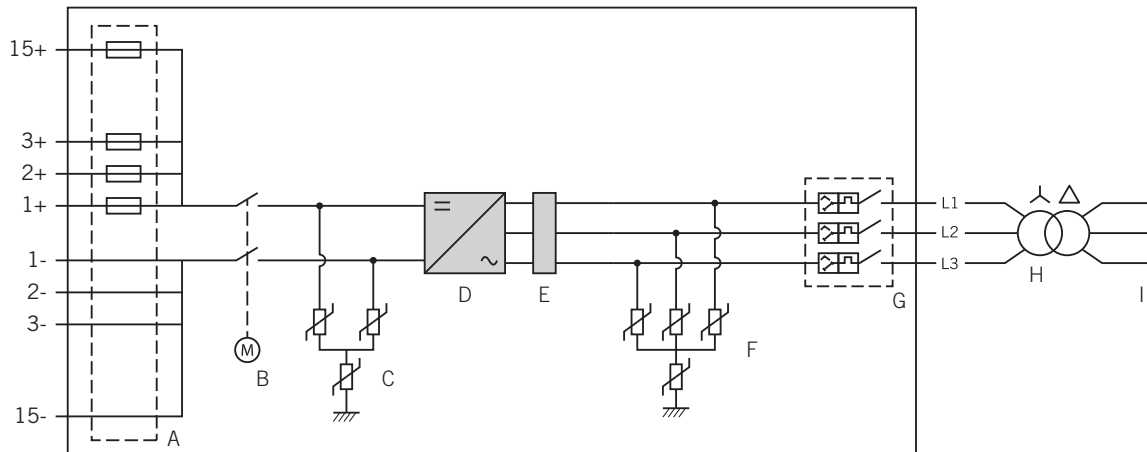
These units are designed for connection to a dedicated grid with an IT-type neutral connection scheme. The IT system neutral connection as a reference point is recommended.

An IT scheme has no directly grounded feed point.

In this system, the resulting intensity of a first phase against mass or phase against ground fault is sufficiently low as to not cause the appearance of dangerous contact voltages.

The PV array must be installed, insulated from the earth in a configuration called *floating* to assure protection against direct and indirect contacts. If requiring grounding for any part of the installation's DC circuit, the equipment must be equipped with the *PV array grounding kit*. If selecting this kit, see the installation and operation manual.

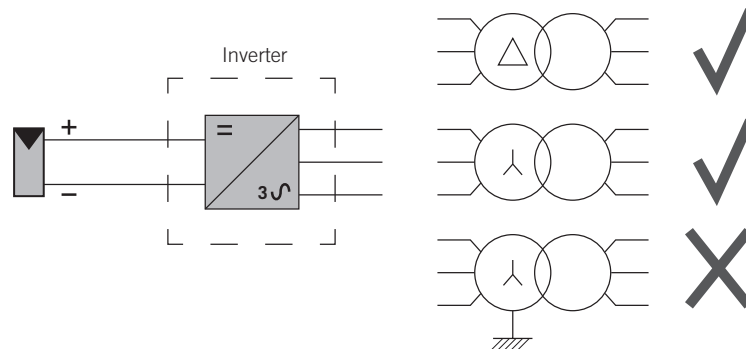
2.14. Electrical diagram of the unit



- | | |
|------------------------|--|
| A. DC fuses, optional | F. AC surge arresters |
| B. Motorized DC switch | G. AC thermomagnetic circuit breaker |
| C. DC surge arresters | H. Transformer |
| D. Inverter. | I. AC output for connection to MV grid |
| E. Filter | |

2.15. Electrical diagram of the system

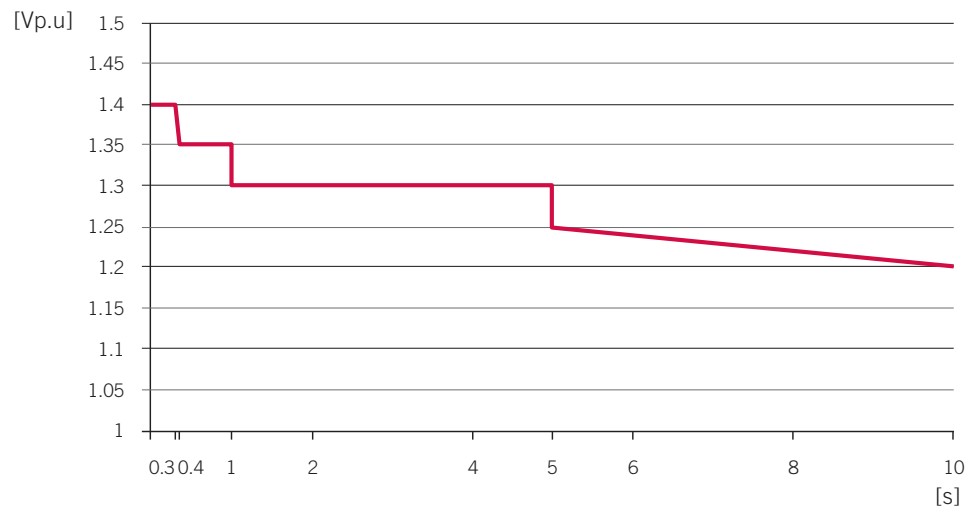
The configuration of the high-voltage winding of the grid connection transformer does not affect the behavior of the unit.



Ingeteam recommends using a transformer with Dy11 connection.

2.16. AC surge maximum curve

Both its equipment and auxiliary services are designed to support the following surge curves.



Higher surges, both in the value and duration, may cause damage to the equipment.

2.17. Configuration parameters

DC inputs	1640TL U B630	1665TL U B640	1690TL U B650	1715TL U B660	1740TL U B670	1800TL U B690
Range of operating input voltage	910 ~ 1.300 V	922 ~ 1.300 V	937 ~ 1.300 V	951 ~ 1.300 V	965 ~ 1.300 V	994 ~ 1.300 V
Maximum input voltage	1.500 V					
Maximum input current	1.800 A					
Maximum short circuit input current	3.000 A					
Maximum source feedback current	0 A					

AC output	1640TL U B630	1665TL U B640	1690TL U B650	1715TL U B660	1740TL U B670	1800TL U B690
Outgoing power factor	> 0.99 (adjustable 0 ~ 1)					
Voltage range (AC) (L-L)	554.4 ~ 756 V	563.2 ~ 768 V	572 ~ 780 V	580.8 ~ 792 V	589.6 ~ 804 V	607.2 ~ 828 V
Range of operating frequency	57 ~ 60.5 Hz					
Number of phases	3					
Nominal output voltage (AC)	630 V	640 V	650 V	660 V	670 V	690 V
Normal output frequency	60 Hz					
Maximum AC output current per line @ 86 °F (30 °C) / @ 122 °F (50 °C)	1.450 A / 1.250 A					
Power @ 86 °F (30 °C) / @ 122 °F (50 °C)	1.637 kW / 1.473 kW	1.663 kW / 1.497 kW	1.689 kW / 1.520 kW	1.715 kW / 1.543 kW	1.741 kW / 1.567 kW	1.793 kW / 1.613 kW
Maximum (AC) current fault and duration	3.440 A @ 11 ms					
Maximum overcurrent protection	1.600 A					
Reconnection time	1 ~ 5 minutes					
Normal temperature range of use	-4 °F (-20 °C) ~ 140 °F (60 °C)					
Maximum temperature at a maximum power @ 1,450 A / @ 1,250 A	up to 86 °F (30 °C) / up to 122 °F (50 °C)					
Housing protection	NEMA 3R					

Values and times of disconnection of the voltage and frequency protections in the interconnection of the unit with the electrical company (for all equipment)

Levels	Simulated source		Maximum time (s) at 60 Hz before the cessation of the current to the simulated source
	Voltage (V)	Frequency (Hz)	
A	< 0.50 Vnom	Nominal	0.16
B	0.50 Vnom ≤ V < 0.88 Vnom (Adjustable, 0.88 Vnom as standard)	Nominal	0.16 ~ 2 (Adjustable, 2 as standard)
C	1.10 Vnom ≤ V < 1.20 Vnom (Adjustable, 1.10 Vnom as standard)	Nominal	0.16 ~ 1 (Adjustable, 1 as standard)
D	1.20 Vnom ≤ V	Nominal	0.16
E	Nominal	f > 60.5	0.16
F	Nominal	f < (59.8 ~ 57.0) (Adjustable, 59 as standard)	0.16
G	Nominal	f < 57	0.16

Precision of the values and times of disconnection of the voltage and frequency protections

Voltage	± 1 %
Frequency	± 0.1 Hz
Time	0.06 s

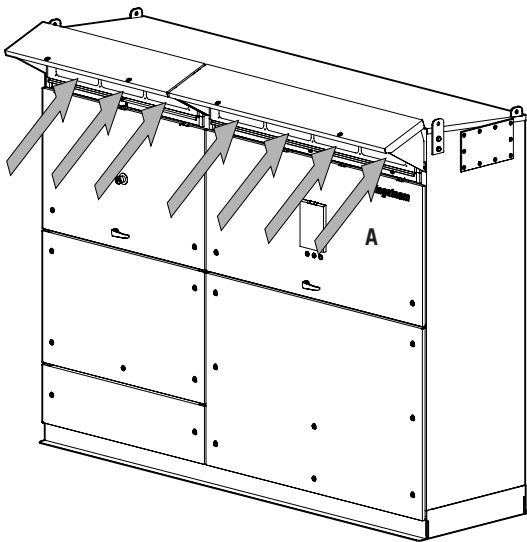
2.18. Cooling system

The cooling system in these inverters consist in four fans that vent room temperature air to the upper part and remove the hot air from the back.

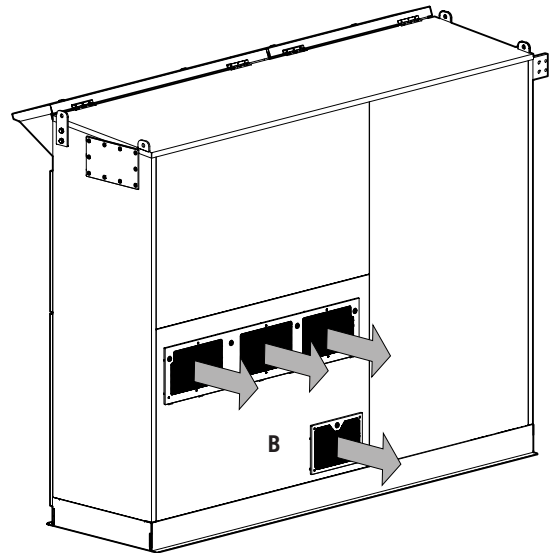
i INFO

The cooling requirements and necessary flow rate are specified in Section “6.6. Cooling”.

These units include monitoring of the correct operation of the fans. Malfunctioning of one or various fans stops the equipment.



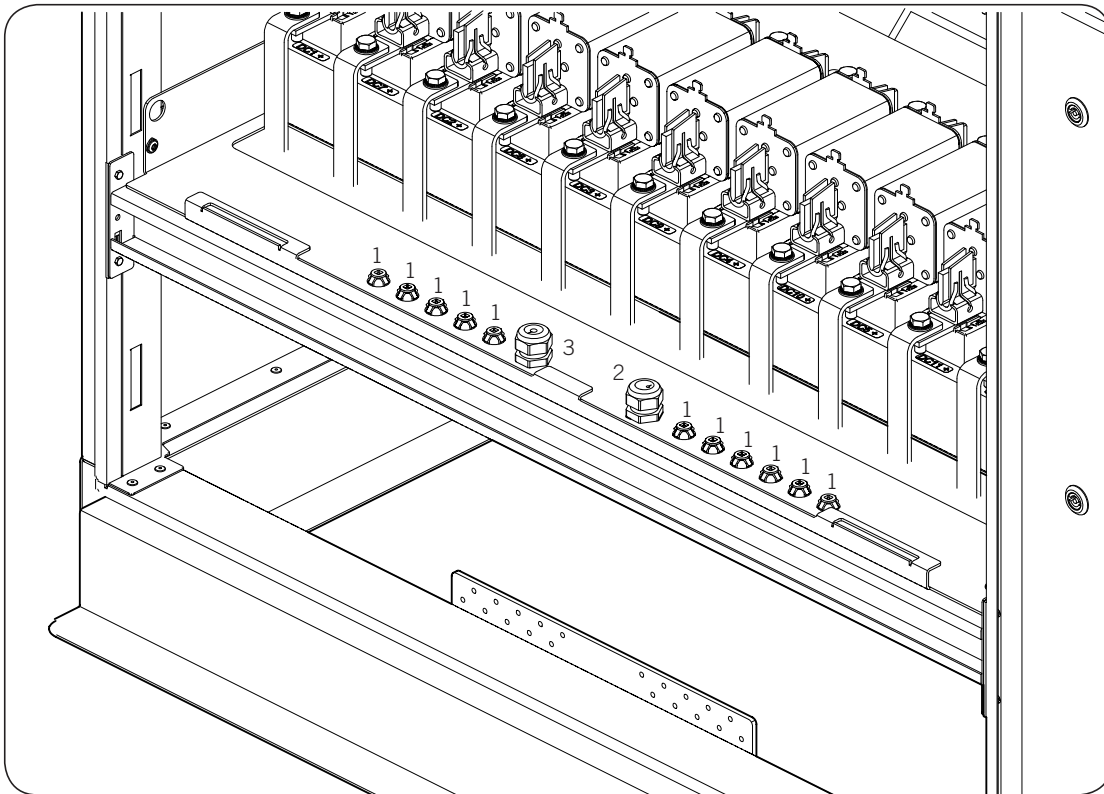
A. Air inlet at room temperature



B. Hot air outlet

2.19. Description of cable inlets

These units have wired accesses on the lower part.



1. Wiring options and auxiliary services. Cover with membrane, permitted wiring diameter 0.24 ~ 0.51 in (6 ~ 13 mm).
2. Fiber optic for synchronization. M25 packing gland, two holes, permitted wiring diameter 0.04 ~ 0.12 in (1 ~ 3 mm).
3. Ethernet. M25 packing gland, one hole, permitted wiring diameter 0.24 ~ 0.51 in (6 ~ 13 mm).

2.20. Utility - Interactive and Grid Support Utility - Interactive modes

This inverter can be configured in two different operation modes: Utility - Interactive mode and Grid Support Utility - Interactive mode.

2.20.1. Description of operation modes

The difference between the modes is centered on the performance in cases of grid instability. While the Utility - Interactive mode only disconnects from the grid when the parameters are outside the range, the Grid Support Utility - Interactive mode supports the grid when certain errors appear (LVRT, reactive power regulation, etc.), thereby keeping the inverter connected.

It is not possible to configure the unit with both modes simultaneously.

The Grid Support Utility - Interactive mode has specific utility interconnectivity settings that allow providing grid support functions such as voltage and frequency or step voltage and frequency adjustment. Products that depend on the interconnection protection functions or devices for internal or external public services are specifically identified.

The Grid Support Utility - Interactive mode is currently available in accordance with the regulations of the two states that include this type of requirement in the USA: California and Hawaii. The two SRDs used to certify the unit were:

- Rule 21, Section Hh. (Revision through August 2nd, 2017) for California.
- SRD-UL-1741-SA-V1.1 Updated: 9/26/2017 (Rule 14H) for Hawaii.

2.20.2. Utility – Interactive mode functions

This mode has the functions typically required by UL1741 before supplement A. They are basically voltage and frequency protections, anti-islanding protection and DC current injection control:

- High/low voltage protection.
- High/low frequency protection.
- Anti-islanding protection.

2.20.3. Grid Support Utility – Interactive mode functions

This mode includes the same functions as the Utility - Interactive mode except the low voltage protection (incompatible with LVRT).

Additionally, it includes the following functions:

- L/HVRT LOW AND HIGH VOLTAGE RIDE-THROUGH (SA9)
- L/HFRT LOW AND HIGH FREQUENCY RIDE-THROUGH (SA10)
- NORMAL RAMP RATE AND SS – SOFT-START RAMP RATE (SA11)
- SPECIFIED POWER FACTOR (SA12)
- VOLT/VAR MODE (Q(V)) (SA13)
- FREQUENCY-WATT (FW) (SA14 OPTIONAL)
- VOLT-WATT (VW) (SA15 OPTIONAL)
- RATINGS FOR GRID SUPPORT UTILITY INTERACTIVE INVERTERS, CONVERTERS (SA16)

2.20.4. Ratings for grid support functions

In order to maintain a stable grid voltage, the inverters must be able to supply or absorb reactive power from/to the EPS. One way to achieve this is to make the inverter supply or absorb reactive power in response to the EPS voltage fluctuations.

The inverter's Volt-VAr mode implements the reactive power response to the EPS voltage fluctuations. This mode works with the following parameters:

Test	Parameters			
	Acronym	Description	Units	Defined value
L/HVRT	td	Is dwell time (s) between pulses as specified by manufacturer	s	5
	MSA _{Vac}	AC voltage measurement accuracy	%V	1
	MSA _t	Accuracy of time	s	0.0166
L/HFRT	td	Dwell time between pulses as specified by manufacturer	s	5
	MSA _{Hz}	Manufacturer's stated AC frequency measurement accuracy	Hz	0.1
	MSA _t	Accuracy of time	s	0.01667
RR	I _{rated}	Output Current Rating	A	1500 @ 1500 Vdc 1600 @ 1000 Vdc
	RR _{norm_up_min}	Minimum normal ramp-up rate	%I _{rated} /sec	1
	RR _{norm_up_max}	Maximum normal ramp-up rate	%I _{rated} /sec	100
	I _{low}	Minimum output current	A	15
	MSA _{RR}	Ramp Rate Accuracy	%I _{rated} /sec	2
	td	Is dwell time between test iterations as specified by the manufacturer	s	1

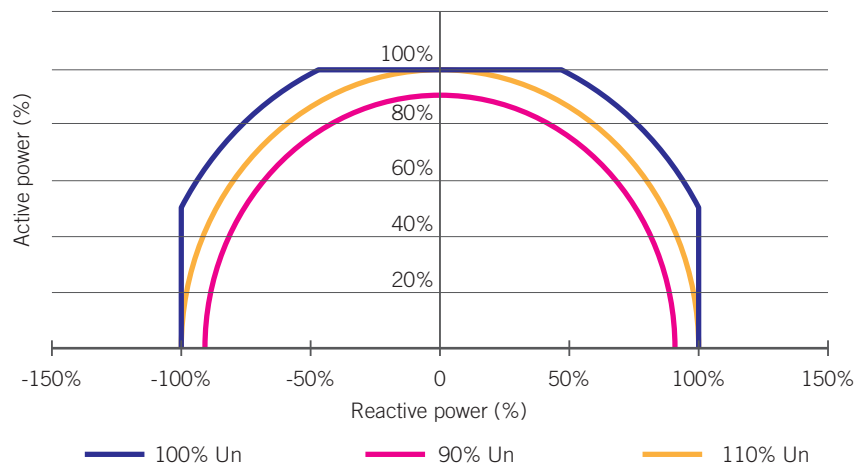
Test	Parameters			
	Acronym	Description	Units	Defined value
SS	I_{rated}	Output Current Rating	A	1500 @ 1500 Vdc 1600 @ 1000 Vdc
	RR_{SS_min}	Minimum normal ramp-up rate	$\%I_{rated}/sec$	0.1
	RR_{SS_max}	Maximum normal ramp-up rate	$\%I_{rated}/sec$	100
	I_{low}	Minimum output current	A	30
	MSA_{SS}	Ramp Rate Accuracy	$\%I_{rated}/sec$	2
	td	Is dwell time between test iterations as specified by the manufacturer	s	1
SPF	S_{rated}	Apparent Power Rating	VA	Rated power depending on model
	P_{rated}	Output Power Rating	W	Rated power depending on model
	$[V_{dc_min}, V_{dc_max}]$	DC Input voltage range with function enabled	V	Voltage range depending on model
	$[V_{ac_min}, V_{ac_max}]$	AC voltage range with function enabled	$\%V_{rated}$	70 ~ 120%
	MSA_{Vac}	AC voltage measurement accuracy	$\%V_{rated}$	1%
	MSA_{Vdc}	DC voltage measurement accuracy	$\%V_{rated}$	1%
	$[P_{low}, P_{rated}]$	Active power range of function	%	20 ~ 100%
	MSA_{PF}	Power Factor Accuracy	--	0.01
	ts	Power Factor Settling Time	s	2
	$PF_{min,ind}$	Minimum Inductive (Underexcited) Power Factor	--	0.85
	$PF_{min,cap}$	Minimum Capacitive (Overexcited) Power Factor	--	0.85
	$PF_{mid,ind}$	Medium Inductive Power Factor	--	0.925
Volt/VAr	S_{rated}	Apparent Power Rating	kVA	1800
	P_{rated}	Output Power Rating	kW	1800
	--	EUT Input Voltage range with function enabled	V	997~1500
	V_{nom}	Nominal AC EPS voltage	V	398
	$[V_{min}, V_{max}]$	AC EPS voltage range with function enabled (V)	$\%V_{nom}$	82~118
	MAS_q	Reactive Power Accuracy	$\%S_{rated}$	2
	--	Maximum Ramp Rate	kVAr/s	1800
	$Q_{max, over cap}$	Maximum Rated Reactive Power Production (Capacitive, Overexcited)	kVAr ($\%S_{rated}$)	948 (52.7%)
	$Q_{max, under ind}$	Maximum Rated Reactive Power Absorption (Inductive, Underexcited)	kVAr ($\%S_{rated}$)	948 (52.7%)
	K_{VARmax}	Maximum Slope	kVAr ($\%S_{rated}/\%V_{rated}$)	119 (29.34% $S_{rated}/\%V_{rated}$)
	Deadband _{min}	Minimum Deadband Range (V)	$\%V_{nom}$	0
	Deadband _{max}	Maximum Deadband Range (V)	$\%V_{nom}$	6
	t_s	Settling Time	S	2
	“Active Power Priority” and “Reactive Power Priority” configurations			YES
FW	P_{rated}	Output Power Rating	W	Rated power depending on model
	MSA_{Hz}	Manufacturer's stated AC frequency measurement accuracy	Hz	0.1
	$MSA_{P(f)}$	Manufacturer's stated P(f) accuracy	$\%P_{rated}$	2.0
	ts	Settling Time	s	2
	$K_{Power-Freq_Max}$	Maximum slope of frequency droop	$\%P_{rated}/Hz$	100
	$K_{Power-Freq_Min}$	Minimum slope of frequency droop	$\%P_{rated}/Hz$	10
	Over frequency (*)			
	$[f_{min}, f_{max}]$	AC frequency range with function enabled	Hz	60.0 ~ 65.0
	$[f_{start_min}, f_{start_max}]$	Adjustment range of the start of frequency droop	Hz	60.0 ~ 64.0

Test	Parameters			
	Acronym	Description	Units	Defined value
VW	P_{rated}	Output Power Rating	W	Rated power depending on model
	$[V_{min}, V_{max}]$	AC voltage range with function enabled	V	Voltage range depending on model
	V_{nom}	Nominal AC voltage	V	Nominal AC voltage depending on model
	MSA_{vac}	AC voltage accuracy	%V	1%
	MSA_{watts}	Output Power accuracy	%W	2%
	MSA_t	Accuracy of time	s	0.0166
	t_s	Settling time	s	2
VW	$[V_{start_min}, V_{start_max}]$	Adjustment range of the start of active power reduction	V	Voltage range depending on model
	$[V_{stop_min}, V_{stop_max}]$	Adjustment range of the stop of the curtailment function	V	No hysteresis
	$K_{Power-Volt_Max}$	Maximum slope of active power reduction	$\%Prated/V$	Slope depending on the rated voltage
	$K_{Power-Volt_Min}$	Minimum slope of active power reduction	$\%Prated/V$	Slope depending on the rated voltage
	$[t_{return_min}, t_{return_max}]$	Range of adjustment of a delay before return to normal operation	s	No hysteresis
	$[K_{Power_Rate_Min}, K_{Power_Rate_Max}]$	Adjustment range of the rate of return to normal operation	$\%Prated/Sec$	No hysteresis
	--	Use of hysteresis in the Volt-Watt function	--	No
	K_{Power_Volt}	Slope of the active power response to changes in voltage	--	
	K_{Power_Rate}	Active power rate of return to normal operation	--	

(*) Under frequency FW behavior has not been evaluated, nevertheless this operation mode could be obtained by the commands from the power plant controller.

2.20.5. Active and reactive power capacities

The following chart shows the reactive power capacity of these units.



These units can support reactive power in the entire semicircle, depending on the output voltage.

3. Equipment reception

3.1. Packaging symbols

Bear in mind the following symbols present on the packaging of the unit:



Move transport packaging with this side up.



Do not use sharp tools to open the shipping packaging.



Prevent the unit from becoming wet.



Do not place anything on top of the shipping packaging.



The contents of the shipping container are fragile.

Keep the unit in its packaging until immediately before installation. Maintain the unit **upright** at all times.

3.2. Equipment identification

The serial number of the unit is its unique identifier. You must quote this number in any communication with Ingeteam.

3.3. 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 5 days of receipt of the unit.

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

4. Storage

CAUTION

Failure to follow the instructions 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:

- The package must be stored in the vertical position.
- Keep the unit free of dirt (dust, shavings, grease, etc.) and away from rodents.
- Keep it 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 “6.3. *Environmental conditions*”.
- 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.

4.1. Conservation

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

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

Deterioration of the packaging (tears, holes, etc.) prevents the units from being kept in optimum conditions before installation. Ingeteam accepts no liability in the case of failing to observe this condition.

4.2. 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 features 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

You can deliver all the packaging to an authorized non-hazardous waste management company.

In any event, each part of the packaging may be recycled as follows:

- Plastic (polystyrene, bag and bubble wrap): the appropriate container.
- Cardboard: the appropriate container.

5. Equipment transport

You must protect the unit, during transport, from mechanical knocks, vibrations, water splashes (rain) and any other product or situation which may damage it or alter its behavior.

Failure to observe these instructions may lead to loss of warranty on the product, for which Ingeteam is not responsible.

INFO

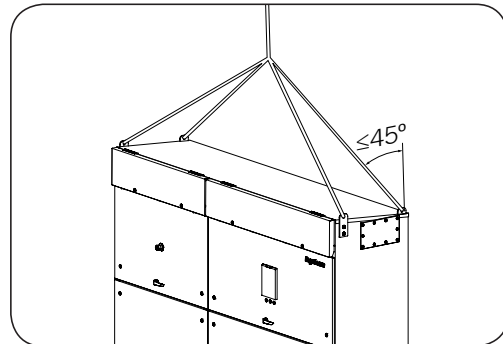
Ingeteam recommends transporting the unpacked equipment using a crane wherever possible.

5.1. Transport using a crane

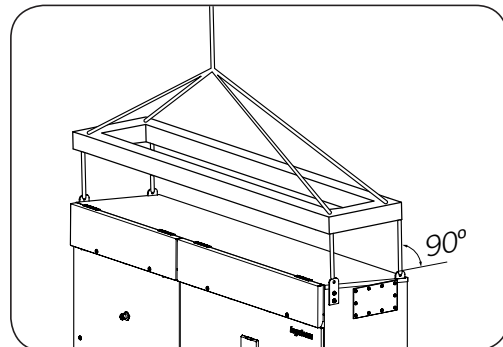
When lifting by crane, you should use the lifting beams fitted to the top of the unit, as shown below.

Ensure that the load is distributed evenly along the lifting beam.

Tie individual cables, chains or ropes to each of the holes, making sure the angle is less than or equal to 45° to vertical and ensuring that the cables are as vertical as possible.



It is always advisable to use a load frame as in the adjoining figure for a proper distribution of the loads, maintaining a 90° angle.



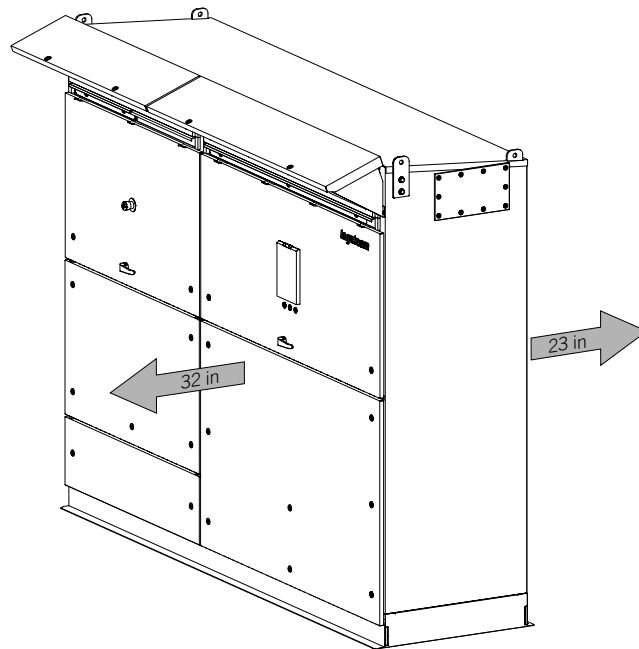
6. Preparation for installing the unit

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.

This chapter summaries the guidelines and details the external elements needed for correct operation of the unit.

6.1. General requirements for installation

- The work space must be suitable for maintenance tasks according to current regulations.



- The external connection devices must be suitable and sufficiently close as set forth in current regulations.
- The supply cables must have a gauge suitable to the maximum current and working conditions.
- Special care must be taken to ensure that there are no external elements near the air inlets and outlets that obstruct proper cooling of the unit.
- This manual does not supersede any laws, regulations or codes applicable to the installation or the use of the unit, whether local, state, provincial, federal or national, including electrical safety codes.
- Installations must be in accordance with laws, regulations, codes and standards applicable in the jurisdiction of the location. Ingeteam accepts no liability for the compliance or non-compliance with these laws, regulations, codes and standards.
- The unit contains no user-serviceable parts.
- Before installing or using the unit, read all the instructions and warnings in this manual.
- Before connecting the unit to the grid, contact the power company. This connection can only be made by qualified personnel.
- The equipment's connection may only be done by qualified personnel.

6.2. Environment

- Place the units in a place which is accessible for installation and maintenance work and which permits use of the keyboard and the reading of the front indicator LEDs.
- The air vents and part of the power module can reach high temperatures. Do not place any material nearby which is sensitive to high air temperatures.
- Avoid corrosive environments that may affect the proper operation of the inverter.
- Never place any object on top of the unit.
- It is recommended to protect the units from direct sunlight. Place the units under a cover that protects them from direct radiation, placing the front part facing north in the Northern Hemisphere and facing south in the Southern Hemisphere.

6.3. Environmental conditions

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

Environmental conditions	
Minimum temperature	-4 °F (-20 °C)*
Minimum surrounding air temperature	-4 °F (-20 °C)*
Maximum operating temperature	140 °F (60 °C) ⁽²⁾
Maximum relative humidity without condensation	100%
Altitude	14,760 ft (4,500 m) ⁽³⁾

⁽¹⁾ If installing the *Low temperature operating kit*, the minimum operating temperature is -22 °F (-30 °C).

⁽²⁾ Operation of the inverter at temperatures greater than 122 °F (50 °C) should only occur occasionally and not permanently. Ingeteam is not responsible for the consequences to the unit resulting from operating it at temperatures higher than 122 °F (50 °C).

⁽³⁾ At altitudes higher than 3300 ft (1000 m), please contact Ingeteam.

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, it is necessary to monitor these units 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. To remove condensation apply a flow of hot air at a maximum temperature of 140 °F (60 °C).

INFO

Ingeteam does not guarantee the proper operation of the equipment if the operation conditions for which it has been designed are not fulfilled.

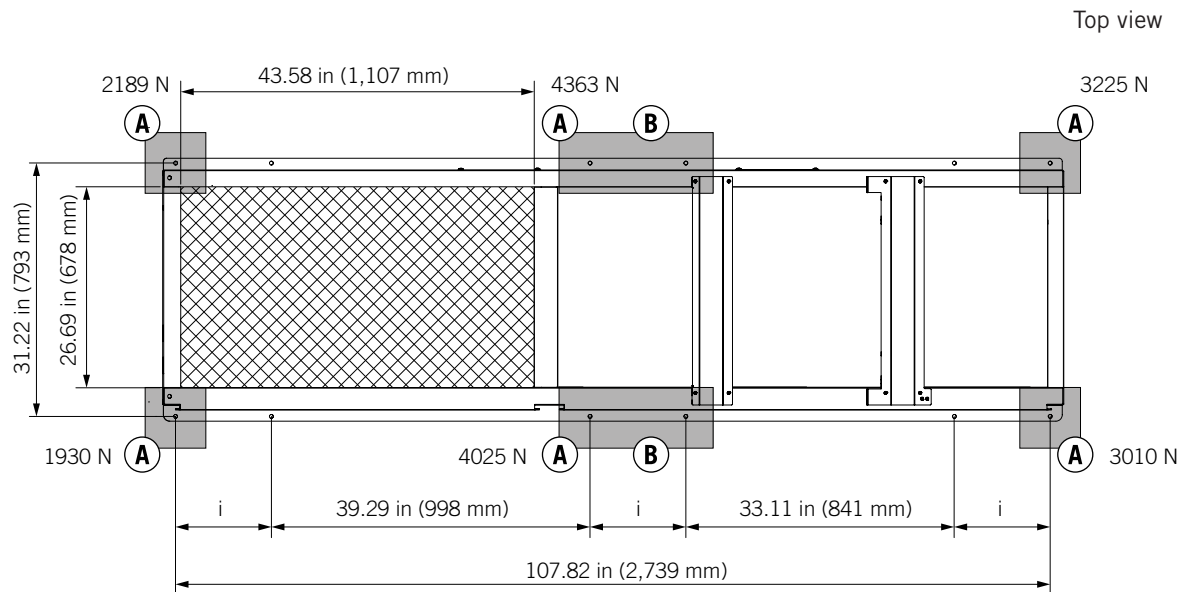
6.4. Fixing surface area

The unit's excessive weight requires a firm base for support, completely horizontal and leveled, assuring proper water drainage and avoiding water accumulation.

To perform the installation calculations it is necessary to take into account the loads that affect the environment conditions, according to the country's regulations.

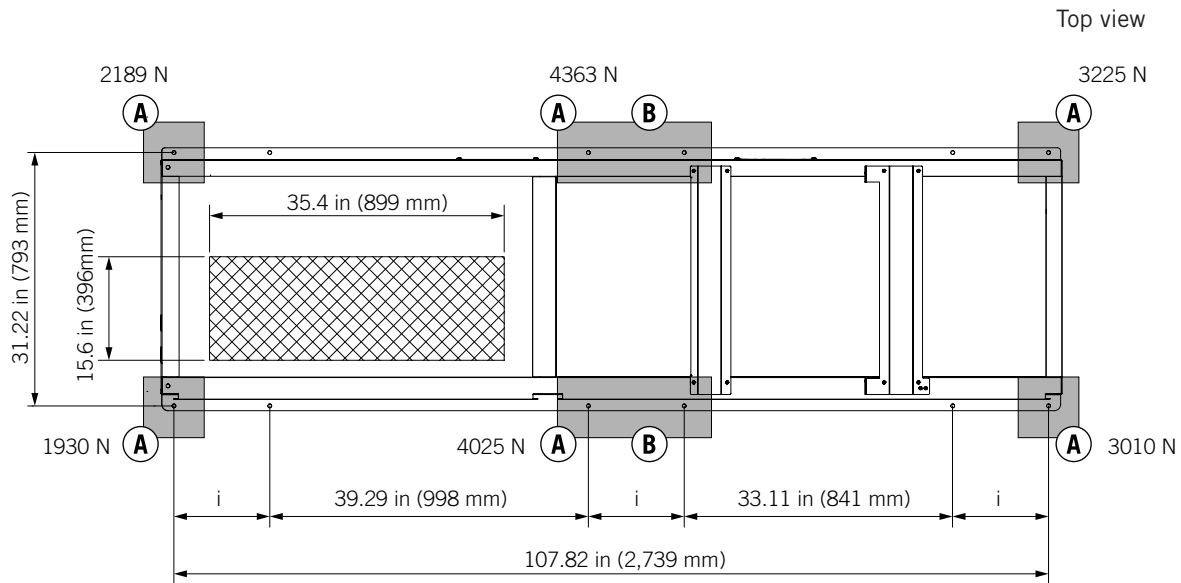
The following figures only show the vertical loads on each of the supports. The minimum number of supports is six, as well as two additional optional ones. They differ depending on whether the inverter has the bottom cover kit:

Without bottom cover



$$i = 11.81 \text{ in (300 mm)}$$

-  Footings
-  Compulsory support points
-  Optional support points
-  Area sealed for DC supply

With bottom cover

$$i = 11.81 \text{ in (300 mm)}$$

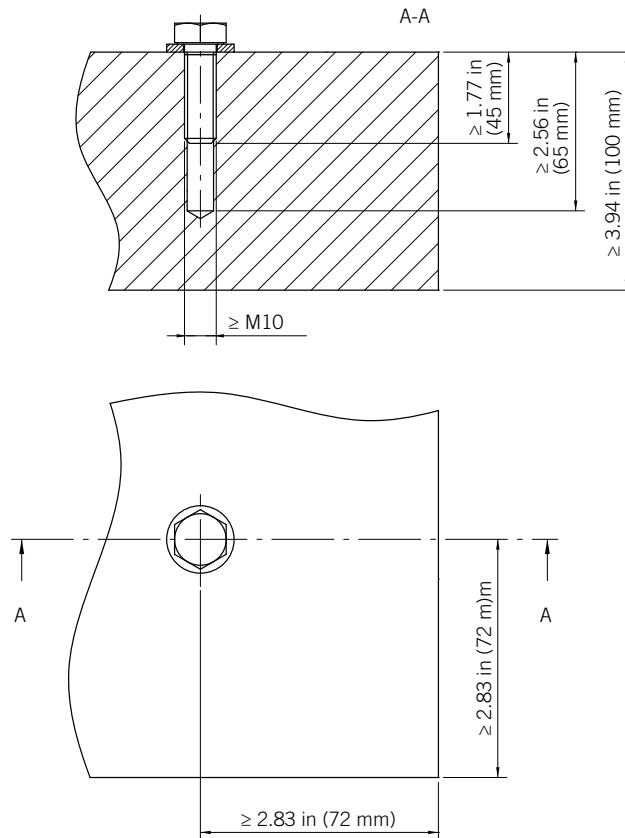
-  Footings
-  Compulsory support points
-  Optional support points
-  Area sealed for DC supply

CAUTION

Seal the area indicated in the previous figure to stop water, humidity and other foreign bodies from entering.

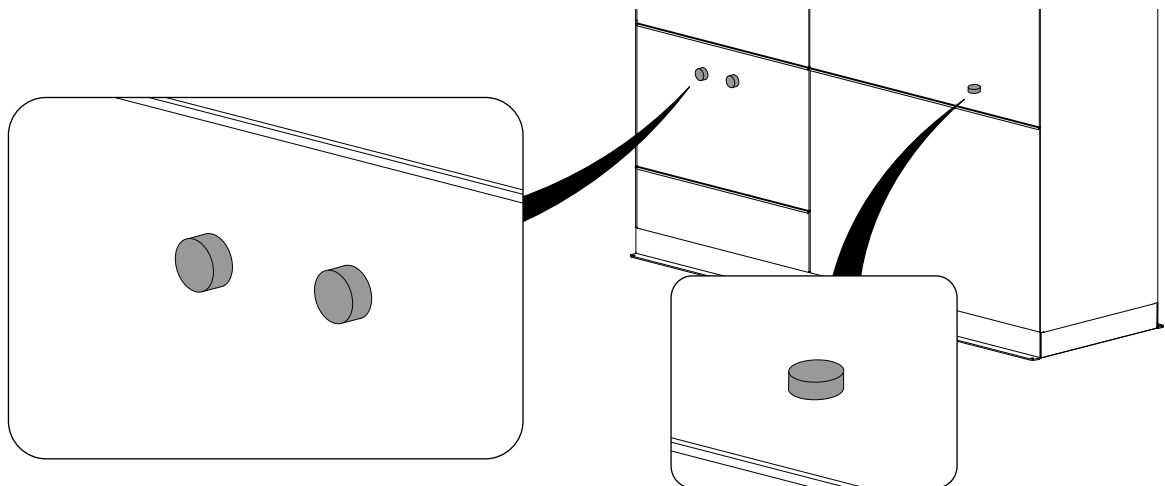
You must follow the following stipulations when choosing the place where the unit is to be bolted in:

- Minimum distance from the center of the bore to the edge of the concrete pad: 2.84 in (72 mm).
- Diameter of the hole drilled in the concrete pad: 0.39 in (10 mm).
- Minimum depth of the hole drilled in the concrete pad: 2.56 in (65 mm).
- Minimum thickness of the concrete pad: 3.94 in (100 mm).
- Minimum depth of anchoring bolt: 1.77 in (45 mm).
- Minimum tensile strength: 6.3 kN.
- Minimum shear strength: 8.2 kN.



6.5. Anti-humidity elements

Before making the connections, you need to remove the anti-humidity elements from the unit. The following figure displays the location of said elements.



6.6. Cooling

CAUTION

Install the unit so that the air entering for cooling does not come from air expelled by the unit or any other heat source.

Do not place any object on top of the unit.

⚠ CAUTION

Facilitate the flow of air entering through the cooling grids.

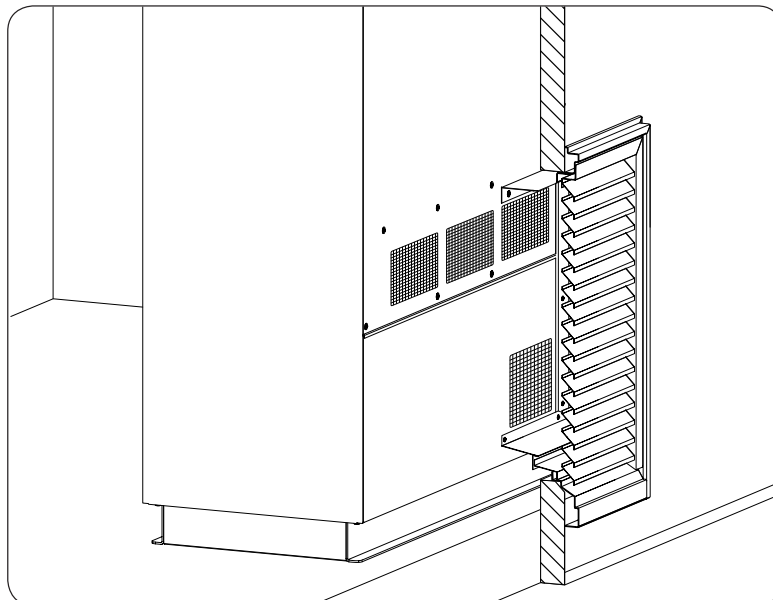
Ingeteam does not guarantee the proper operation of the equipment if the operation conditions for which it has been designed are not fulfilled.

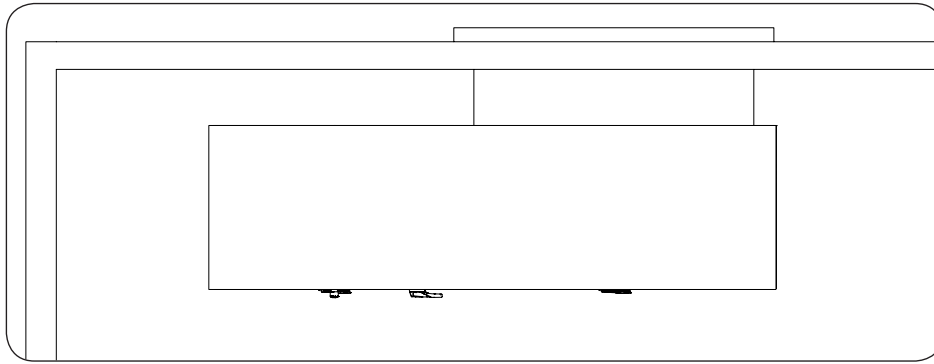
Operation of the inverter at temperatures greater than 122 °F (50 °C) should only occur occasionally and not permanently. Ingeteam is not responsible for the consequences to the unit resulting from operating it at temperatures higher than 122 °F (50 °C).

Installation in cabin

Adequate ventilation must be provided and the following requirements met to guarantee proper operation within the whole range of temperatures for which the equipment was designed:

- If installing the equipment in a cabin or closed precinct, you must make sure that the airflow is at least 60.82 ft³/s (6,200 m³/h) per installed inverter.
- These inverters come with filters in the air inlet. Ingeteam recommends a filter in the air vent inlet of the class G4 cabin (in accordance to the *EN779* standard). We recommend a separation of 1.18 in (3 cm) between the air inlet vent and the filter.
- For correct cooling appropriate to the filters installed in the unit, air quality must be guaranteed to environmental class 3S2, in accordance with standard *EN 60721-3-3*.
- The entry of air to the cabin or enclosed location must be dimensioned such that the speed of the air intake is less than 9.84 ft/s (3 m/s).
- Total permissible pressure loss in the cabin ventilation system (inlet grille and filter, air outlet duct and outlet grille) for the total required flow rate is a maximum of 2.09 lb/ft² (100 Pa).
- Ingeteam recommends installing an air outlet duct (plenum) to facilitate the extraction of the hot air generated by unit operation to the outside of the cabin or enclosed location. The installation of this plenum must guarantee that the air expelled by the inverter does not return to the interior of the cabin or closed precinct. The construction of a plenum with a slight slope towards the outside is recommended to prevent accumulation and entry of water to the unit.





- The plenum-grille unit must be completely replaceable from the exterior of the cabin or closed precinct.
- Ingeteam recommends a maximum distance of 20 in (≈50 cm) from the back of the inverter to the cabin wall or closed precinct.
- If the indicated plenum is installed, it will not be necessary to use additional extractor fans inside the cabin or enclosed location. In the event that there are other heat-generating components in the cabin, consider whether the use of additional fans is necessary. In such a case you must take into account the increase of pressure loss due to the increase in air speed through the intake grids, and the interaction between fans.
- When placing the plenum, the installer must use the included inserts.
- Install exterior outlet grids that prevent the entry of water and dirt. The outlet grilles must cover the plenum's total area.
- The maximum temperature rise inside the cabin or enclosed location with respect to the outside temperature must be less than 41 °F (5 °C).
- The speed and temperature of the intake air at the air inlets must be as homogeneous as possible.
- To ensure proper cooling of the equipment, proper maintenance of the cabin's and unit's filters must be performed at the indicated frequency.

i INFO

For more information request document ABK0000IMC01 from Ingeteam.

If you have any queries or suggestions, contact Ingeteam.

Installation outdoors

Adequate ventilation must be provided and the following requirements met to guarantee proper operation within the whole range of temperatures for which the equipment was designed:

- Make sure that the inverter's inputs and outputs of air are protected against water and dust.
- An airflow of at least 60.82 ft³/s (6,200 m³/h) per inverter is required.
- These inverters come with filters in the air inlet. Ingeteam recommends a filter in the air vent inlet of the class G4 cabin (in accordance to the *EN779* standard). We recommend a separation of 1.18 in (3 cm) between the air inlet vent and the filter.
- For correct cooling appropriate to the filters installed in the unit, air quality must be guaranteed to environmental class 3S2, in accordance with standard *EN 60721-3-3*.

6.7. Requirements for DC feed fuses

These inverters can be equipped with fuse holders for DC, depending on the client's needs. Inverters with fuse holders have between 6 and 30 fuse holders according to the unit configuration.

The fuses to be installed in the bases provided must meet the following specifications.

Electrical specifications

- Rated voltage greater than or equal to 1500 VDC.

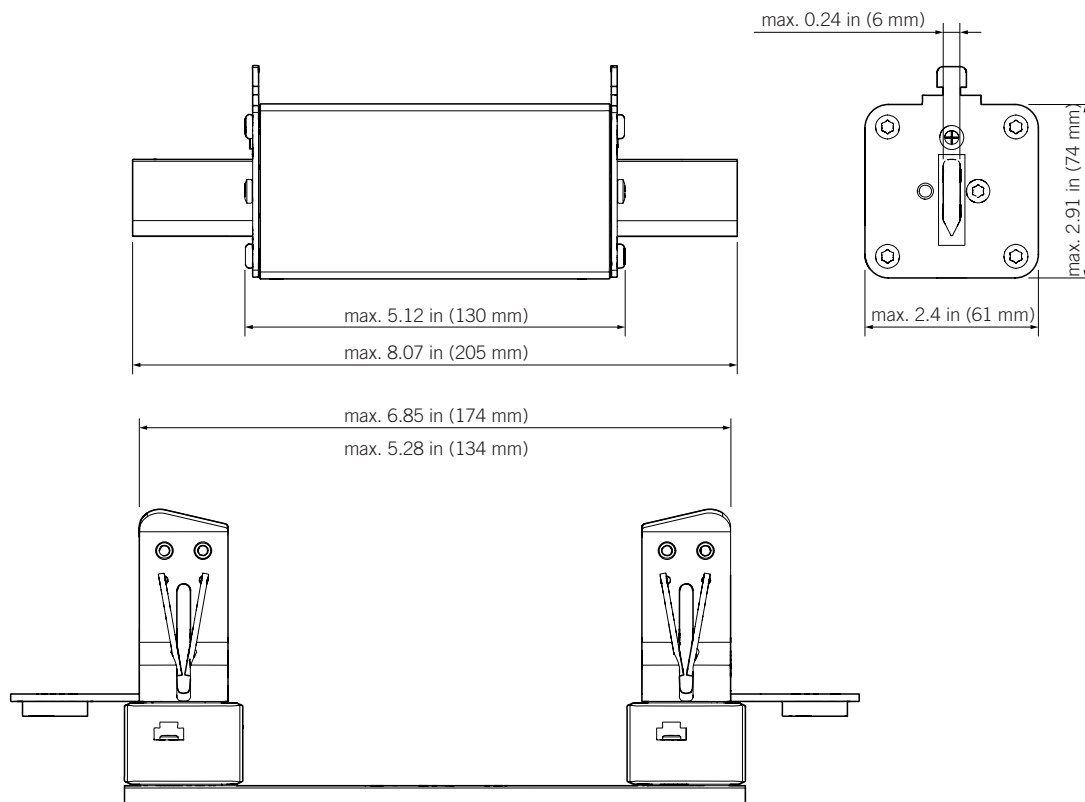
- gPV class.
- Rated current of 50 A ~ 500 A, depending on the specifications of the unit.

Fuses of the following sizes and formats are allowed:

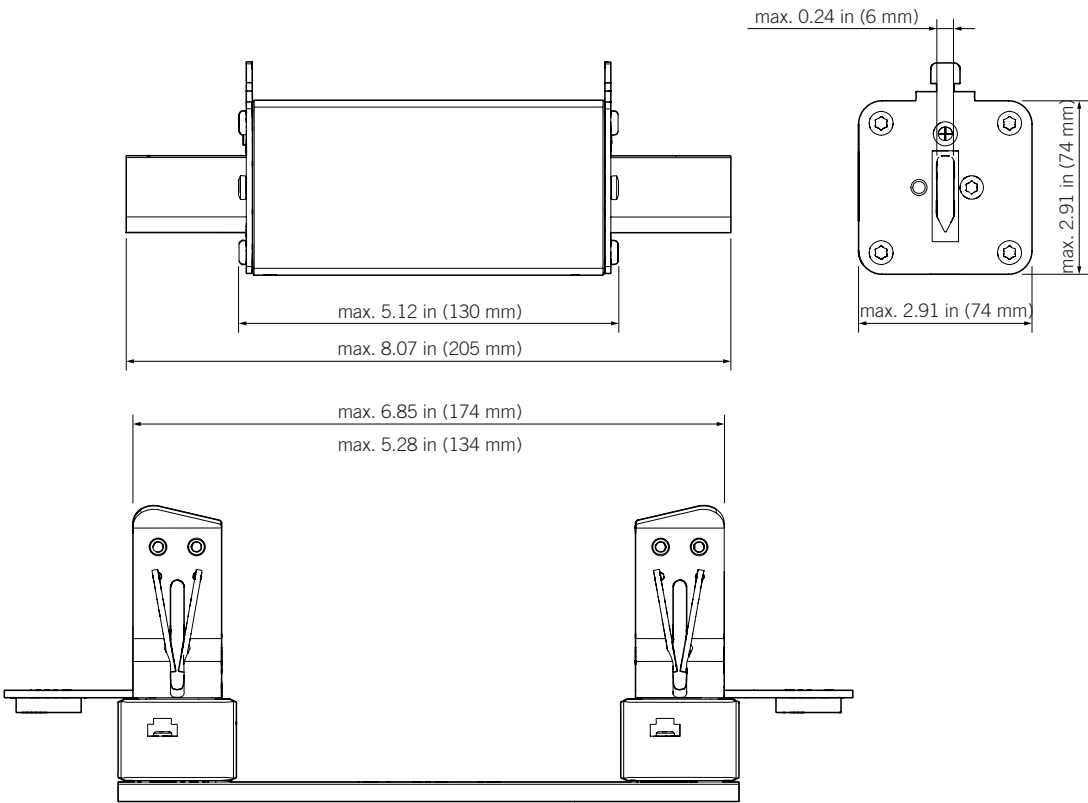
Number of inputs	Number of fuses	Fuse holder base size	Maximum size	Recommended size with I_{max}
6	6 or 12 ⁽¹⁾	3L	630 A	600 A
7	7 or 14 ⁽¹⁾	3L	630 A	500 A
8	8 or 16 ⁽¹⁾	3L	630 A	400 A
9	9 or 18 ⁽¹⁾	3L	630 A	350 A
10	10 or 20 ⁽¹⁾	3L	630 A	315 A
11	11 or 22 ⁽¹⁾	3L	630 A	315 A
12	12 or 14 ⁽¹⁾	3L	630 A	315 A
13	13 or 26 ⁽¹⁾	2XL	400 A	250 A
14	14 or 28 ⁽¹⁾	2XL	400 A	250 A
15	15 or 30 ⁽¹⁾	2XL	400 A	250 A

⁽¹⁾ depending on whether it is installed on the positive pole or both poles.

2XL Mechanical specifications



3L Mechanical specifications



These inverters can be equipped with fuse holders from different manufacturers, that is why in the previous figure they indicate as reference the minimum measures of the fuse holders that can be used.

Approval references

 **CAUTION**

For continuous fire risk protection, only replace with the same fuse.

The following fuse references meet the required electrical and mechanical specifications.

Bussmann	Fuse holder base size	Fuse size	Rated current	Rated voltage
PV-125A-2XL-15	2XL, 3L	2	125 A	1500 VDC
PV-160A-2XL-15			160 A	
PV-200A-2XL-15			200 A	
PV-250A-2XL-15			250 A	
PV-250A-3L-15	3L	3	250 A	
PV-315A-3L-15			315 A	
PV-355A-3L-15			355 A	
PV-400A-3L-15			400 A	

Siba		Fuse holder base size	Fuse size	Rated current	Rated voltage
Without an indicator	With indicator and adapter for microswitch				
20 243 28,250	20 243 29,250	3L	NH3L	250 A	1500 VDC
20 243 28,315	20 243 29,315			315 A	
20 243 28,350	20 243 29,350			350 A	
20 243 28,400	20 243 29,400			400 A	
20 243 28,450	20 243 29,450			450 A	
20 243 28,500	20 243 29,500			500 A	

Mersen	Fuse holder base size	Fuse size	Rated current	Rated voltage
HP15NH3LGPV200	3L	3	200 A	1500 VDC
HP15NH3LGPV250			250 A	
HP15NH3LGPV315			315 A	
HP15NH3LGPV350			350 A	
HP15NH3LGPV400			400 A	

6.8. Requirements for transformers

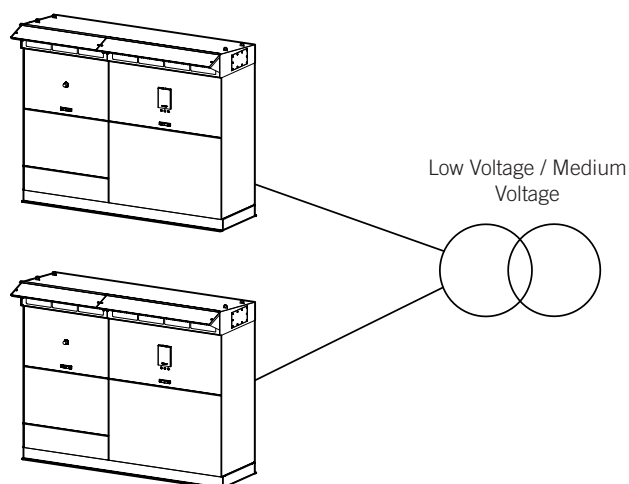
6.8.1. Grid connection transformer

⚠ CAUTION

These units must be connected to a transformer with the neutral of the low-voltage side isolated, thus generating an IT grid.

This section lists the technical specifications of the grid connection transformer which converts the medium or high supply voltage to the operating voltage of the unit.

1. The transformer's power must be greater than the sum of the power ratings of the connected inverters, keeping in mind the locations environmental conditions and height.
2. **If connecting the equipment to the transformer's same low voltage winding, these must be synchronized.** These equipment have all the necessary elements to synchronize up to four inverters.



i INFO

See section "13. Connection of the DCAC connections module" to proceed with connection.

3. PV fields connected by these inverters to the same transformer must have the same voltage settings.
4. The short circuit voltage of a transformer should not be greater than 8% between the primary winding and secondary winding(s).
5. We recommend inserting a grounded metal screen between the high voltage winding and low voltage winding.
6. The low voltage winding must withstand pulsating voltage components with dU/dt of 500 V/ μ S voltage. Because of inverter operation, the voltage between a phase and ground can reach 3/2 of the open circuit voltage of the PV array.
7. We recommend using the Dy11 connection.
8. The connection to the medium voltage grid will be the nominal connection point.
9. We advise using transformers equipped with five-point voltage regulators, with the possibility of selecting the following options:

5%	2.5%	0%	-2.5%	-5%
----	------	----	-------	-----
10. The impedance of the inverter's transformer (Z_{mv}) must be calculated according to the breaking capacity of the inverter's thermomagnetic circuit breaker. Depending on the AC voltage of the inverter, its thermomagnetic circuit breaker supports the following rated short circuit current (I_k):

AC voltage	I_k
Up to 450 Vac	85 kA
460 ~ 690 Vac	65 kA

The following table outlines the transformer's short circuit voltage according to the inverter's AC voltage and the number of inverters connected to the same transformer. The transformer's short circuit voltage (U_{cc}) must be equal to or greater than the ones shown in the following table:

AC voltage	Minimum U_{cc} depending on the number of inverters connected to the same transformer			
	1 inverter	2 inverters	3 inverters	4 inverters
Up to 450 Vac	1.9%	3.8%	5.6%	7.5%
460 ~ 690 Vac	2.3%	4.6%	6.9%	9.2%

No electronic equipment may be connected to the power grid. All auxiliary loads must be isolated from the power grid via a galvanically isolated transformer, as shown in the section "6.8.2. Auxiliary transformer".

CAUTION

The distance between the inverter and the transformer must not be greater than 30 meters.

6.8.2. Auxiliary transformer

Some unit components such as fans, contactors or power supplies, require auxiliary power to operate. No electronic equipment may be connected to the power grid. All auxiliary loads must be isolated from the power grid via a galvanically isolated transformer.

This is why it is essential to install an auxiliary services transformer with galvanic isolation, suitable for the grid with a single phase voltage of 220 V 50/60 Hz.

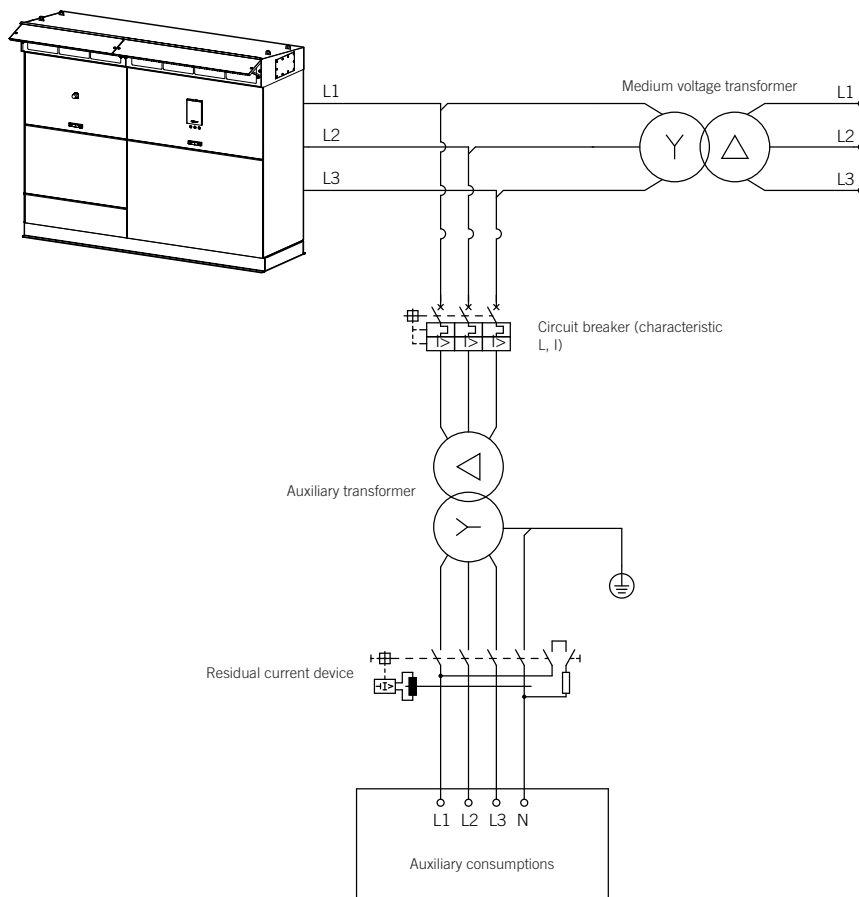
CAUTION

The Auxiliary service transformer must have galvanic insulation. It is forbidden to use autotransformers or other devices without galvanic isolation to match the grid voltage to the single phase voltage required for the proper operation of the unit.

Ingeteam accepts no liability for any consequences arising from non-compliance with these instructions.

It is possible to install the *auxiliary services kit*, and if you prefer you may install an auxiliary transformer acquired from third parties. In this last example, you should follow the following guidelines.

The auxiliary transformer transforms the voltage from the power part of the unit to its control and current part.



The primary circuit is connected to the power input. We recommend installing protection and switching components to protect this transformer.

In the event of using a residual current device between the transformer secondary connected to ground and the auxiliary loads of the unit, said device shall be 300 mA, of industrial use, a selective version and super immune.

The technical requirements of the auxiliary transformer are:

- The transformer's power should be suitable for the loads connected to it, taking the site environmental conditions into account. The minimum power value is 4700 VA per inverter.
- The power winding must withstand pulsating voltage components with dU/dt of 500 V/μs. Because of inverter operation, the voltage between a phase and ground can reach 3/2 of the open circuit voltage of the PV array.
- Delta connection is advised in the power part and star connection in auxiliary loads.
- We recommend connecting the neutral of the auxiliary loads to ground.

6.9. Measuring equipment connected to the power grid

All measuring devices connected to the power grid (wattmeters, meters, etc.) should be isolated from the grid by voltage transformers, current transformers, etc.

7. Installing the unit

Before installing the unit, you must remove the packaging, taking special care not to damage the housing.

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

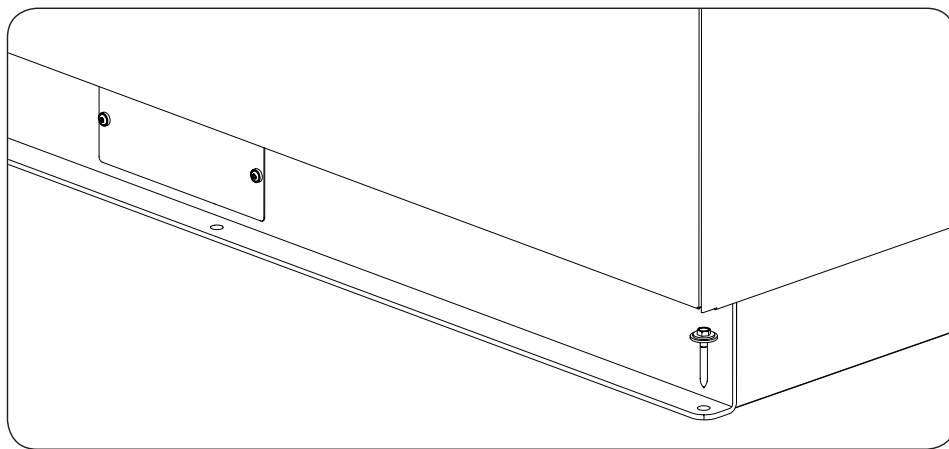
CAUTION

All installation operations must comply with current regulations.

Before carrying out the installation, take into account the instructions in section “6. Preparation for installing the unit”.

7.1. Fixing the unit to the floor

To fasten the inverter, bolt a series of bolts to the ground via the dedicated holes on the lower base.



Follow these steps:

1. Mark the fixing points on the floor.
2. Drill the ground with a proper bit.
3. Bolt through the base's holes.
4. Check that the unit properly secured.

7.2. Opening the ventilation system protections

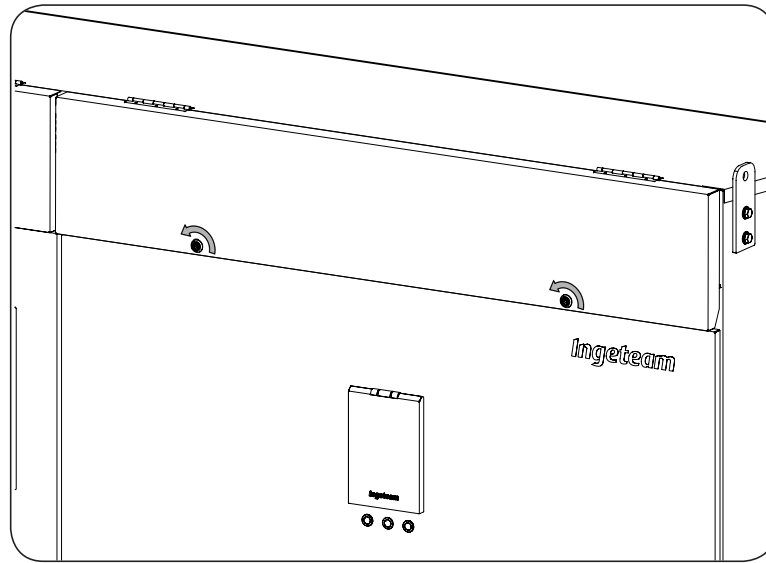
CAUTION

The ventilation system protection must remain open whenever the unit is running. Failing to do this may cause faults.

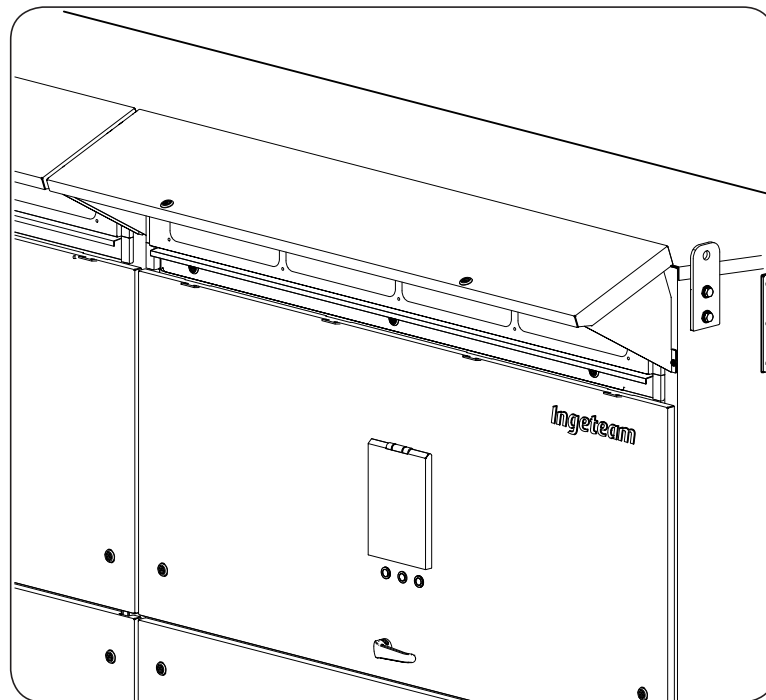
Ingeteam accepts no liability for the consequences of non-compliance with this warning.

Before starting the connections, the ventilation system protections must be opened. To do this, take the following steps:

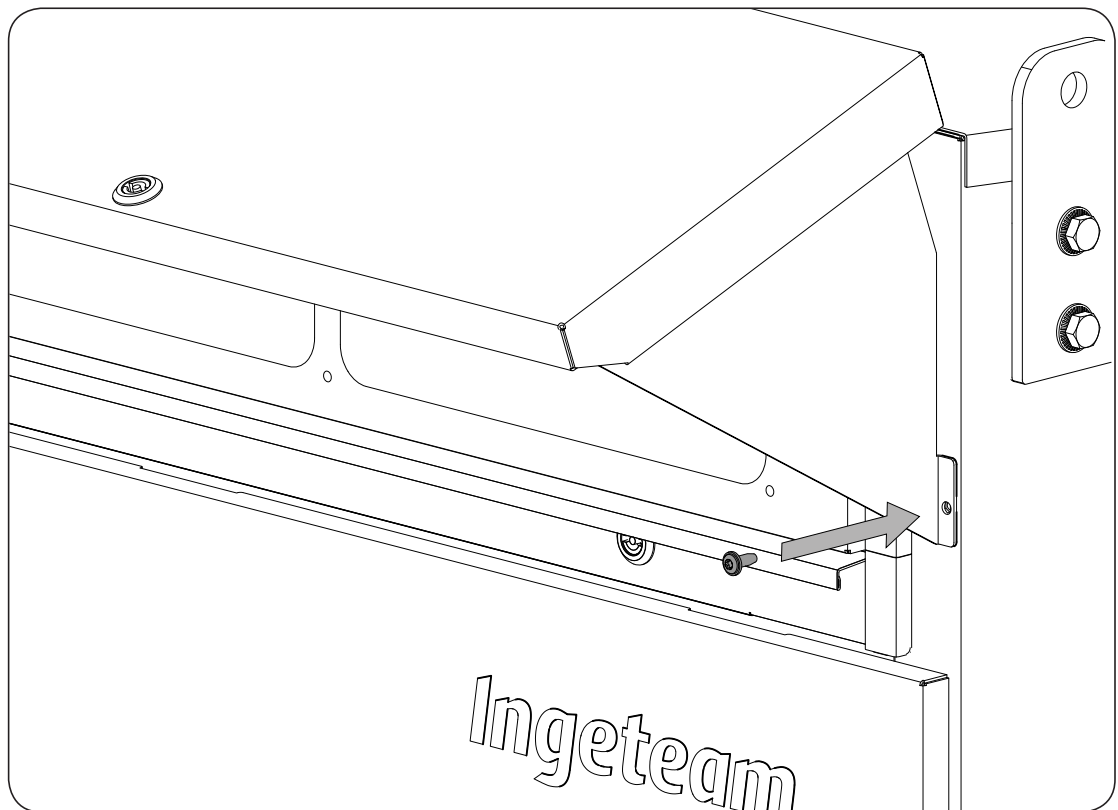
1. For each of the front side protections, release the two frontal locks turning them counterclockwise one quarter of the way using the key provided.



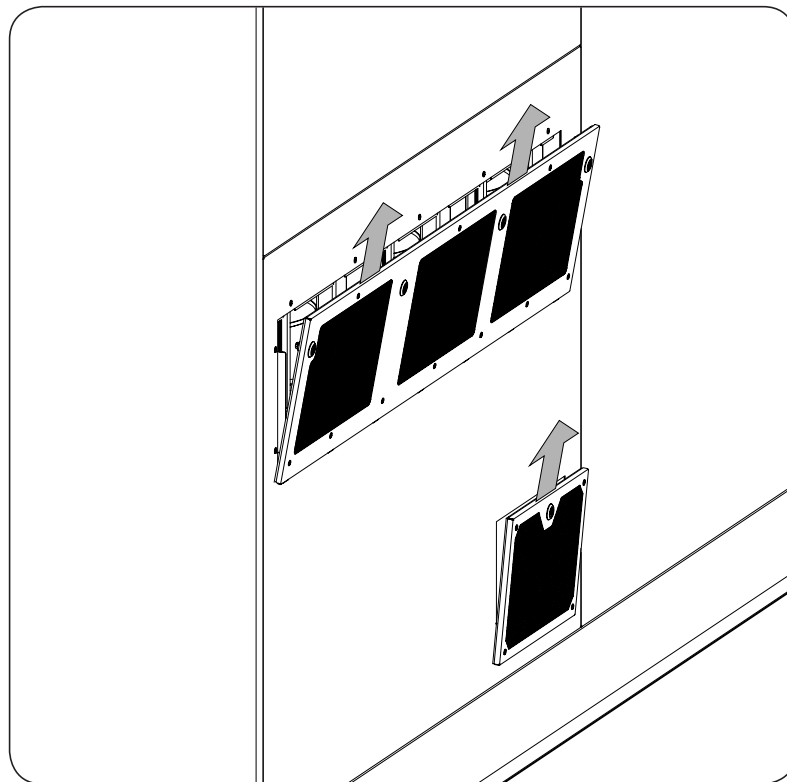
2. Open the protection and extend the folding supports on both ends.



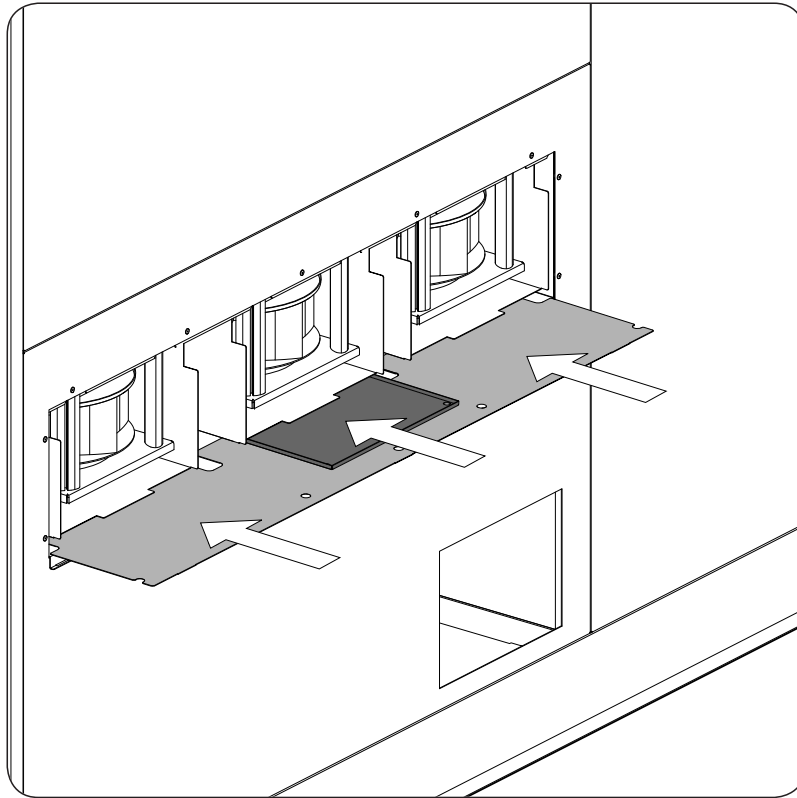
3. Fasten the two supports using bolts.



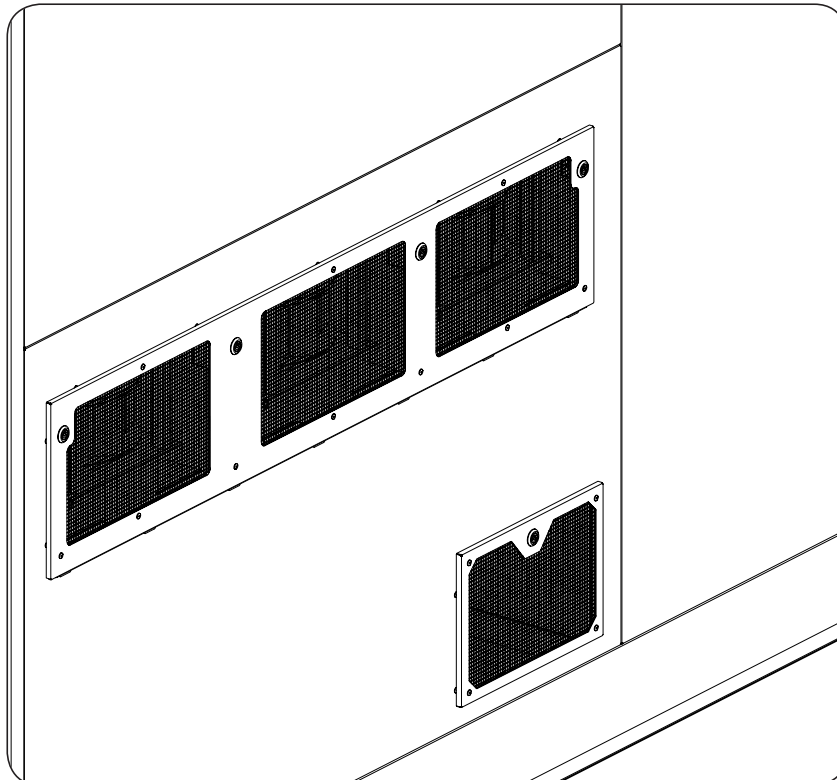
4. If the inverter is fitted with a sand trap kit, remove the grilles from the rear side. The protections in the rear ventilation system are removed together with these.



5. Insert the protections from both ventilation ducts in the receptacle shown in the following figure.



6. Close both grilles.



7.3. Connection process sequence

Once the unit has been mounted in its final position and has been solidly secured, make the electrical connections to it. The order is as follows:

1. Ground connection.
2. DC connection.
3. Connection of the PV array grounding kit [optional].
4. Auxiliary services connection.
5. Communication accessories connection.
6. Synchronization connection.
7. Options connection.
8. Optional kit connection.
9. AC connection.

DANGER

Before starting the connection process, press the emergency stop button and keep it interlocked until all the connections required for the unit to operate correctly have been made.

Do not power the inverter until you have made all the connections and the unit is closed.

8. Ground connection

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

Read carefully before starting the connection process.

INFO

All unit grounds must be electrically interconnected.

To find the different components listed below, consult Section *"2.6. Location of components"*.

Refer to Section *"Important safety instructions"* and the safety paragraph in this section before operating the equipment.

8.1. Safety instructions for the ground connection

DANGER

Before starting the connection process, press the emergency stop button and keep it interlocked until all the connections required for the unit to operate correctly have been made.

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 capacitances are fully discharged.

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

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

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

Use the Personal Protective Equipment specified in section *"Personal Protective Equipment"*.

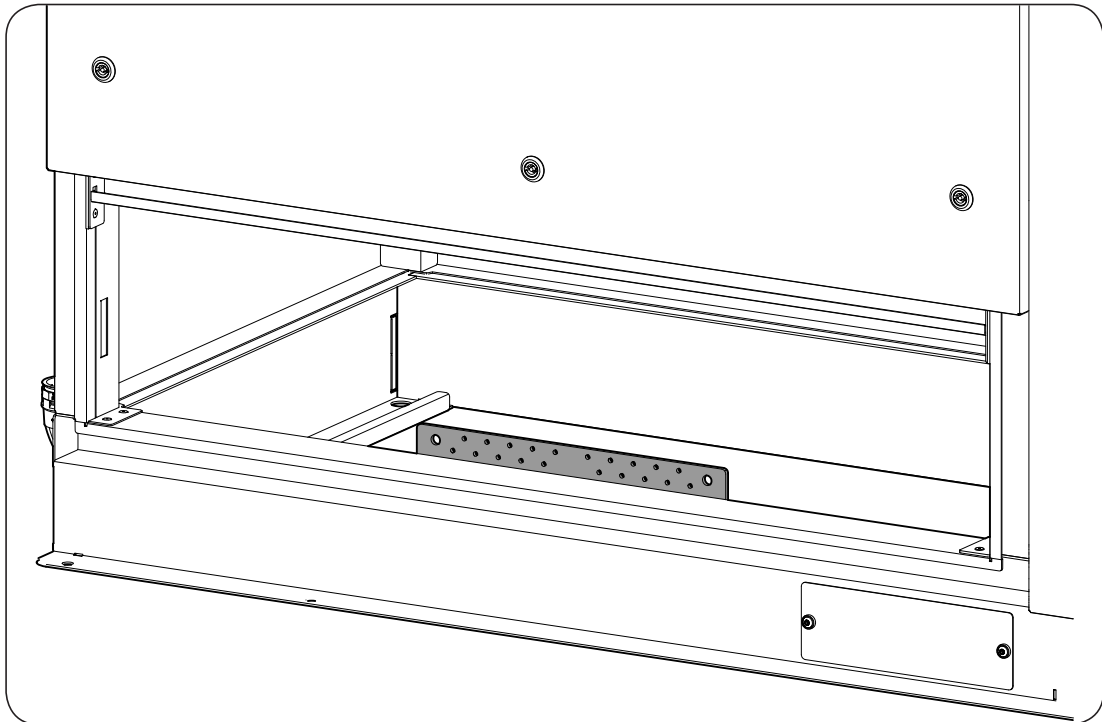
CAUTION

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 shavings in the threads when screwing them in and apply a suitable lubricant.

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

8.2. Connection area

The metal parts of the inverter (equipment ground) are electrically connected to the grounding bar on the front of the DCAC connections module. All ground connections must be done here.



8.3. Wiring requirements for the ground connection

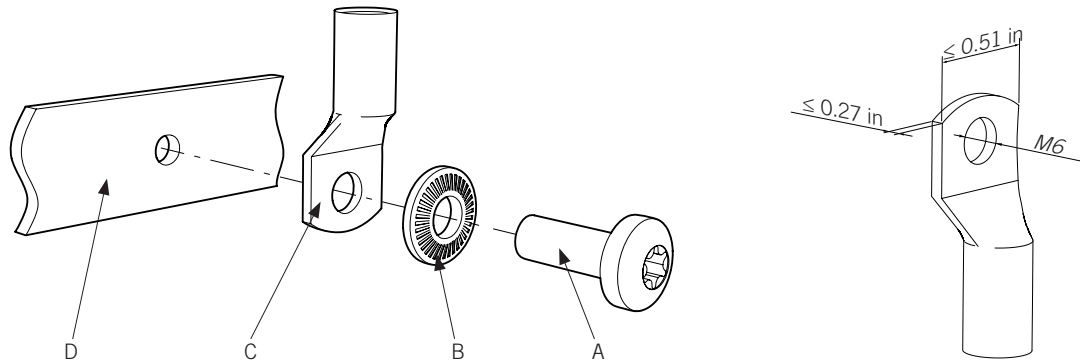
- The correct dimensioning of the grounding conductor is the installer's responsibility, depending on the plant specifications and inverter characteristics. The recommended minimum cable size is 6 AWG.
- All cables must withstand temperatures greater than +194 °F (+90 °C) and comply with the *National Electrical Code ANSI/NFPA 70*.
- The ground connection wiring gauge depends on the overcurrent protection device installed in the main circuit-breaker of the unit. The gauge must be in accordance with the *National Electrical Code ANSI/NFPA 70* and its article 250.122.
- The installation must be grounded in accordance with articles 690.41 to 690.47 of the *National Electrical Code ANSI/NFPA 70*.
- Copper and aluminum cables must be used, dimensioned based on inverter and PV plant characteristics.
- The selected breaking capacity on the AC thermomagnetic circuit breaker AC is 65 kA.
- Ingeteam accepts no responsibility for the installation of the inverter in installations with a higher than specified short-circuit current.
- The short-circuit current delivered by the inverter is considerably lower than the breaking capacity of the AC thermomagnetic circuit breaker.

8.4. Ground connection via a terminal

8.4.1. Requirements for the ground connection via a terminal

- For the ground connection, the terminals must be compression terminals.
- Only use the bolts and washers provided by Ingeteam upon delivery of the unit.
- Use copper or tinned copper terminals.

- The torque should be 50 lb.in (5.6 Nm).



- A. Torx T30 bolt.
- B. M6 washer.
- C. Terminal. Hole diameter of M6, maximum thickness of 0.27 in (7 mm), maximum width of 0.51 in (13 mm).
- D. M6 Threaded busbar.

8.4.2. Making the ground connections via a terminal

1. Strip the cable according to the size of terminal to be used.
2. Crimping the terminal on the cable.
3. Clean the contact surfaces on both the terminal and the connection bar with a clean cloth and ethanol.
4. Connect the terminal to the connection bar using the bolts and washers supplied by Ingeteam with the unit, respecting the torque specified.
5. Ensure the correct connection of the cable and terminal.

9. DC connection

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

Read carefully before starting the connection process.

INFO

To find the different components listed below, consult Section “2.6. Location of components”.

Refer to Section “Important safety instructions” and the safety paragraph in this section before operating the equipment.

9.1. Safety instructions for the DC connection

DANGER

DC cables connected to PV panels exposed to sunlight may be at a dangerously high voltage which could cause serious injury and even death.

Before connecting DC cables to the inverter verify the absence of voltage.

Before starting the connection process, press the emergency stop button and keep it interlocked until all the connections required for the unit to operate correctly have been made.

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 capacitances are fully discharged.

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

There is a risk of fire when using wiring gauges with a lower permissible current than the maximum possible from the PV modules.

After working on the terminals the polycarbonate guard must be put back into place.

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

Use the Personal Protective Equipment specified in section “Personal Protective Equipment”.

CAUTION

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 shavings in the threads when screwing them in and apply a suitable lubricant.

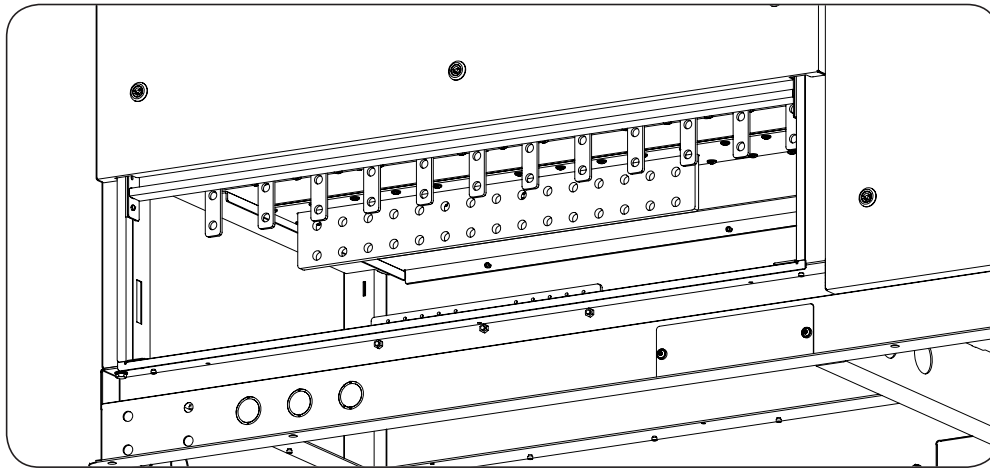
The polarities indicated in the following figure must be followed. Ingeteam accepts no liability for any damages caused by an incorrect connection.

Before connecting the wires, ensure that the DC fuses are not fitted in the bases. Install fuses once you have connected the wiring and checked that the polarity is correct.

Ingeteam accepts no liability for the consequences of non-compliance with these instructions.

9.2. Connection area

The PV array connections are made in the part of the DCAC connections module shown in the following figure. The DC supply will be different depending on the selected configuration.



9.3. Wiring requirements for the DC connection

- Use only copper or aluminum cables.
- The DC connection cables must withstand at least 1000 V between poles and between each pole and ground.
- All cables must withstand temperatures greater than +194 °F (+90 °C) and comply with the *National Electrical Code ANSI/NFPA 70*.
- The cable gauge must be based on the continuous currents permitted in table 310.16 of the *National Electrical Code ANSI/NFPA 70*.

9.4. DC connection via a terminal

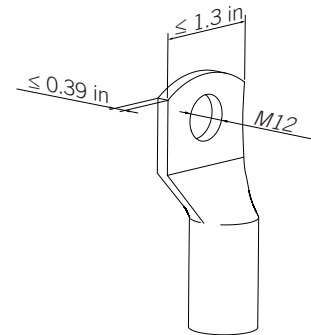
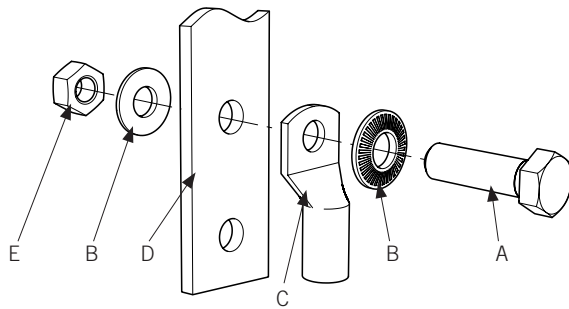
9.4.1. Requirements for DC connection via a terminal

- For DC connection, compression terminals must be used. The terminals used can be with 1 or 2 holes.
- The inverter busbars are made of copper. We recommend using tinned copper terminals, while copper terminals are allowed. If you use aluminum cables, you must use bimetallic terminals or other components that eliminate the galvanic couple of the joint.
- No more than two cables should be connected to each DC busbar.
- Only use the bolts and washers provided by Ingeteam upon delivery of the unit.
- All torques indicated must be respected and maintained.

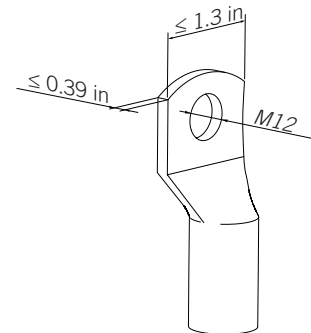
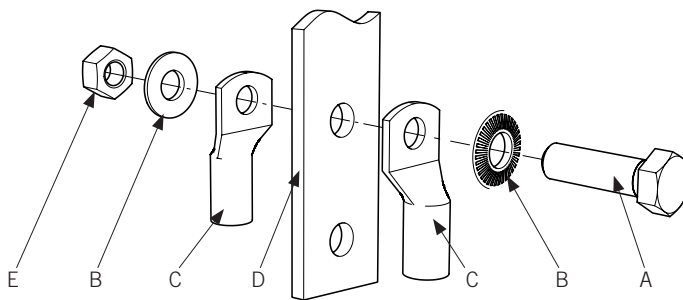
	Wire gauge	Tightening torque. M12 screws (lubricated*)
Minimum	In accordance with the current circulating through the conductors	405 lb.in (45.7 Nm) (with lubrication)
Maximum	750 kcmil**	

* The fasteners are supplied factory lubricated with Loctite 8009. If necessary, apply the same lubricant again or another compatible one.

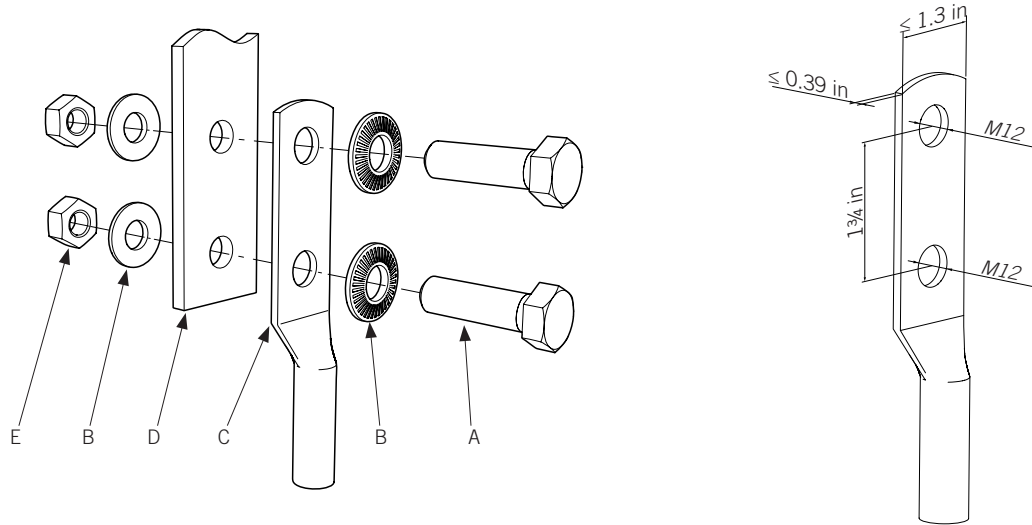
** To facilitate handling of the wiring, Ingeteam recommends using more than one smaller gauge cable instead of one large gauge cable. For example, it is preferable to use two 400 kcmil cables instead of one 750 kcmil cable.

DC connection via a terminal with one hole

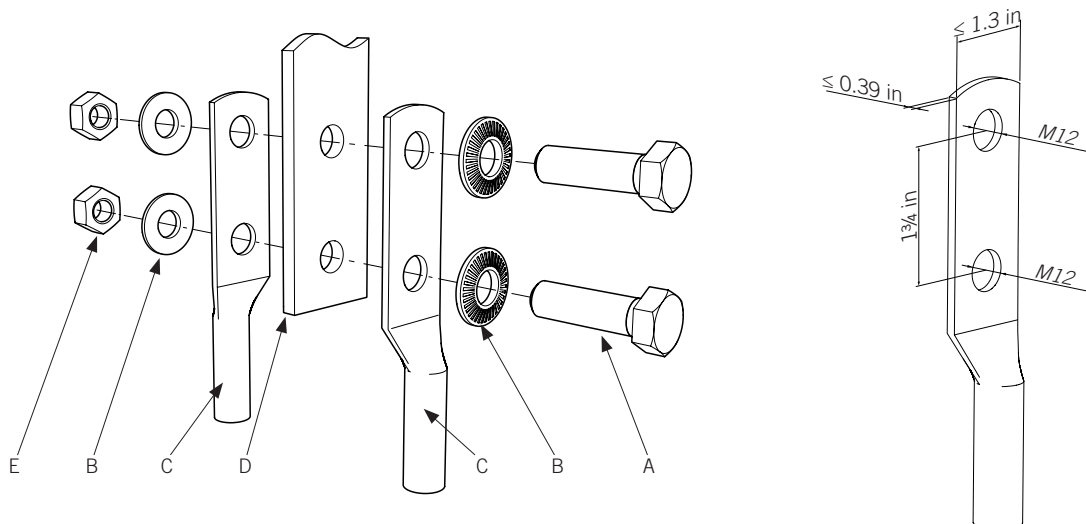
- A. M12 hex head bolt.
- B. M12 washer.
- C. Terminal. Hole diameter of M12, maximum thickness of 0.39 in (10 mm), maximum width of 1.3 in (33 mm).
- D. Busbar. When using a single hole terminal, use only the **top hole** in the connection position of the plate.
- E. M12 nut.

DC connection via two terminals with one hole

- A. M12 hex head bolt.
- B. M12 washer.
- C. Terminal. Hole diameter of M12, maximum thickness of 0.39 in (10 mm), maximum width of 1.3 in (33 mm).
- D. Busbar. When using a single hole terminal, use only the **top hole** in the connection position of the plate.
- E. M12 nut.

DC connection via a terminal with two holes

- A. M12 hex head bolt.
- B. M12 washer.
- C. Terminal. Hole diameter of M12, maximum thickness of 0.39 in (10 mm), maximum width of 1.3 in (33 mm), vertical distance between holes of 1 ³/₄ in (44.5 mm).
- D. Busbar.
- E. M12 nut.

DC connection via two terminals with two holes

- A. M12 hex head bolt.
- B. M12 washer.
- C. Terminal. Hole diameter of M12, maximum thickness of 0.39 in (10 mm), maximum width of 1.3 in (33 mm), vertical distance between holes of 1 ³/₄ in (44.5 mm).
- D. Busbar.
- E. M12 nut.

9.4.2. DC connection process

⚠ DANGER

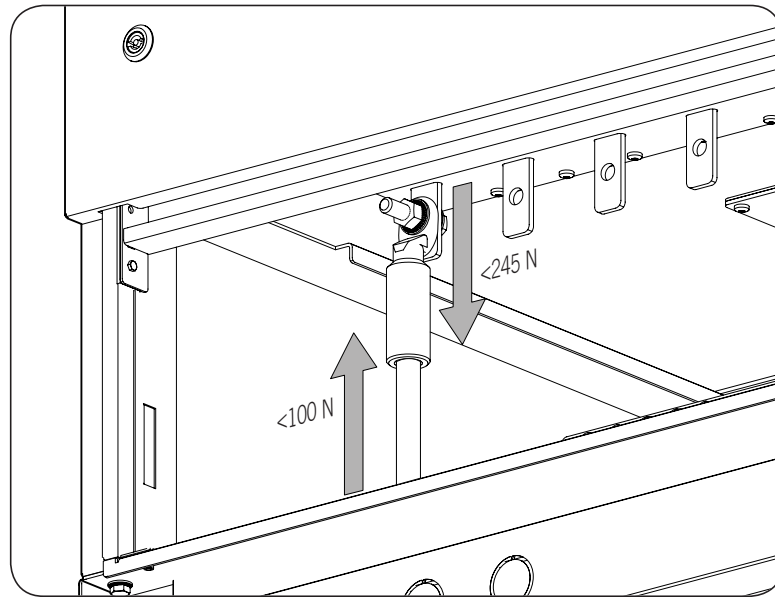
Reverse connection of the DC would have fatal consequences on the unit and could cause serious damage to persons close to the unit.

Respect the connections indicated in the figures bearing in mind the polarity.

⚠ CAUTION

In the DC connections the forces exerted by the cabling must not deform the plates. The maximum vertical limits are indicated in the following figure.

Appropriate systems must be installed to ensure this requirement is met. Ingeteam accepts no liability for the consequences of non-compliance with this warning.

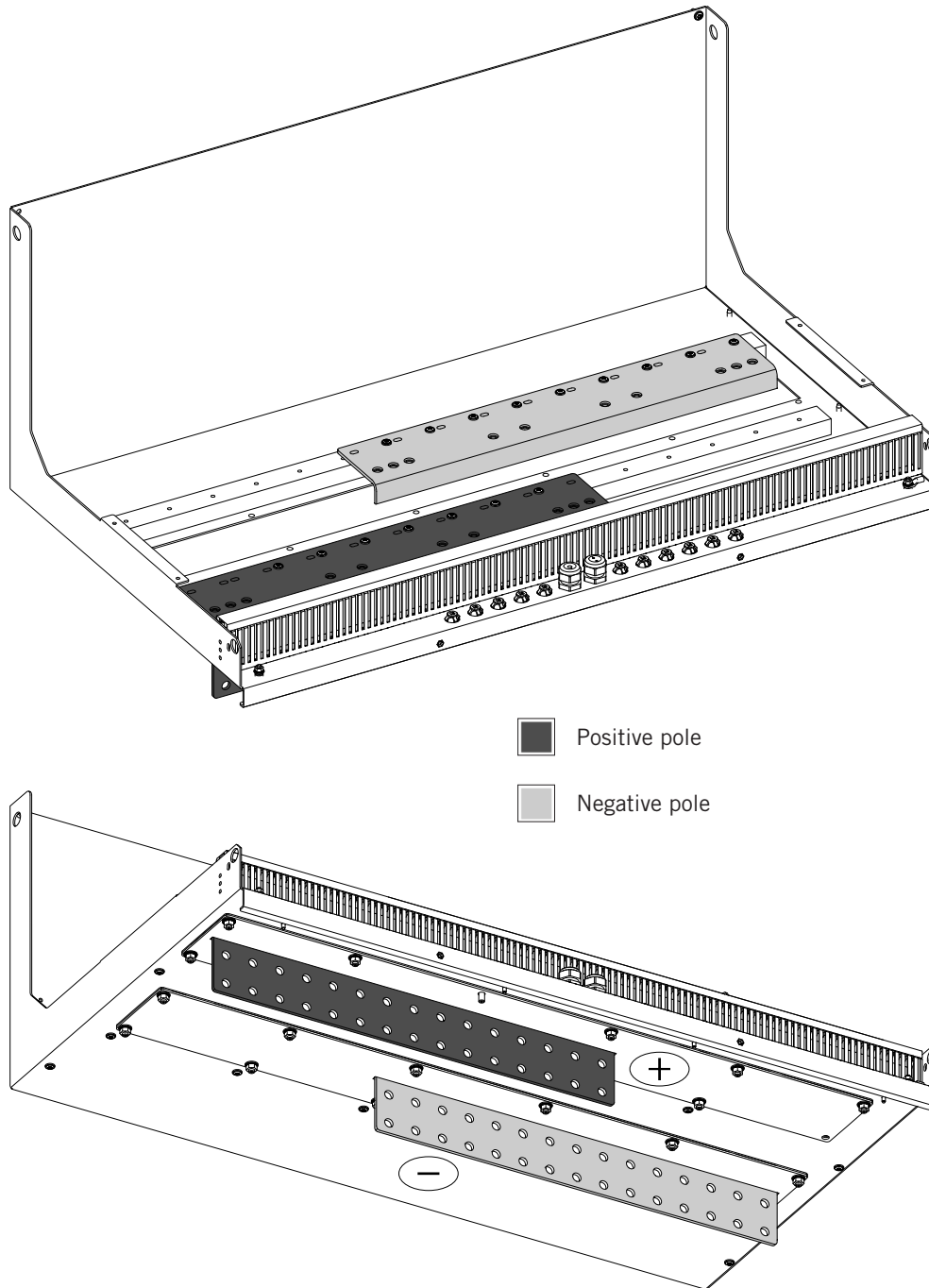


To connect the DC wiring, carry out the following process:

1. Access the DC power supply by removing it and the dedicated panels.
2. If the unit has DC feed fuses, ensure that these are not fitted in their bases. If this is not the case, remove them (see Section “9.5. Connection/disconnection of the DC fuses”).
3. Strip the cable according to the size of terminal to be used.
4. Crimping the terminal on the cable.
5. Clean the contact surfaces on both the terminal and the connection bar with a clean cloth and ethanol.
6. Connect the terminal to the busbar via the bolts and washers supplied by Ingeteam upon delivery of the unit, respecting the indicated tightening torque and polarities indicated in the following points of this section, relative to the fuses installed (see figures below).
7. Check polarity of the strings connected to the inverter. If the polarity is incorrect, change it. Connecting a string with the incorrect polarity and starting up the unit can cause irreversible damage to the unit.
8. If the unit has fuses, install them in their bases (see Section “9.5. Connection/disconnection of the DC fuses”).
9. Reinstall it or the panels.

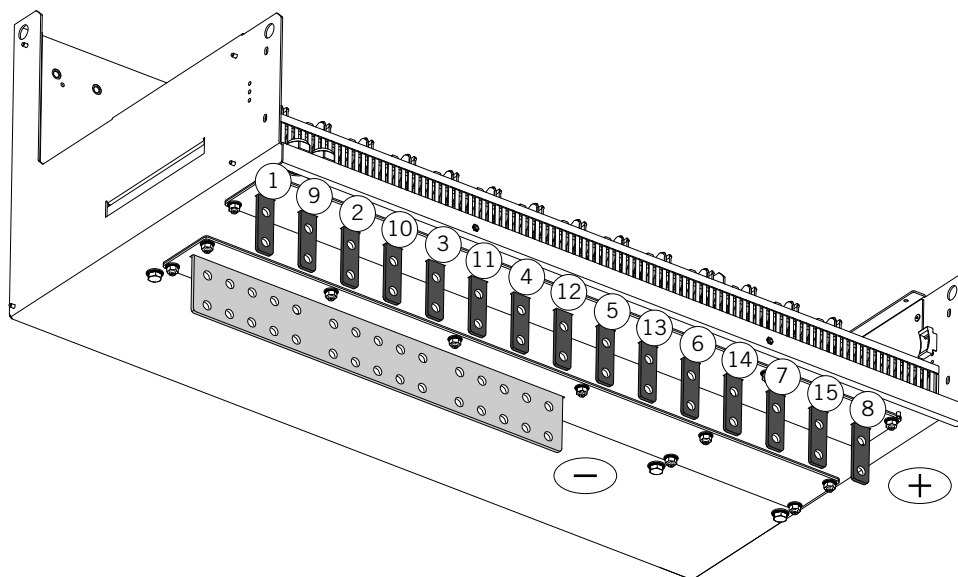
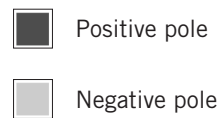
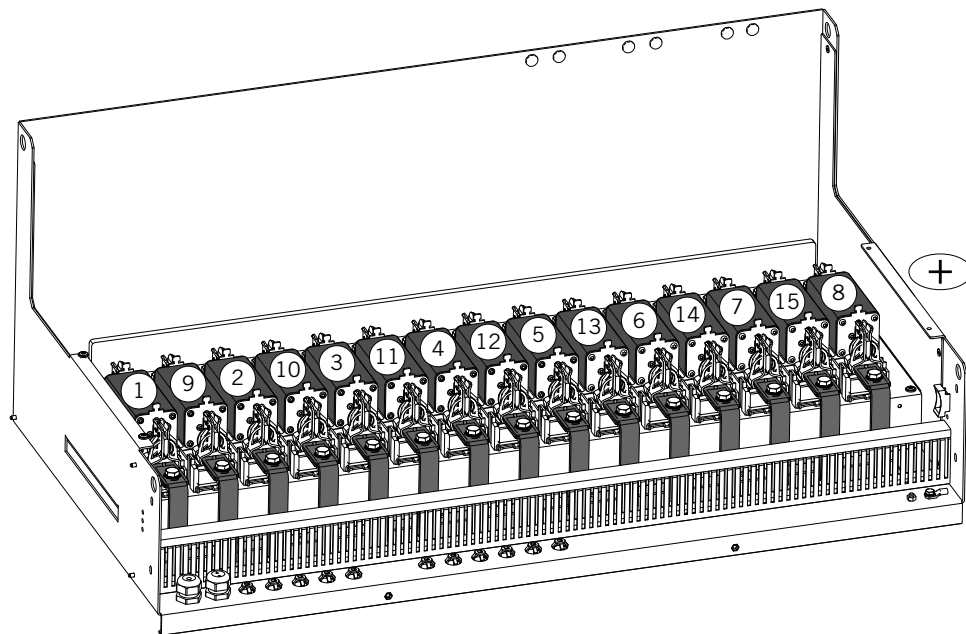
Units without fuses

To connect the DC, respect the indicated polarities in the following figure:



Units with fuses in the positive pole

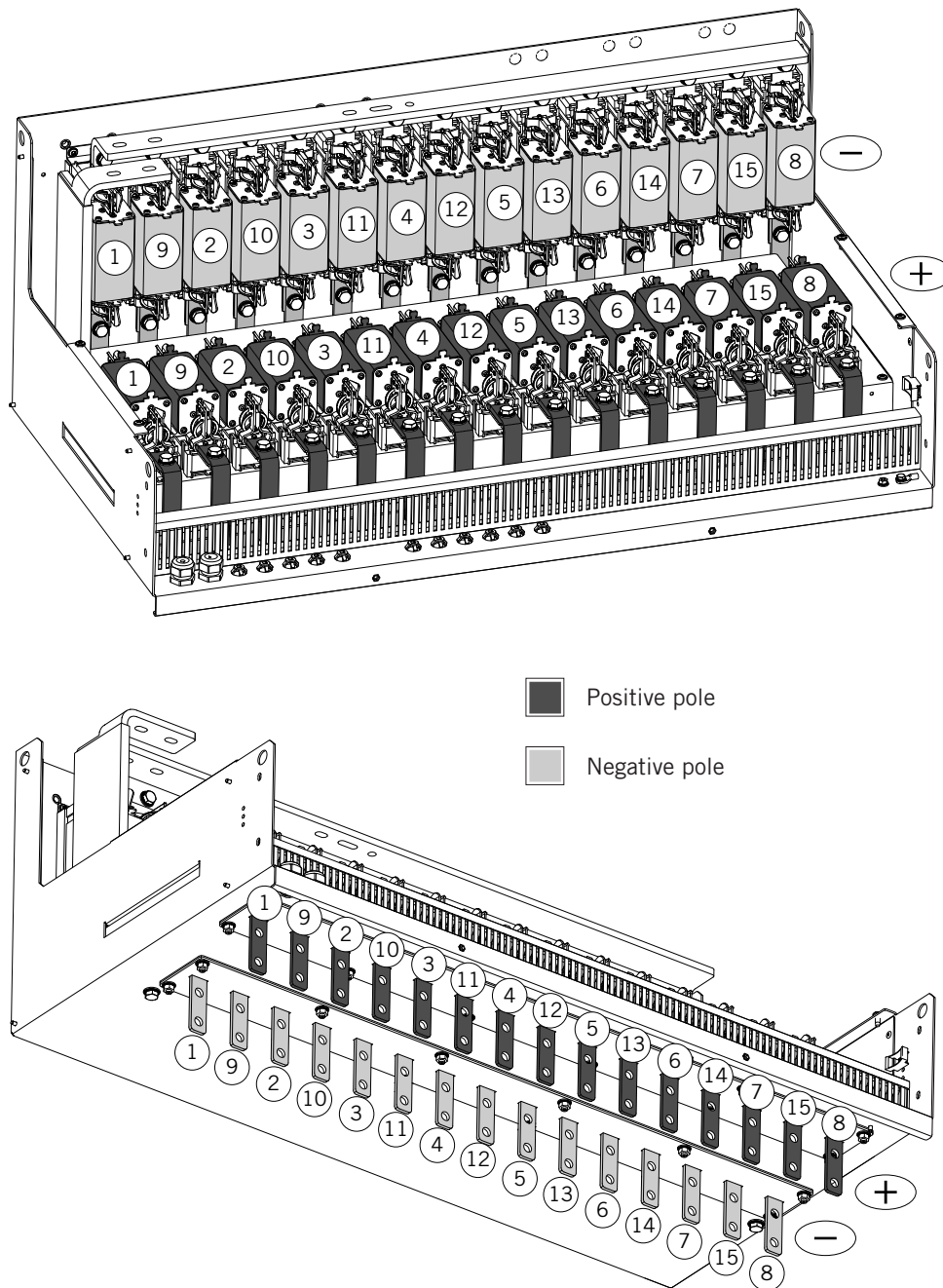
To connect the DC, respect the polarities and the order of the connection busbars specified in the following figure:



The number of fuses and connections varies as a function of the selected configuration.

Units with fuses in the positive and negative poles

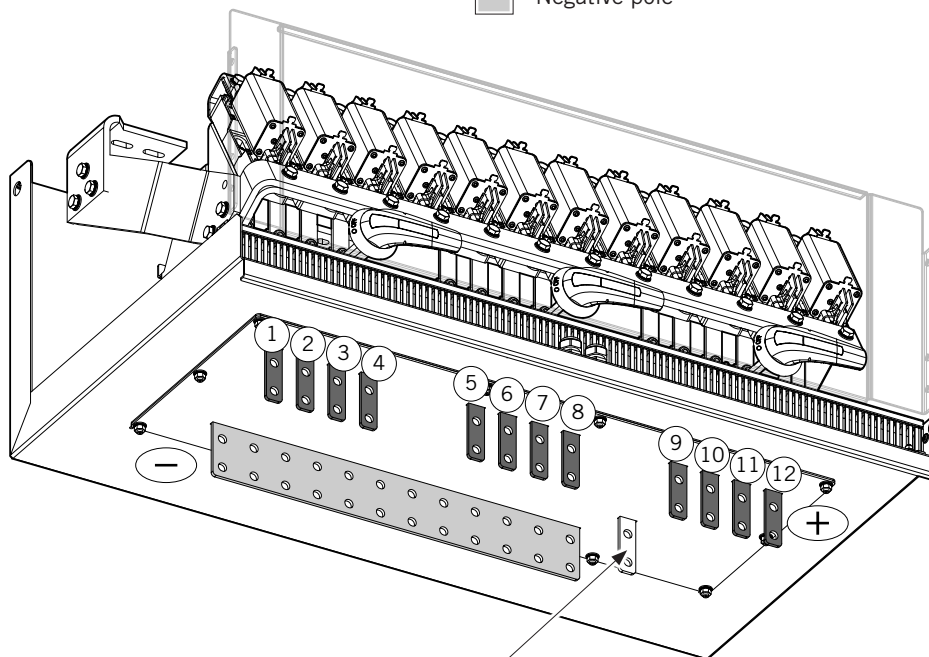
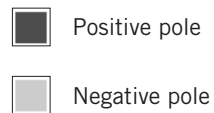
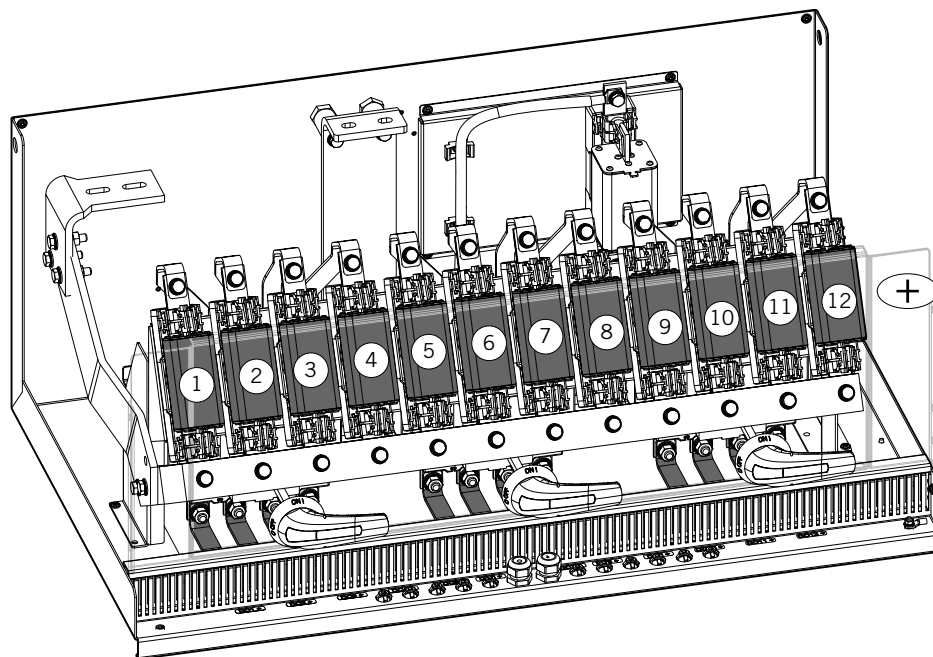
To connect the DC, respect the polarities and the order of the connection busbars specified in the following figure:



The number of fuses and connections varies as a function of the selected configuration.

Units with *Integrated DC combiner box* with fuses on the positive pole

To connect the DC, respect the polarities and the order of the connection busbars specified in the following figure:



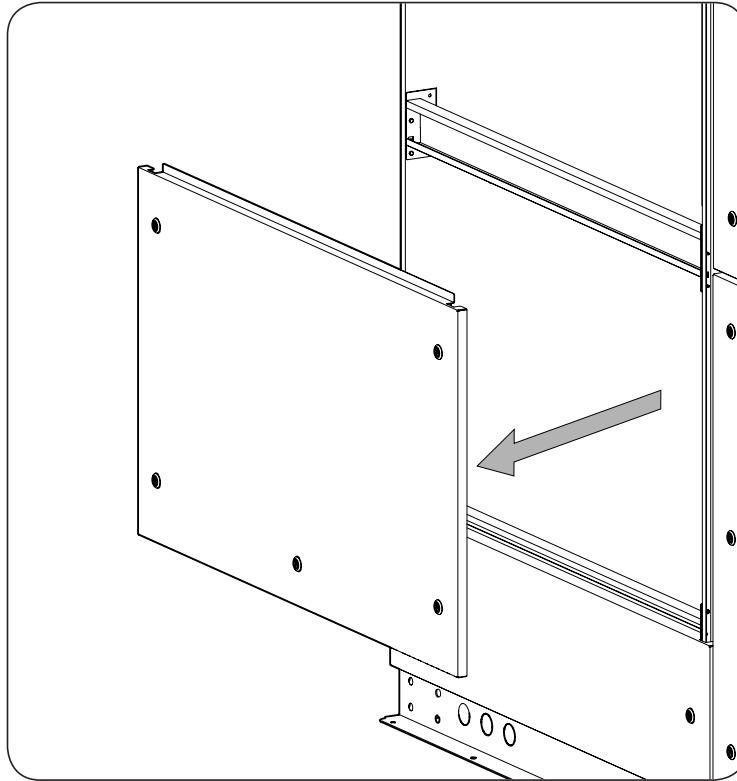
Busbar if several inverters are connected to the same winding
(see section "10.2. Units connected to the same transformer windings")

The number of fuses and connections varies as a function of the selected configuration.

9.5. Connection/disconnection of the DC fuses

After connecting the cables, the DC fuses should be fitted. To install, follow this order:

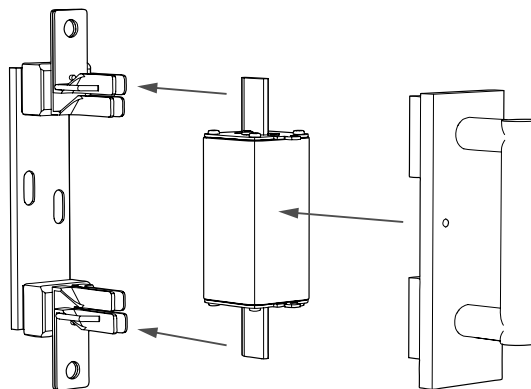
1. Open the folding door of the DCAC connections module.
2. Remove the mid-frontal cover.



CAUTION

To install fuses in their holders, use a tool designed for this task, as well as for removing them.

3. Insert the fuse guides into the guides on the tool and insert the fuse into its holder, making sure that the fuse is completely inserted.



4. When it has been installed, remove the tool.
5. Close the housing.

The process for removing the fuses is the reverse of the above.

10. Connection of the PV array grounding kit [optional]

i INFO

To find the different components listed below, consult Section “2.6. Location of components”.

Refer to Section “Important safety instructions” and the safety paragraph in this section before operating the equipment.

This kit enables the grounding of the negative pole of the PV array, depending on the technology of the panels used or the applicable standard. The ground connection of the PV array is made via a 5 A fuse in accordance to the standard UL1741.

If the inverters are connected to independent windings, the grounding for each of them is independent (standard configuration). The grounding of inverters connected to the same transformer winding must be shared and unique, as otherwise there could be current flowing between the different ground connections, so additional wiring is required.

The different types of connection are explained below.

10.1. Units connected to independent transformer windings

If the inverter or inverters are connected to independent windings (galvanically insulated from each other), their grounding must be independent, therefore no additional wiring is required between the units.

10.2. Units connected to the same transformer windings

To perform this ground connection, one of the inverters connected to the transformer winding must have the grounding kit (-TSGND).

For a single ground connection, the grounded poles are connected between all the inverters and are grounded at a single common point.

The connection of the grounded poles of the inverters must be done using a copper or aluminum wire of 35 mm² to 50 mm² and at least 1500 V insulation (not supplied by Ingeteam) and fuses (supplied by Ingeteam). The purpose of these fuses is not to protect the ground connection but to offer the installer the possibility of insulating the units in a simple way in order to carry out maintenance tasks.

When operating, the inverters behave as completely independent units.

It is important to distinguish two scenarios:

- Two units connected to the same transformer winding.
- Three units connected to the same transformer winding.

10.2.1. Two units connected to the same transformer winding

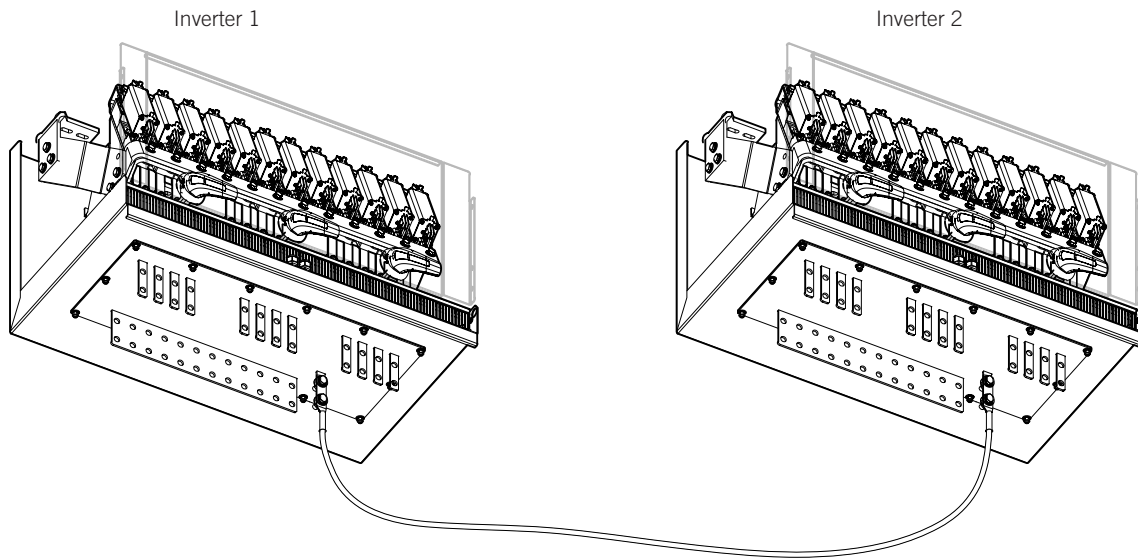
When connecting two units to the same transformer winding, the grounding of the system must be unique and shared, as otherwise there could be currents flowing through the different ground connections.

Each inverter will be equipped with the following elements to carry out the configuration:

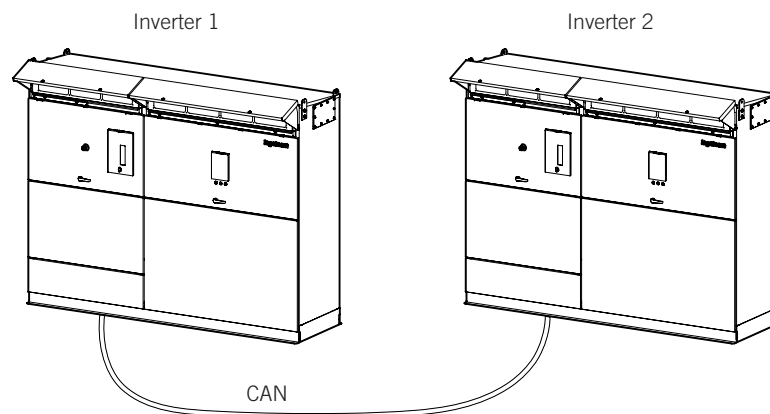
- One independent input with 1500 V fuse to connect the grounded fuses.
- One CAN communication cable for connecting the communications of both inverters.

Once the units have been installed, the following connections are performed:

1. Connect the grounded pole of each unit through a 35 mm² section cable with 1000/1500 V insulation. This connection can be done through the cable grommets provided in the bases of the units in question.

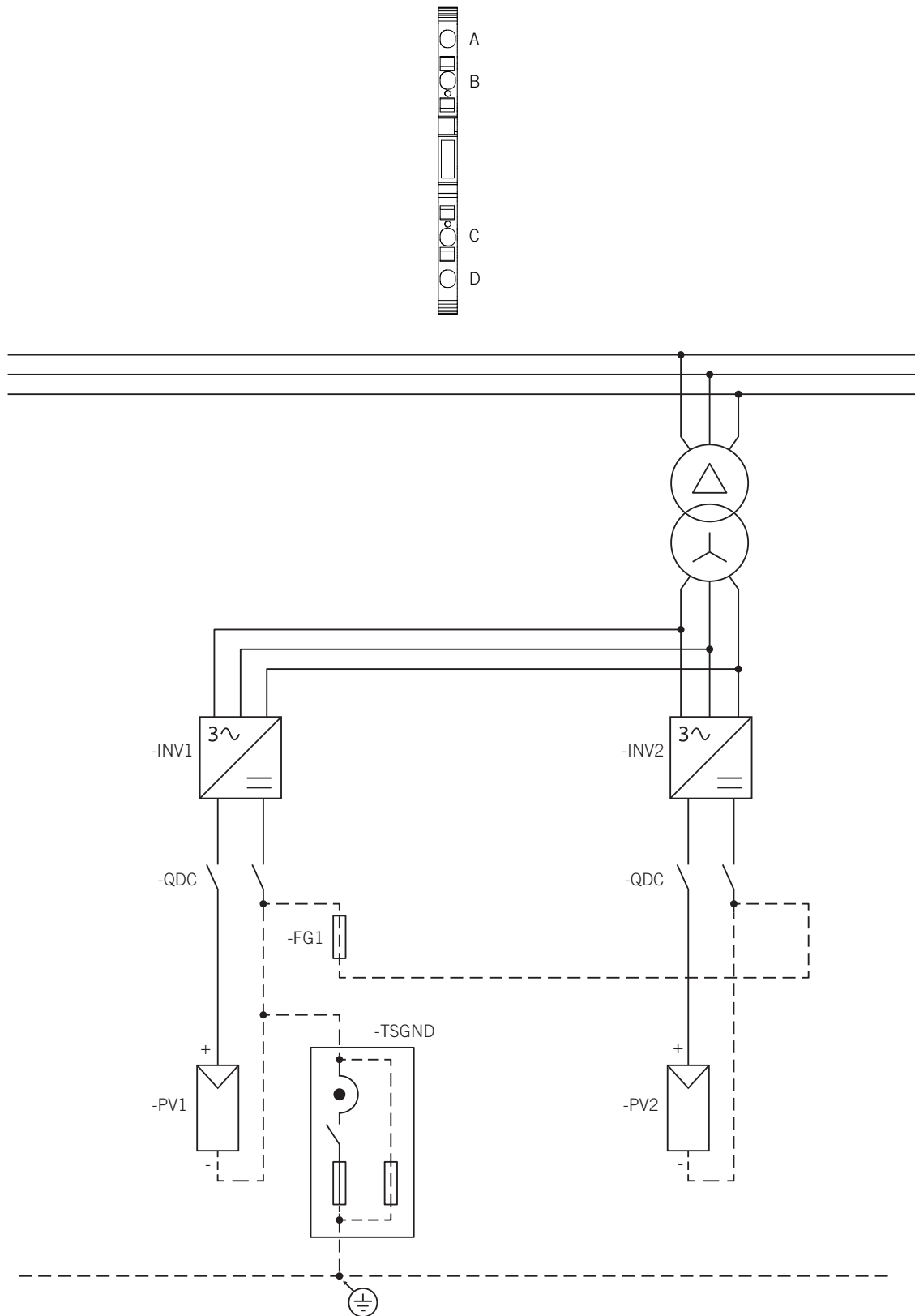


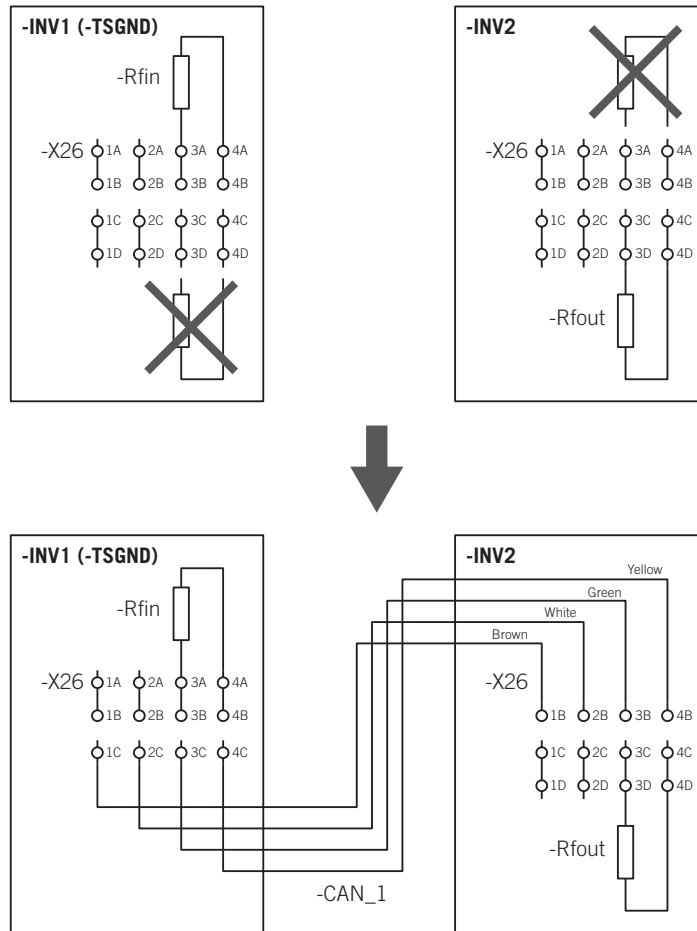
2. Connect the CAN communication buses from both inverters using the cable provided. To connect the communication buses, carry out the following process:



On the inverter where the grounding kit (-TSGND) is being installed, remove the end of line resistor from the wiring between -X26.3D and -X26.4D and connect the CAN cable with the color code described in the diagram to -X26.1C, -X26.2C, -X26.3C, -X26.4C.

On the other inverter, remove the end of line resistor from the wiring between -X26.3A y -X26.4A and connect the other end of the CAN cable with the color code described in the diagram to -X26.1B, -X26.2B, -X26.3B, -X26.4B.





10.2.2. Three units connected to the same transformer winding

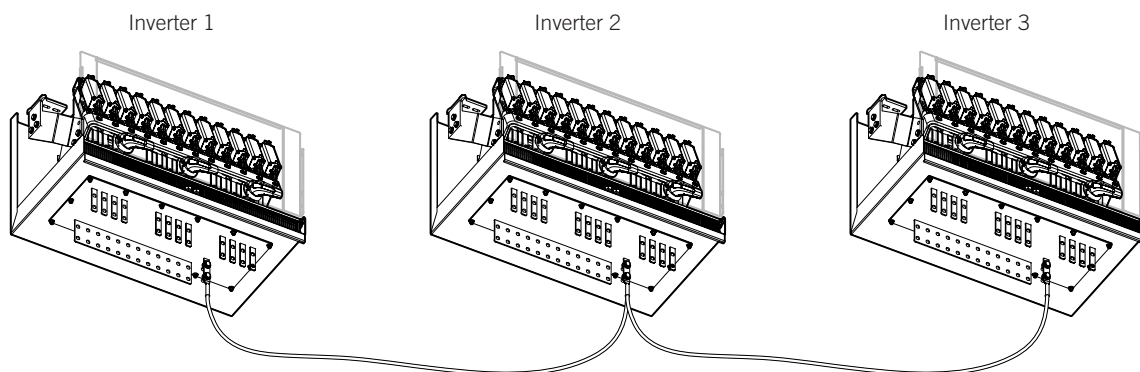
When connecting three units to the same transformer winding, the grounding of the system must be unique and shared, as otherwise there could be currents flowing through the different ground connections.

Each inverter will be equipped with the following elements to carry out the configuration:

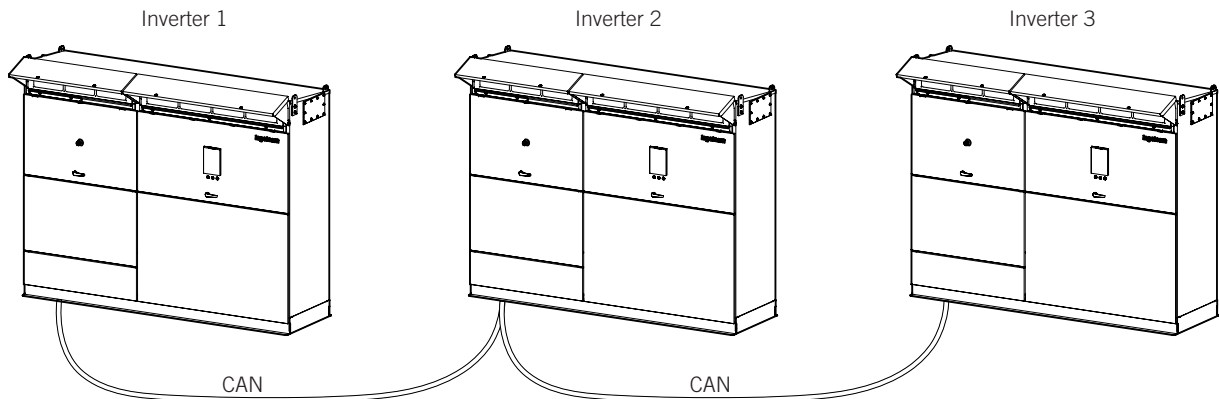
- One independent input with 1500 V fuse to connect the grounded fuses.
- One CAN communication cable for connecting the communications of the inverters.

Once the units have been installed, the following connections are performed:

1. Connect the grounded pole of the three units through 35 mm² section cables with 1000/1500 V insulation. This connection can be done through the cable grommets provided in the bases of the units in question.



2. Connect the CAN communication buses from the inverters using the cable provided. To connect the communication buses, carry out the following process:

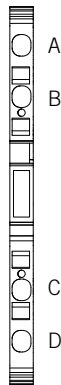


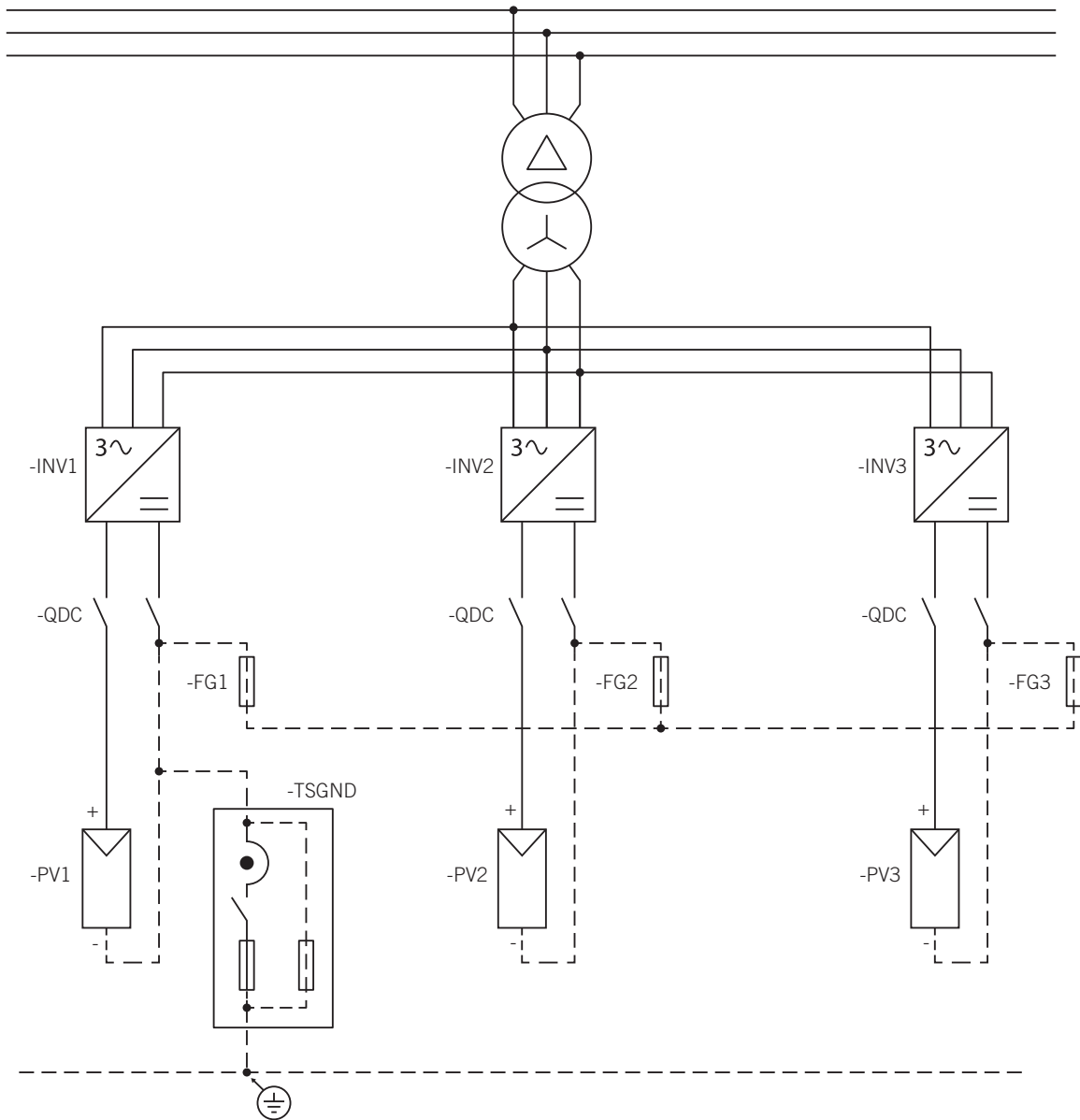
On the inverter with -TSGND, remove the end of line resistor from the wiring between -X26.3D and -X26.4D and connect the CAN cable with the color code described in the diagram to -X26.1C, -X26.2C, -X26.3C, -X26.4C.

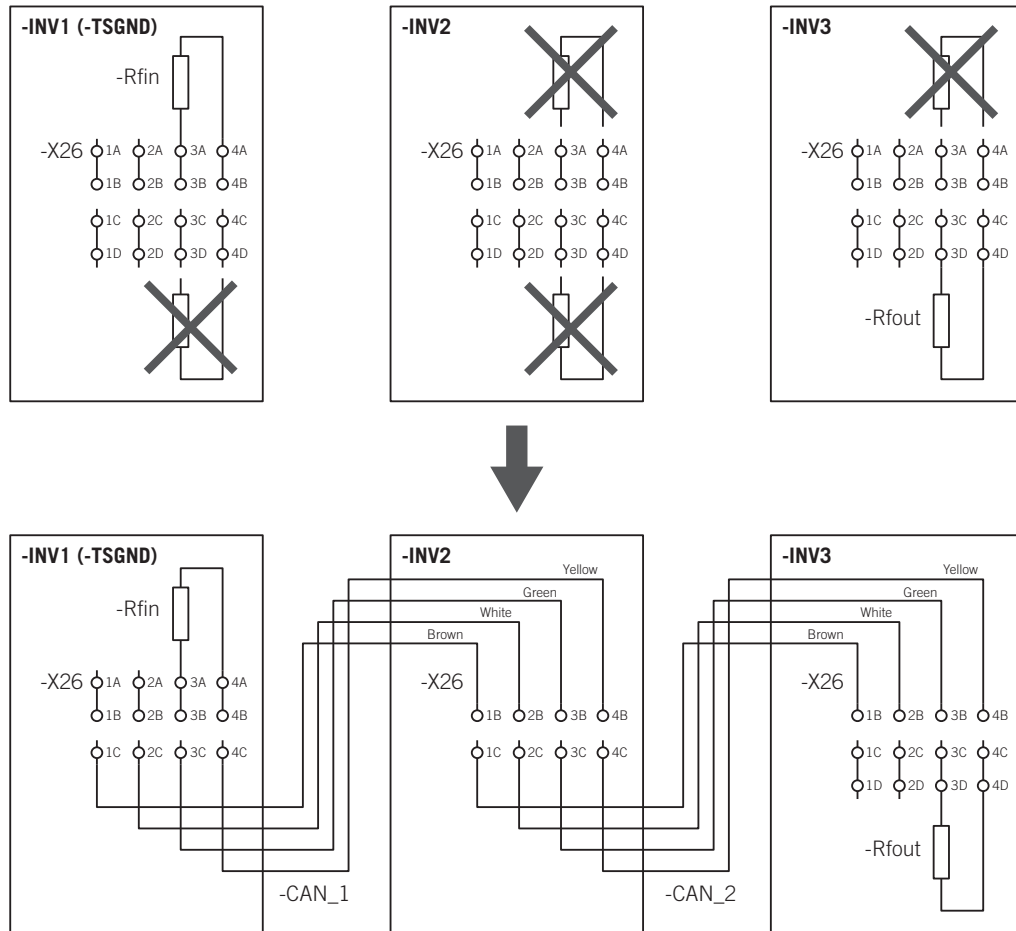
On inverter 2, remove the end of line resistor from the wiring between -X26.3A and -X26.4A and connect the other end of the CAN cable with the color code described in the diagram to -X26.1B, -X26.2B, -X26.3B, -X26.4B.

On inverter 2, remove the end of line resistor from the wiring between -X26.3D and -X26.4D and connect another CAN cable with the color code described in the diagram to -X26.1C, -X26.2C, -X26.3C, -X26.4C.

On inverter 3, connect the other end of the CAN cable with the color code described in the diagram to -X26.1B, -X26.2B, -X26.3B, -X26.4B and remove the end of line resistor from the wiring between -X26.3A and -X26.4A.







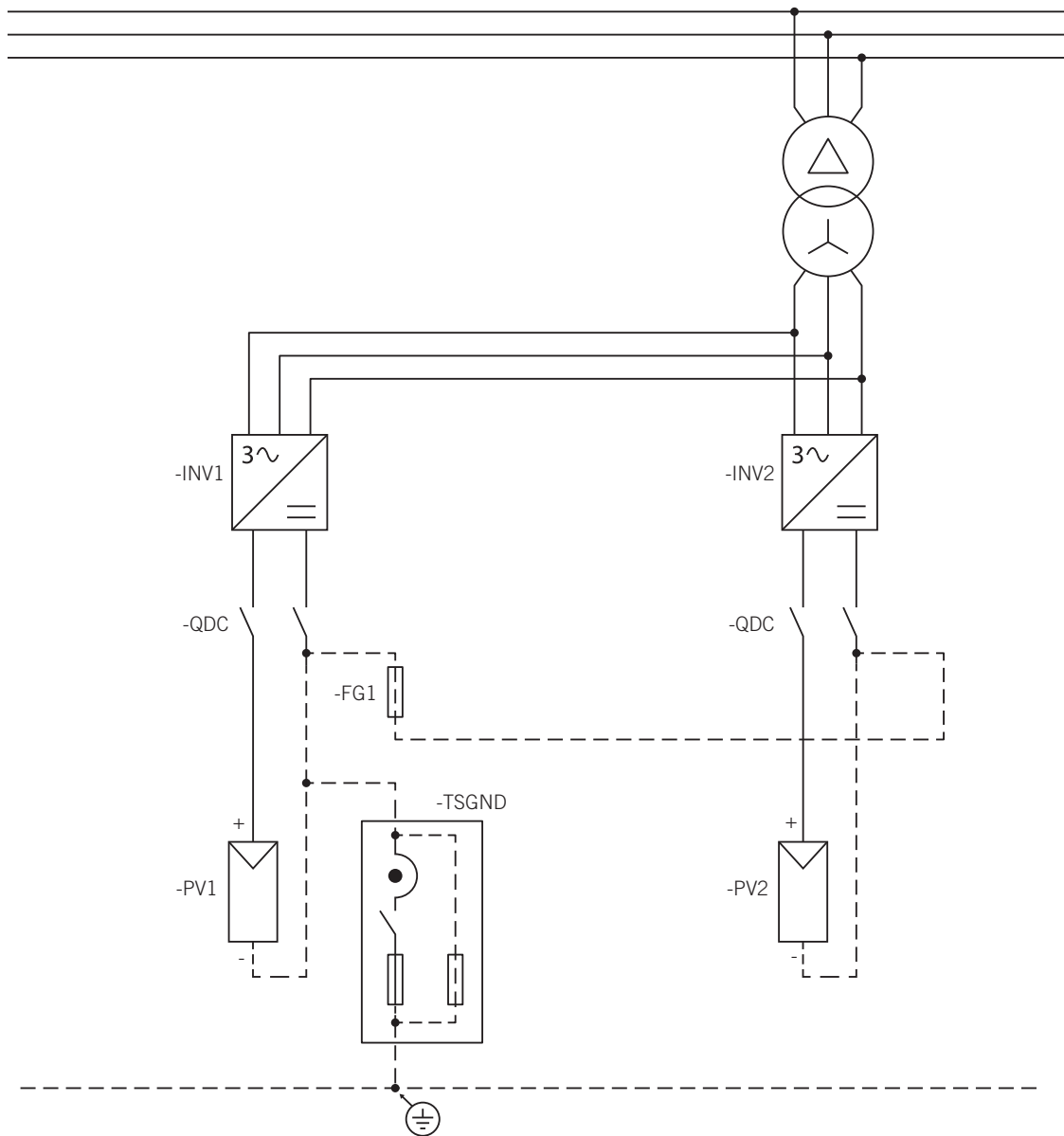
10.3. Operating procedure on grounded inverters

The purpose of this section is to describe in detail the procedure for working safely with grounded inverters.

To carry out maintenance operations on inverters connected to the same transformer winding, it is recommended to consider them as a single unit, therefore they must all be disconnected and the absence of voltage must be verified.

When operating, the inverters behave as completely independent units.

In the following diagram the inverter with -TSGND and the inverter without -TSGND are marked in a system with two inverters against one transformer:



If the inverter has the -TSGND card installed, its operating procedure will be different to that of the inverter without a -TSGND card. Follow the instructions below for each case.

In addition, we will differentiate between operations upstream and downstream of the switch.

10.3.1. Inverters with -TSGND card

⚠ DANGER

All the operations described below must always and without exception be performed following the five golden rules.

Operations upstream of the DC switch (inverter side)

The unit with a -TSGND card is the one that performs the ground connection of the entire system, so if it is disconnected the ground connection of the system is temporarily removed. Because of this, before stopping the

inverter with the -TSGND card and working on it, it is recommended to stop the other units connected to the same transformer winding, if any, via the display.

If the event that they are not stopped via the display, they will stop when the ground connection in the inverter with the -TSGND card is temporarily removed, as they will detect an insulation fault in the grounded pole.

The motorized switch on the units opens both the positive pole and the negative pole in the PV array, leaving the inverter completely isolated. Therefore, to perform any operation upstream from the switch, simply follow the steps given in section “20. Shutting down the unit”.

Operations downstream of the DC switch (PV Array side)

To perform operations downstream of the switch it is essential to ensure the grounding of the grounded pole through a rigid ground connection, so that the equipotentiality of this point cannot be affected by an insulation fault in the PV array that results in the rupture of the grounding fuse.

The correct procedure is described below:

1. Check that there are no insulation faults in the PV array. The existence of an insulation fault in the non-grounded pole of the inverter can cause a short circuit by grounding the grounded pole.

DANGER

The existence of an insulation fault in the non-grounded pole of the inverter can cause a short circuit by grounding the grounded pole.

2. Put all the inverters connected to the same transformer winding in manual stop (see section “20.2. Stopping the inverter from the display”). It is possible but not recommended to stop them using the emergency push button, as this causes the main circuit breaker and the DC switch to trip, which is not necessary for performing the operations described below.
3. Open all the string boxes or level 1 boxes connected to the inverter on which work is to be carried out.
4. Connect a provisional portable ground between the grounded pole of the PV array and the installation's ground connection in the inverter on which work is to be carried out (it is possible to make this connection on the unit's grounding plate). This connection must be made taking into account that there may be voltage in the grounded pole that is being worked on, if there has been an insulation fault that has caused the grounding fuse to blow, or if the inverter with the -TSGND card has been completely shut down.
5. Disconnect the unit that work is to be carried out on following the steps described in section “20. Shutting down the unit”.
6. Remove the polycarbonate protection from the inverter and verify that there is not voltage in all the inputs of the inverter that is going to be worked on downstream of the motorized switch.
7. Remove the fuse from the connection of the grounded poles for the inverters (FG.1) in the inverter that is being worked on.

Once these steps have been completed it is safe to work on the inverter.

The steps to re-energize the inverters connected to the same transformer winding are listed below.

1. Insert the fuse from the connection of the grounded poles for the inverters (FG.1) in the inverter that is being worked on.
2. Place the polycarbonate protections in the inverter that is being worked on and close the unit housing.
3. Disconnect the provisional portable ground between the grounded pole of the PV array and the installation's ground connection in the inverter being worked on. This connection must be made taking into account that there may be voltage in the grounded pole that is being worked on, if there has been an insulation fault that has caused the grounding fuse to blow.
4. Close all the string boxes or level 1 boxes connected to the inverter on which work is being carried out.
5. Commission the inverter that is being worked on, following the instructions in section “18. Commissioning”.
6. Start all the inverters connected to the same transformer winding using the display.

10.3.2. Inverters without -TSGND card

DANGER

All the operations described below must always and without exception be performed following the five golden rules.

Operations upstream of the DC switch (inverter side)

The motorized switch on the units opens both the positive pole and the negative pole in the PV array, leaving the inverter completely isolated. Therefore, to perform any operation upstream from the switch, simply follow the steps given in section “20. Shutting down the unit”.

Operations downstream of the DC switch (PV Array side)

To perform operations downstream of the switch it is essential to ensure the grounding of the grounded pole in the array through a rigid ground connection, so that the equipotentiality of this point cannot be affected by an insulation fault in the PV array that results in the rupture of the grounding fuse.

The correct procedure is described below:

1. Check that there are no insulation faults in the PV array.

DANGER

The existence of an insulation fault in the non-grounded pole of the inverter can cause a short circuit by grounding the grounded pole.

2. Put all the inverters connected to the same transformer winding in manual stop (see section “20. Shutting down the unit”) or remotely via communications. It is possible but not recommended to stop them using the emergency push button, as this causes the main circuit breaker and the DC switch to trip, which is not necessary for performing the operations described below.
3. Open all the string boxes or level 1 boxes connected to the inverter on which work is to be carried out.
4. Connect a provisional portable ground between the grounded pole of the PV array and the installation's ground connection in the inverter on which work is to be carried out (it is possible to make this connection on the unit's grounding plate). This connection must be made taking into account that there may be voltage in the grounded pole that is being worked on, if there has been an insulation fault that has caused the grounding fuse to blow.
5. Disconnect the unit that work is to be carried out on following the steps described in section “20. Shutting down the unit” of the operating manual.
6. Remove the polycarbonate protection from the inverter and verify that there is not voltage in all the inputs of the inverter that is going to be worked on downstream of the motorized switch.
7. Remove the fuse from the connection of the grounded poles for the inverters (FG.1) in the inverter that is being worked on.

Once these steps have been completed it is safe to work on the inverter.

The steps to re-energize the inverters connected to the same transformer winding are listed below.

1. Insert the fuse from the connection of the grounded poles for the inverters (FG.1) in the inverter that is being worked on.
2. Place the polycarbonate protections in the inverter that is being worked on and close the unit housing.
3. Disconnect the provisional portable ground between the grounded pole of the PV array and the installation's ground connection in the inverter being worked on. This disconnection must be made taking into account that there may be voltage in the grounded pole that is being worked on, if there has been an insulation fault that has caused the grounding fuse to blow.
4. Close all the string boxes or level 1 boxes connected to the inverter on which work is being carried out.
5. Commission the inverter that is being worked on, following the instructions in section “18. Commissioning”.

11. Connecting auxiliary services

INFO

If the unit incorporates *the Auxiliary Services kit* by default, the connections indicated in this section are not necessary.

To find the different components listed below, consult Section “2.6. Location of components”.

Refer to Section “Important safety instructions” and the safety paragraph in this section before operating the equipment.

These units have alternating current to power certain of the unit’s elements, like the fans, power sources or motorized DC switch.

This auxiliary voltage must be 220 V 50/60 Hz between phase and neutral.

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

Read carefully before starting the connection process.

11.1. Safety instructions for connecting auxiliary services

DANGER

Before starting the connection process, press the emergency stop button and keep it interlocked until all the connections required for the unit to operate correctly have been made.

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 capacitances are fully discharged.

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

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

Use the Personal Protective Equipment specified in section “Personal Protective Equipment”.

CAUTION

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 shavings in the threads when screwing them in and apply a suitable lubricant.

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

11.2. Connection area

The terminal block for making the auxiliary AC connections is -XAUX located in DCAC connections module.

The thermomagnetic breaker -Q2 protects the auxiliary AC connection.

During connection, make sure that the thermomagnetic circuit breaker -Q2 is in the OFF position. To check correct operation, return to the ON position. Upon performing this step, the display lights up and the inverter's electronics starts. It is now possible to communicate with the inverter.

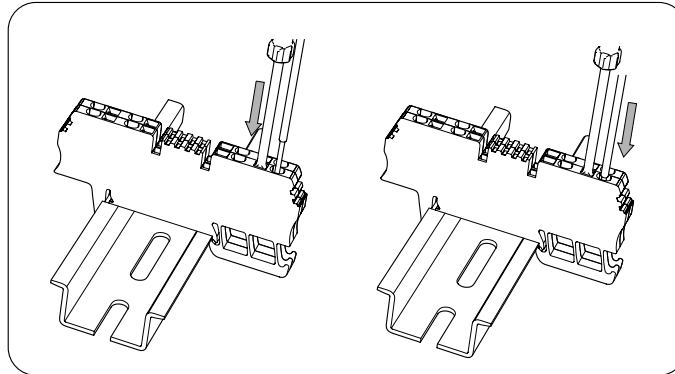
11.3. Wiring requirements for connecting ancillary services

- The wiring gauge for ancillary services must be 12 AWG.
- All cables must withstand temperatures greater than +194 °F (+90 °C) and comply with the *National Electrical Code ANSI/NFPA 70*.

11.4. Ancillary services connection process

1. To locate the wiring access towards the interior of the unit see section “2.19. Description of cable inlets”.
2. Strip the cables.

3. Crimp the wire ends according to the wire gauge being used.
4. Open the terminal. The terminals used in this terminal strip are of the clamp type. To insert the cable into the desired position press with a flat head screwdriver, insert the cable and then remove the screwdriver. The phase is wired at -XAUX.1 and neutral at -XAUX.2.



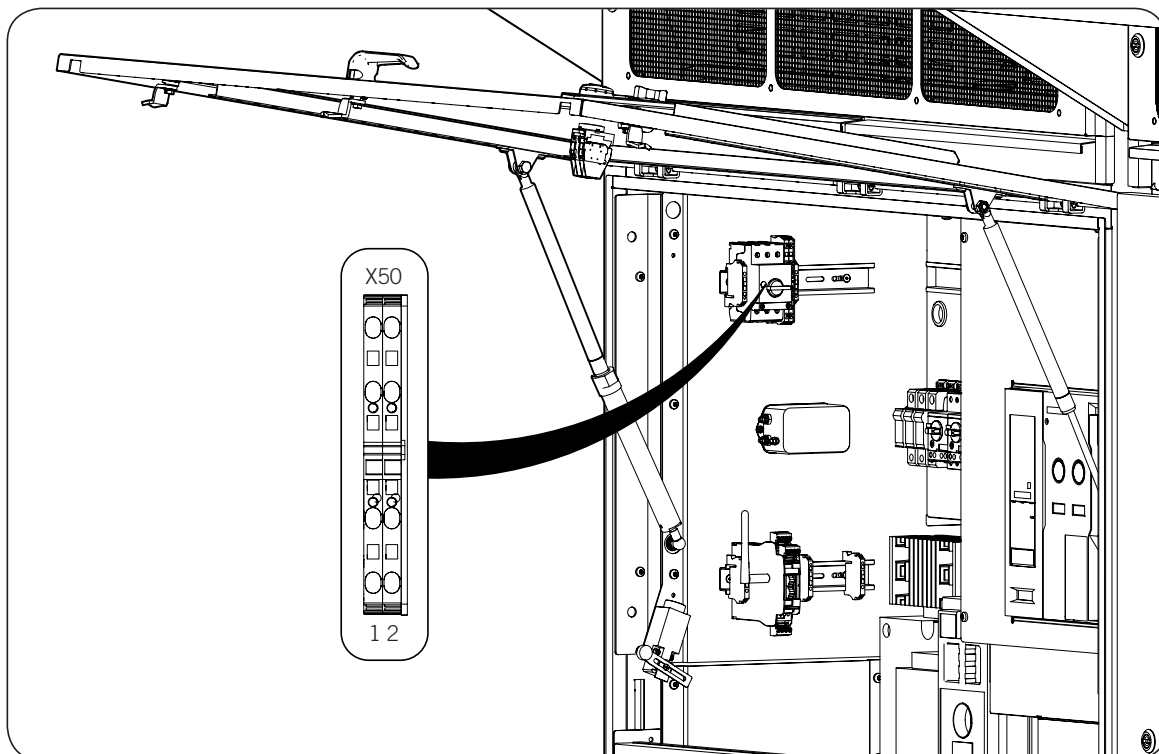
11.5. Connecting an external power supply service

To avoid the Qdc switch not tripping in the event an auxiliary power failure, Ingeteam recommends installing an external power supply system.

The external supply system must meet the following specifications:

Auxiliary power supply system	
Voltage	230 Vac
Frequency	50/60 Hz
Power	≥ 3500 W

The system must be connected to terminals -X50 in the DCAC connections module.



To perform the connection correctly, follow the indications in the following table.

Connecting the auxiliary power supply system	
-X50.1	Phase
-X50.2	Neutral

The consumption of this input will last a maximum of 20 seconds in the event of having to open the DC switch without auxiliary voltage.

12. Connection of the communication accessories

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

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

- Ethernet (standard).
- 3G.

INFO

To find the different components listed below, consult Section “2.6. Location of components”.

Refer to Section “Important safety instructions” and the safety paragraph in this section before operating the equipment.

See the corresponding communication accessories manual for further information.

Read carefully before starting the connection process.

12.1. Safety instructions for connecting the communication accessories

DANGER

Before starting the connection process, press the emergency stop button and keep it interlocked until all the connections required for the unit to operate correctly have been made.

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 capacitances are fully discharged.

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

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

Use the Personal Protective Equipment specified in section “Personal Protective Equipment”.

CAUTION

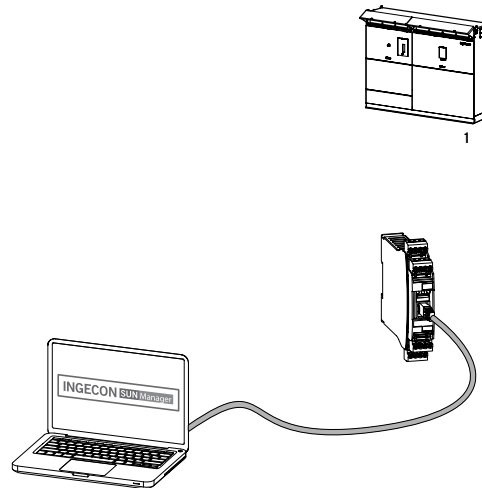
In order to keep the nuts and bolts of the unit in good condition it is important to make sure there is no dirt or shavings in the threads when screwing them in and apply a suitable lubricant.

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

12.2. Ethernet communication

The inverters include standard hardware to communicate via Ethernet, located on the side of the upper assembly panel of the DCAC connections module.

Due to this hardware you can connect one or various inverters to your computer. The following diagram shows the connection of one or more units to a computer via Ethernet.

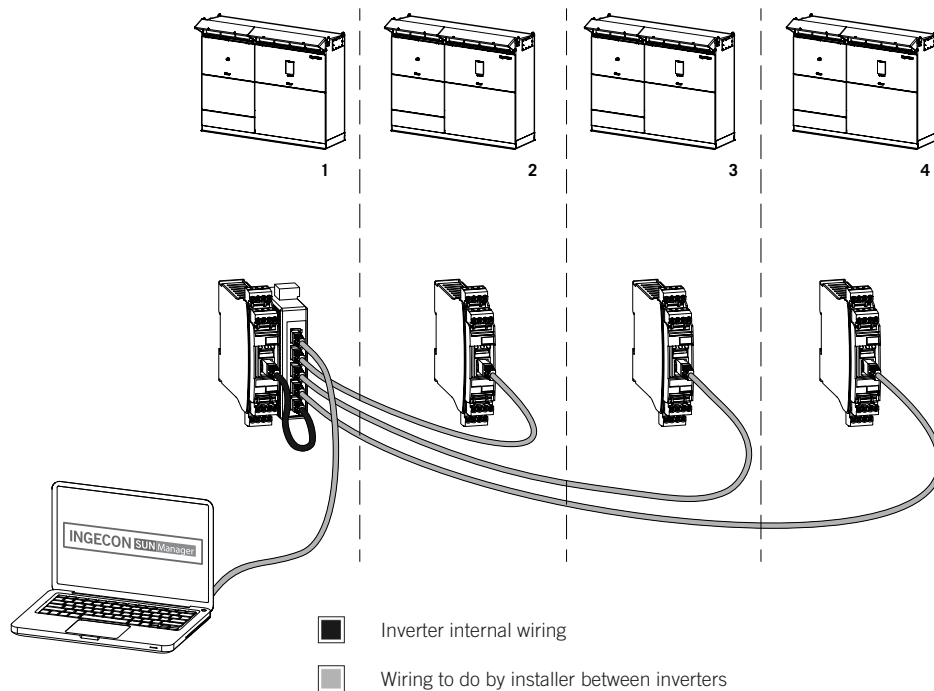


Inverter connection

i INFO

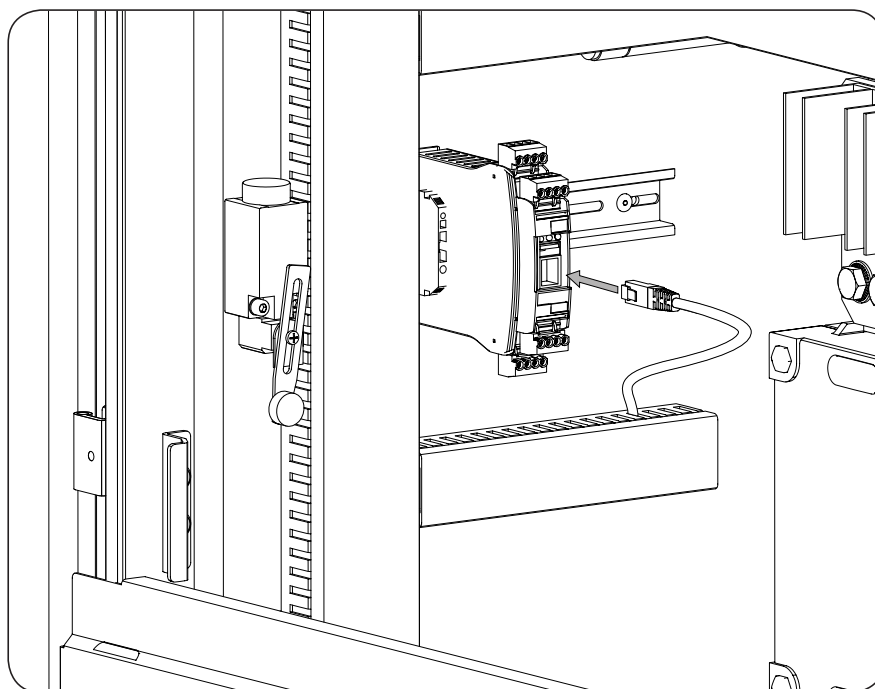
For plant control, connect via port A. If the monitoring kit for DC input currents is installed, the communications for said kit shall be connected via port B.

To make the connection of various inverters you must install a switch. Ingeteam offers the optional switch by order upon the delivery of the unit.



Connection of several inverters

After connecting the Ethernet cables, it must be led through the ducts on the unit towards the dedicated cable entrances (see the following diagram and section “2.19. Description of cable inlets”).



The communication hardware allows the configuration of two Ethernet interfaces with two different IP addresses for the same inverter.

i INFO

The two network interfaces are identified as *Ethernet Interface Primary* and *Ethernet Interface Secondary*. They are configured from the *Ethernet* tab in the website's main menu.

The *Ethernet Interface Primary* is reserved for inverter control in real time. To do this, the communication with the plant control or PPC must be established with the IP address set in this network interface.

The *Ethernet Interface Secondary* is for monitoring the inverter and its internal devices. Therefore the plant Scada or other monitoring system must establish communication with the IP address set in this network interface.

In addition, below is the configuration of the serial parameters for the Dual Ethernet card with RS-485 output.

i INFO

The two serial lines are identified as *Serial Interface Primary* and *Serial Interface Secondary*.

They are configured from the *Serial Interface* tab in the website's main menu. After pressing the  button in the corresponding interface.

Parameters	Serial Interface Primary	Serial Interface Secondary
Serial Port Speed (Bauds)	115200	9600
Modbus TCP: First Char timeout	250	250
Modbus TCP: Inter Char timeout	10	50
Modbus TCP: Session timeout	240	240
Modbus TCP: Max Connections	16	16
Modbus TCP: CRC Retries	1	1

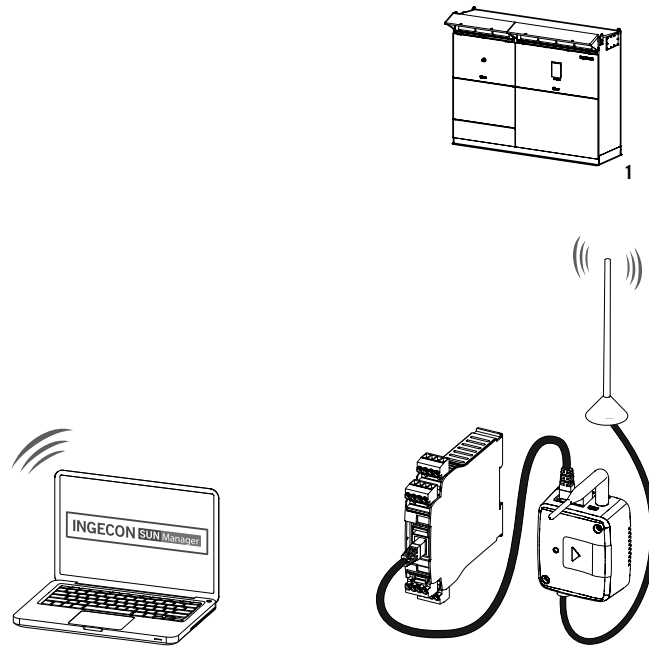
i INFO

For more information, see the Ethernet communications manual, available at www.ingetteam.com.

12.3. Communication via 3G

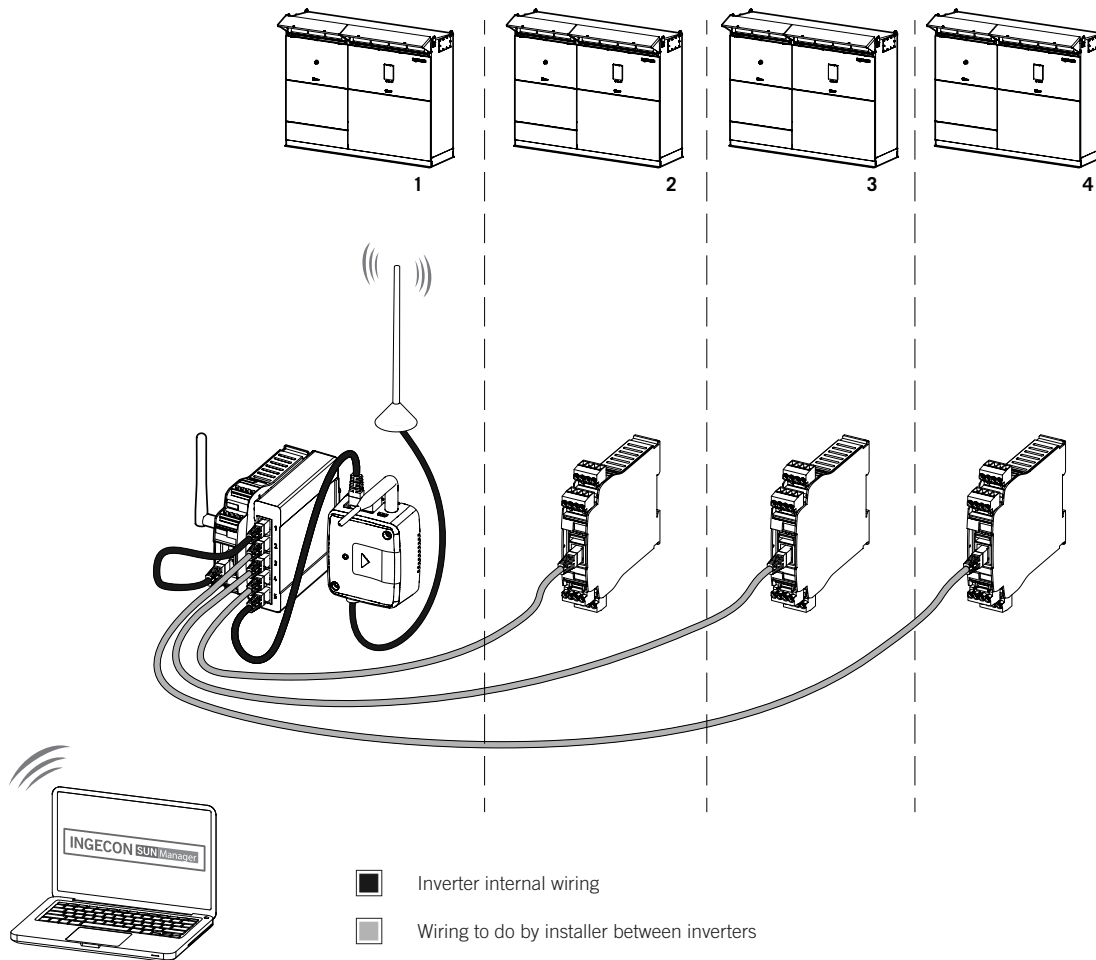
Optionally, the inverters can include hardware to communicate via 3G, located on the side of the upper assembly panel of the DCAC connections module. The 3G modem antenna must be placed in the unit's exterior.

The following diagram shows the connection of one or more units to a computer via 3G.



Inverter connection

To make the connection of various inverters you must install a switch. Ingeteam offers the optional switch by order upon the delivery of the unit.



Connection of several inverters

13. Connection of the DCAC connections module

If several inverters are connected to the same transformer, you need to synchronize them. Ingeteam recommends synchronizing inverters even if connected to independent windings.

The inverters have as standard all the necessary elements for synchronization (electronic card and fiber cables).

This chapter explains the requirements and process for wiring the synchronization.

Read carefully before starting the connection process.

i INFO

To find the different components listed below, consult Section “2.6. Location of components”.

Refer to Section “Important safety instructions” and the safety paragraph in this section before operating the equipment.

13.1. Safety instructions for the synchronization connection

⚠ DANGER

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 capacitances are fully discharged.

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

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

Use the Personal Protective Equipment specified in section “Personal Protective Equipment”.

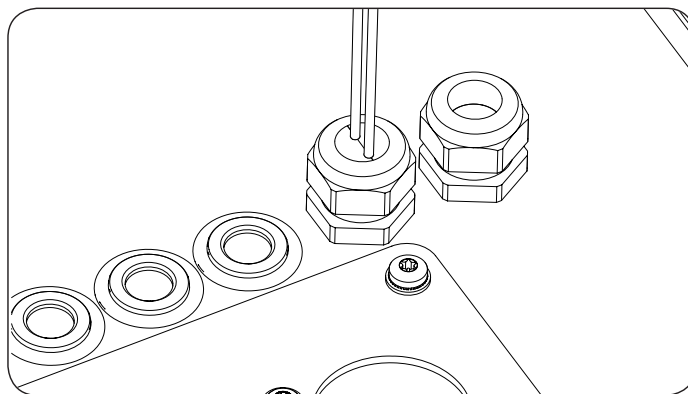
⚠ CAUTION

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 shavings in the threads when screwing them in and apply a suitable lubricant.

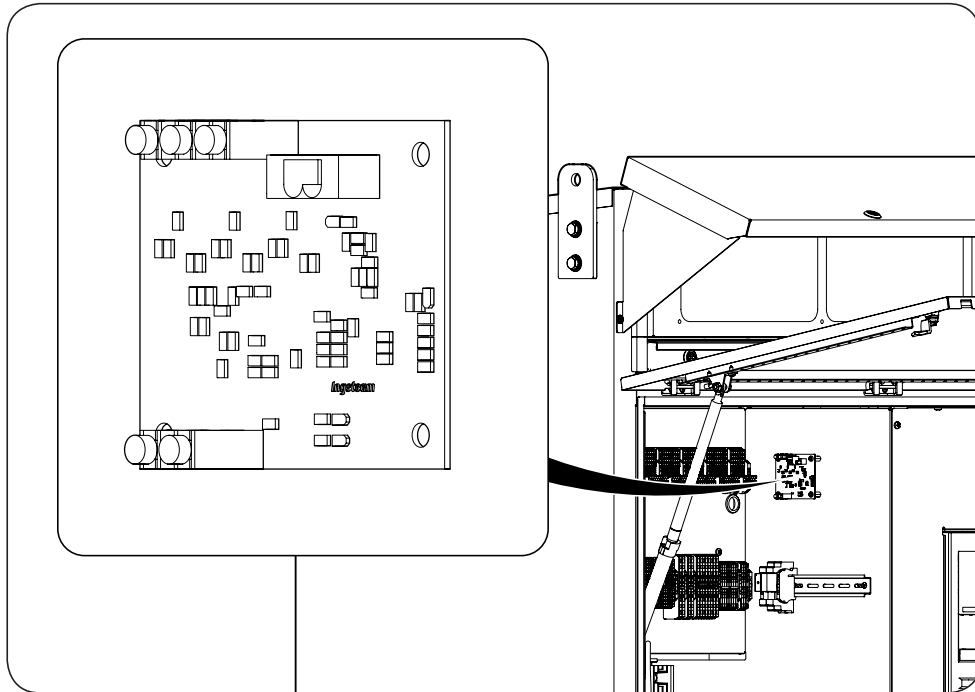
Ingeteam accepts no liability for any damages caused by an incorrect connection.

13.2. Connection area

The fiber wiring is entered through the enabled packing glands (see section “2.19. Description of cable inlets”) making sure to close the seal as displayed in the following figure.



The synchronization card is located in the right panel of the DCAC connections module.

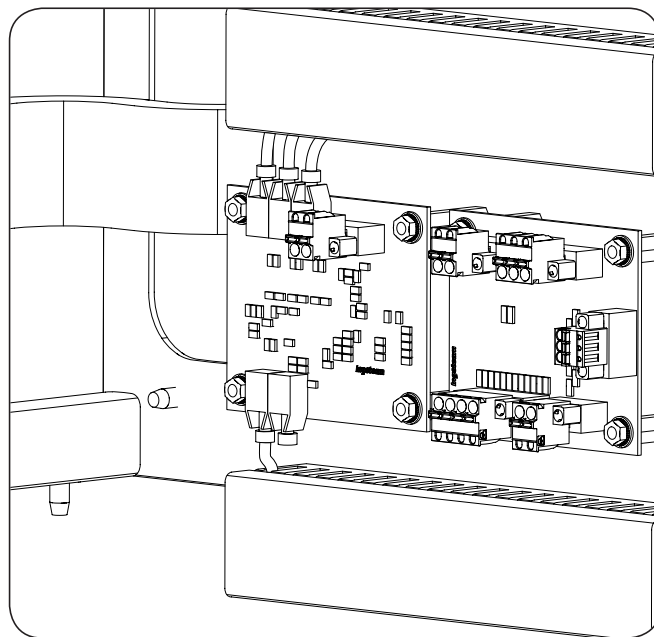


13.3. Wiring requirements for the synchronization connection

Use the cable supplied by Ingeteam.

13.4. Synchronization connection process

1. Open the folding door of the DCAC connections module.
2. Connect the fibers in the synchronization cards following the diagrams displayed in section “13.4.1. Configuring the synchronization”. The wiring is lead through the ducts available up to the wiring accesses.



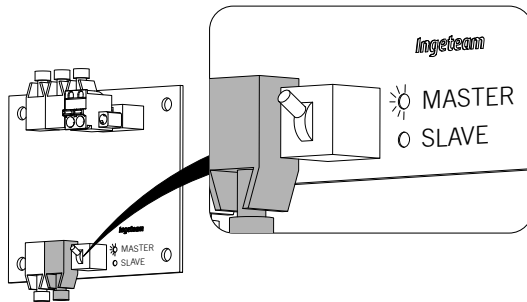
3. Leading the fiber optics cables through the packing glands, closing them properly and making sure they're sealed.
4. Close the folding door of the DCAC connections module.

13.4.1. Configuring the synchronization

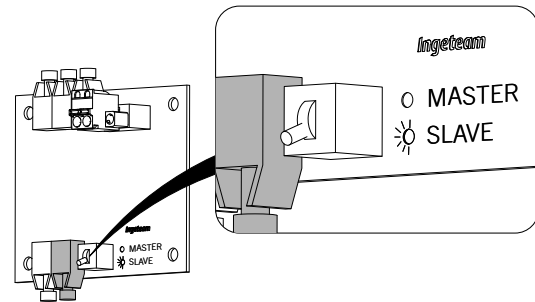
You can synchronize up to four inverters. This depends on the number of synchronized inverters, following the connection diagrams from this section.

For synchronization, one of the inverters must be set as master and the rest as slaves. The configuration as master or slave is done via the synchronization card of each inverter.

The synchronization card has a switch with which you can select the operating mode (master-slave). In the previous figure, we show the switch's position for both configurations.



The synchronization card configured as master



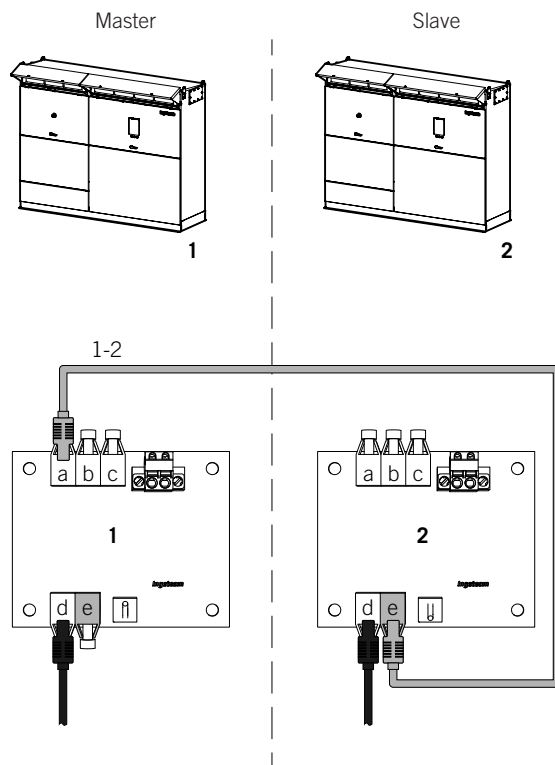
The synchronization card configured as slave

i INFO

If this step is not done properly, it presents an alarm on the display.

Synchronization of two inverters

To perform the synchronization of two inverters wired according to the following diagram, using the fiber optics provided by Ingeteam.



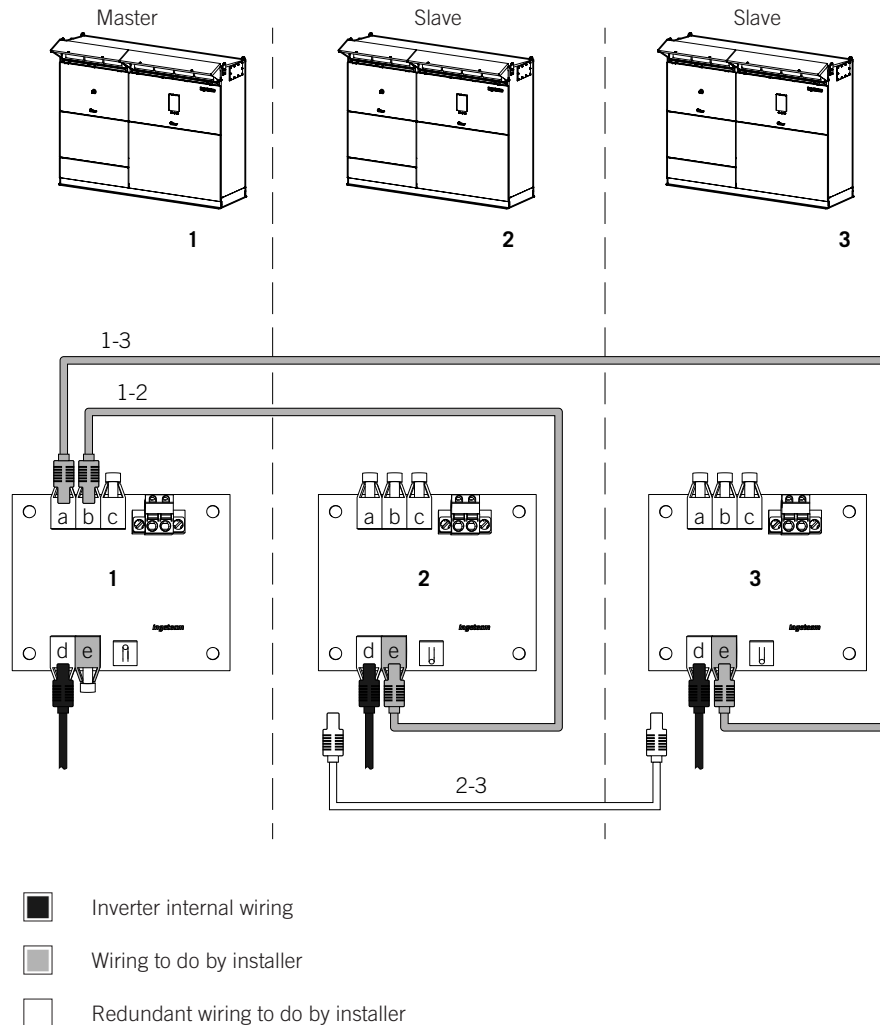
-  Inverter internal wiring
-  Wiring to do by installer

If an incident on the master inverter (1) on the slave inverter (2) disconnect the fiber optics cable 1-2 from the connector 2.e and configure this inverter as master via its synchronization card switch.

Synchronization of three inverters

In this section we indicate the diagram to perform the synchronization of three inverters. Wire according to the diagram using the fiber optics cables provided by Ingeteam.

Ingeteam provides one additional fiber optics cable with the aim of making the synchronization system redundant. Ingeteam recommends the pre-installation of said wiring, **without performing a connection**. When confronting an incident of an inverter configured as master, you can reconfigure the system selecting another inverter as master in a three inverter synchronization system



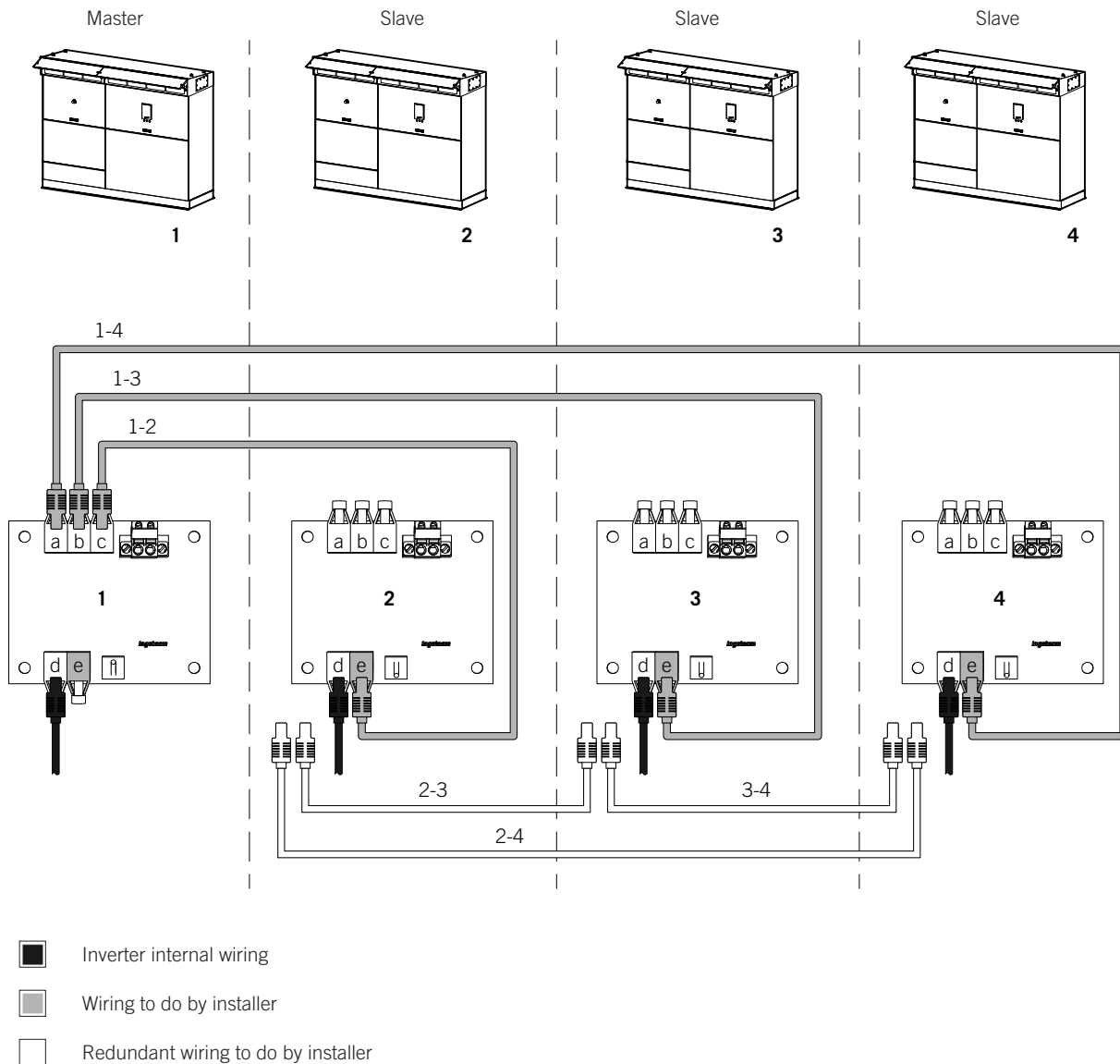
If the master inverter has the incident (in the aforementioned diagram marked as 1) perform the following steps to reconfigure the system to establish inverter 2 as master and maintaining the synchronization with inverter 3 (slave):

1. On inverter 2, disconnect the fiber optics cable 1-2 from connector 2.e.
2. On inverter 2, connect the pre-installed cable 2-3 on connector 2.a.
3. On inverter 3, disconnect the fiber optics cable 1-3 from connector 3.e.
4. On inverter 3, connect the pre-installed cable 2-3 on connector 3.e.
5. Configure the synchronization switch of inverter 2 as master by activating the switch.

Synchronization of four inverters

In this section we indicate the diagram to perform the synchronization of four inverters. Wire according to the diagram using the fiber optics cables provided by Ingeteam.

Ingeteam provides one additional fiber optics cable with the aim of making the synchronization system redundant. Ingeteam recommends the pre-installation of said wiring, **without performing a connection**. When confronting an incident of an inverter configured as master, you can reconfigure the system selecting another inverter as master in a three inverter synchronization system



If the master inverter has the incident (in the aforementioned diagram marked as 1) perform the following steps to reconfigure the system to establish inverter 2 as master and maintaining the synchronization with inverters 3 and 4 (slaves):

1. On inverter 2, disconnect the fiber optics cable 1-2 from connector 2.e.
2. On inverter 2, connect the pre-installed cable 2-3 on connector 2.a.
3. On inverter 2, connect the pre-installed cable 2-4 on connector 2.b.
4. On inverter 3, disconnect the fiber optics cable 1-3 from connector 3.e.
5. On inverter 3, connect the pre-installed cable 2-3 on connector 3.e.
6. On inverter 4, disconnect the fiber optics cable 1-4 from connector 4.e.
7. On inverter 4, connect the pre-installed cable 2-4 on connector 4.e.
8. Configure the synchronization switch of inverter 2 as master by activating the switch.

14. Connection options

These units offer the possibility as standard of connecting various options for unit control and/or monitoring. The installer can decide to use them or not depending on the requirements of each installation.

INFO

To find the different components listed below, consult Section “2.6. Location of components”.

Refer to Section “Important safety instructions” and the safety paragraph in this section before operating the equipment.

14.1. Safety instructions for connecting optional equipment

DANGER

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 capacitances are fully discharged.

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

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

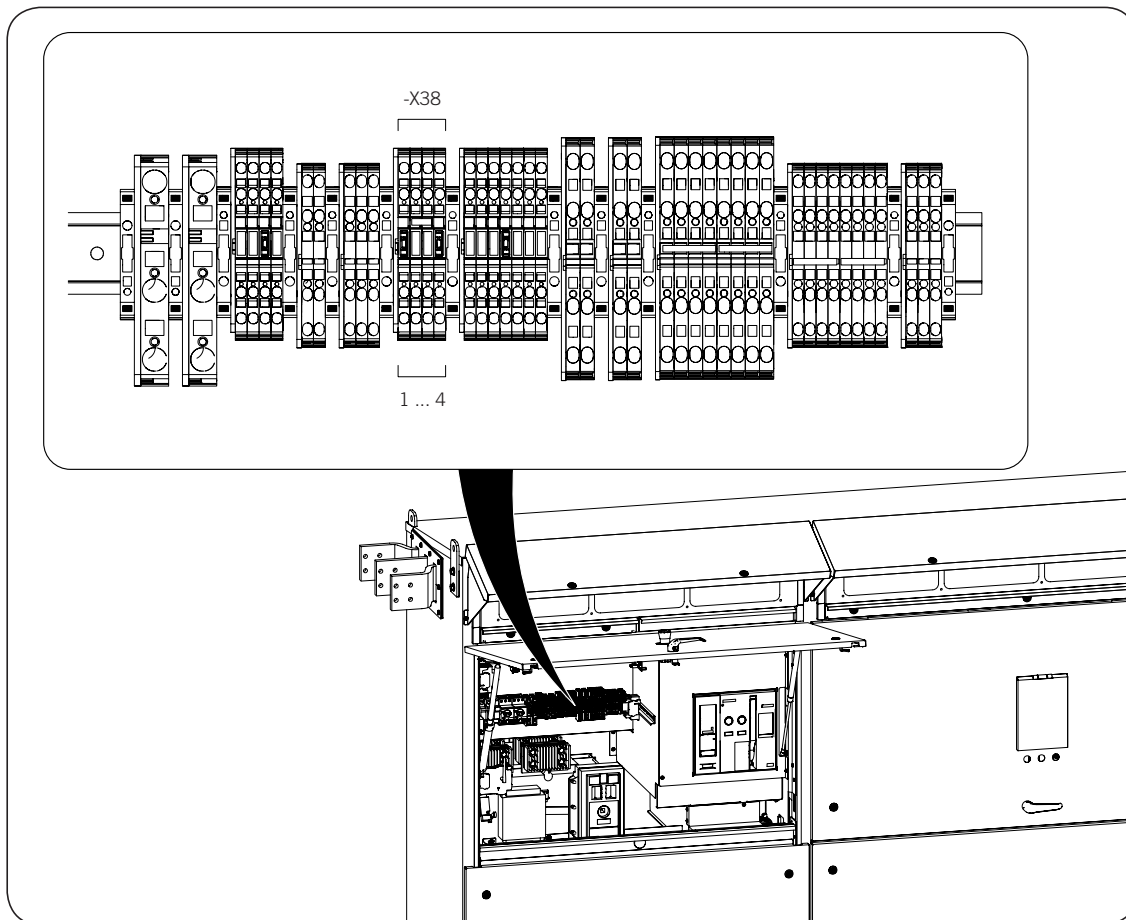
Use the Personal Protective Equipment specified in section “Personal Protective Equipment”.

CAUTION

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 shavings in the threads when screwing them in and apply a suitable lubricant.

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

14.2. Connection area



14.3. Wiring requirements for connecting optional equipment

- The wiring for connecting the options needs to be carried out by the client.
- All cables must withstand temperatures greater than +194 °F (+90 °C) and comply with the *National Electrical Code ANSI/NFPA 70*.
- Use copper cables.
- The minimum section is 18 AWG and the maximum is 12 AWG.
- This cable must be no longer than 66 ft (≈20 m).
- The normally closed contact must be prepared for 230 VAC 50/60 Hz and a power of 40 VA.

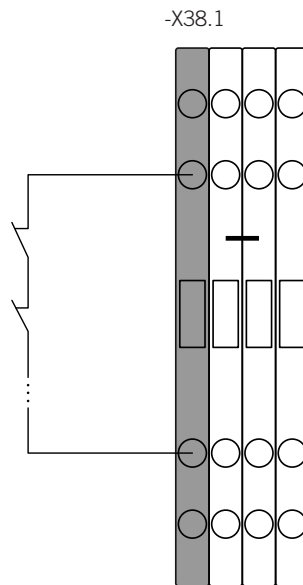
14.4. Connection process for monitoring components external to the unit

The inverter enables the monitoring of an element outside the unit (temperature sensors, sensors detecting the opening or closing of external junction boxes, main external AC thermomagnetic breaker, etc.).

In the case of a fault in a monitored element, the inverter goes into shutdown status and will not operate until the element returns to its normal condition.

To connect the external monitoring components to the unit, it comes with the -X38.1 terminal in the DCAC connections module.

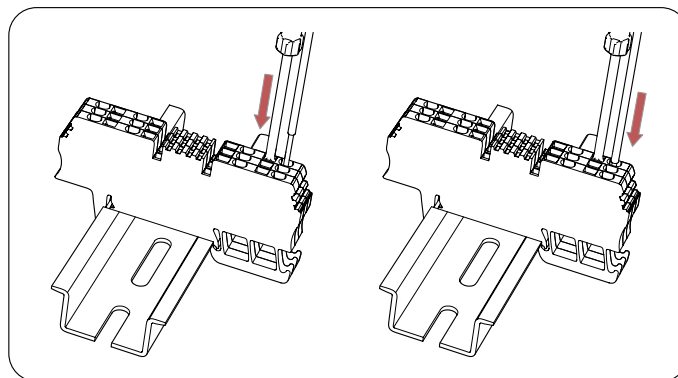
The normally closed, voltage-free contacts to monitor are installed between the two free positions on terminal -X38.1, removing the vertical link.



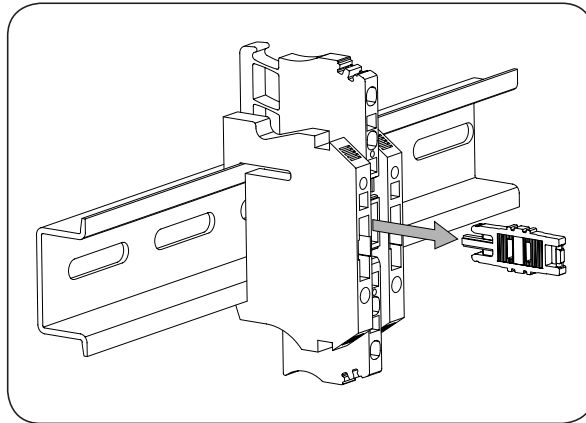
- Open contact: fault in the monitored component.
- Closed contact: no fault at monitored component.

To make the connection, follow the following steps:

1. Strip the cables.
2. Crimp the wire ends according to the wire gauge being used.
3. Open the terminal. The terminals used in this terminal strip are of the clamp type. To insert the cable into the desired position press with a flat head screwdriver, insert the cable and then remove the screwdriver.



4. Remove the vertical link.



14.5. Inverter remote manual stop connection process

⚠ CAUTION

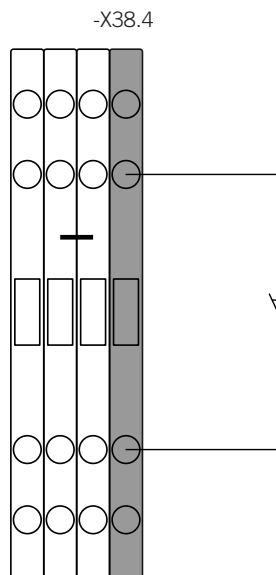
It is not possible to use the same contact to perform the manual stop of several units.

The motorized DC switch and the AC thermomagnetic circuit breaker have a limited number of operating cycles, so excessive use may lead to premature wear.

The inverter enables an emergency shutdown to be performed externally. This remote actions is equivalent to pressing the emergency stop button. The inverter goes to a stop status, disconnecting from the grid safely, opening the motorized DC switch and the AC thermomagnetic circuit breaker.

To connect the inverter remote manual stop, terminal block -X38.4 is provided in the DCAC connections module.

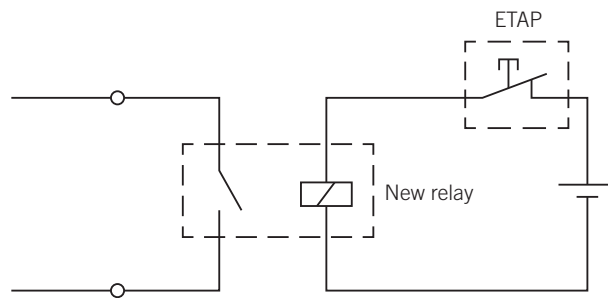
A normally closed volt-free contacts will be fitted between the free positions on the terminal -X38.4 by removing the horizontal link, as shown in the following figure.



- Open contact: inverter goes into Stop status.
- Closed contact: inverter goes into Start status.

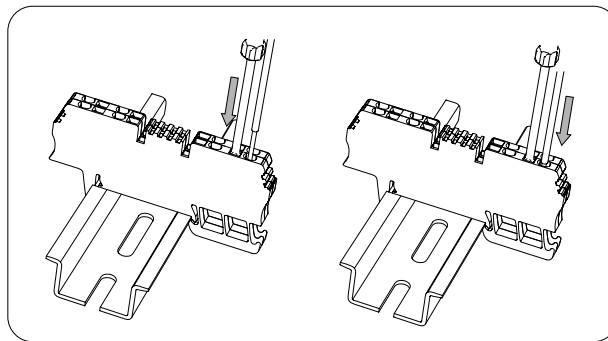
⚠ CAUTION

The maximum length permitted for the wiring of this contact is 10 meters. If necessary to use longer wiring, add an intermediate relay as shown in the following figure.

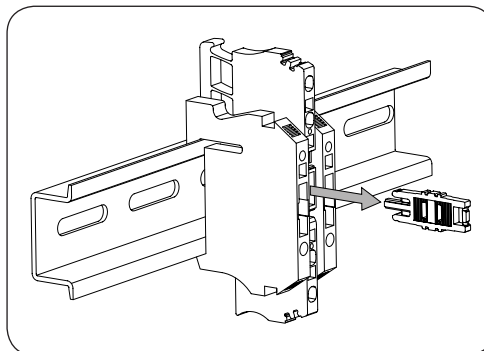


To make the connection, follow the following steps:

1. Strip the cables.
2. Crimp the wire ends according to the wire gauge being used.
3. Open the terminal. The terminals used in this terminal strip are of the clamp type. To insert the cable into the desired position press with a flat head screwdriver, insert the cable and then remove the screwdriver.



4. Remove the vertical link.



15. Optional kit connection

These units may incorporate several optional kits. Throughout this section we detail the connection process of the kits in which an installer is required.

INFO

To find the different components listed below, consult Section “2.6. Location of components”.

Refer to Section “Important safety instructions” and the safety paragraph in this section before operating the equipment.

15.1. Safety instructions for connecting optional kits

DANGER

Before starting the connection process, press the emergency stop button and keep it interlocked until all the connections required for the unit to operate correctly have been made.

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 capacitances are fully discharged.

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

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

Use the Personal Protective Equipment specified in section “Personal Protective Equipment”.

CAUTION

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 shavings in the threads when screwing them in and apply a suitable lubricant.

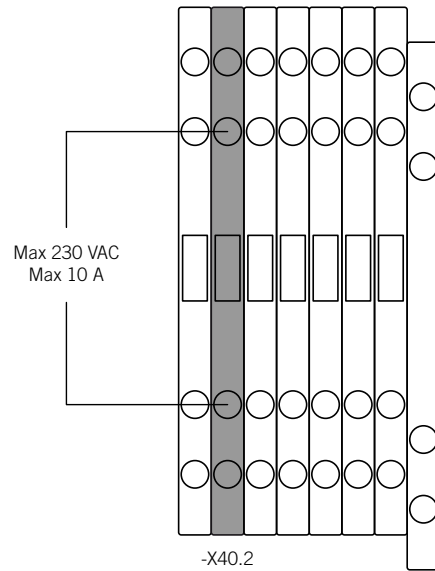
Ingeteam accepts no liability for any damages caused by an incorrect connection.

15.2. Connection of the status indicator auxiliary contact

- The wiring for connecting the optional kits needs to be carried out by the client.
- All cables must withstand temperatures greater than +194 °F (+90 °C) and comply with the *National Electrical Code ANSI/NFPA 70*.
- Use copper cables.
- Minimum gauge of 18 AWG and maximum of 12 AWG.
- This cable must be no longer than 66 ft (≈20 m).
- Normally closed and open contacts must be prepared for 230 VAC 50/60 Hz and a 10 A current.

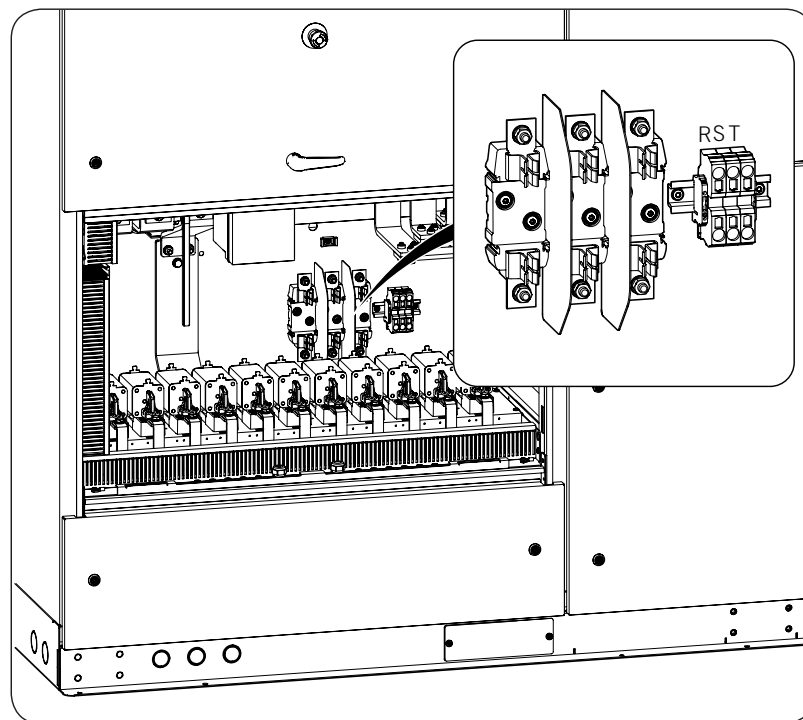
Ingeteam offers the possibility of monitoring the AC circuit breaker status (open or closed) via a normally open, power free contact with a maximum of 230 VAC and 10 A.

For this monitoring, wire the -X40.2 terminal's free positions according to the following diagram:



15.3. Connecting the ancillary services feeder kit

The dimensions of the cables to connect this kit must be studied by the installer according to the requirements and specifications of the PV plant. Connect the cable to the terminals shown in the following figure.



16. AC connection

This chapter explains the requirements and process for connecting the AC cabling to the unit.

Read carefully before starting the connection process.

INFO

To find the different components listed below, consult Section “2.6. Location of components”.

Refer to Section “Important safety instructions” and the safety paragraph in this section before operating the equipment.

For other configurations different to those described in this document, please contact Ingeteam.

16.1. Safety instructions for the AC connection

DANGER

Before performing the connection, check there is no voltage in the AC wiring.

Before starting the connection process, press the emergency stop button and keep it interlocked until all the connections required for the unit to operate correctly have been made.

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 capacitances are fully discharged.

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

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

There is a risk of fire when using wiring gauges with a lower permissible current than the maximum possible current.

Use the Personal Protective Equipment specified in section “Personal Protective Equipment”.

CAUTION

In order to prevent damage to the unit, it is mandatory to install the required wiring for the emergency trip system in the Medium Voltage switchgear, or the equivalent protection upstream of the inverter, is operating.

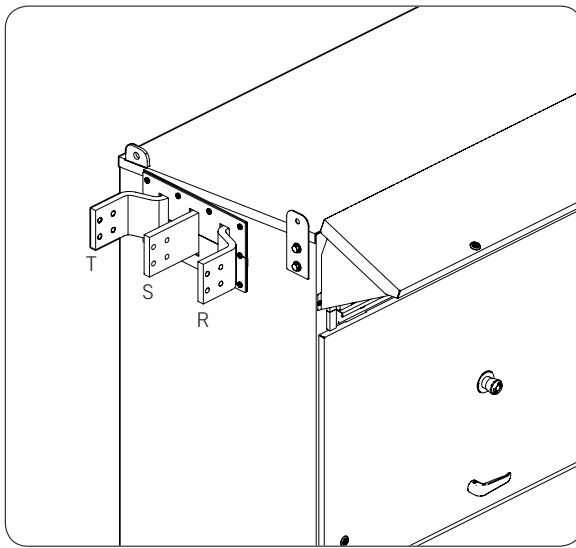
In order to keep the nuts and bolts of the unit in good condition it is important to make sure there is no dirt or shavings in the threads when screwing them in and apply a suitable lubricant.

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

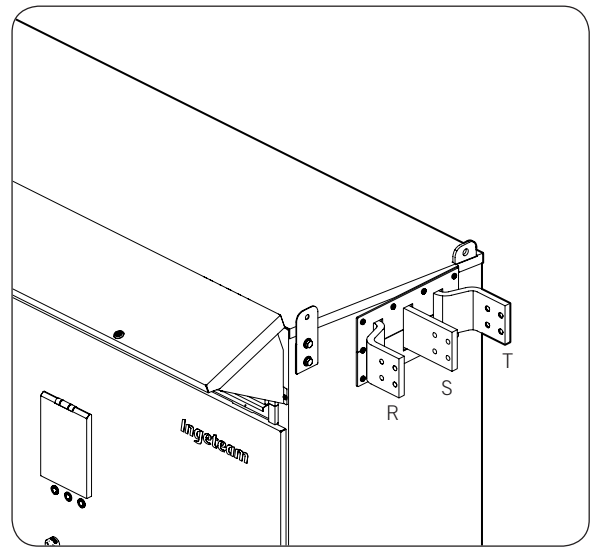
16.2. Connection area

There are different types of AC connection relative to the installation's requirements. In all these configurations the power supply can be found in the right of left side of the inverter, depending on the client's requirements in the order.

The order of the busbars for phases R, S, T for all configurations is the same as that specified in the following figures, depending on whether they are right-hand side or left-hand side connections.



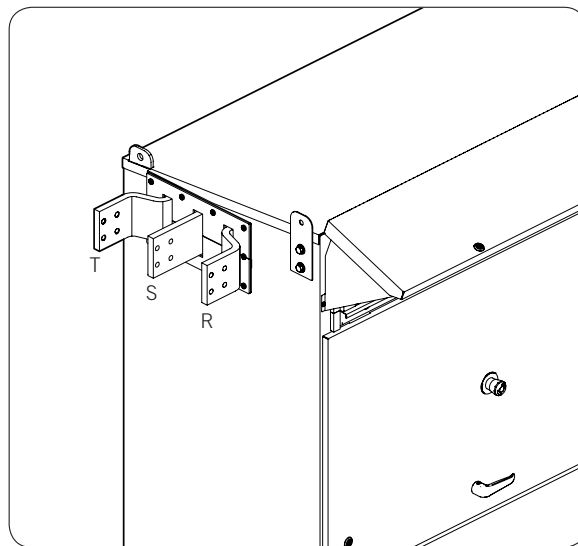
Units with busbars on the left



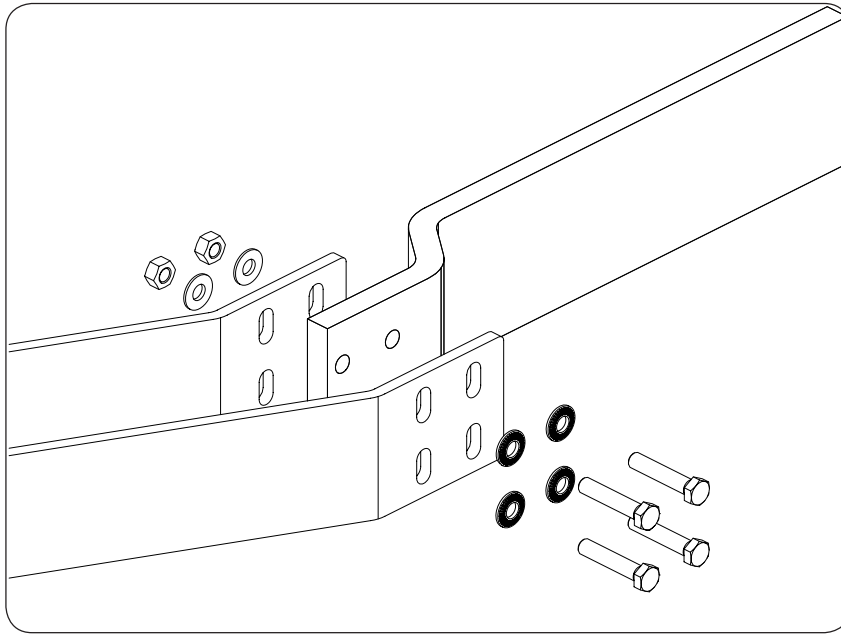
Units with busbars on the right

Upper busbars for busbar connection

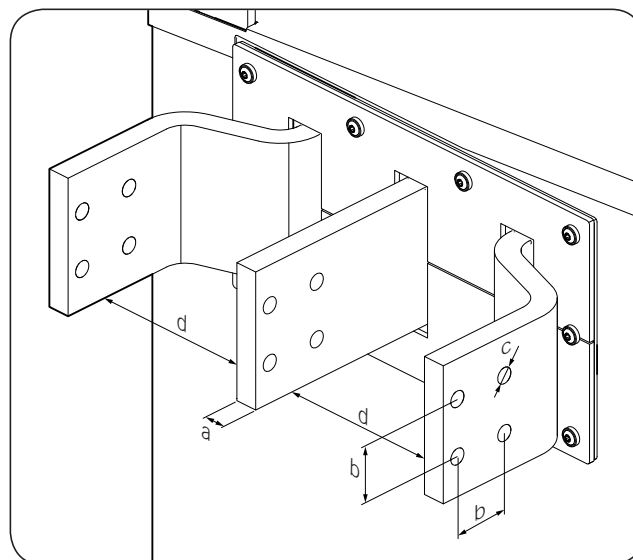
The AC phase busbars are located in the upper left or right side, depending on the unit configuration.



The connection is made via the flexible busbars.



The dimensions of the inverter busbars are as follows:



a 0.78 in (20 mm)

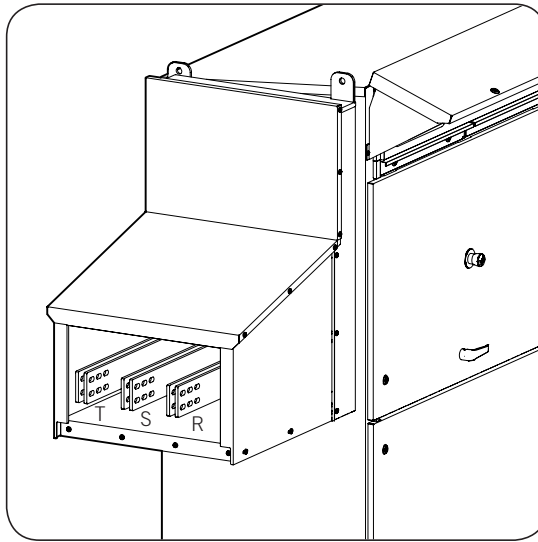
b 1.97 in (50 mm)

c 0.55 in (14 mm)

d 7.08 in (180 mm)

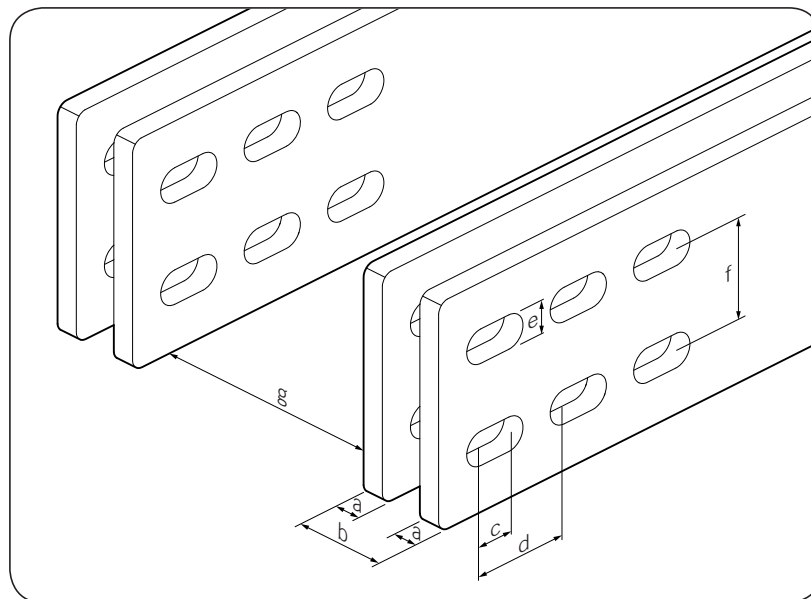
Medium height busbars for direct connection to transformer busbars

The AC phase busbars are located on the left or right side, depending on the unit configuration.



The connection is made directly to the transformer busbars.

The dimensions of the inverter busbars are as follows:



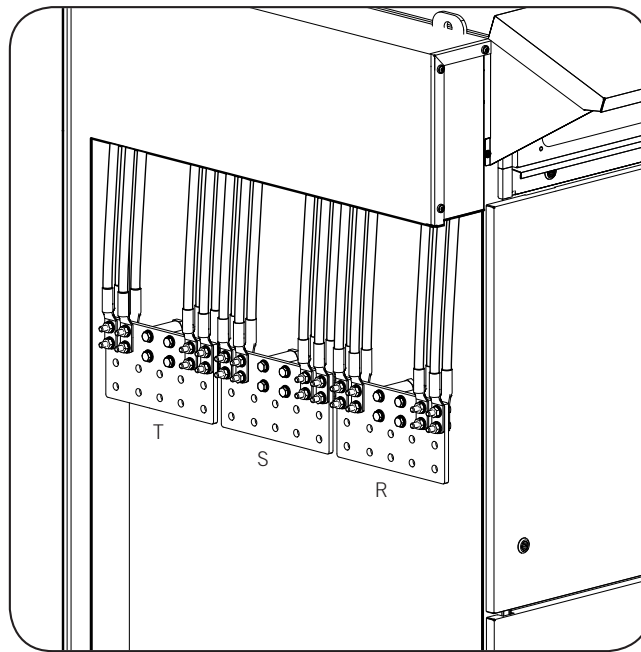
a	0.39 in (10 mm)	e	0.59 in (15 mm)
b	1.57 in (40 mm)	f	1.75 in (44.5 mm)
c	0.59 in (15 mm)	g	4.84 in (123 mm)
d	1.75 in (44.5 mm)		

Connection for lower cable input

CAUTION

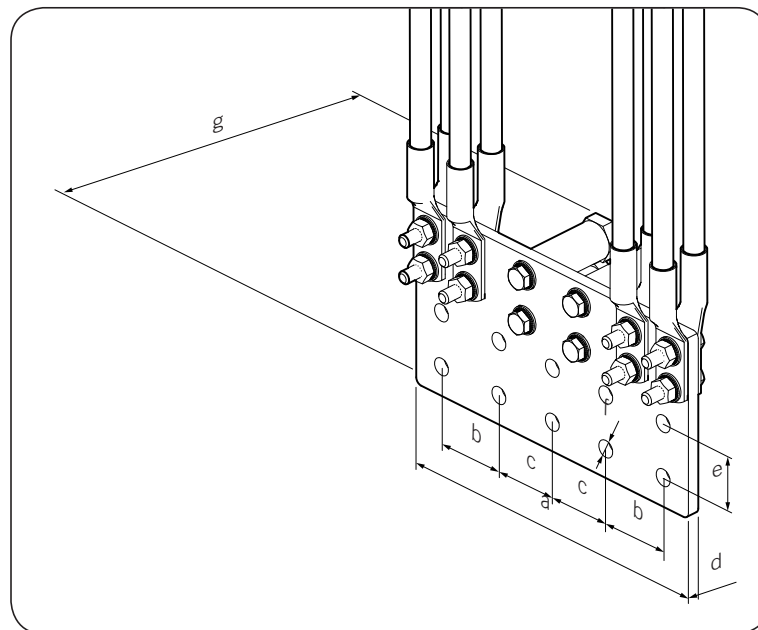
After connecting the cables to the inverter, ensure that the current distribution through the parallel conductors is correct.

The AC phase busbars are located on the left or right side, depending on the unit configuration, and the cable entry is done from the lower part of the enclosure that protects the connection. The following figure represents a cross-section view of the enclosure.



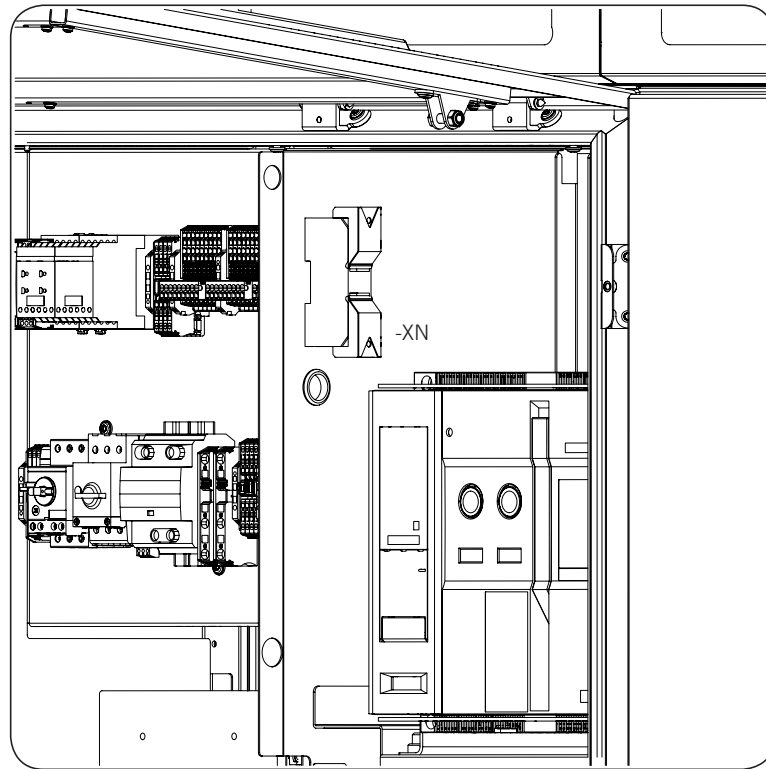
Each phase has five connection positions per plate, with two holes per position. It is possible to connect one or two wires per position (on one side of the busbar or on both), so the maximum number of wires per phase is ten (five positions, two wires per position).

The dimensions of the inverter busbars are as follows:



a	10.82 in (275 mm)	e	1.75 in (44.5 mm)
b	2.28 in (58 mm)	f	0.55 in (14 mm)
c	2.13 in (54 mm)	g	2.83 in (72 mm)
d	0.39 in (10 mm)		

In all the above cases the neutral connection terminal (-XN) is located inside the DCAC connections module.



16.3. Connecting the AC phases via busbars

16.3.1. Requirements for the AC phase connection busbars

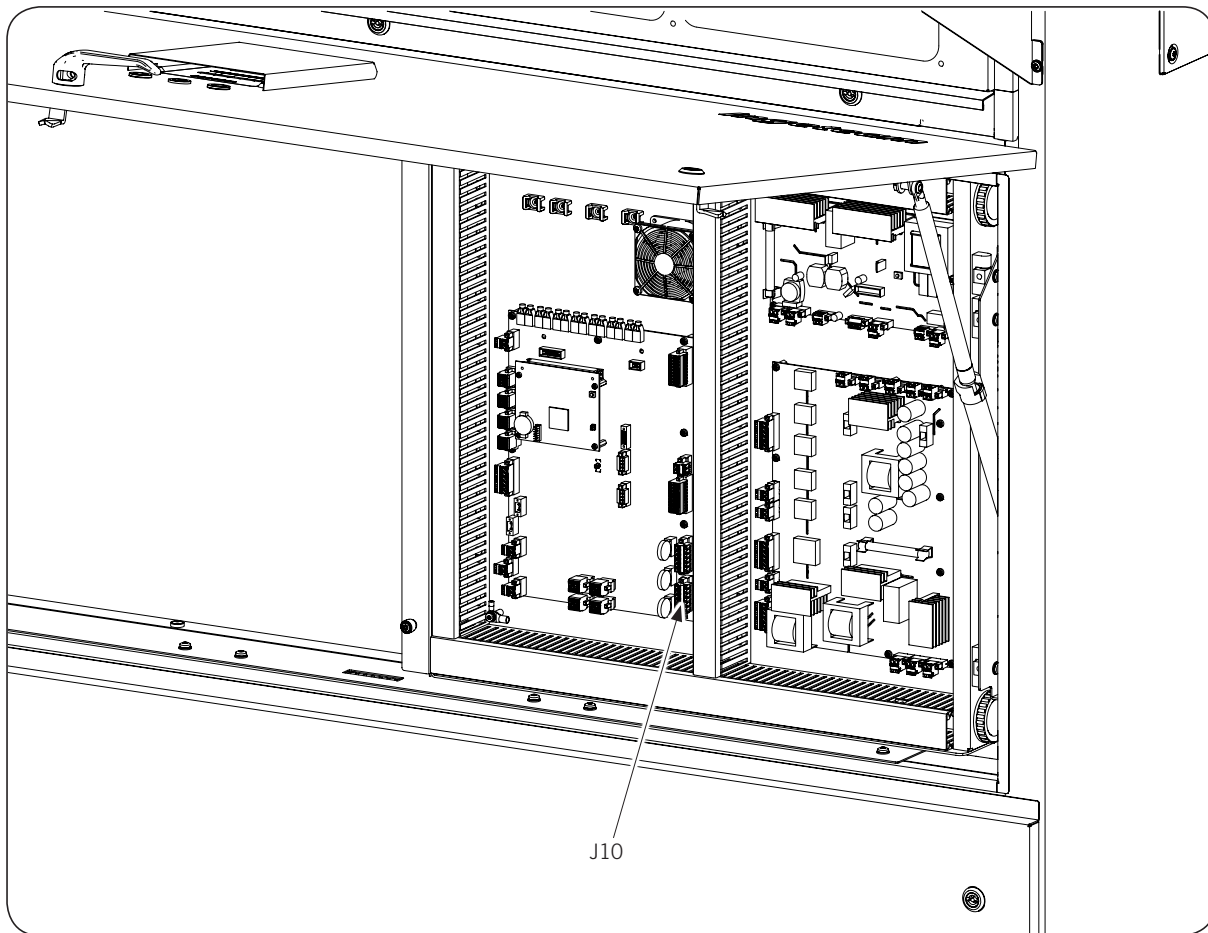
If using busbars for the AC connection, the requirements must be established with Ingeteam according to the characteristics of the PV plant.

16.3.2. Connection process

Proceed in the following order for each phase:

1. Clean the contact surfaces on both the terminal and the busbar with a clean cloth and ethanol.
2. Connect the busbars using the bolts, nuts and washers specified by Ingeteam, applying a tightening torque of 42 Nm with NLGI 1 anti-seize lubrication.

3. To connect to transformers with the low-voltage winding in delta or to transformers without the neutral accessible, it is necessary to change the position of a wire in the -CCU. Connect the cable going to -J10.1 (labeled as N on the card) from the -CCU in J10.2.



16.4. Connecting the AC phases via terminals

16.4.1. Wiring and terminal requirements for the AC connection

If using wiring for the AC connection, it must meet the following requirements.

Wiring

- The correct dimensioning of the AC wiring is the installer's responsibility, depending on the plant specifications and inverter characteristics.
- The wire gauge must be based on each unit's continuous currents. Incorrect dimensioning can lead to overheating and fires.
- Only copper or aluminum cable must be used.
- The cables for connection to the unit grid must withstand at least the phase voltage and 1500 V between a phase and ground.
- If the inverter and the grid connection point are far enough apart to require the use of longer cables, an external distribution box must be used close to the investor to make this connection.

Terminals

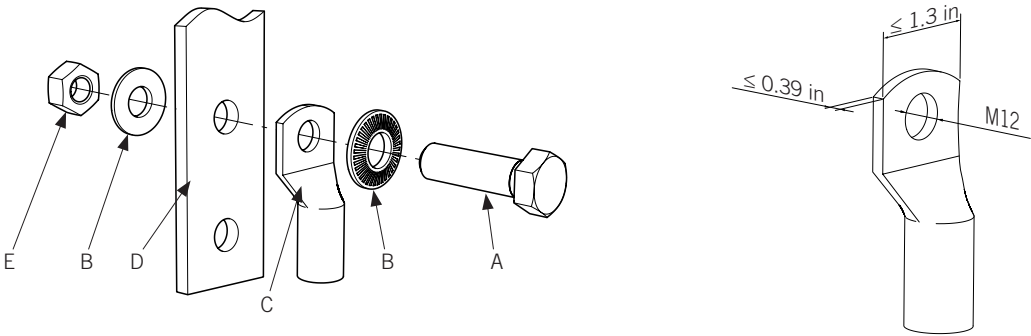
- For AC connections, compression terminals must be used. The terminals used can be with 1 or 2 holes.

- The inverter busbars are made of copper. We recommend using tinned copper terminals, while copper terminals are allowed. If you use aluminum cables, you must use bimetallic terminals or other components that eliminate the galvanic couple of the joint.
- Use the screws, washers and nuts specified by Ingeteam.
- All torques indicated must be respected and maintained.

	Wire gauge	Tightening torque
Phases		
Up to ten wires per phase, depending on the type of busbar		
Minimum	In accordance with the current circulating through the conductors	405 lb.in (45.7 Nm) (with lubrication)
Maximum	750 kcmil*	
Neutral		
Section	6 AWG	44 lb.in (5 Nm), M6 terminal (without lubrication)

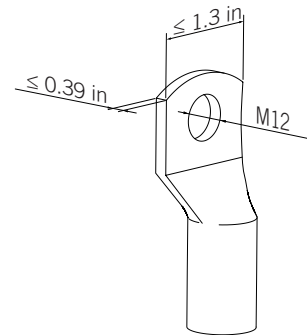
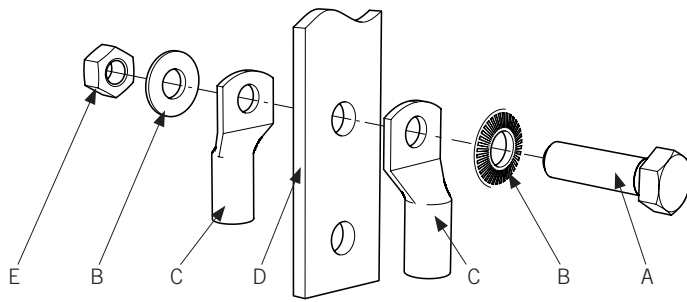
* To facilitate handling of the wiring, Ingeteam recommends using more than one smaller gauge cable instead of one large gauge cable. For example, it is preferable to use two 400 kcmil cables instead of one 750 kcmil cable.

Phase connection via a terminal with one hole



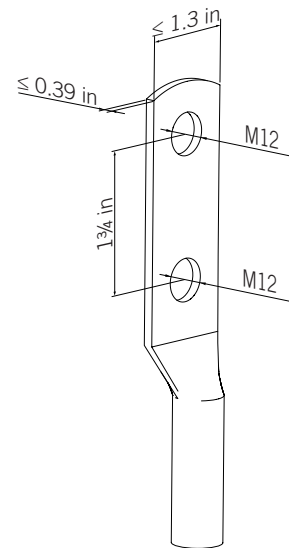
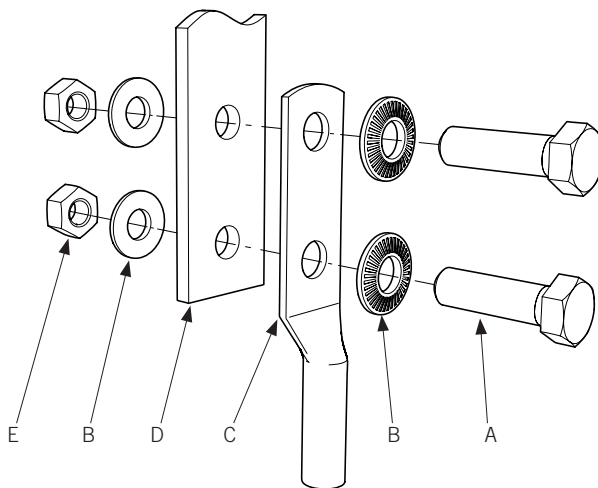
- A. M12 DIN 933 screw.
- B. M12 NFE-25 511 M washer.
- C. Terminal. Hole diameter of M12, maximum thickness of 0.39 in (10 mm), maximum width of 1.3 in (33 mm).
- D. Busbar. When using a single hole terminal, use only the **top hole** in the connection position of the plate.
- E. M12 DIN 934 nut.

Phase connection via two terminals with one hole



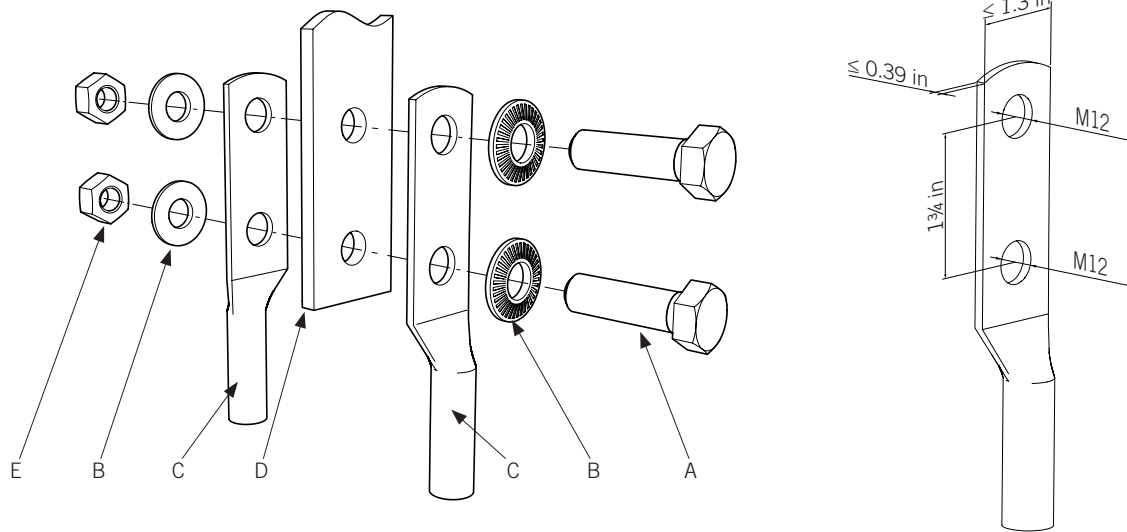
- A. M12 DIN 933 screw.
- B. M12 NFE-25 511 M washer.
- C. Terminal. Hole diameter of M12, maximum thickness of 0.39 in (10 mm), maximum width of 1.3 in (33 mm).
- D. Busbar. When using a single hole terminal, use only the **top hole** in the connection position of the plate.
- E. M12 DIN 934 nut.

Phase connection via a terminal with two holes



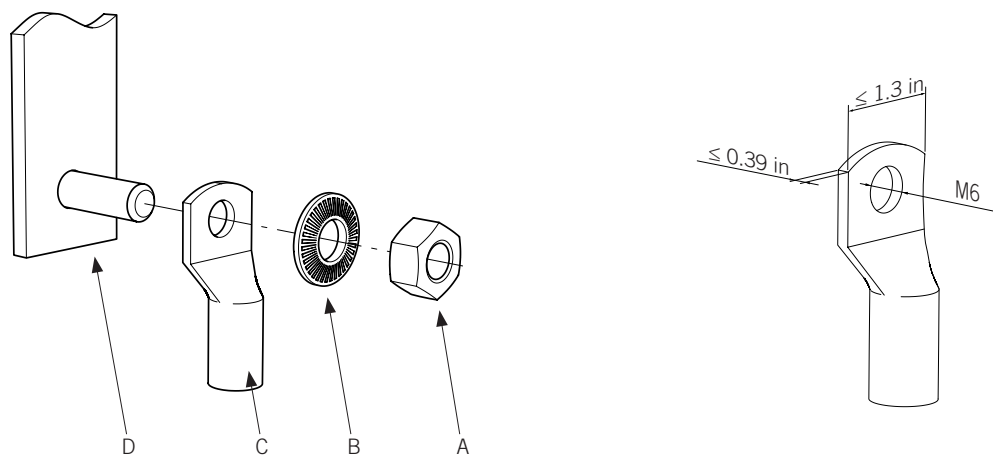
- A. M12 DIN 933 screw.
- B. M12 NFE-25 511 M washer.
- C. Terminal. Diameter of the M12 hole, maximum thickness of 0.39 in (10 mm), maximum width of 1.3 in (33 mm), vertical distance between holes of 1 3/4 in (44.5 mm).
- D. Busbar.
- E. M12 DIN 934 nut.

Phase connection via two terminals with two holes



- A. M12 DIN 933 screw.
- B. M12 NFE-25 511 M washer.
- C. Terminal. Diameter of the M12 hole, maximum thickness of 0.39 in (10 mm), maximum width of 1.3 in (33 mm), vertical distance between holes of 1 3/4 in (44.5 mm).
- D. Busbar.
- E. M12 DIN 934 nut.

Neutral connection via a terminal with one hole



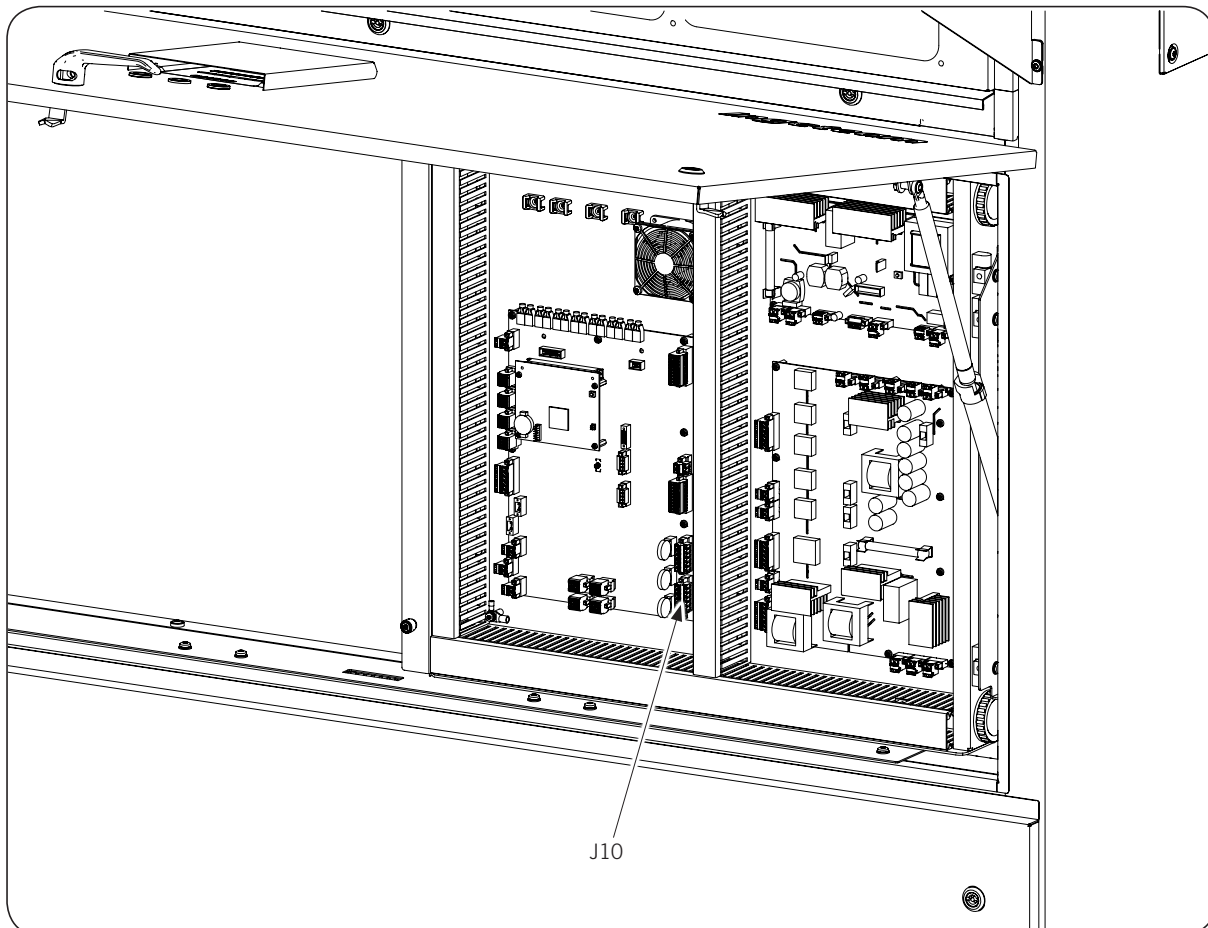
- A. M6 DIN 934 nut.
- B. M6 NFE-25 511 M washer.
- C. Terminal. Hole diameter of M6, maximum thickness of 0.39 in (10 mm), maximum width of 1.3 in (33 mm).
- D. Busbar.

16.4.2. AC phases connection process via a terminal

Proceed in the following order for each phase:

1. Clean the contact surfaces on both the terminal and the busbar with a clean cloth and ethanol.

2. Connect the terminals using the bolts, nuts and washers specified by Ingeteam, applying a tightening torque of 42 Nm with NLGI 1 anti-seize lubrication.
3. Ensure the correct connection of the cable and terminal.
4. To connect to transformers with the low-voltage winding in delta or to transformers without the neutral accessible, it is necessary to change the position of a wire in the -CCU. Connect the cable going to -J10.1 (labeled as N on the card) from the -CCU in J10.2.



16.5. Connecting the AC neutral

i INFO

This procedure is valid when the phases are connected using busbars, and also when the phases are connected via wires.

Based on whether the connection of the unit is done in a transformer with the low-voltage side in star or delta, the neutral connection process is different.

Units connected to transformers with the low-voltage side in star connection

1. Once you have accessed the AC neutral, peel the cable according to the size of the terminal to use.
2. Crimping the terminal on the cable.
3. Clean the contact surfaces on both the terminal and the connection terminal with a clean cloth and ethanol.
4. Connect the terminal to the free -XN terminal.
5. Ensure the correct connection of the cable.

Units connected to transformers with the low-voltage side in delta connection or star without accessible neutral

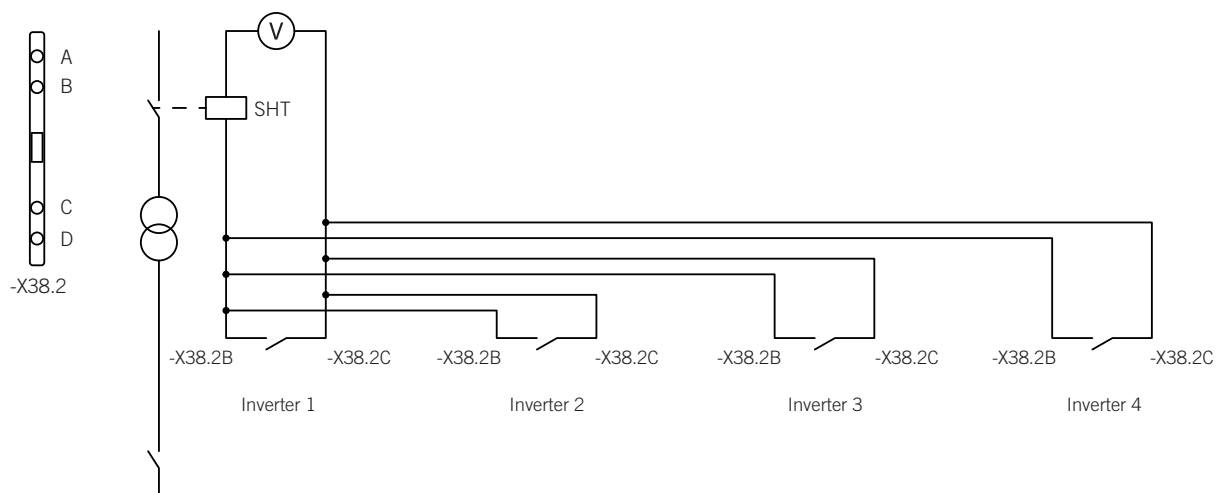
To connect to transformers with the low-voltage winding in delta or to transformers without the neutral accessible, it is necessary to change the position of a wire in the -CCU.

Connect the cable going to -J10.1 (labeled as N on the card) from the -CCU in J10.2.

16.6. Connecting the Medium Voltage switchgear emergency trip

These units have a normally open voltage-free contact for the emergency trip of the Medium Voltage switchgear or the equivalent protection upstream of the inverter.

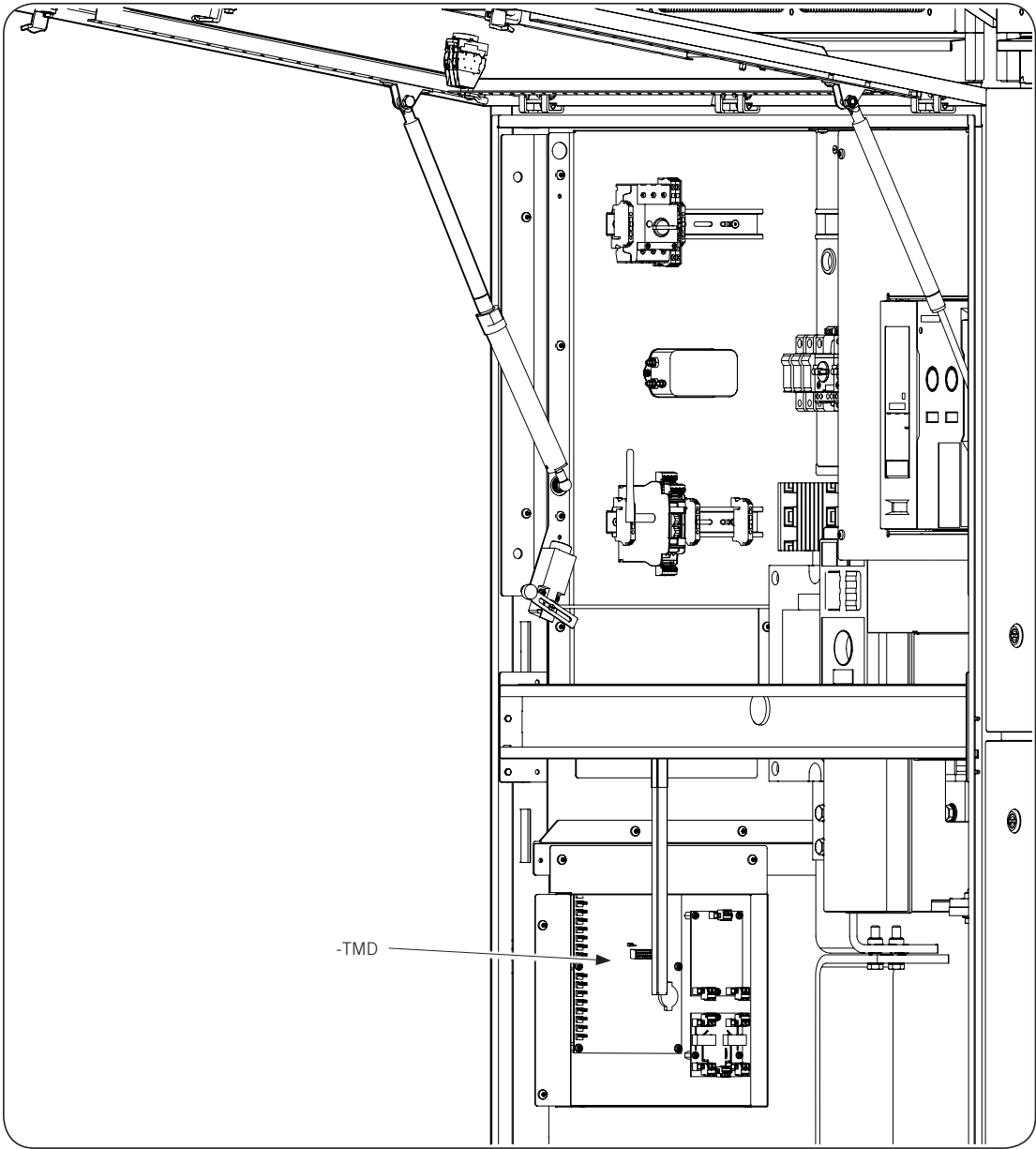
The wiring must be connected between positions B and C of terminal -X38.2. Below is an example diagram, although other alternatives that produce the same result are possible (tripping the Medium Voltage switchgear). In the event of several inverters connected to the same transformer, the wiring must be done in parallel through a single power supply.



SHT: trip coil

17. Configuring the optional DC input current monitoring kit

The main function of the kit is to permanently monitor the current flowing through each multiple input in the inverter, in order to detect abnormal currents due to faults in the PV array and/or protection elements (fuses).
For its correct operation the Modbus node must be configured. This configuration is done in the kit's control card (-TMD in the following figure).



17.1. Configuring the Modbus node

This kit is assigned node number 2 by default. In the event that you want to modify this node number, you must configure the switch in the card according to the following table, taking into aware that position 8 must always be set to 1:

Node number	Switch							
	1	2	3	4	5	6	7	8
001	1	0	0	0	0	0	0	1
002	0	1	0	0	0	0	0	1

Node number	Switch							
	1	2	3	4	5	6	7	8
003	1	1	0	0	0	0	0	1
004	0	0	1	0	0	0	0	1
005	1	0	1	0	0	0	0	1
006	0	1	1	0	0	0	0	1
007	1	1	1	0	0	0	0	1
008	0	0	0	1	0	0	0	1
009	1	0	0	1	0	0	0	1
010	0	1	0	1	0	0	0	1
011	1	1	0	1	0	0	0	1
012	0	0	1	1	0	0	0	1
013	1	0	1	1	0	0	0	1
014	0	1	1	1	0	0	0	1
015	1	1	1	1	0	0	0	1
016	0	0	0	0	1	0	0	1
017	1	0	0	0	1	0	0	1
018	0	1	0	0	1	0	0	1
019	1	1	0	0	1	0	0	1
020	0	0	1	0	1	0	0	1
021	1	0	1	0	1	0	0	1
022	0	1	1	0	1	0	0	1
023	1	1	1	0	1	0	0	1
024	0	0	0	1	1	0	0	1
025	1	0	0	1	1	0	0	1
026	0	1	0	1	1	0	0	1
027	1	1	0	1	1	0	0	1
028	0	0	1	1	1	0	0	1
029	1	0	1	1	1	0	0	1
030	0	1	1	1	1	0	0	1
031	1	1	1	1	1	0	0	1
032	0	0	0	0	0	1	0	1
033	1	0	0	0	0	1	0	1
034	0	1	0	0	0	1	0	1
035	1	1	0	0	0	1	0	1
036	0	0	1	0	0	1	0	1
037	1	0	1	0	0	1	0	1
038	0	1	1	0	0	1	0	1
039	1	1	1	0	0	1	0	1
040	0	0	0	1	0	1	0	1
041	1	0	0	1	0	1	0	1
042	0	1	0	1	0	1	0	1
043	1	1	0	1	0	1	0	1
044	0	0	1	1	0	1	0	1
045	1	0	1	1	0	1	0	1
046	0	1	1	1	0	1	0	1
047	1	1	1	1	0	1	0	1
048	0	0	0	0	1	1	0	1

Node number	Switch							
	1	2	3	4	5	6	7	8
049	1	0	0	0	1	1	0	1
050	0	1	0	0	1	1	0	1
051	1	1	0	0	1	1	0	1
052	0	0	1	0	1	1	0	1
053	1	0	1	0	1	1	0	1
054	0	1	1	0	1	1	0	1
055	1	1	1	0	1	1	0	1
056	0	0	0	1	1	1	0	1
057	1	0	0	1	1	1	0	1
058	0	1	0	1	1	1	0	1
059	1	1	0	1	1	1	0	1
060	0	0	1	1	1	1	0	1
061	1	0	1	1	1	1	0	1
062	0	1	1	1	1	1	0	1
063	1	1	1	1	1	1	0	1
064	0	0	0	0	0	0	1	1
065	1	0	0	0	0	0	1	1
066	0	1	0	0	0	0	1	1
067	1	1	0	0	0	0	1	1
068	0	0	1	0	0	0	1	1
069	1	0	1	0	0	0	1	1
070	0	1	1	0	0	0	1	1
071	1	1	1	0	0	0	1	1
072	0	0	0	1	0	0	1	1
073	1	0	0	1	0	0	1	1
074	0	1	0	1	0	0	1	1
075	1	1	0	1	0	0	1	1
076	0	0	1	1	0	0	1	1
077	1	0	1	1	0	0	1	1
078	0	1	1	1	0	0	1	1
079	1	1	1	1	0	0	1	1
080	0	0	0	0	1	0	1	1
081	1	0	0	0	1	0	1	1
082	0	1	0	0	1	0	1	1
083	1	1	0	0	1	0	1	1
084	0	0	1	0	1	0	1	1
085	1	0	1	0	1	0	1	1
086	0	1	1	0	1	0	1	1
087	1	1	1	0	1	0	1	1
088	0	0	0	1	1	0	1	1
089	1	0	0	1	1	0	1	1
090	0	1	0	1	1	0	1	1
091	1	1	0	1	1	0	1	1
092	0	0	1	1	1	0	1	1
093	1	0	1	1	1	0	1	1
094	0	1	1	1	1	0	1	1

Node number	Switch							
	1	2	3	4	5	6	7	8
095	1	1	1	1	1	0	1	1
096	0	0	0	0	0	1	1	1
097	1	0	0	0	0	1	1	1
098	0	1	0	0	0	1	1	1
099	1	1	0	0	0	1	1	1
100	0	0	1	0	0	1	1	1
101	1	0	1	0	0	1	1	1
102	0	1	1	0	0	1	1	1
103	1	1	1	0	0	1	1	1
104	0	0	0	1	0	1	1	1
105	1	0	0	1	0	1	1	1
106	0	1	0	1	0	1	1	1
107	1	1	0	1	0	1	1	1
108	0	0	1	1	0	1	1	1
109	1	0	1	1	0	1	1	1
110	0	1	1	1	0	1	1	1
111	1	1	1	1	0	1	1	1
112	0	0	0	0	1	1	1	1
113	1	0	0	0	1	1	1	1
114	0	1	0	0	1	1	1	1
115	1	1	0	0	1	1	1	1
116	0	0	1	0	1	1	1	1
117	1	0	1	0	1	1	1	1
118	0	1	1	0	1	1	1	1
119	1	1	1	0	1	1	1	1
120	0	0	0	1	1	1	1	1
121	1	0	0	1	1	1	1	1
122	0	1	0	1	1	1	1	1
123	1	1	0	1	1	1	1	1
124	0	0	1	1	1	1	1	1
125	1	0	1	1	1	1	1	1
126	0	1	1	1	1	1	1	1
127	1	1	1	1	1	1	1	1

17.2. Configuring the measurement string numbers

i INFO

The string numbers are factory set. In exceptional cases it may be necessary to modify this setting. To do this, please contact Ingeteam.

17.3. Monitoring

i INFO

The communications connection of the kit shall be done via Ethernet port B in the unit. For plant control, connect via port A.

17.3.1. Communication via Modbus registries

With the connection to the communication data bus for reading data from the unit, it is possible to have real-time information about the currents and alarms generated.

INFO

To obtain information about how this information is structured and how to access it through the MODBUS protocol, request document AAV1089IMB04 from Ingeteam.

17.3.2. Communication with the unit's display

It is possible to view the data registered by the kit through the *Monitoring* menu on the inverter's display, in option *Input DC measurement*.

17.4. Alarms

There are three types of alarms: general alarms, abnormal current alarms, and blown fuse alarms.

17.5. General alarms

Code	Alarm	Description
0x0001	Abnormal current alarm	Abnormal current in a series
0x0004	Fuse alarm	Blown fuse
0x0010	CI temperature alarm	High CI temperature

17.6. Abnormal current alarms

When general alarm 0x0001 is activated, the abnormal current alarms shows which series are affected.

Code	Alarm	Description
0x0001	Abnormal current in series 1 alarm	Abnormal current in series 1
0x0002	Abnormal current in series 2 alarm	Abnormal current in series 2
0x0004	Abnormal current in series 3 alarm	Abnormal current in series 3
0x0008	Abnormal current in series 4 alarm	Abnormal current in series 4
0x0010	Abnormal current in series 5 alarm	Abnormal current in series 5
0x0020	Abnormal current in series 6 alarm	Abnormal current in series 6
0x0040	Abnormal current in series 7 alarm	Abnormal current in series 7
0x0080	Abnormal current in series 8 alarm	Abnormal current in series 8
0x0100	Abnormal current in series 9 alarm	Abnormal current in series 9
0x0200	Abnormal current in series 10 alarm	Abnormal current in series 10
0x0400	Abnormal current in series 11 alarm	Abnormal current in series 11
0x0800	Abnormal current in series 12 alarm	Abnormal current in series 12
0x1000	Abnormal current in series 13 alarm	Abnormal current in series 13
0x2000	Abnormal current in series 14 alarm	Abnormal current in series 14
0x4000	Abnormal current in series 15 alarm	Abnormal current in series 15
0x8000	Abnormal current in series 16 alarm	Abnormal current in series 16

17.7. Blown fuse alarms

When general alarm 0x0004 is activated, the blown fuse alarms shows which series are affected.

Code	Alarm	Description
0x0001	Blown fuse in series 1 alarm	Blown fuse in series 1

Code	Alarm	Description
0x0002	Blown fuse in series 2 alarm	Blown fuse in series 2
0x0004	Blown fuse in series 3 alarm	Blown fuse in series 3
0x0008	Blown fuse in series 4 alarm	Blown fuse in series 4
0x0010	Blown fuse in series 5 alarm	Blown fuse in series 5
0x0020	Blown fuse in series 6 alarm	Blown fuse in series 6
0x0040	Blown fuse in series 7 alarm	Blown fuse in series 7
0x0080	Blown fuse in series 8 alarm	Blown fuse in series 8
0x0100	Blown fuse in series 9 alarm	Blown fuse in series 9
0x0200	Blown fuse in series 10 alarm	Blown fuse in series 10
0x0400	Blown fuse in series 11 alarm	Blown fuse in series 11
0x0800	Blown fuse in series 12 alarm	Blown fuse in series 12
0x1000	Blown fuse in series 13 alarm	Blown fuse in series 13
0x2000	Blown fuse in series 14 alarm	Blown fuse in series 14
0x4000	Blown fuse in series 15 alarm	Blown fuse in series 15
0x8000	Blown fuse in series 16 alarm	Blown fuse in series 16

18. Commissioning

This chapter details the process for commissioning the unit.

i INFO

To find the different components listed below, consult Section “2.6. Location of components”.

Refer to Section “Important safety instructions” and the safety paragraph in this section before operating the equipment.

18.1. Unit inspection

These models are equipped with three thermomagnetic circuit breakers to protect their various components. These should be in the OFF position prior to unit start-up.

⚠ DANGER

Before working on the thermomagnetic switches, check that there are no electrical hazards inside the unit.

When checking that there is no voltage, wearing dielectric gloves and safety goggles approved for electrical hazards is required.

18.1.1. Inspection

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

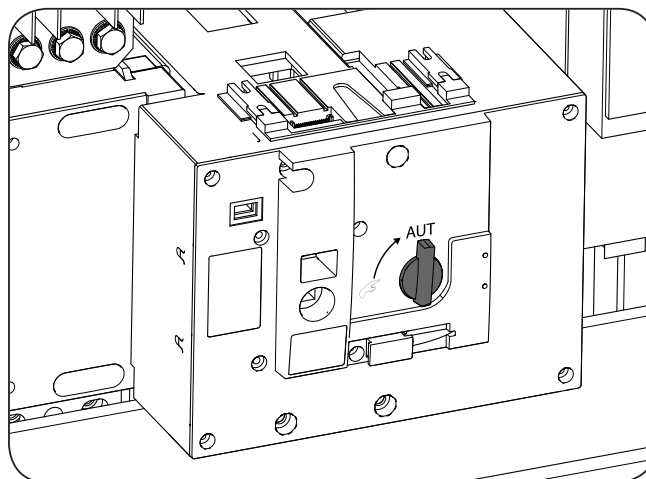
Wiring

- Check that there are no loose wires. The minimum distance must be at least 0.6 in (15 mm) between phases in the AC power and between the polarities in the DC power.
- Check that the cables are correctly connected.
- 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.

Removing the clear plastic type protections, like polycarbonates, for performing this inspection is strictly forbidden.

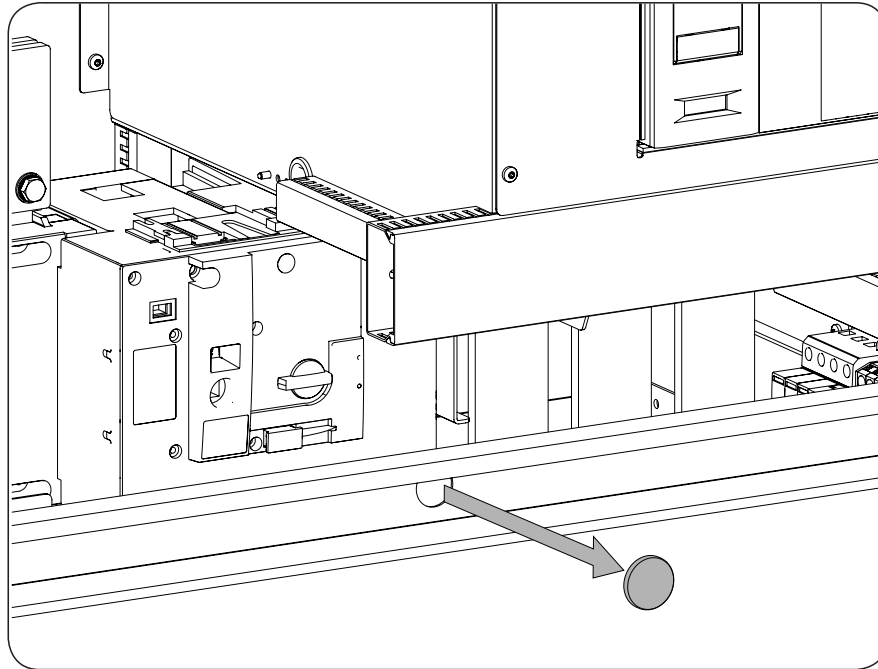
DCAC connections module

- Check that the DC arresters are properly inserted into the base and that their status window is not red.
- Check that the AC arresters are properly inserted into the base and that their status window is not red.
- Check that the DC switch is in automatic mode (AUTO) and on OFF. The OFF position is indicated via the status window

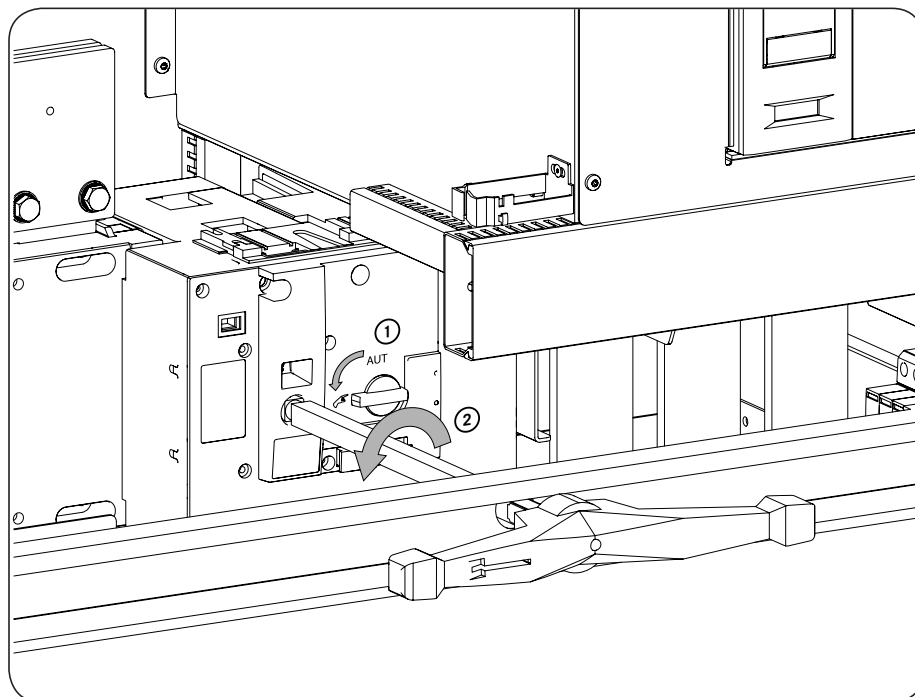


Exceptionally, and only for maintenance or servicing tasks, the DC switch can be operated manually. To perform this action, turn the operating mode selector 90° counter-clockwise. Upon selecting manual mode, it frees access for the installation of the switch opening rotary knob.

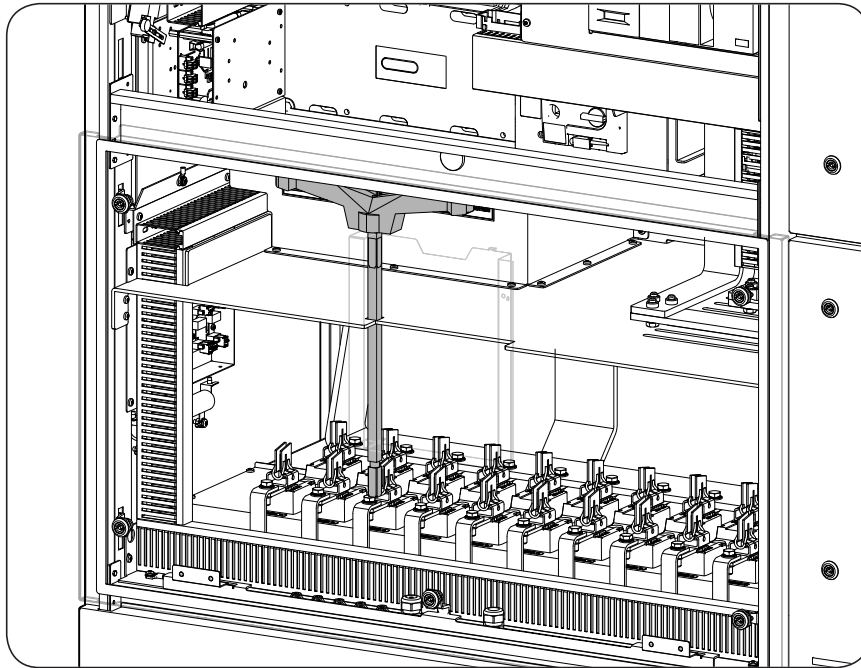
To insert the knob, remove the protection cap from the unit enclosure.



With manual mode selected, insert the knob and turn it counterclockwise.



The rotary knob for manual activation of the DC switch is located on the inside of the middle plate of the DCAC connections module.

**⚠ CAUTION**

Manual operation of the DC switch limits unit safety and protection. Ingeteam accepts no liability for damage resulting from this action.

i INFO

By default, the DC switch must always be in AUTO. Otherwise an alarm is activated.

18.1.2. Shutting down

Make sure that during the installation and connection operations the level of protection is not altered.

Maintain both the power and signal wiring long enough in all connections to avoid undesirable strain on the internal electrical connections.

Check that the cables used have the same degree of protection as the unit itself.

Folding doors

If the unit doors have opened at some point, close them and check they are properly closed.

⚠ CAUTION

The guarantee does not cover damage caused by inadequate sealing of the unit.

Safety measures**i INFO**

Opening any of the doors on the unit causes the unit to be disconnected from the grid, go into manual stop status, and opens the corresponding motorized DC switch.

18.2. Opening the ventilation system protection

CAUTION

The ventilation system protection must remain open whenever the unit is running. Otherwise it will not operate correctly.

Ingeteam accepts no liability for the consequences of non-compliance with this warning.

For more information about the opening process see section “7.2. Opening the ventilation system protections”.

18.3. Unit configuration

Once the unit has been mounted in its final position and has been solidly secured, ensure that the inverter is properly set up.

DANGER

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 capacitances are fully discharged.

18.3.1. IP number configuration

INFO

For more information consult the corresponding Accessories for communication via Ethernet manual.

18.4. Power-up

DANGER

The AC switch may not be operated manually under any circumstances. If this warning is not followed, the safety of personnel and equipment cannot be guaranteed.

Ingeteam accepts no liability for the consequences of non-compliance with this warning.

First carry out a general visual inspection and wiring check, then proceed to connect the unit to the grid by following the guidelines in this document.

The tasks outlined for this step must be carried out with all the doors of the unit closed, thus avoiding possible contact with live components.

18.4.1. Start-up

CAUTION

Failure to comply with the verification tasks described releases Ingeteam from any liability for possible damage to the system or the inverter itself caused by such failure.

Once the wiring has been completed and all components of the inverter have been checked, start up the unit. Take the following steps in the order they appear:

1. Perform the checks indicated in Section “18.1.1. Inspection”.
2. Check that -Q1 is OFF. If not, switch it to OFF.
3. Disable the safety setpoints and locks, in any, for the following elements: -Q1, -Q2, -Q4, -Q5, and -QDC.
4. Set thermomagnetic circuit breaker -Q2 to ON. The -Q2 thermomagnetic circuit breaker protects the inverter’s auxiliary services. Upon turning it ON, the unit’s electronics connect and may begin communications.
5. Set thermomagnetic circuit breaker -Q4 to ON.
6. Set thermomagnetic circuit breaker -Q5 to ON.

7. Check that the variables on the monitoring menu are consistent; in particular the VAC and VDC levels (see Section “19.6.1. Monitoring”).
8. Close all of the unit's doors and keep the emergency stop button interlocked (manual stop).
9. Check alarms on the display. If everything is in order, only the manual stop alarm should be displayed.
10. Once the previous points have been verified, reset the emergency push button and start the inverter via the display.
11. The motorized DC switch must close automatically, powering the unit's DC.

18.4.2. Checking and measurement

INFO

Ingeteam recommends checking the waveform of the current generated in the three phases using an ammeter clamp. Use the PPE listed in section “Personal Protective Equipment” to get this reading.

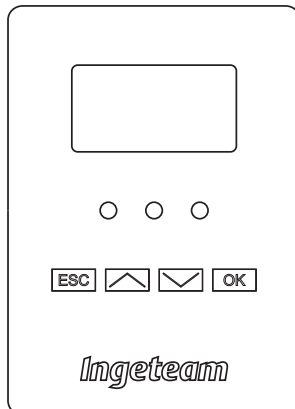
During initial connection to the grid, Ingeteam recommends monitoring the temperatures inside the unit to check correct operation of the cooling system.

Once connected to the unit network, the green LED is still lit; verify that no error LED display is on.

Check that the monitoring menu parameters are consistent:

- The PV array voltage is within the expected operating range relative to the plant's configuration.
- The Vac voltage of each of the phases shown on the display is within the inverter's operating range.
- The RMS value of currents Iac1, Iac2 and Iac3 displayed should be similar.
- There are no alarms in the inverter.

19. Display control



These inverters incorporate a display and keypad unit to interface with the installer and the user.

This interface allows the display of the main internal parameters and the configuration of the entire system during installation.

Parameters, variables and commands are organized as menus and submenus.

19.1. Keypad and LEDs

The keypad has four keys:

ESC	To exit a parameter, leave a menu and return to the next level up in the structure to not confirm a change or not accept a suggestion.
^	With this key you can scroll up the list of parameters or folders within the same level or increase the value of an editable parameter by one base unit.
v	With this key you can scroll down the list of parameters or folders within the same level or decrease the value of an editable parameter by one base unit.
OK	Its purpose is to accept a parameter as valid, to enter a lower level menu in the structure, to confirm a change or accept a suggestion.

The front panel has three LEDs:



Green LED

Off: inverter disconnected.

Slow flashing: Standby due to low irradiance.

Fast flashing: Start-up process.

On: Inverter connected to the grid.



Orange LED

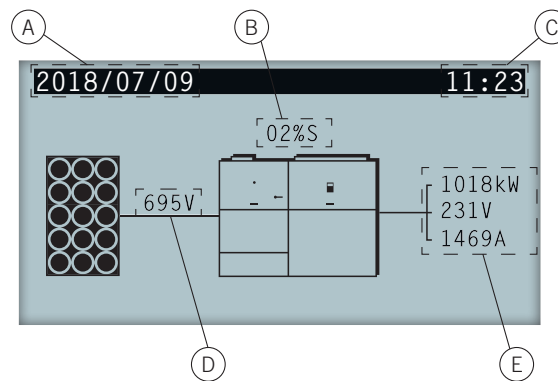
This announces the existence of an alarm generated by an error external to the inverter and the installation (for example, frequency error).



Red LED

This announces the existence of an alarm generated by an error internal to the inverter (for example, ventilation error).

19.2. Display



- A. Current date, YYYY-MM-DD.
- B. Power reduction percentage and reason for this reduction*.
- C. Current time, hh:mm. If there is a loss of communication between the inverter and the display, the two points stop blinking.
- D. Voltage and power of the PV array. Both pieces of data are displayed alternately.
- E. Power, voltage and current fed to the grid.

Pressing the key OK takes you to the main menu. Pressing the key $\wedge$ displays the daily power graph. Pressing $\vee$ displays the energy graph for the last 24 days.

* The reasons for power reduction are as follows:

T: Temperature. The inverter is limiting the power due to internal overheating.

C: Communications. The inverter is limiting the power after having received a reduction setpoint through communications.

F: Grid frequency. The inverter is limiting the power due to the grid frequency variation.

V: Grid voltage. The inverter is limiting the power due to the grid voltage variation.

Q: Reactive priority. The inverter is limiting the power due to the injection of reactive power.

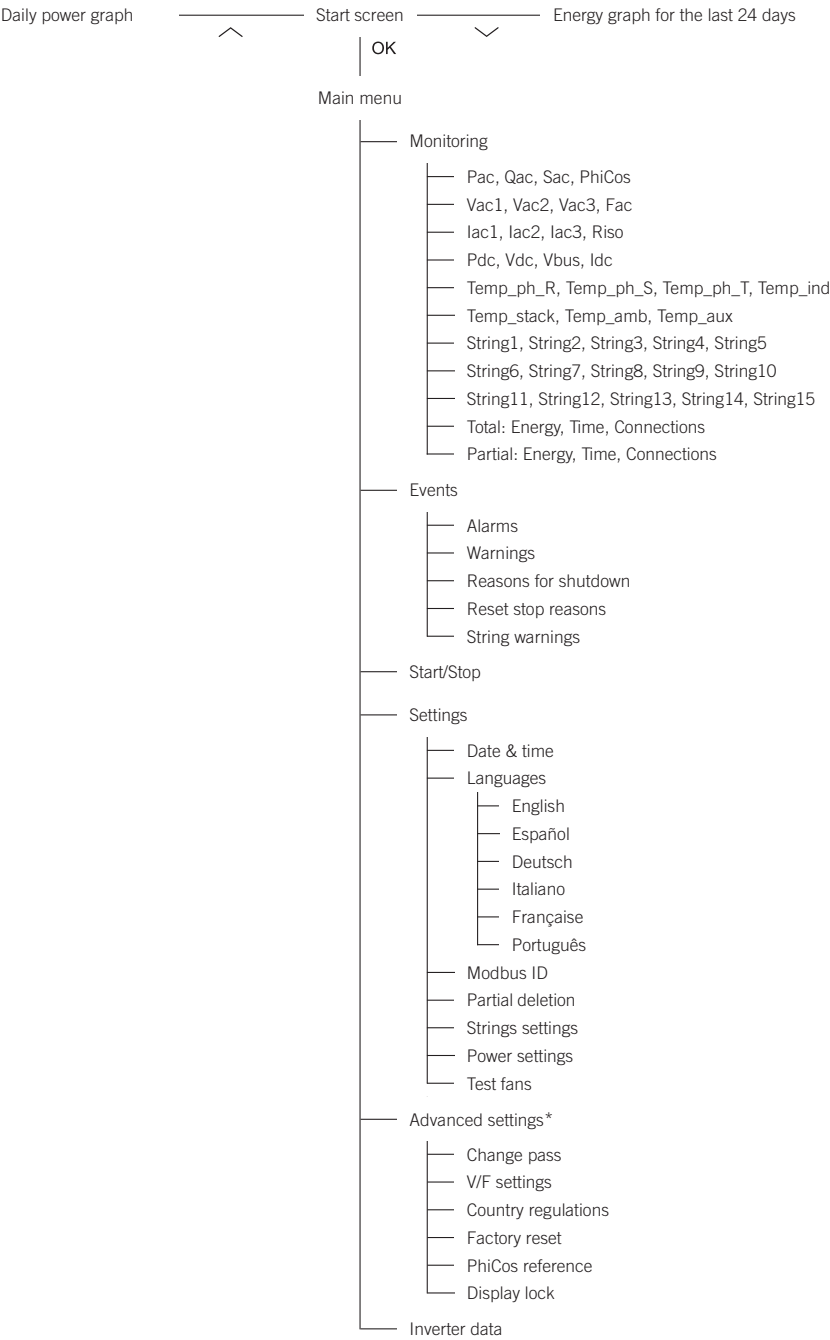
A: Configuration. The inverter is configured to limit its power.

R: Initial connection ramp. The inverter is limiting the power after a reconnection to the grid.

S: Self consumption mode. The inverter is limiting the power due to functioning in self consumption mode.

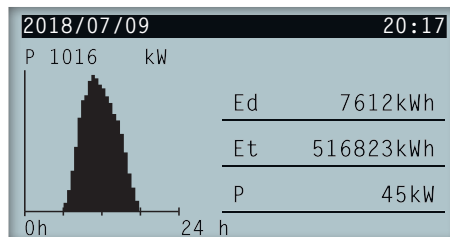
M: Reserved mode.

19.3. Menu structure



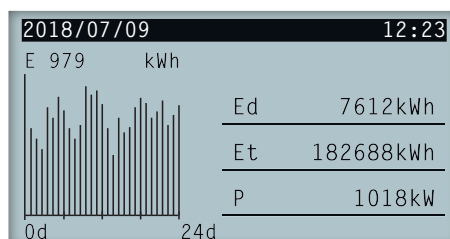
* Menu intended for the installer and password-protected.

19.4. Daily power graph



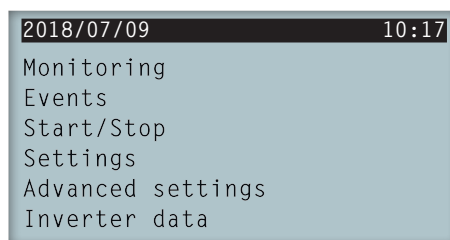
In this screen you can consult the daily power graph. The daily energy values (Ed), from the first connection of the day to the time of the query, the total accumulated energy (Et) and the power (P) are also listed.

19.5. Energy graph for the last 24 days



In this screen you can consult the energy graph for the last 24 days. The daily energy values (Ed), from the first connection of the day to the time of the query, the total accumulated energy (Et) and the power (P) are also listed.

19.6. Main menu



The main menu contains the following submenus:

<i>Monitoring</i>	This menu includes a series of screens which show the main variables being monitored. The right-hand screen shows the first one as an example.
<i>Events</i>	This shows the main events such as alarms, warnings and reasons for shutdown.
<i>Start/Stop</i>	Start up and shutdown the inverter manually.
<i>Settings</i>	Modify parameters to adapt the unit to different operational conditions.
<i>Advanced settings</i>	To carry out advanced settings in the inverter. Its access is restricted by the installer password. Is not user-accessible.
<i>Inverter data</i>	Key data relative to the inverter: serial number, firmware loaded, etc.

To access the various menus and submenus, the desired option must be highlighted over a black background using the $\wedge$ and $\vee$ keys and press the OK key to access it.

19.6.1. Monitoring

This menu includes a series of screens which show the main variables being monitored. To move between the different screens use the keys $\wedge$ and $\vee$.

The structure and interpretation of the variables of this menu are shown below:

<i>Pac</i>	Inverter AC power, in kilowatts.
<i>Qac</i>	Inverter AC reactive power, in reactive kilovolt-amperes.
<i>Sac</i>	Inverter AC apparent power, in kilovolt-amperes.
<i>CosPhi</i>	Cosine of Phi. Cosine of the phase shift angle between the voltage and current supplied by the inverter. The cosine of phi can be positive or negative: • Positive: the inverter injects positive reactive energy. The current is ahead with respect to the voltage. • Negative: the inverter injects negative reactive energy. The current is delayed with respect to the voltage.
<i>Vac1</i>	Phase 1 (R) AC voltage (in volts).
<i>Vac2</i>	Phase 2 (S) AC voltage (in volts).
<i>Vac3</i>	Phase 3 (T) AC voltage (in volts).
<i>Fac</i>	Frequency generated by the inverter, in hertz.
<i>Iac1</i>	AC current of phase 1, in amperes.
<i>Iac2</i>	AC current of phase 2, in amperes.
<i>Iac3</i>	AC current of phase 3, in amperes.
<i>Riso</i>	Insulation resistance of the PV array, in kilohms.
<i>Pdc</i>	Inverter DC power, in kilowatts.
<i>Vdc</i>	Inverter DC voltage, in volts.
<i>Vbus</i>	BUS voltage, in volts.
<i>Idc</i>	DC Current, in amperes.
<i>Temp_ph_R</i>	Temperature of phase R, in centigrade.
<i>Temp_ph_S</i>	Temperature of phase S, in centigrade.
<i>Temp_ph_T</i>	Temperature of phase T, in centigrade.
<i>Temp_ind</i>	Temperature of coil, in centigrade.
<i>Temp_stack</i>	Temperature of power converter, in centigrade.
<i>Temp_amb</i>	Temperature of environment, in centigrade.
<i>Temp_aux</i>	Auxiliary temperature, in centigrade.
<i>String1</i>	Current string 1.
<i>String2</i>	Current string 2.
<i>String3</i>	Current string 3.
<i>String4</i>	Current string 4.
<i>String5</i>	Current string 5.
<i>String6</i>	Current string 6.
<i>String7</i>	Current string 7.
<i>String8</i>	Current string 8.
<i>String9</i>	Current string 9.
<i>String10</i>	Current string 10.
<i>String11</i>	Current string 11.
<i>String12</i>	Current string 12.

String13 Current string 13.

String14 Current string 14.

String15 Current string 15.

Total

Energy Total energy fed through the inverter throughout its useful life.

Time Total time that the inverter has been feeding the grid.

Connections Total number of grid connections.

Partial

Energy Partial energy fed by the inverter.

Time Partial time that the inverter has been connected to the grid.

Connections Partial number of grid connections.

19.6.2. Events

This menu shows the events occurring in the inverter.

Alarms

The alarms indicate current events in the inverter that lead to its shut-down.

Alarm				
Name	Variable	Code	LED Lighting	Description
Overvoltage	1	0x0001	Orange	This alarm displays when there is an input voltage in the panel (PV) above the unit's limit. This voltage is read before the motorized switch, specifically on the panel input string grouping plates.
Voltage difference	1	0x0002	Orange	The difference between the panel and bus voltage measurements, both sides of the DC switch, is greater than the expected limit.
Panel overcurrent	1	0x0004	Red	DC current above the limit allowed by the unit.
AC zero sequence current	1	0x0008	Red	The instantaneous sum of the AC currents exceeds a maximum value.
BUS overvoltage	1	0x0010	Red	There is overvoltage exceeding the maximum DC voltage limit.
Instantaneous AC overvoltage	1	0x0020	Orange	The instantaneous AC voltage in one of the three phases exceeds the unit's HW limit.
AC rms voltage or AC frequency	1	0x0040 0x0200	Orange	The network voltage in one or several phases is outside of the limits established in the unit's settings for a period above that defined in the settings. This alarm can be instantaneous or permanent, depending on the duration of the fault. The unit's voltage and frequency relays are configured according to the limits established in the regulations applicable to each installation.
Instantaneous AC overcurrent	1	0x0080	Red	The instantaneous AC current in one of the three phases exceeds the unit's instantaneous limit.
AC rms overcurrent	1	0x0100	Red	The AC rms current in one of the three phases exceeds the unit's instantaneous limit.
PWM fault	1	0x0400	Red	There have been multiple faults in the power switches. For safety reasons, the unit will stand by for an inspection.

Alarm				
Name	Variable	Code	LED Lighting	Description
PWM HW fault	1	0x1000	Red	The voltage variation in the DC bus exceeds a maximum value. The DC voltage under normal operation remains constant, with changes due to the control of the maximum power point. This behavior is generally due to a fault in the power electronics or a loss of insulation in the DC side.
DC/AC fault	1	0x2000	Red	Isolated fault in a power electronics switch.
Inverter lock	1	0x8000	Red	Caused by several different alarms considered critical enough, which are repeated a specific number of times.
Manual stop	2	0x0001	Orange	It can be caused by the following: - Emergency stop button pressed. - Folding doors open (end switches not pressed). - Stop from display. - Stop from remote control (via communications frame). - Stopped by user by placing a contact in the emergency push button and end switch monitoring circuit.
Hardware error	2	0x0002	Red	In the grid connection process abnormal events can occur, such as overcurrent in the power block output or overcurrent in the grid filters. This alarm can also appear if the serial number of the card does not match the unit's firmware, or due to an overload in the program's memory system.
Leak current	2	0x0004	Orange	The instantaneous sum of the AC currents exceeds an instantaneous maximum value. Monitor the insulation of the AC to ground circuit.
Power consumption	2	0x0008	Orange	Normal photovoltaic unit stoppage when the PV array power is null.
Temperature	2	0x0040 0x0080 0x0100 0x0200 0x0400 0x0800	Orange	The inverter control monitors the temperature of critical elements. In the event of high temperature in said elements or abnormal temperature differences with the ambient temperature, the inverter is stopped. A warning will be generated previously. Check the condition of the fans, remove foreign bodies from the ventilation duct, and blow on them to remove dirt. In addition, check the units' ventilation duct, inlet grilles, air filters, and outlet grilles.
Fault in IGBT R-S-T	2	0x1000 0x2000 0x4000	Red	The unit's driver stage detected an overcurrent in one of the power switches.
Phase R overcurrent	2	0x8000	Red	During a transient the unit has generated a current above the limit established in phase R.
Phase S overcurrent	3	0x0001	Red	During a transient the unit has generated a current above the limit established in phase S.
Phase T overcurrent	3	0x0002	Red	During a transient the unit has generated a current above the limit established in phase T.
AC contactor fault	3	0x0004	Red	Anomaly in the AC contactor actuation system, which allows the connection of the inverter to the electric grid.
DC contactor fault	3	0x0008	Red	Anomaly in the operation of the contactor or DC motorized switch.
AC Protection	3	0x0010	Red	One of the AC thermomagnetic circuit breakers has tripped and remains open. For the correct operation of the inverter they must be closed. Check the condition of these protections.

Alarm				
Name	Variable	Code	LED Lighting	Description
Arrestors	3	0x0020	Red	The purpose of the surge arrester protection alarm is to monitor the status of the unit's AC and SC surge arresters. The monitoring signal of the AC and SC surge arresters is serialized.
Ventilation	3	0x0040 0x0080 0x0100 0x0800	Red	Anomaly in the unit fans. The inverter monitors the status of the fans. If the control sends a start signal to the fan and it does not turn, the control performs a series of actions to try to make it start. If the fan still does not start, the unit generates a ventilation alarm.
Exchanger ventilation.	3	0x1000	Red	Anomaly in the cooling system of the power block where the electronic cards and power phases are installed. The system monitors the proper operation of the fans and their activation circuit.
Preload circuit fault	3	0x0200	Red	Some of the preload processes (preload from AC or from DC) have not completed correctly. The preload from AC is used to load the DC BUS from the electric grid. It is useful for connecting the inverter at night or to systems with batteries. The DC preload is designed for units with batteries.
Fan card	3	0x0400	Red	Breakage of the fan monitoring card. If the card is damaged, the ventilation system will not operate correctly.
Electronic supply	3	0x2000	Red	Some of the electronic supply signals are not correct.
Config. change	3	0x8000	Red	Inverter setting change
Insulation fault	4	0x0001	Orange	The inverter is continuously analyzing the impedance between the bus positive and ground as well as between the bus negative and ground. In addition, it analyzes the possible bus voltage imbalance between the two voltage measurements between positive and ground and negative and ground. If the impedance measurement is lower than that configured, the inverter indicates an insulation fault.
Low DC voltage	4	0x0004	Orange	Insufficient DC voltage to ensure the correct operation of the inverter. It only occurs if the inverter is connected to the grid. If it occurs repeatedly, check the DC voltage using the unit's internal oscilloscope. If the alarm persists, contact the Technical Service.
Control Saturation	4	0x0020	Red	The control output signal is close to the maximum values for extended periods of time. This effect occurs because the relation between the DC voltage and the AC voltage is low, one of the plant protection elements has disconnected and the unit has suffered an AC overvoltage that has prevented it from controlling the current properly.
Synchronization system	4	0x0040	Red	Fault in the inverter synchronization system. Review section <i>"13. Connection of the DCAC connections module"</i> .
Wiring in fiber optics	4	0x0080 0x0100 0x0200	Red	When the inverter is not running it evaluates the condition of the fiber optics that control the power block. Review the power block in the event that this alarm appears.
Ancillary services system	4	0x0400	Red	The inverter is continuously monitoring the ancillary services voltage. If the voltage is not within a specific threshold ($80\% U_{n_{Aux}}$ and $120\% U_{n_{Aux}}$). Check the ancillary supply voltage to the unit.

Alarm				
Name	Variable	Code	LED Lighting	Description
CSS system or voltage sag system	4	0x0800	Red	Fault in the CSS system. Replace the CSS or inspect the wiring.
CAN communications	4	0x1000	Red	Communication error between the CCU and the devices connected through the CAN bus, which are: • Grounding card (optional) • Display • CSS • TMD string measurement card (optional) • Other inverters that include the same cards
Grounding	4	0x2000	Red	Error in the system's grounding card. Check the correct insulation of the PV array.
Inverter communication	4	0x2000	Red	If the inverter is configured to stop if it loses communication with the PPC, after a period without frames the unit will stop by reducing its power ramp. The unit starts normally once the communication is restored.

Warnings

The warnings are events that do not lead to the shut-down of the inverter but do need maintenance action.

Warnings				
Name	Variable	Code	LED Lighting	Description
Blocked fan	1	0x0001	Orange	The fan could be blocked.
High temperature	1	0x0002	Orange	Power regulation via internal temperature of the inverter greater than the operating temperature
Low temperature	1	0x0004	Orange	Power regulation via internal temperature of the inverter lower than the operating temperature
DC overvoltage	1	0x0008	Orange	High DC input voltage
LVRT system	1	0x0080	Orange	Fault in the INGECON SUN LVRT electronic system
Insulation	1	0x0100	Orange	Insulation resistance out of range
LVRT system	1	0x0080	Orange	Fault in the INGECON SUN LVRT electronic system
Insulation	1	0x0100	Orange	Insulation resistance out of range
Low DC voltage	1	0x0200	Orange	Low voltage in the DC input.
Standby due to power consumption	1	0x0400	Orange	Standby due to stoppage due to power consumption
CAN communication	1	0x0800	Orange	Communication fault in the unit peripherals in the CAN bus
Inverter configuration	1	0x4000	Orange	The default configuration has been loaded in the inverter
High temperature between phases	1	0x8000	Orange	The temperature difference between phases is above 10 °C

Reasons for shutdown

Log file that indicates the alarms that have triggered the inverter shutdown, indicating the date and time of the shutdown.

Reset stop reasons

This option resets the *Stop reasons* log file.

19.6.3. Start/Stop

The operation of the inverter can be stopped and started manually using this option.

19.6.4. Settings

In this menu you can make the following settings:

<i>Date & time</i>	To modify the date and time of the inverter.
<i>Languages</i>	Selection of the language for the text on the inverter display.
<i>Modbus ID</i>	Assignment of a number that identifies the inverter. In installations with more than one inverter, each one must be assigned a different number. Ingeteam recommends using correlative numbering.
<i>Partial deletion</i>	Deletes the partial meters.
<i>Strings settings</i>	Not applicable.
<i>Power settings</i>	Reduce the unit power.
<i>Test fans</i>	By accessing this option it is possible to run a test to check the inverter fans are working properly.

19.6.5. Advanced settings

CAUTION

The settings included within this menu can only be modified by a qualified installer.

Ingeteam accepts no liability for incorrect use of the installer password nor the consequences that may arise from incorrect configuration of the unit by the user and / or the installer.

INFO

To modify the parameters of this menu the installer password will be requested. The installer password is 3725.

Within this menu you can change the password, adjust the voltage and frequency values or modify the country and the regulations applicable to the inverter.

19.6.6. Inverter data

From this menu you can consult different data referring to the inverter.

20. Shutting down the unit

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

It also explains the different actions which cause the unit to shut down and their scope.

⚠ DANGER

The AC switch may not be operated manually under any circumstances. If this warning is not followed, the safety of personnel and equipment cannot be guaranteed.

Ingeteam accepts no liability for the consequences of non-compliance with this warning.

Use the PPE listed in section *“Personal Protective Equipment”*.

⚠ CAUTION

See section *“Important safety instructions”* before operating the equipment.

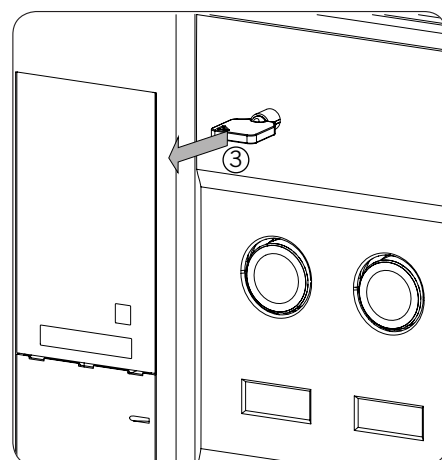
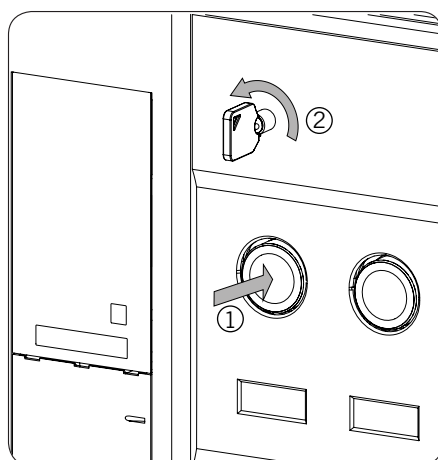
The inverter's electro-mechanical elements have a limited number of operating cycles for on-load disconnection. A large number of disconnections or instantaneous trips leads to higher wear in them, which can lead to undesirable, early deterioration.

Following the steps below gives safe, no-load disconnection, maximizing the life of any electro-mechanical components in the inverter.

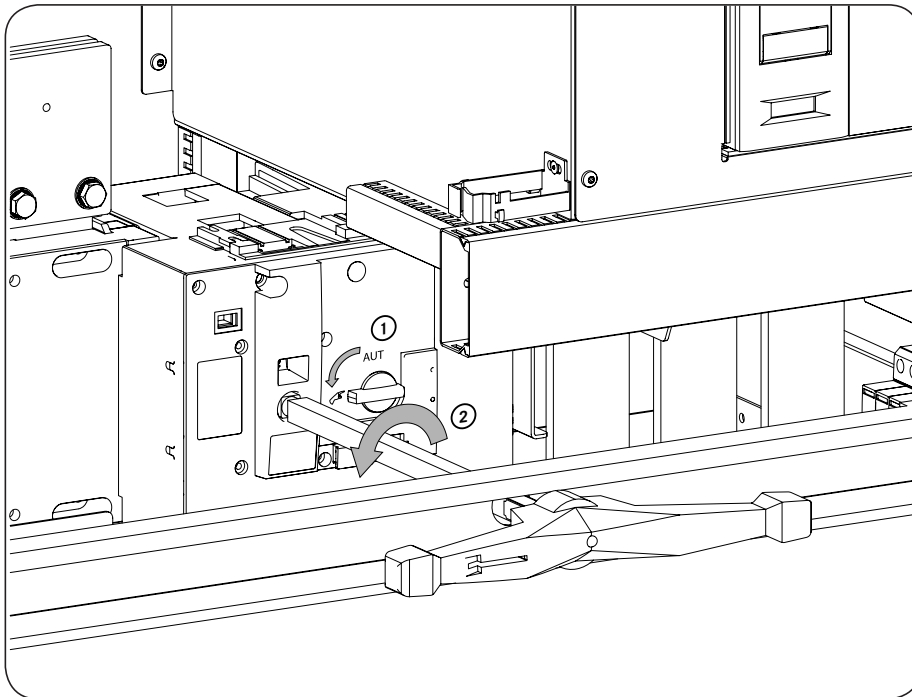
20.1. Process of shutting down the unit

To carry out any maintenance task on the unit involving access to the inside, it is necessary to disconnect the unit and isolate any source of voltage. All operations performed on the inverter for disconnecting it must be done on the DCAC connections module. Proceed in the following order to disconnect voltage sources safely:

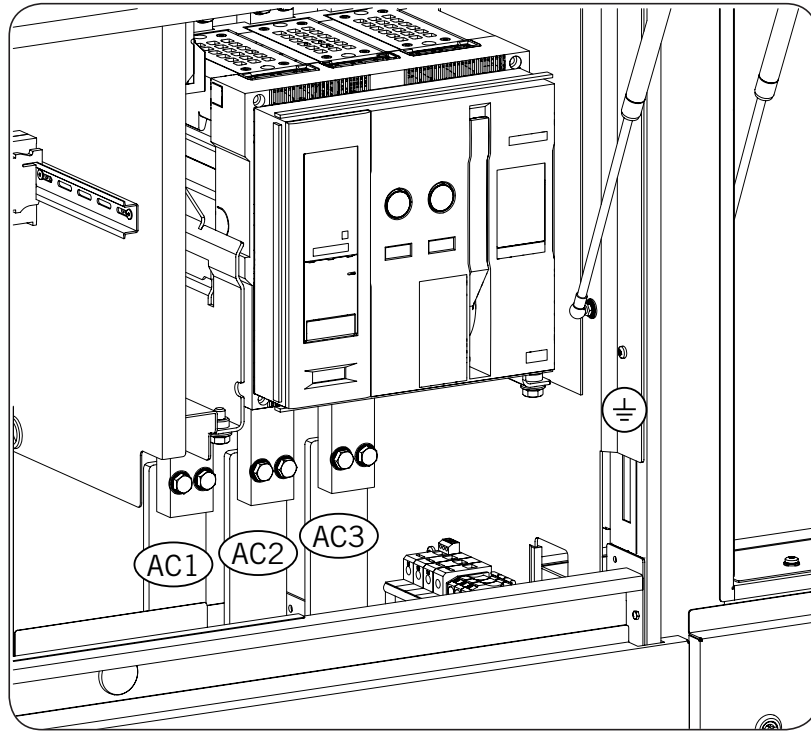
1. Stop inverter on the display. The unit disconnects, stopping to inject AC power.
2. Press the emergency stop button. Pressing the emergency stop button causes the motorized DC switch to open.
3. Wait 10 minutes for the unit's capacities to discharge before entering into the unit.
4. Access the DCAC connections module via the folding door.
5. Check that the AC thermomagnetic circuit breaker is in OFF.
6. The OFF position of the AC thermomagnetic circuit breaker must be locked to prevent any reconnection. To do this, press the OFF button on the thermomagnetic circuit breaker and turn and remove the locking key.



7. Check that the DC switch is in OFF. If the switch has not moved automatically to the OFF position, operate it manually. If manual actions are necessary, wait 10 minutes for the internal capacities to discharge.

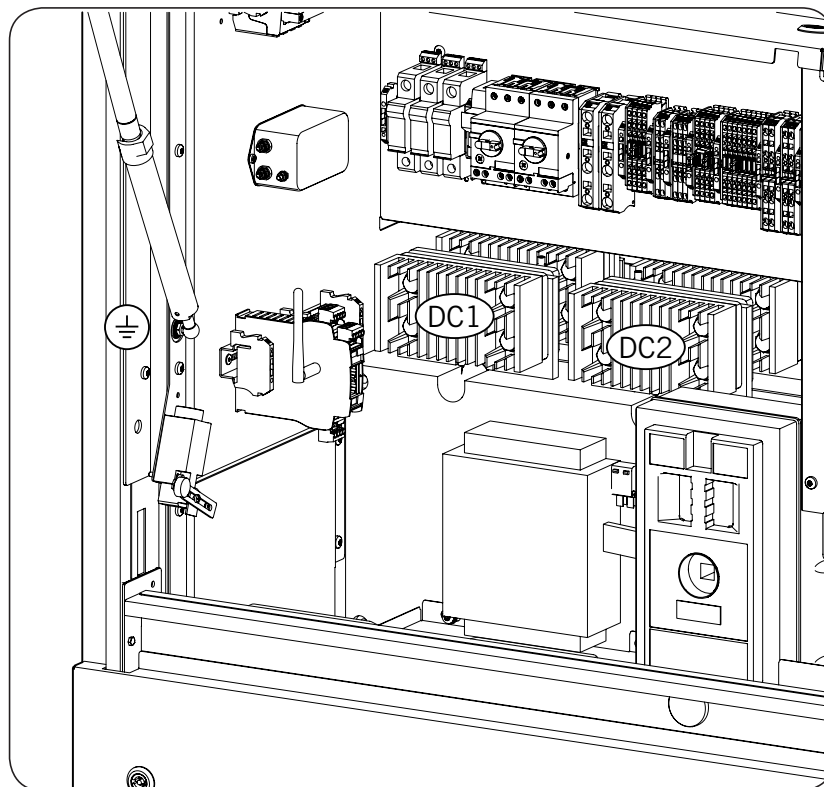


8. Block the DC switch via consignment lock. "Personnel at work" will be posted.
9. Open the thermomagnetic circuit breaker -Q5. "Personnel at work" will be posted.
10. Open the thermomagnetic circuit breaker -Q4. "Personnel at work" will be posted.
11. Open the thermomagnetic circuit breaker -Q2. "Personnel at work" will be posted.
12. Disconnect the voltage at the main inverter AC supply, located in the DCAC connections module. This action will need to be carried out by means of an element external to the unit. If it is not possible to disconnect the main AC supply from outside the unit, bear in mind that the AC busbars will be live and work must be carried out using the appropriate PPE.
13. Isolate the PV array powering the DCAC connections module from the outside. If it is not possible to disconnect the PV array that powers the DCAC connections module outside of it, bear in mind that the DC fuses and busbars will be live and work must be carried out using the appropriate PPE.
14. Check that there is no voltage by using an appropriate multimeter between the following points.



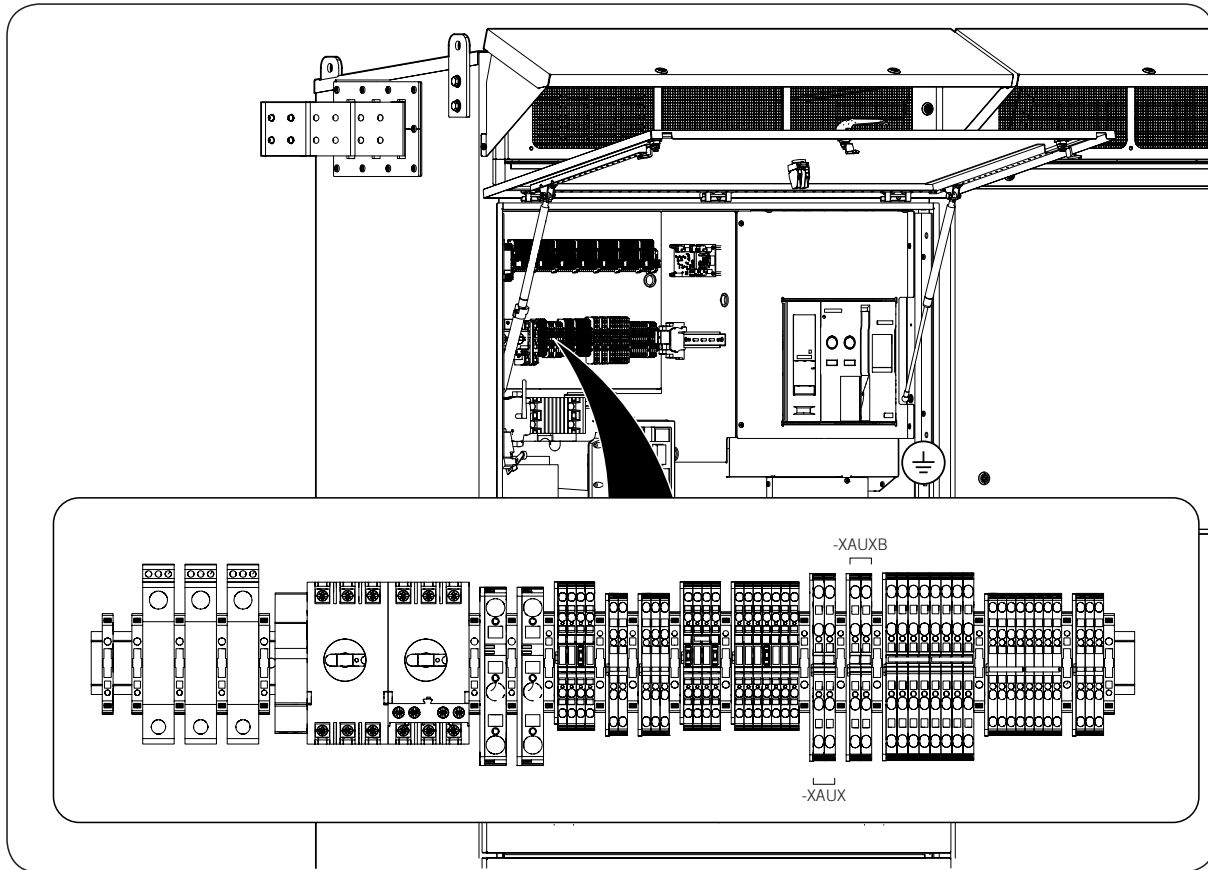
AC busbar 1 - AC busbar 2
 AC busbar 2 - AC busbar 3
 AC busbar 1 - AC busbar 3
 AC busbar 1 - Ground*
 AC busbar 2 - Ground*
 AC busbar 3 - Ground*

* Use the metal structure of the inverter as a grounding point, on a part that is not painted.



DC 1 - DC 2
 DC 2 - DC 3
 DC 1 - Ground*
 DC 2 - Ground*

* Use the metal structure of the inverter as a grounding point, on a part that is not painted.



-XAUX.1 - Ground*
 -XAUX.2 - Ground*
 -XAUXB.1 - Ground*
 -XAUXB.2 - Ground*

* Use the metal structure of the inverter as a grounding point, on a part that is not painted.

20.2. Stopping the inverter from the display

It may be necessary on occasions to carry out an isolated unit shutdown without following the protocol explained under point “20.1. Process of shutting down the unit”. This must only be carried out when you do not wish to gain access to the inside of the inverter and you wish to switch the inverter to shutdown status, stopping delivering power to the grid.

To do this from the display, switch the inverter to shutdown status. The inverter will stop switching and disconnect the grid connection AC thermomagnetic circuit breaker.

⚠ DANGER

This shutdown procedure does not guarantee complete disconnection of all sources of voltage connected to the unit, hence accessing the inside of the unit after performing this shutdown is prohibited. If you wish to gain access to the inside of the inverter, follow the procedure in Section “20.1. Process of shutting down the unit”.

20.3. Inverter shutdown from the emergency stop button

For the case of an unexpected situation, these units have an emergency stop button. When pressed, the following actions are performed:

1. If the unit is connected to the grid, the inverter will stop switching and disconnect the grid connection AC thermomagnetic circuit breaker.
2. Opening of the motorized DC switch.

It will not be possible to start inverter operation again until the emergency stop button has been returned to its original position.

DANGER

This shutdown procedure does not guarantee complete disconnection of all sources of voltage connected to the unit, hence accessing the inside of the unit after performing this shutdown is prohibited. If you wish to gain access to the inside of the inverter, follow the procedure in Section “20.1. Process of shutting down the unit”.

CAUTION

The inverter's electro-mechanical elements have a limited number of operating cycles for on-load disconnection. A large number of disconnections or instantaneous trips leads to higher wear in them, which can lead to undesirable, early deterioration.

20.4. Inverter shutdown by opening a door

These units have a safety system whereby, using a limit switch, the unit switches to shutdown status and is automatically disconnected from the PV array and electricity grid when a door is opened with the unit running. The opening of a folding door is equivalent to activating the emergency pushbutton.

Until it has been ensured that all the unit's doors have been closed correctly, it cannot be returned to the operating condition again.

DANGER

This shutdown procedure does not guarantee complete disconnection of all sources of voltage connected to the unit, hence accessing the inside of the unit after performing this shutdown is prohibited. If you wish to gain access to the inside of the inverter, follow the procedure in Section “20.1. Process of shutting down the unit”.

CAUTION

Ingeteam accepts no liability for the consequences of tampering with the safety system.

The inverter's electro-mechanical elements have a limited number of operating cycles for on-load disconnection. A large number of disconnections or instantaneous trips leads to higher wear in them, which can lead to undesirable, early deterioration.

21. Preventive protocol in the event of sand/dust storms

DANGER

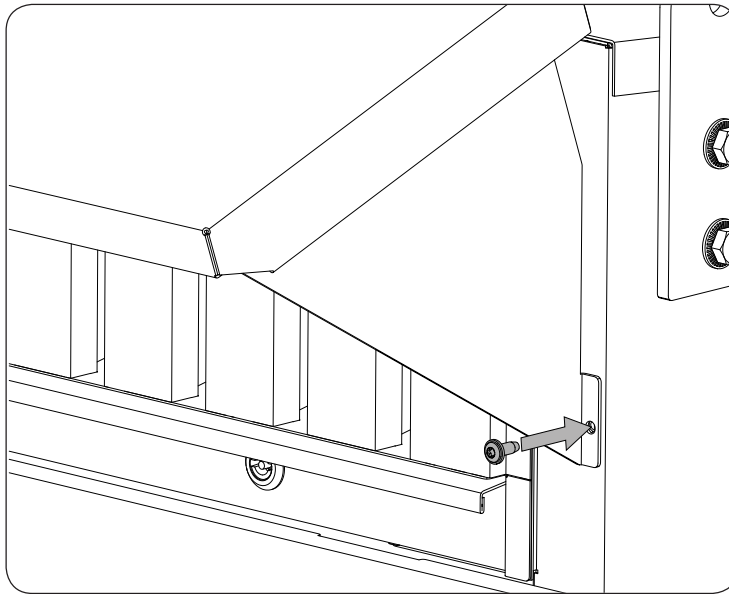
To install the front and rear ventilation system protection system, the inverter must be in stopped status. The inverter must remain in stopped status while the cooling system is closed.

Ingeteam accepts no liability for the consequences of non-compliance with this warning.

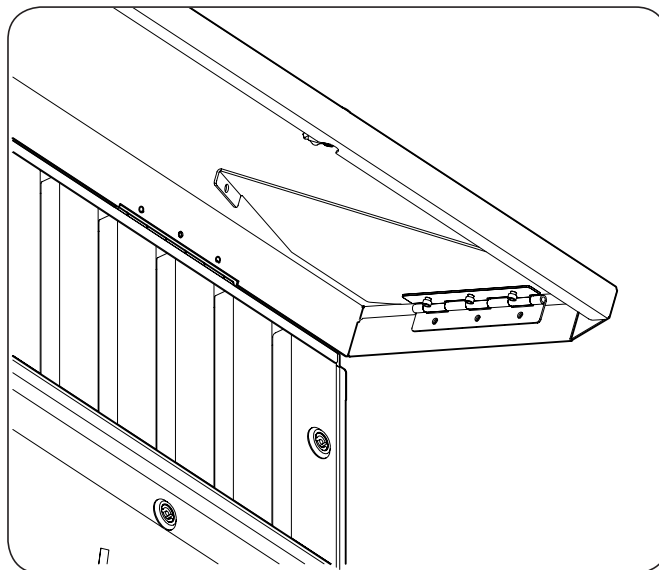
Depending on the location of the installation, the units may be subject to sand or dust storms. In the event of an expected storm, follow the protocol below for each inverter.

Front ventilation system

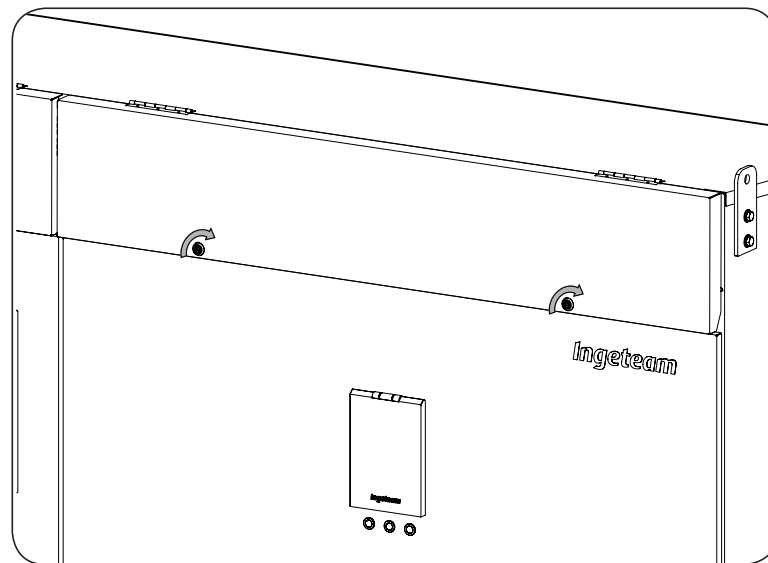
1. Remove the side bolts from the protection system.



2. Fold the two supports inwards.

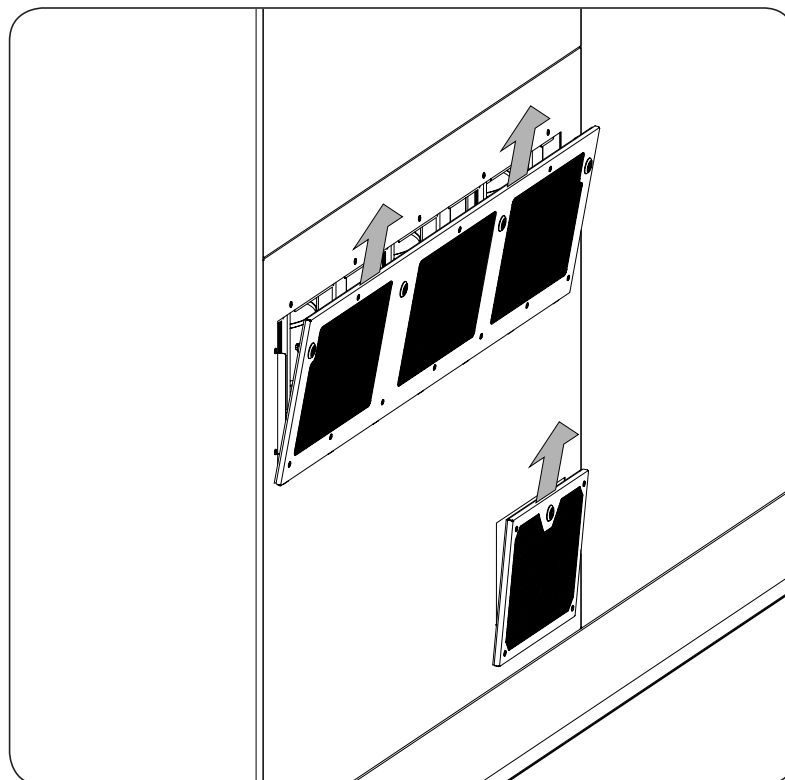


3. Close the protection and fasten it using the locks provided.

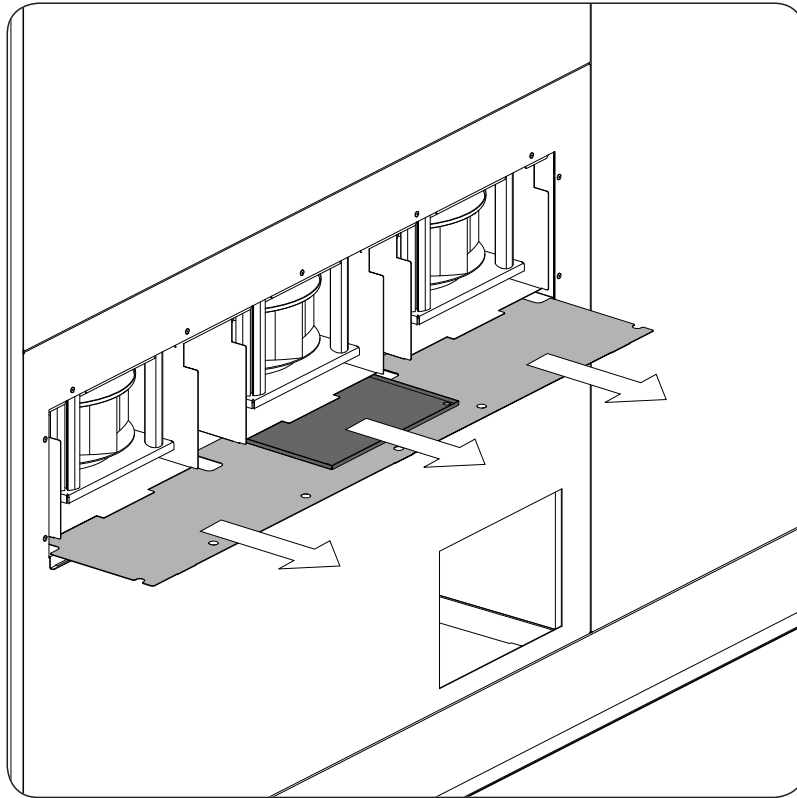


Rear ventilation system

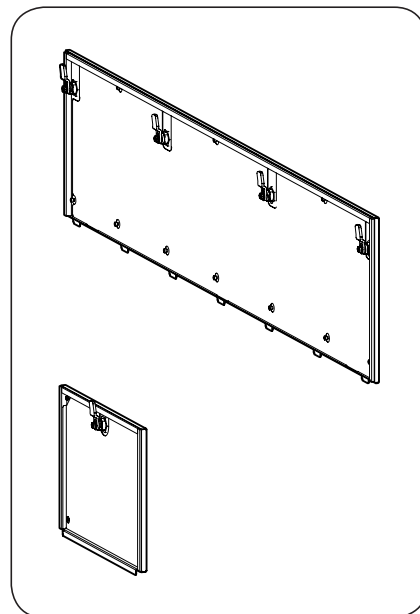
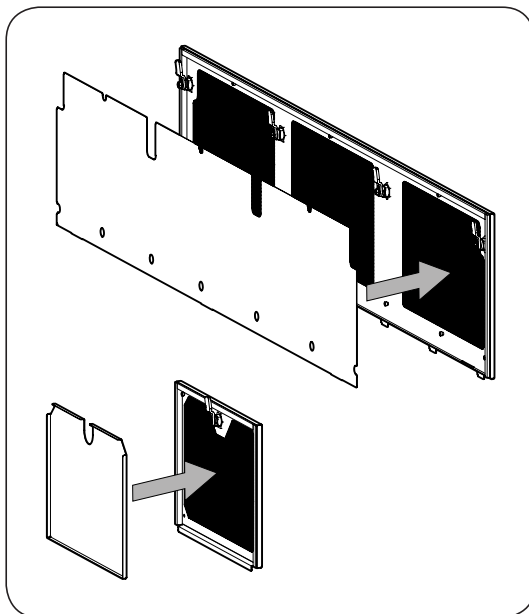
1. Remove the grilles in the rear side.



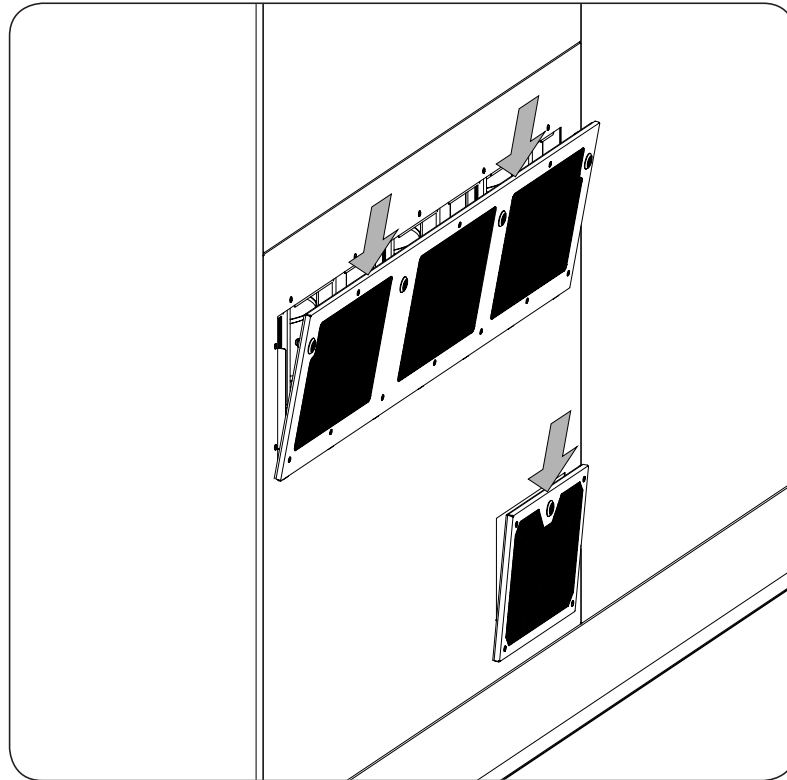
2. Remove the protections for both ventilation ducts from the receptacle shown in the following figure.



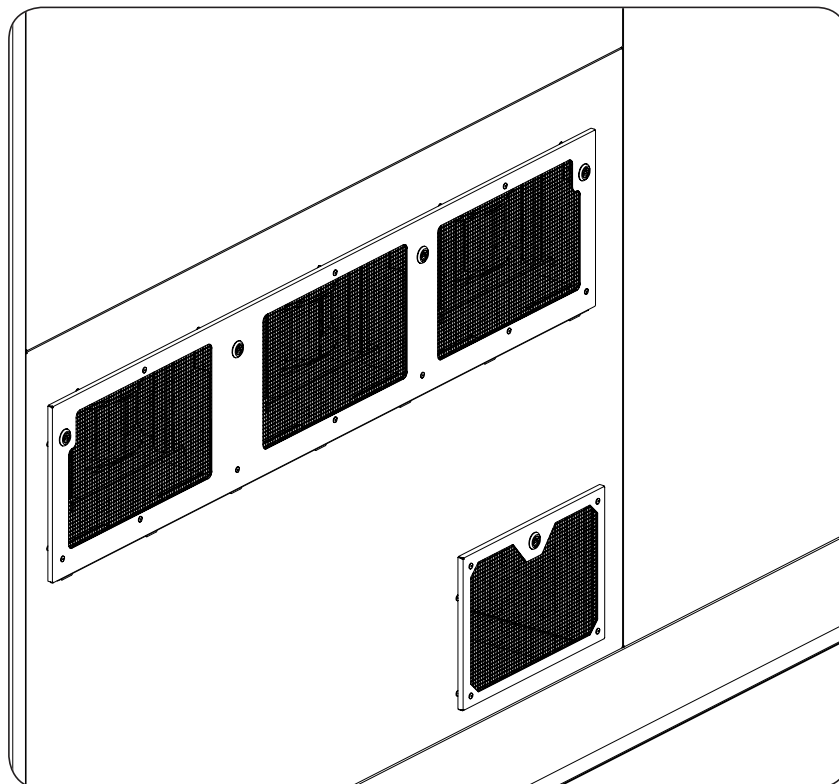
3. Insert the protections inside of the grilles.



4. Install the grilles in their positions.



5. Close both grilles.



22. Maintenance

Throughout this chapter we will list the maintenance tasks along with preventative and corrective replacements for proper inverter maintenance.

INFO

To find the different components listed below, consult Section *“2.6. Location of components”*.

Refer to Section *“Important safety instructions”* and the safety paragraph in this section before operating the equipment.

The various maintenance tasks must be performed by qualified personnel.

22.1. Safety conditions

DANGER

In order to perform the maintenance tasks considered voltage-free, or for preventative and corrective maintenance, stop the unit with the emergency stop button and make sure there is not voltage prior to performing any operation. Once the inverter is switched off, wait at least 10 minutes until internal capacitances are fully discharged.

INFO

To disconnect the unit, follow the instructions in Section *“20. Shutting down the unit”*.

To connect the unit, follow the instructions in Section *“18.4. Power-up”*.

22.2. Maintenance tasks

Maintenance tasks are divided into three types: inspection, check and action.

Besides these three types, we group them relative to their frequency.

Inspection

This consists in observing the different elements without needing to operate them.

Check

This consists in observing the element's status or performance via an operation.

Action

This consists in executing an action.

22.2.1. Frequency of maintenance tasks

CAUTION

The maintenance frequency described are established for normal weather conditions. In the event of more severe conditions, the frequency must be increased according to necessity, especially for filter cleaning.

Maintenance tasks must be done in the following frequencies.

WEEKLY maintenance tasks	MONTHLY maintenance tasks	ANNUAL maintenance tasks
Inspection, voltage-free	Inspection, voltage-free	Inspection, voltage-free
Inspection of dirt accumulated in the air inlet and outlet vents	General inspection	Unit case
Inspection of dirt accumulated in the filters and sand trap (optional kit)	Action, voltage-free	Busbars
	Vacuum unit's interior	Wiring and connections
	Vacuum air inlet and outlet vents	Relays
	Cleaning or replacing filters and sand traps (optional kit)	AC and DC arresters
	Check, voltage-free	Unit grounding
	Joints, hinges, door locks and other mechanical elements	Action, voltage-free
	Inspection, with voltage	AC thermomagnetic circuit breaker
	Inspect noises and vibrations	Check, voltage-free
	Check, with voltage	Fuses
	Reading, download and analysis of data via the INGECON SUN Manager.	Thermomagnetic circuit breakers
	Reasons for stopping and quality of the waveform	Condenser capacities
		Check, with voltage
		DC switch and emergency push button
		Fans
		End switches
		Low temperature kit
		Temperatures: thermography
		LED and display status
		Voltage and current values
		Firmware of the unit and display

22.2.2. WEEKLY maintenance tasks

Inspection of dirt accumulated in the air inlet and outlet vents (inspection, no voltage)

If there is accumulated dirt that interferes with the cooling of the inverter, clean it as described in the monthly maintenance tasks.

Inspection of dirt accumulated in the filters and sand trap (optional kit) (inspection, no voltage)

If there is accumulated dirt that interferes with the cooling of the inverter, clean it (or replace it) as described in the monthly maintenance tasks.

22.2.3. MONTHLY maintenance tasks

General inspection (inspection, voltage-free)

Make a visual inspection of the interior state of the inverter.

Check for parts that are damaged or in poor condition, having suffered any type of premature degradation due to overheating, rust or other external aggressions.

Check inside the unit is free from dust and other elements. If there is any dirt inside clean it with a vacuum cleaner.

Check that there is no moisture inside the unit. If moisture exists, dry before making electrical connections or starting up the unit.

Verify the lack of insects and other animals in the unit's inside. If animals are found within the inverter, take the necessary measures to remove them.

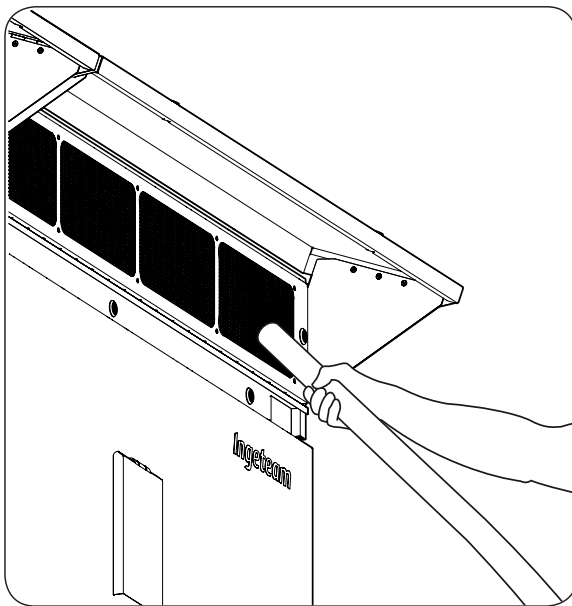
Vacuum the unit's interior (action, voltage-free)

The accumulation of dust and dirt can affect the proper operation of the unit. Vacuum the dirt and dust in the unit's interior.

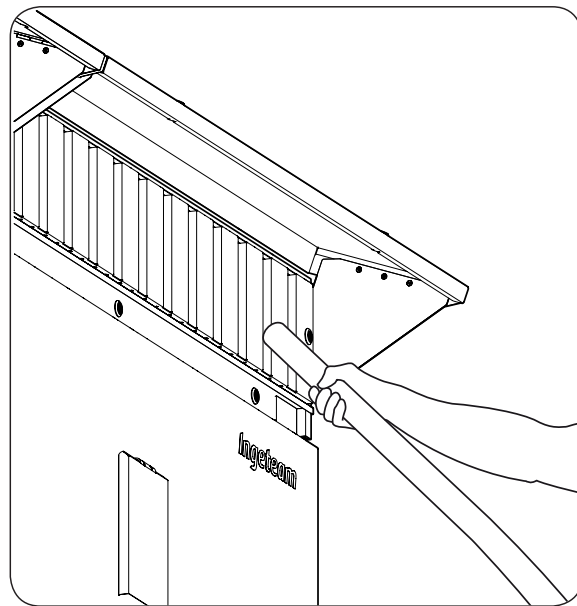
Vacuum air inlet vents (action, voltage-free)

Accumulated dust and dirt may adversely affect the cooling ability of the fans and result in overheating of the unit.

Dust and dirt must be removed from the outside of the top grilles using a vacuum cleaner.



Without sand trap

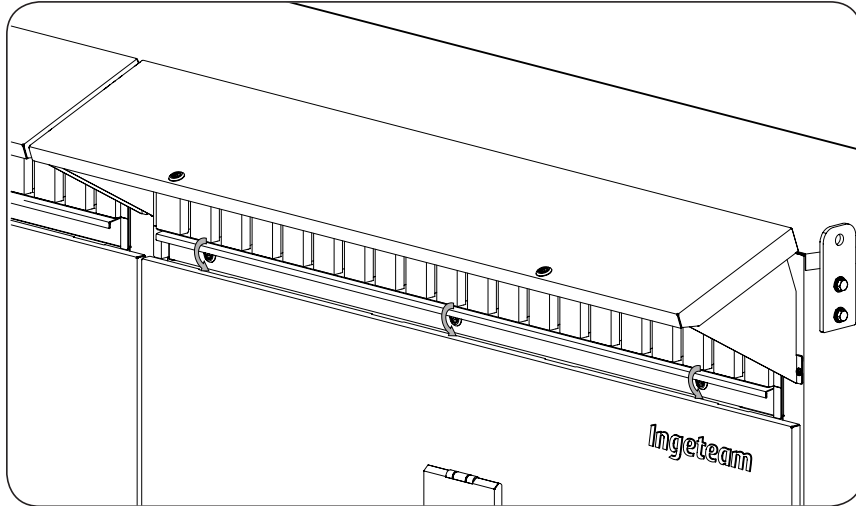


With sand trap

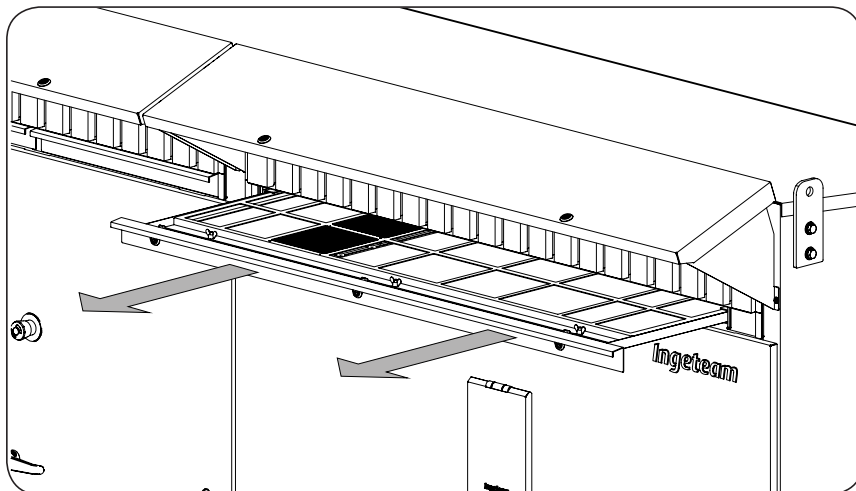
Cleaning or replacing filters and sand trap system (action, voltage-free)

To remove the filters, follow these instructions. The process is the same even if the inverter does not have the sand trap system installed.

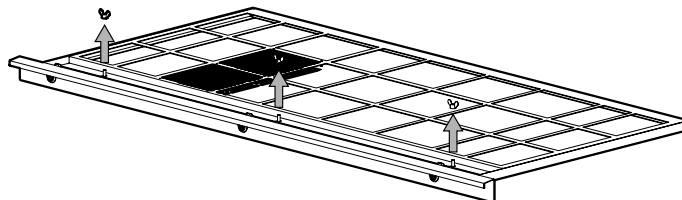
1. Using the key provided, unlock the front locks on the filter holder tray.



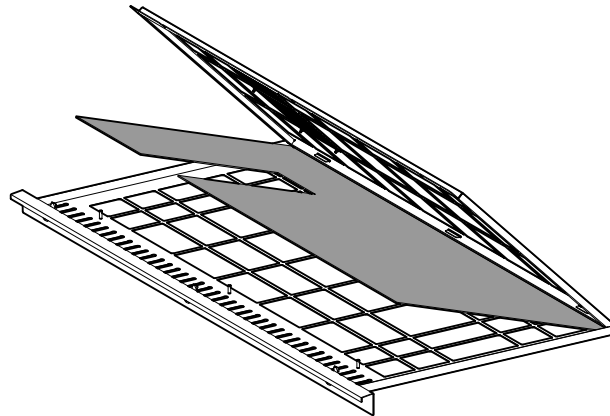
2. Extract the filter holder tray horizontally.



3. Remove the indicated locks.



4. Remove the filter and clean it using compressed air. If necessary, wash with water at a temperature below 70 °C. If the filter is in bad condition, replace it.

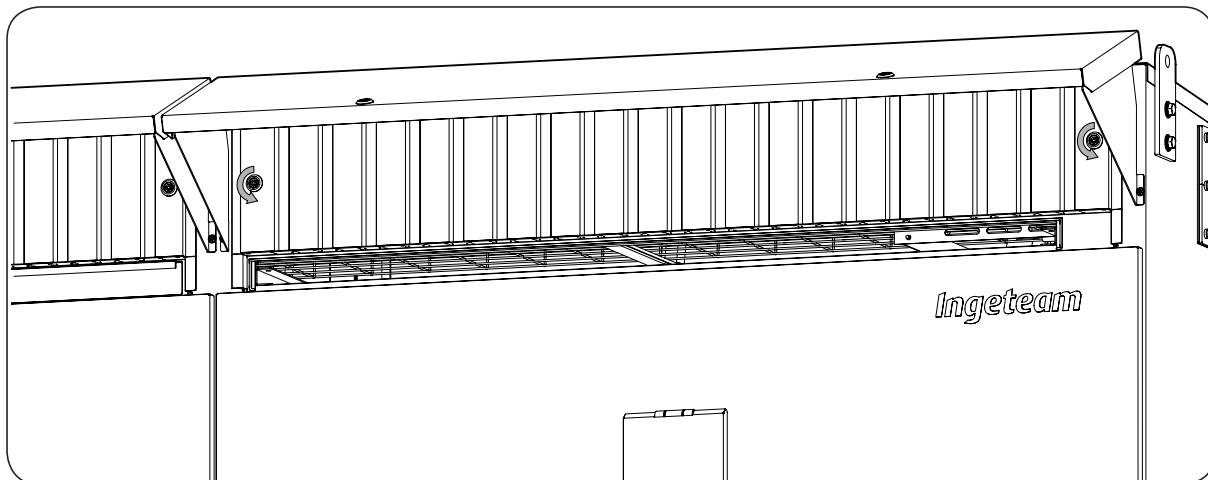
**Filters used on the unit.**

Ventilation filters

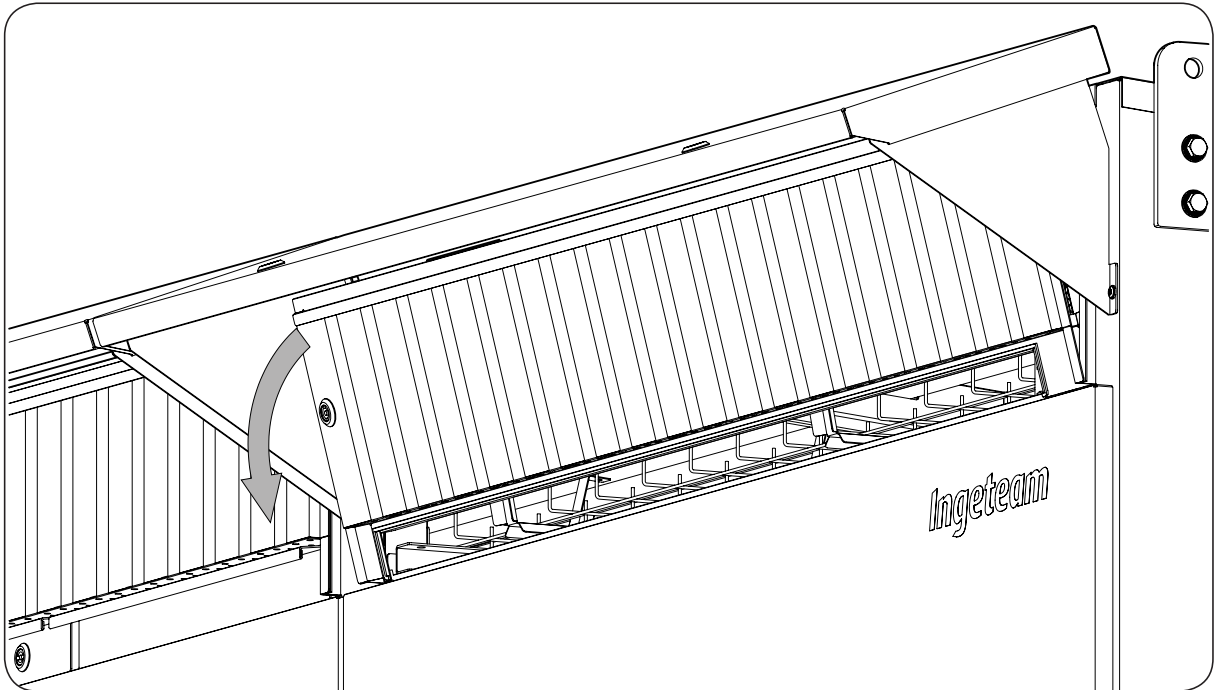
Self-extinguishing filters with synthetic fibers 150 gr/m². 10 mm thickness. Class G-3 following standard *EN 779*.

To clean the sand trap system, follow these instructions:

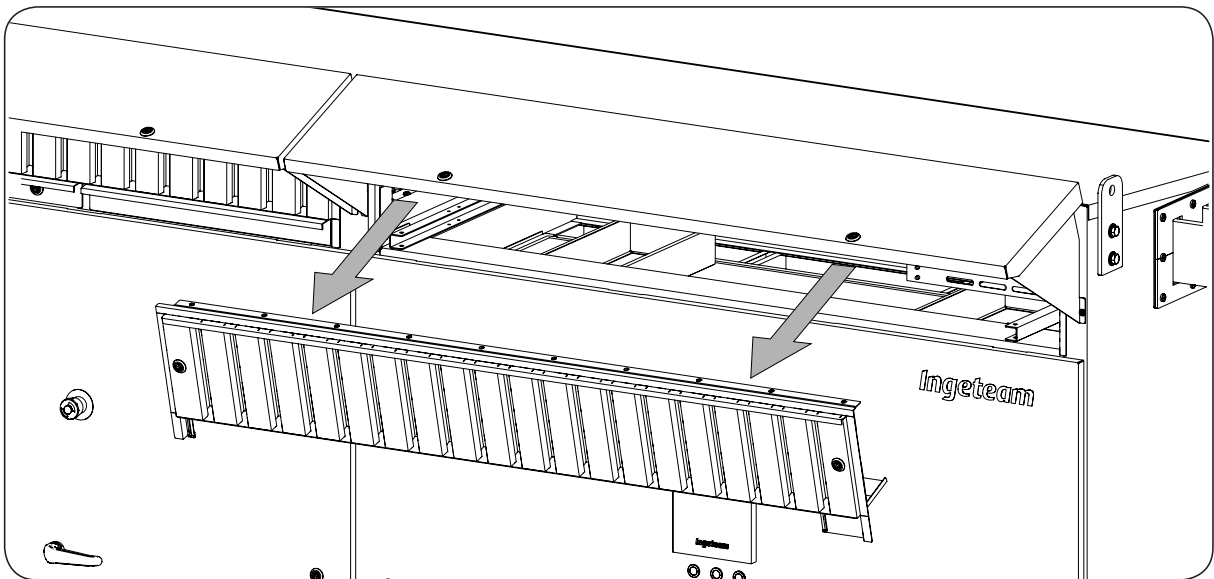
5. Using the key provided, unlock the indicated locks.



6. Turn the sand trap system slightly.



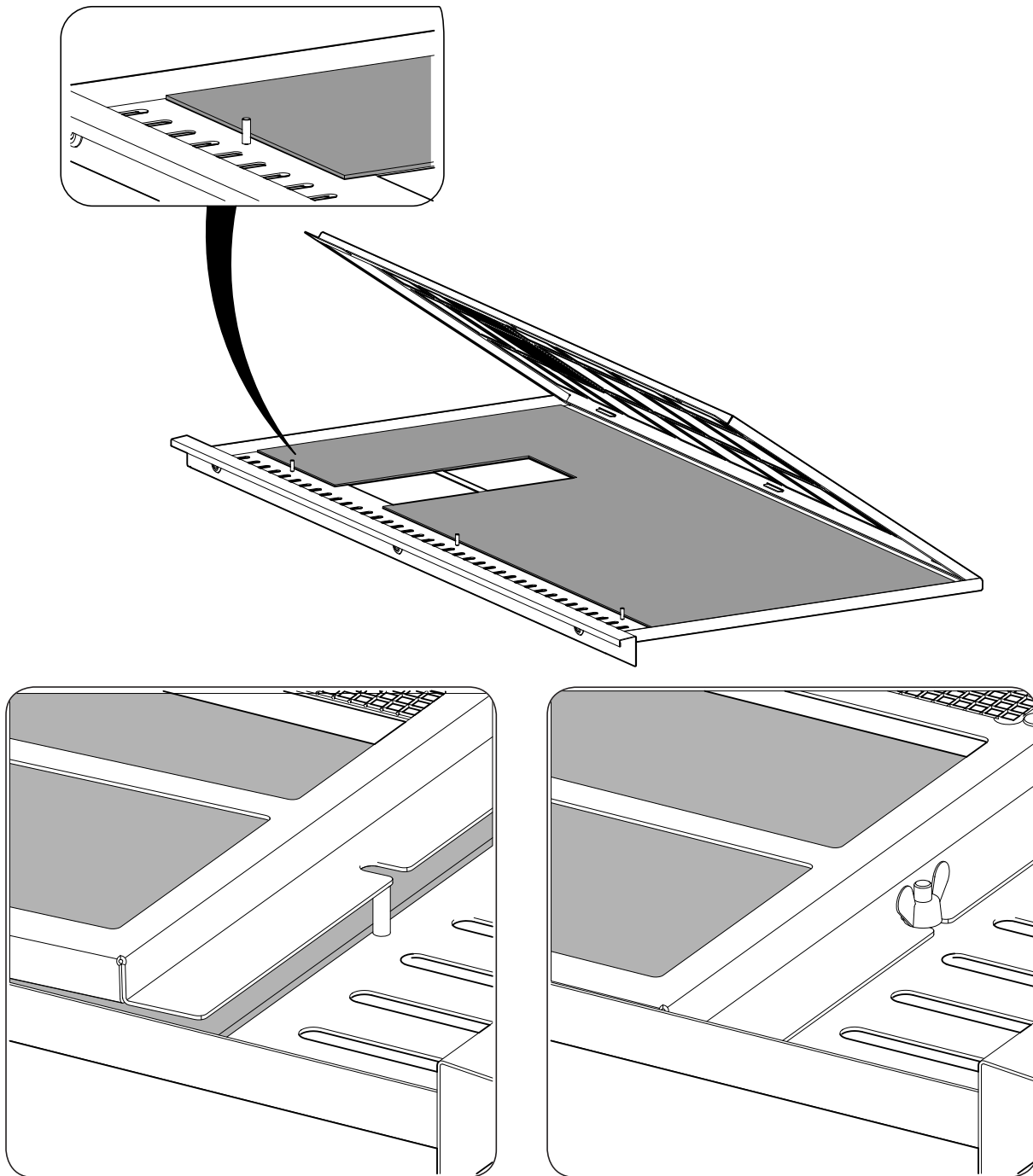
7. Remove the sand trap system.



8. Clean the sand trap system using compressed air.
9. Vacuum the inside of the unit through the hole where the filter and sand trap system where.

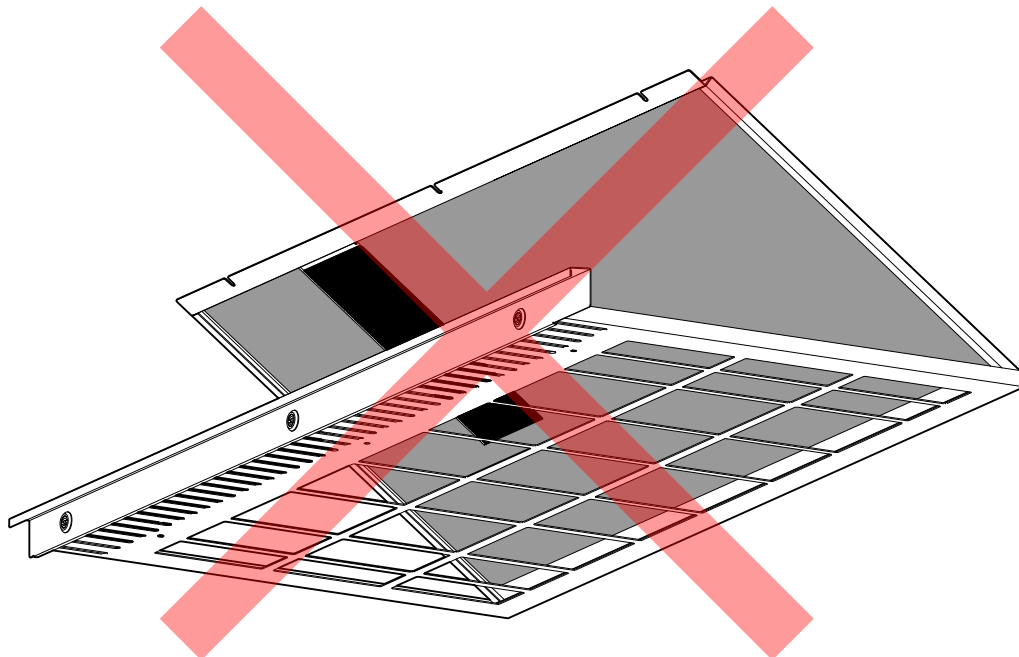
To install the filter and sand trap system, follow the instructions in reverse order, paying special care to fit the filter as shown below:

With the filter holder tray open, install the filter in the lower part of the filter holder, as shown in the following figure.



CAUTION

Do not install the filter in the gap in the top part of the filter holder tray (see following figure).



Joints, hinges, door locks and other mechanical elements (check, voltage-free)

Check that the joints maintain their elasticity and are not hardening, broken or wearing away.

Check that the unit's hinges and locks are correct and that the unit maintains their level of protection.

If we observe one of these problems, contact Ingeteam.

Inspect noises and vibrations (inspection, with voltage)

Check that there are not anomalous noises coming from the unit, or vibrations.

If we observe one of these problems, contact Ingeteam.

Download the history of the stops via the INGECON SUN Manager.

INFO

For more information on the process, download the data via the INGECON SUN Manager and see the video *Scope* in the videos section of the INGECON SUN Training website (http://www.ingeconsuntraining.info/?page_id=3269). The access data are:

Username: powermaxb
Password: Manual

The location of the components displayed in the videos may be different. If in doubt, contact Ingeteam.

Check via the proper measurement tools that the waveforms in DC and AC are correct.

Reasons for stopping and quality of the waveform (check, voltage-free)

Download the history of the stops via the INGECON SUN Manager.

Check via the proper measurement tools that the waveforms in DC and AC are correct.

22.2.4. ANNUAL maintenance tasks

Unit housing (inspection, voltage-free)

You must carry out a visual check of the condition of the housing, confirming the condition of the locks, doors and handles as well as the fixing of the units to their anchor points. In addition, you must check the condition of the housing for dents, scratches or rust that might degrade the unit or cause it to lose its protection classification. If these types of defects are noticed, the parts affected must be replaced.

Check the condition of the cables entries and ensure they have the same degree of protection as the unit itself.

Apply talcum powder on the elastic joints on the cover.

Busbars (inspection, voltage-free)

Visually check that the busbars on the AC and DC power maintain the security distance along with the initial electrical properties and are rust and humidity free.

Wiring and connections (inspection, voltage-free)

Check that the unit's signal wiring, along with the aerial connectors are in good condition and properly installed.

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 color of the insulation and terminals.

Relays (inspection, voltage-free)

Check visually, always with no voltage on the unit, that there is no darkening of the relay housing caused by heating and that the standby position is correct. They must be replaced if any anomaly is observed.

Below are a list of relays that must be checked:

DCAC connections module	Power module
-K6	-K5
-K8	-K7
-K9	

AC and DC arresters (inspection, voltage-free)

Check that the AC and DC arrestor status indicator is not red and that it is installed solidly in its base.

Inverter grounding (inspection, voltage-free)

Check that the inverter's grounding connection is correct.

AC thermomagnetic circuit breaker (action, voltage-free)

DANGER

To carry out the maintenance tasks for the AC thermomagnetic circuit breaker it is also necessary to disconnect the inverter and check the absence of voltage upstream and downstream of the inverter. To do this, open the Medium Voltage protections or equivalent systems.

INFO

The AC thermomagnetic circuit breaker operation and maintenance manual is provided with the inverter. Follow the instructions provided.

In the event of an automatic trip of the AC thermomagnetic circuit breaker, follow the instructions specified in the manufacturer's manual.

All inspection tasks shall be carried out following the manufacturer's manual.

The following parts must be lubricated annually for the correct maintenance of the AC thermomagnetic circuit breaker:

- Motor.

- Auxiliary contacts.
- Main shaft.
- Mechanism.

To locate these components, see the AC thermomagnetic circuit breaker operation and maintenance manual.

The lubricant recommended by the manufacturer is PLG-322 by N.E.O. For equivalents, please contact Ingeteam.

Fuses (check, voltage-free)

Check the condition of the various fuses protecting the unit. Check for continuity via a suitable multimeter.

Below are the fuses that can be used with the units.

DCAC connections module
DC Power supply fuses
Common mode filter fuses (-CMC)

If one of the fuses is broken, replace it.

Thermomagnetic circuit breakers (check, voltage-free)

The thermomagnetic circuit breakers are the following:

- Q1
- Q2
- Q4

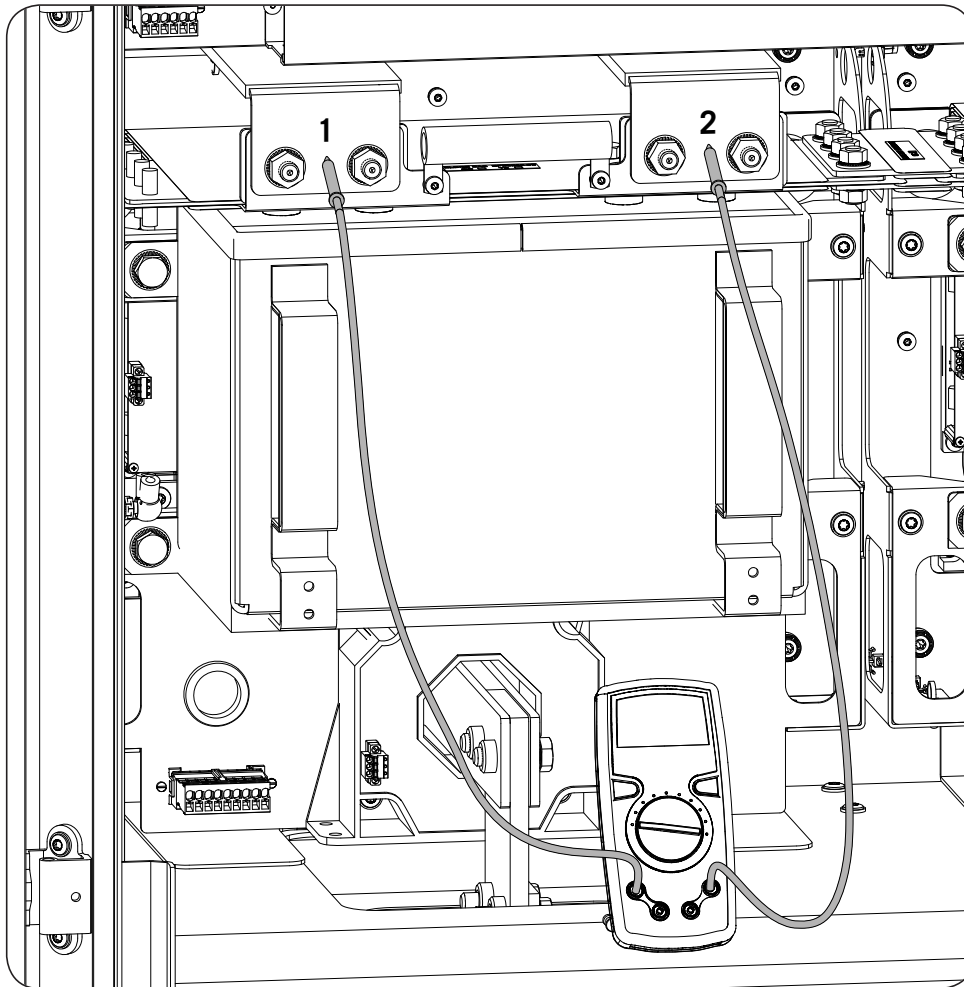
Activate the thermomagnetic circuit breakers to check their proper performance.

If one of the thermomagnetic circuit breakers is broken, replace it.

Condenser capacity (check, voltage-free)

Check the BUS condenser capacity and the condenser of the harmonic filter.

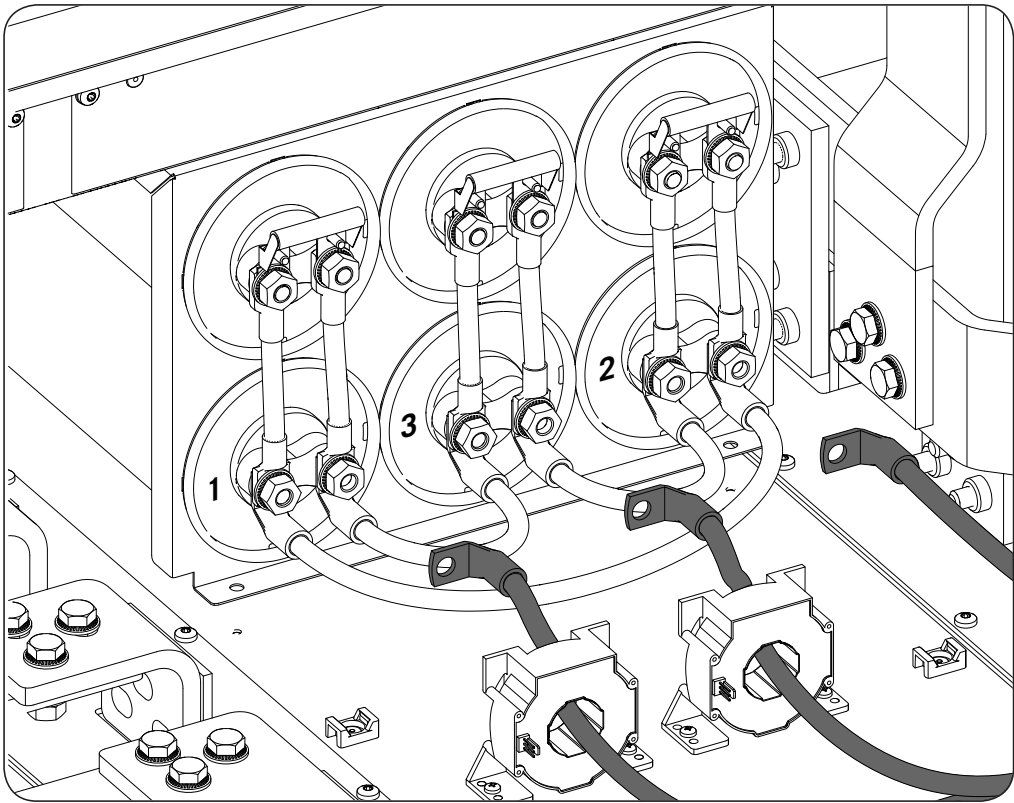
To check the proper status of the BUS condenser, access it via the upper part of one of the power module and measure the capacity with the proper multimeter between 1-2 of the following figure.



The measurement result must be the following:

Measurement points	Value
1-2	9000 ± 900 µF

To check the harmonic filter capacitors, access the bottom of the power module, disconnect the terminals indicated on the following figure, and measure the capacities with a suitable multimeter between points 1-2, 2-3 and 1-3 of the condensers (marked in light gray).



The measurement results must be the following:

Measurement points	Value
1-2	$300 \pm 30 \mu\text{F}$
2-3	$300 \pm 30 \mu\text{F}$
1-3	$300 \pm 30 \mu\text{F}$

If one of the condensers is broken, replace it.

Upon reinstalling the bolts, apply a tightening torque of 71 lb.in (8 Nm) without lubrication.

DC switch and emergency push button (check, with voltage)

Carry out the DC switch test via the emergency pushbutton.

1. Press the emergency pushbutton and watch the proper opening of the DC switch.
2. Reset the emergency pushbutton, wait three seconds and see if the DC switch closes properly.

If there is a failure, contact Ingeteam.

Fans (Check, with voltage)

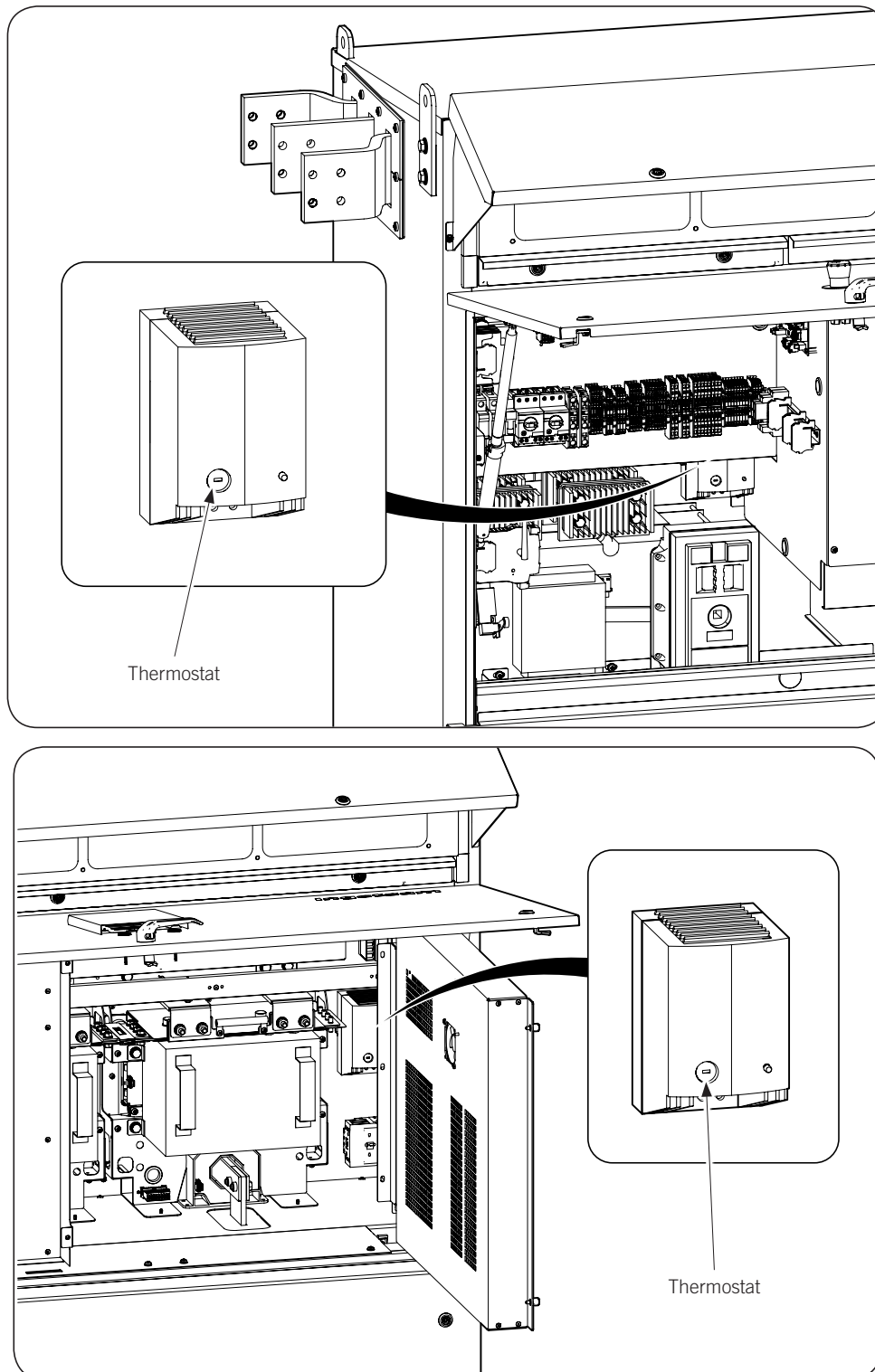
Perform the fan test via the display. If one of the fans is broken, replace it.

End switch (check, with voltage)

Check that upon opening the inverter's folding doors it goes into manual stop status, and both the DC switch and AC contactor open. If there is a failure, contact Ingeteam.

Optional low temperature kit (check, with voltage)

Check that the resistor located in each module works properly. For this, turn the thermostat to the resistor and start to operate.

**Temperatures: thermography (Check, with voltage)**

Locate the hot points by checking all the power connections and other elements.

Look for different temperatures between similar points (the three AC phases, for example). Differences in temperature greater than 50 °F (10 °C) between similar points are considered abnormal.

If there are abnormal measurements, contact Ingeteam.

Display and LED and led status (check, with voltage)

Check that the Display characters can be properly viewed, along with the access to the different menus.

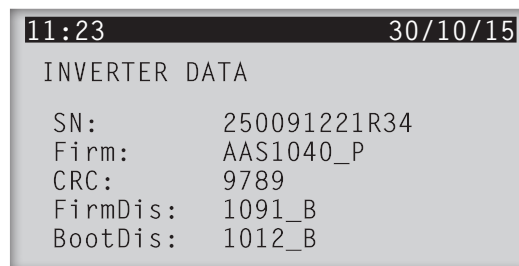
Check that the LEDs light up correctly.

Voltage and current values (check, with voltage)

Check that the voltage and current values measured by the equipment are correct.

Firmware version of the unit and display (check, with voltage)

Access the *Inverter data* via the display menu.



The field *Firm* indicates that the unit's firmware version. The field *FirmDis* indicates that the display's firmware version.

Check with Ingeteam if there are available updates of both firmware versions.

INFO

For more information on the firmware update process for the unit and display, see the video *Firmware upgrade* in the videos section of the INGECON SUN Training website (http://www.ingeconsuntraining.info/?page_id=3269). The access data are:

Username: powermaxb
Password: Manual

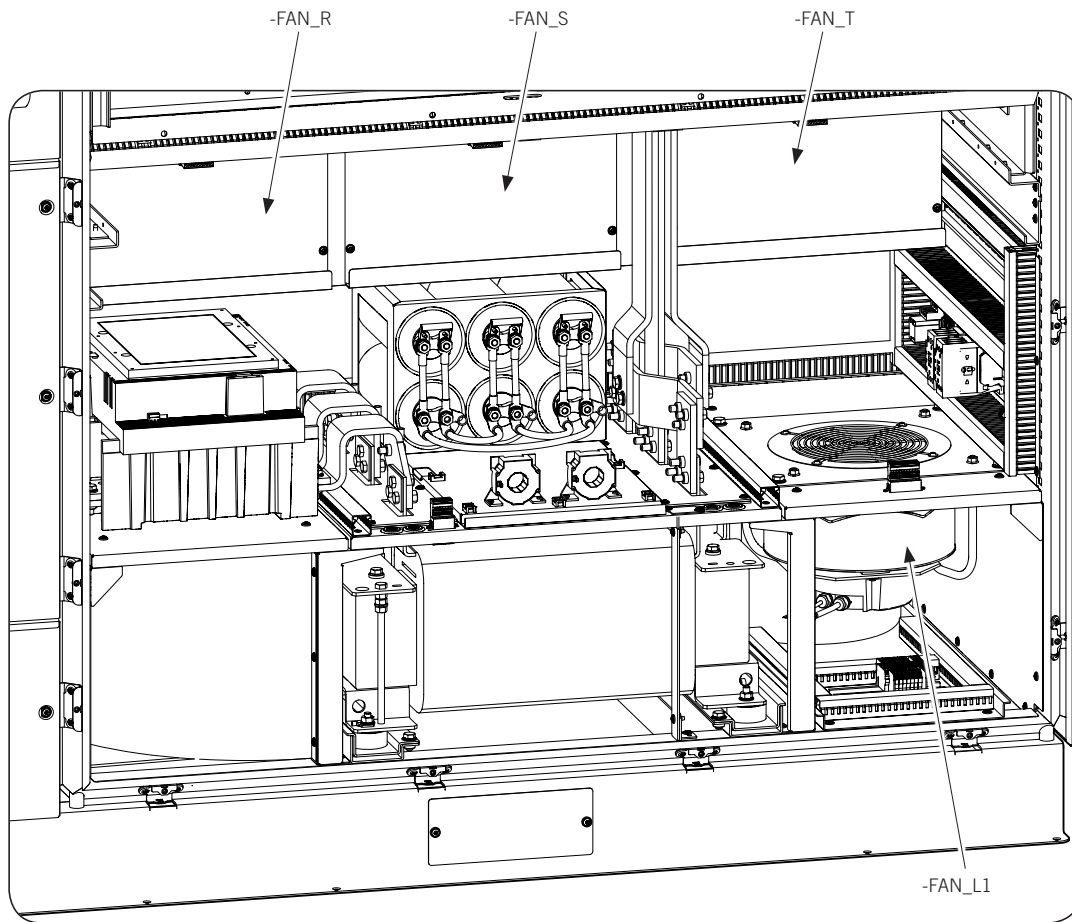
22.3. Preventative replacement tasks

Preventative replacement tasks aim to replace components prior to their loss of function.

Preventative replacement tasks	
Element	Replacement frequency
Fans	10 years
Motorized switch	3000 operations
Air filters	2 years or deterioration
AC thermomagnetic circuit breaker	12,500 operations

22.3.1. Replacement of fans

These inverters have four fans located on the mid/lower part of the power module.

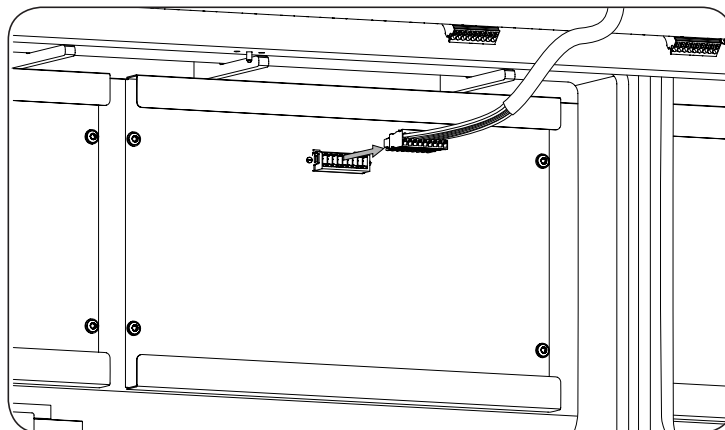


If a fan has come to the end of its life or is malfunctioning, it should be replaced.

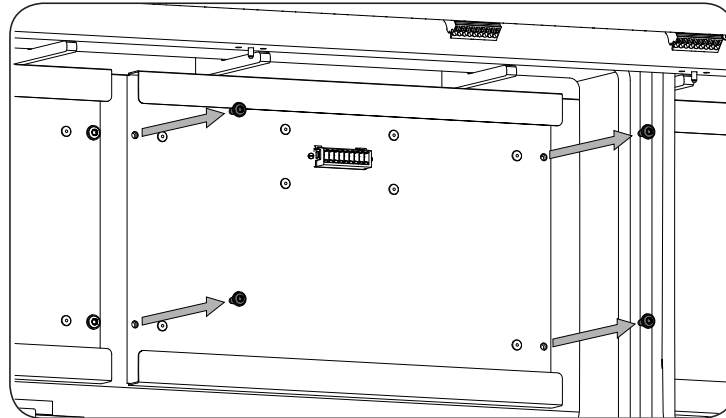
To replace the three fans aligned on the middle of the module, go to the procedure for replacement of the lower fan. Once you have accessed the power module, follow these steps for each case:

Mid-lower area fans (-FAN_R, -FAN_S, -FAN_T)

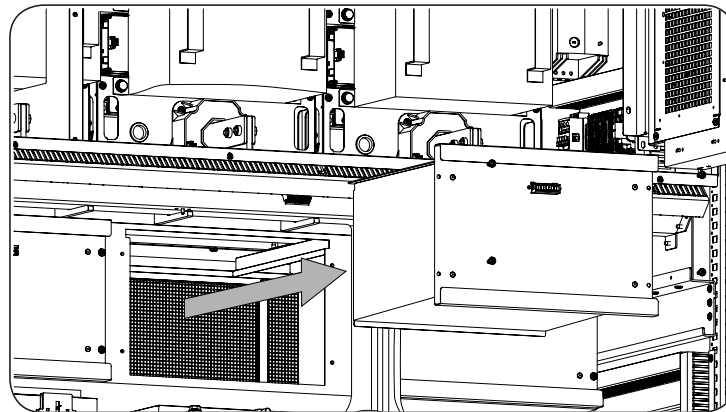
1. Uninstall the aerial connector of the fan to be replaced.



2. Remove the four front Torx bolts.



3. Remove the box where the fan is.



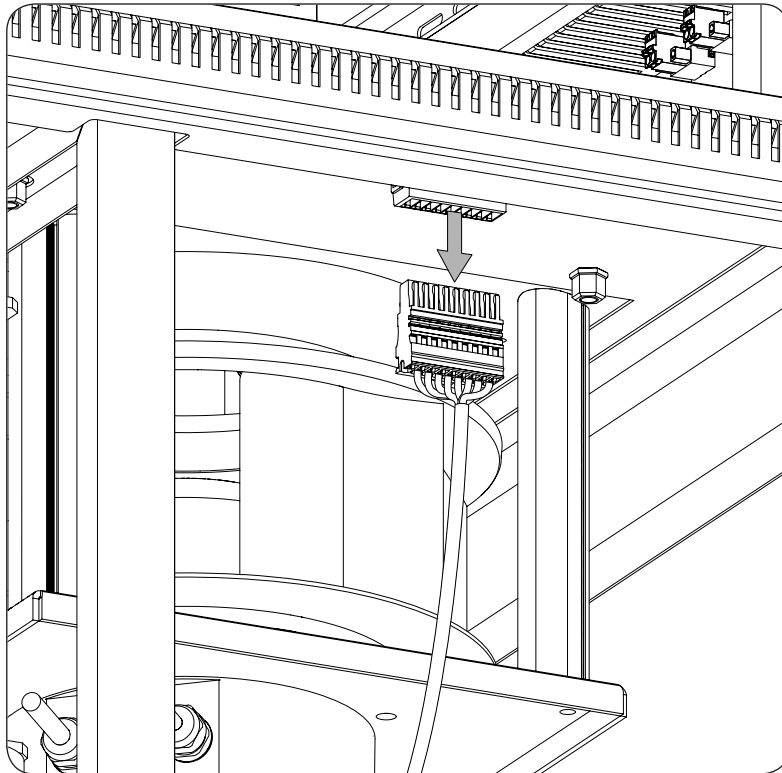
4. Install the new fan with its box.

Ingeteam offers the option of replacing only the fan. In this case, the fan comes with the assembly instructions and electrical diagram for installation.

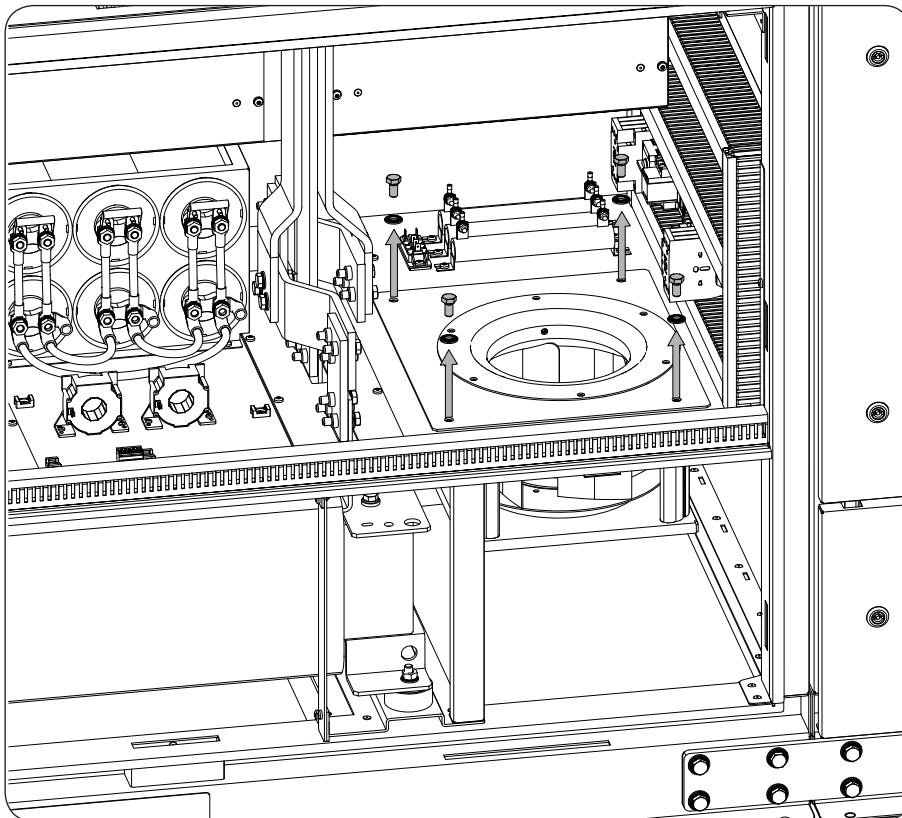
5. Rescrew the fastening bolts.
6. Reinstall the aerial connector.

Lower area fan (-FAN_L1)

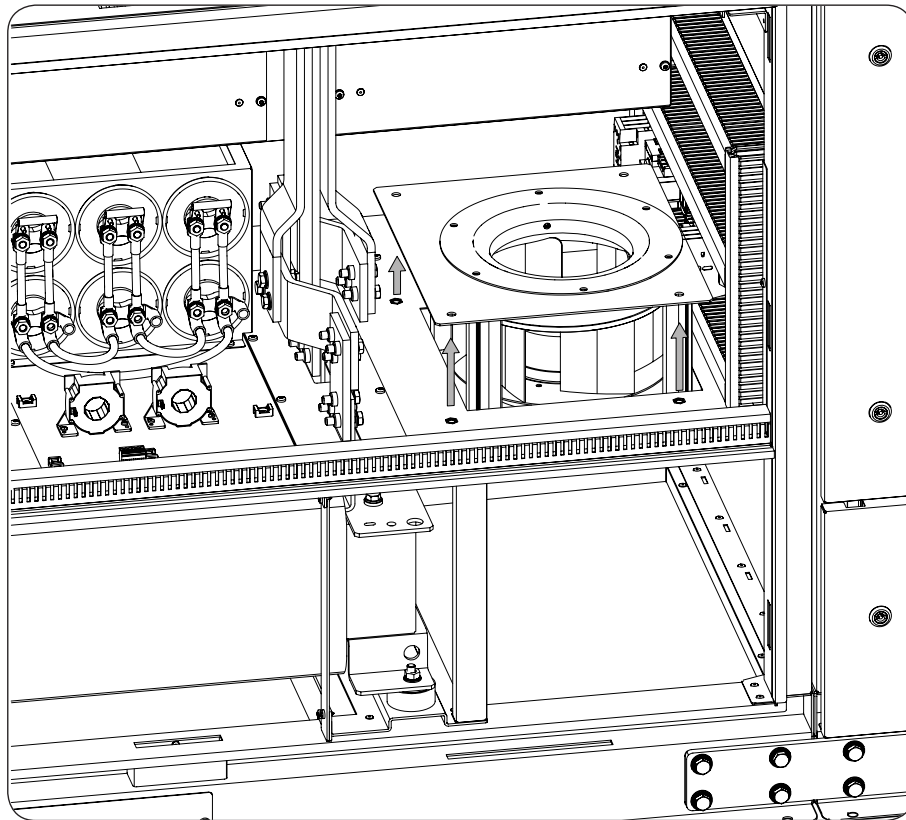
1. Uninstall the aerial connector of the fan to be replaced.



2. Remove the four fastening bolts on the upper part.



3. Extract the fan vertically.



4. Install the new fan.
5. Screw in the fastening bolts removed in point 2 applying a 30 Nm torque with NLGI 1 anti-seize lubricant.
6. Reinstall the aerial connector.

22.4. Corrective replacement tasks

Corrective replacement tasks aim to replace components prior to their loss of function.

Corrective replacement tasks	
Element	Replacement frequency
Arrestors	After tripping
Relays	If not operative
AC thermomagnetic circuit breaker	If not operative
Electronic devices of the converter panel	If not operative
Electrical cards of the unit	If not operative
Power phase	If not operative
Harmonics filter	If not operative
Information stickers	If not legible
Fuses	If not operative
Display	If not operative
DC switch	If not operative

22.4.1. Replacement of arrestors

When an arrestor is tripped, the inverter must display an alarm. After a trip, the affected arrestor must be replaced. Follow these steps:

1. Access the DCAC connections module via the folding door.
2. Identify the affected arrestor. An arrestor displays the status window in red after being tripped.
3. Remove the affected arrestor from its base.
4. Insert a new arrestor in the base with the same characteristics as the one removed.
5. Close the DCAC connections module.

If the base of arresters' base have suffered damages because of a discharge, replace the base + arresters group.

22.4.2. Replacement of relays

The unit has five electromechanical relays: three on the DCAC connections module (-K6, -K8 and -K9) and two on the power module (-K5 and -K7).

All unit relays are installed over DIN rail bases. The replacement of these consists in removing the broken relay and inserting its spare in the base.

22.4.3. AC thermomagnetic switch replacement

Contact Ingeteam.

22.4.4. Electrical cards of the unit

Contact Ingeteam.

22.4.5. Replacement of the power phase

DANGER

Not installing the connection busbars between phase, after the replacement of one or various power phases, causes severe damage to the unit. Ingeteam is not responsible for the damage caused from not properly installing these busbars.

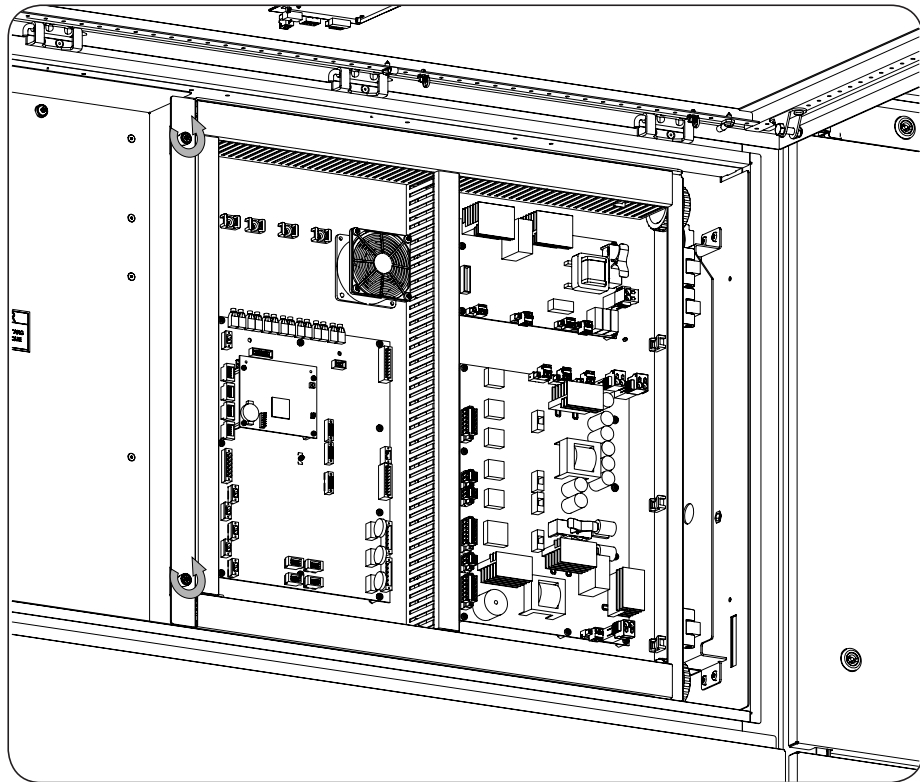
CAUTION

The replacement of a power phase must be executed by two people due to its weight.

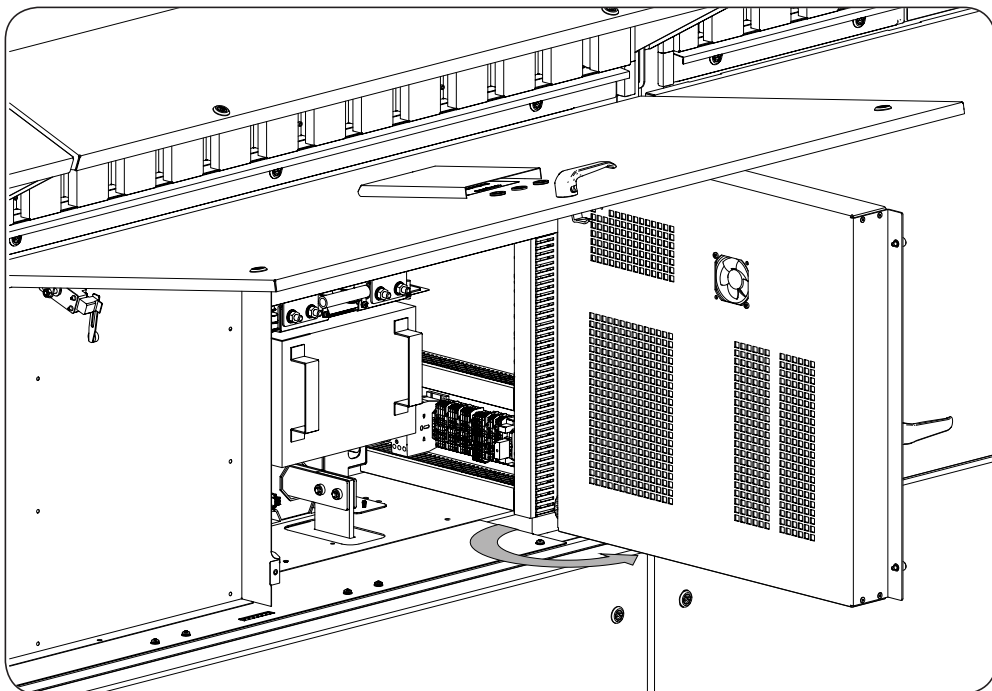
The unit has three electronic devices (-R, -S, -T) on the upper part of the power module. To replace one power phase, perform the following steps:

1. Access the power supply module via the folding door.

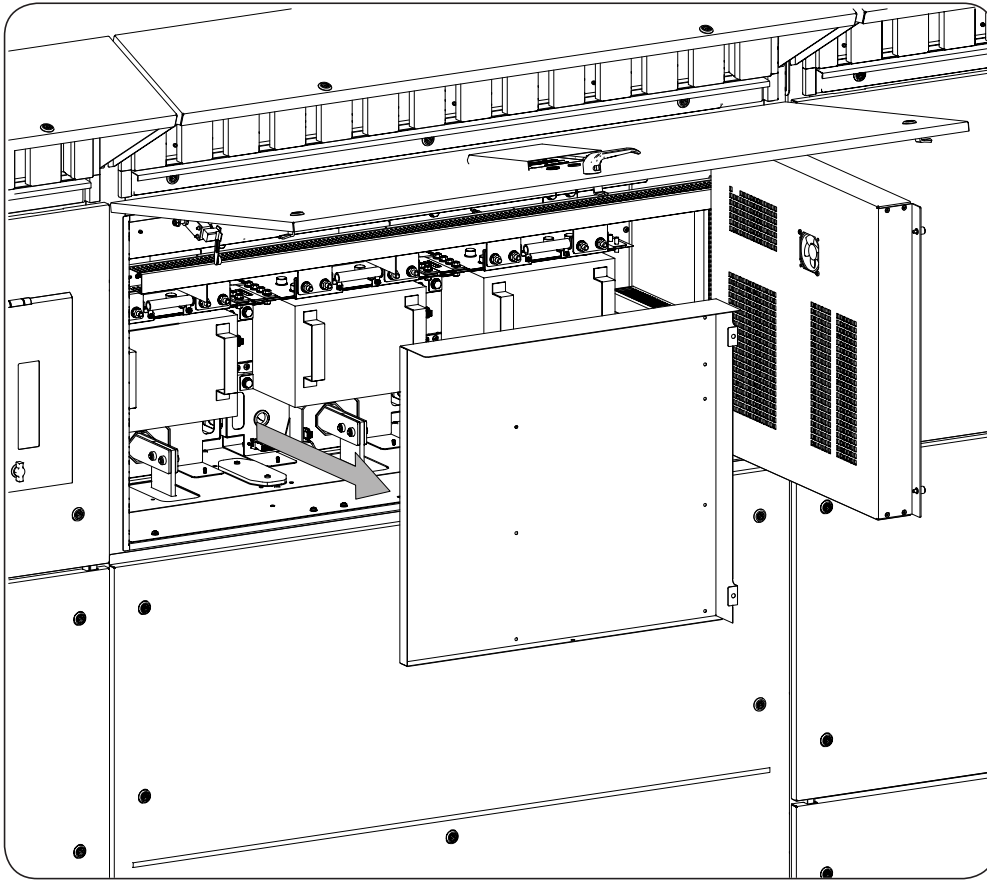
2. Unscrew the electronic panels Torx screws.



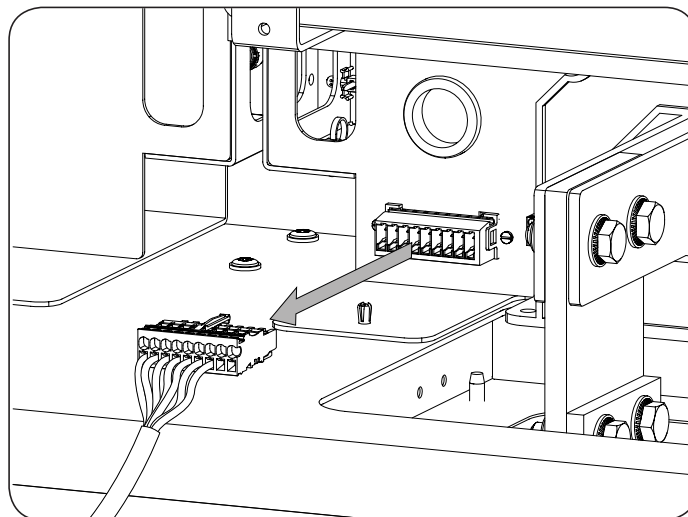
3. Open the electronic panel.



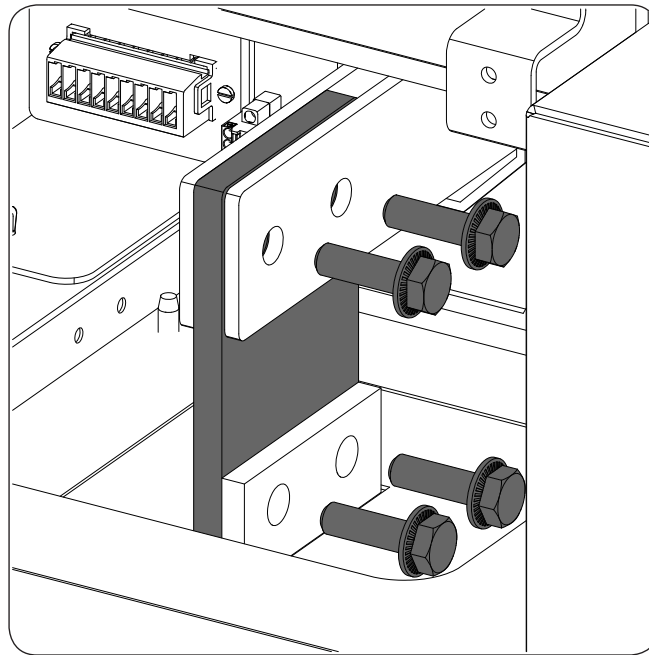
4. Remove the fastening bolts from the protective panel and extract it.



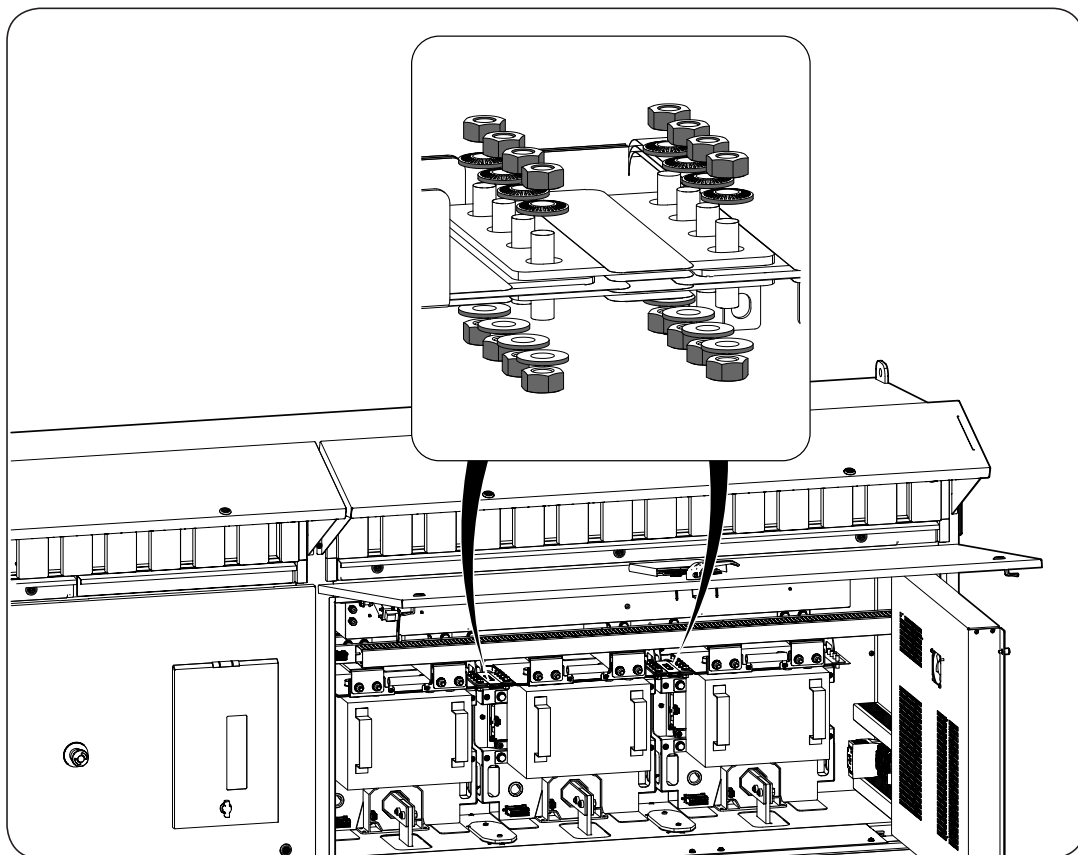
5. Uninstall the aerial connector from its nine positions from the phase to replace.



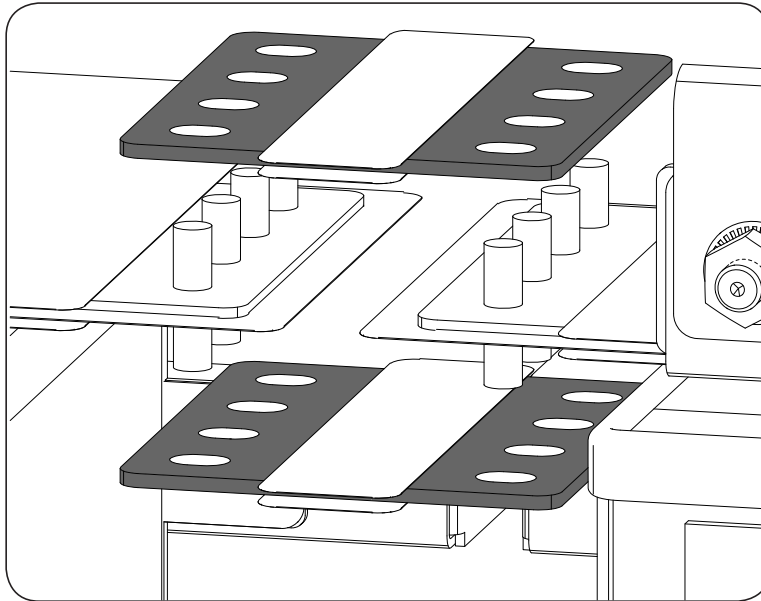
6. Uninstall the four M10 screws and remove the plate shadowed in the following figure. The tightening torque for these screws is 30 Nm.



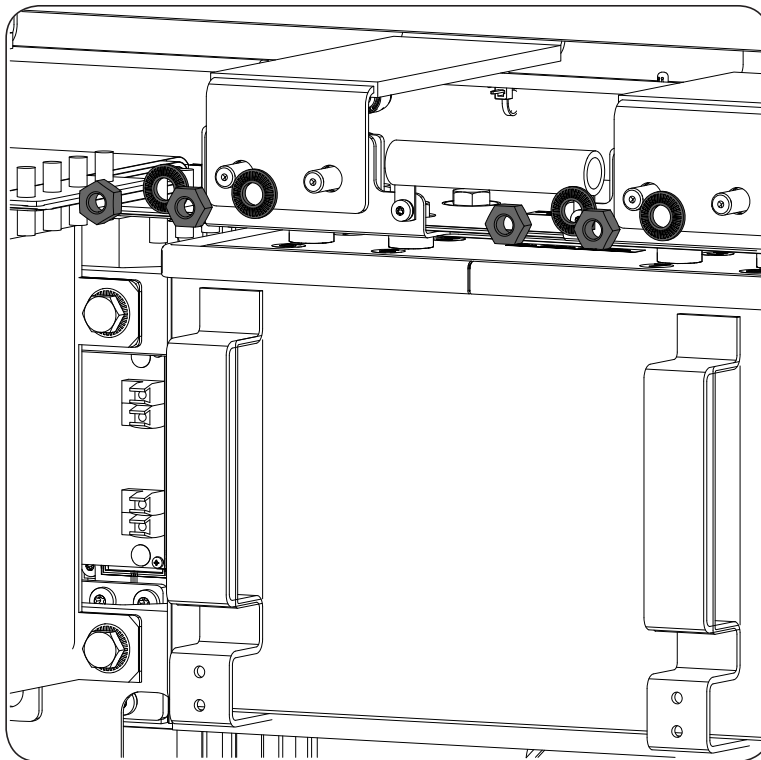
7. The phases are joined to each other via two connection busbars. Uninstall the M8 bolts from the phase's plates to replace. To uninstall phases -R and -T, you must remove 16 bolts. To uninstall phases -S you must remove 32 bolts. The tightening torque for these screws is 8 Nm.



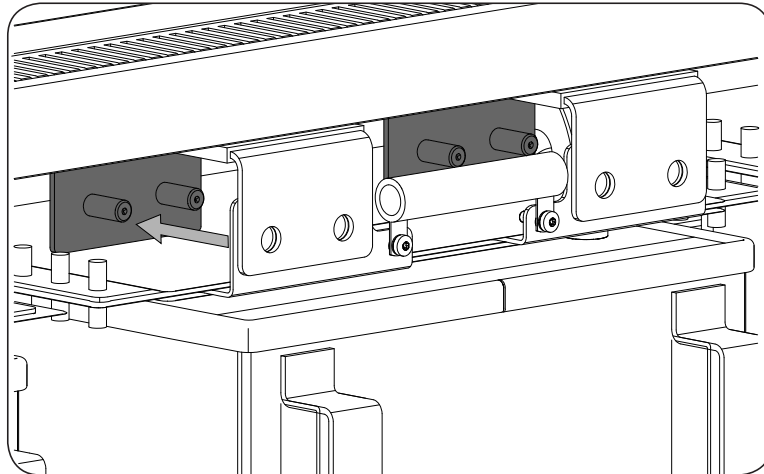
8. Remove the connection busbars between phases. The tightening torque without lubrication for the nuts is 71 lb.in (8 Nm).



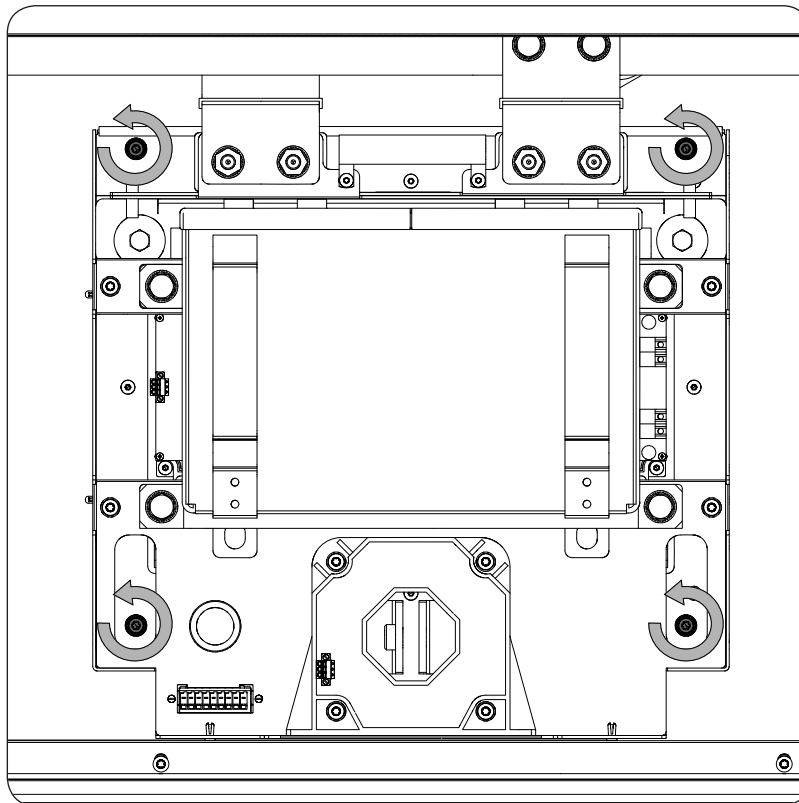
9. Remove the nuts and washers indicated in the following figure. The tightening torque with lubrication for the nuts is 265 lb.in (30 Nm).



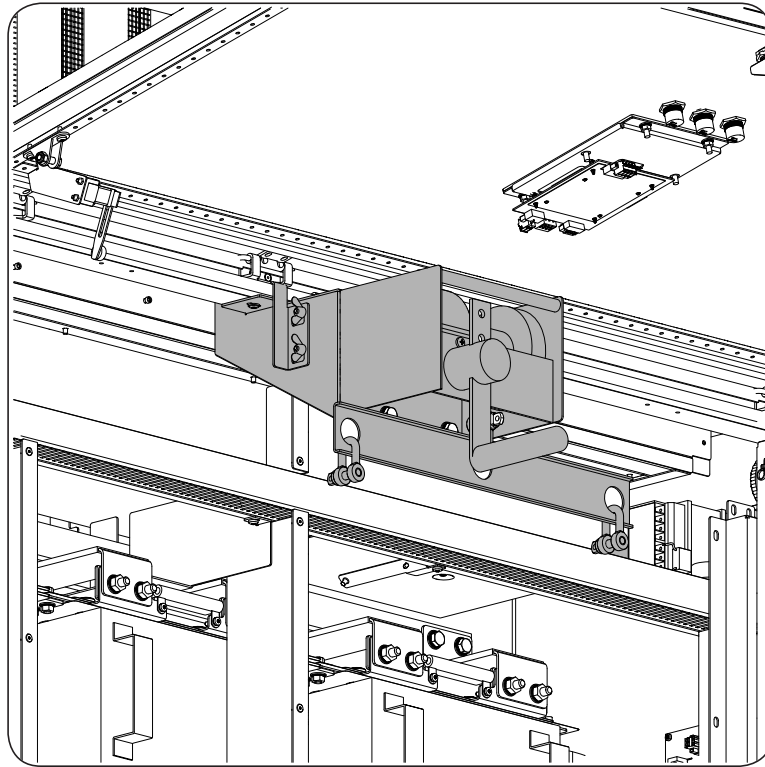
10. Remove the busbars indicated in the following figure.



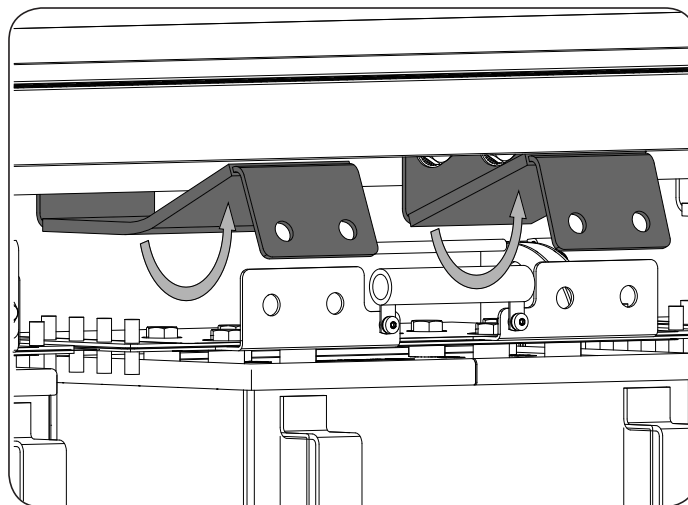
11. Unscrew the four front stud bolts indicated in the following figure.



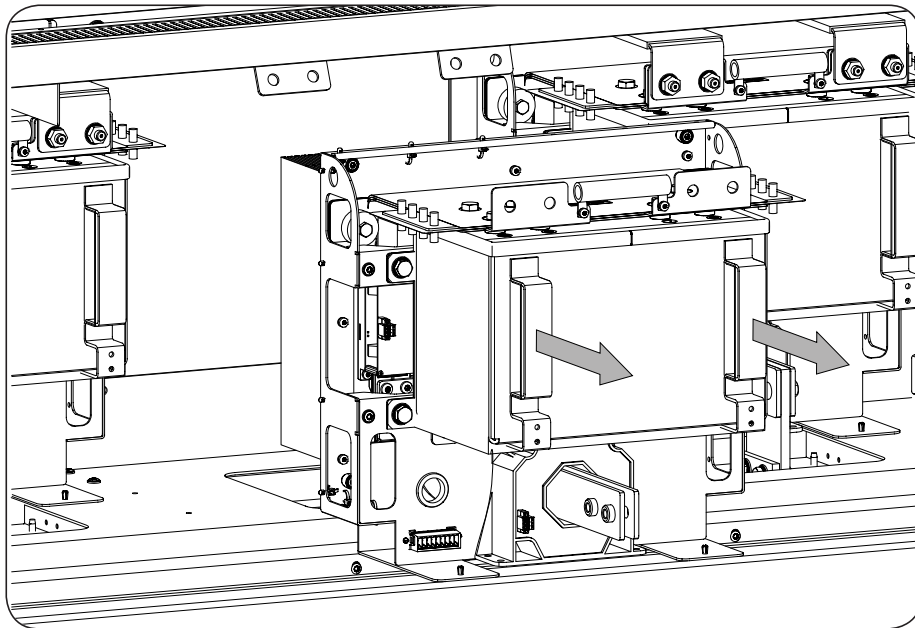
12. Install the hoist in the upper part using the fasteners in the holes provided.



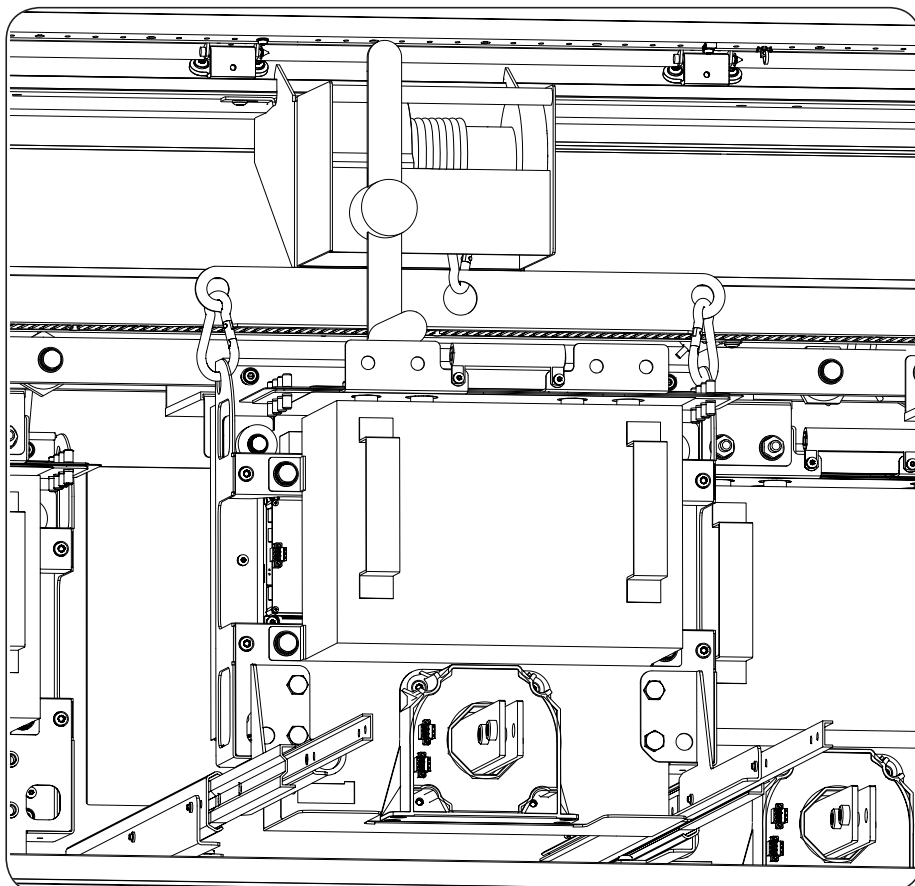
13. Lift the positive and negative busbars up to remove the phase.



14. Remove the power phase by pulling the two handles.



15. Fasten the phase using the hoist.



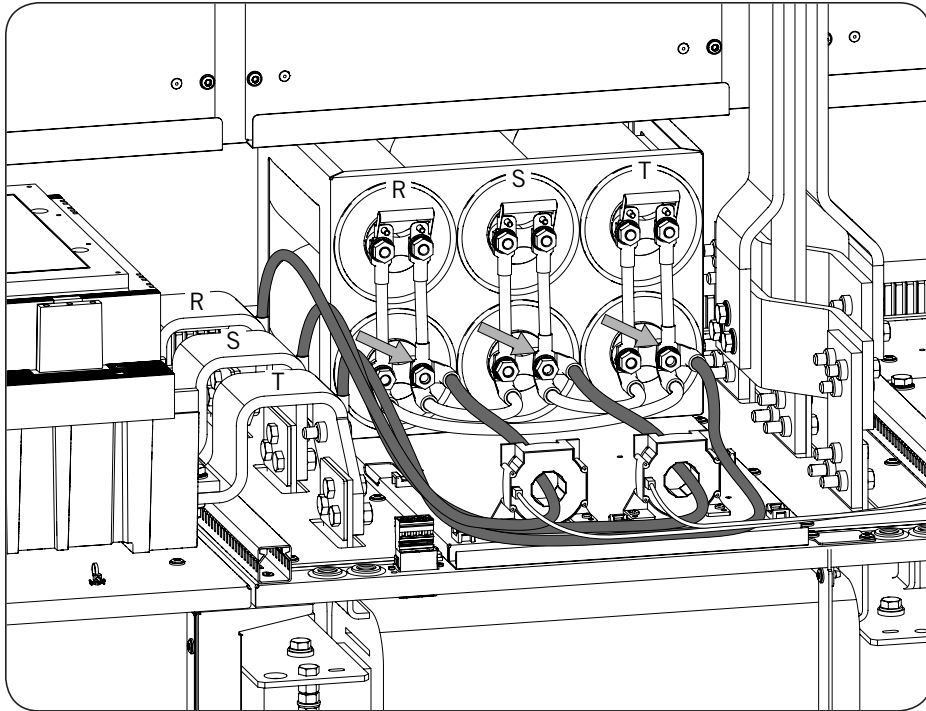
16. Using the hoist, deposit the phase on a safe surface out of the inverter.
17. Remove the plates from the phase using the two screws installed in each one.
18. Install the replacement phase following the reverse order.

 DANGER

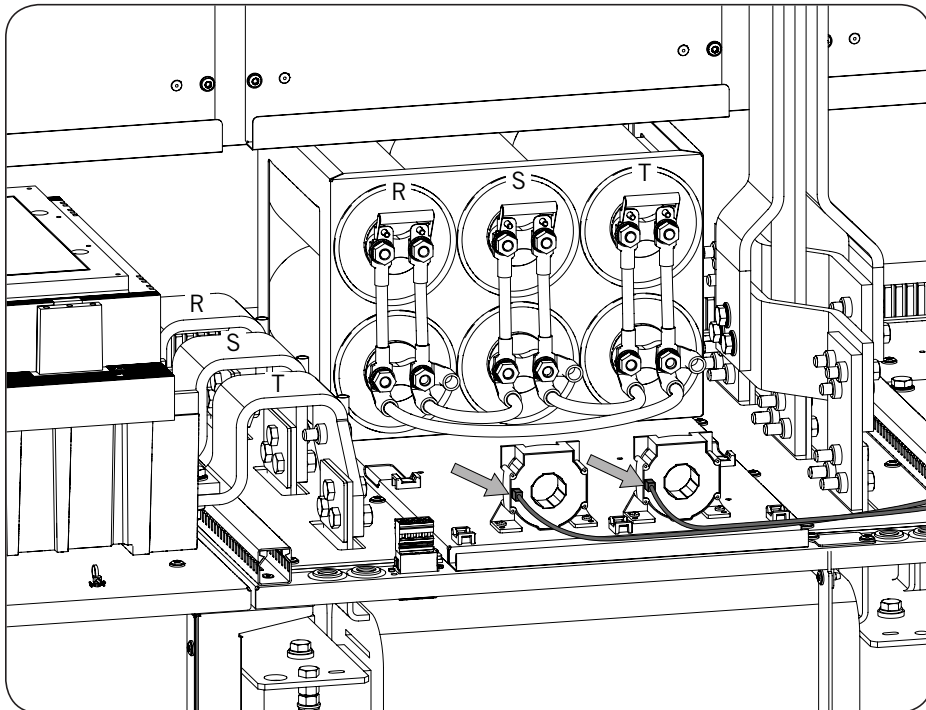
Check that the connection busbars between phases are properly installed. If their installation is not correct, they may cause damage to the equipment.

22.4.6. Replacing the harmonics filter

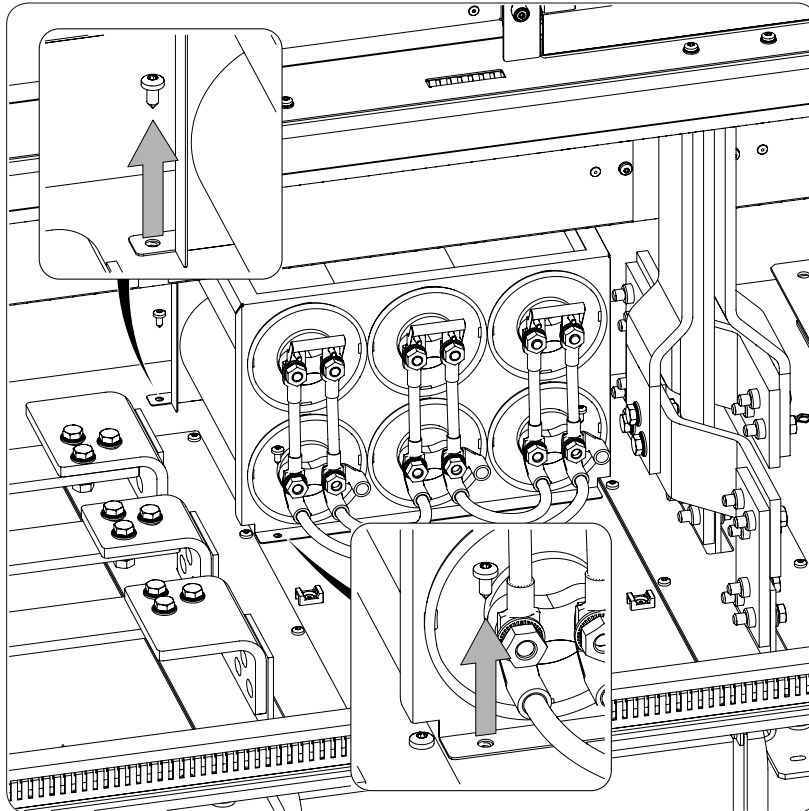
1. Access the lower part of the power module.
2. Disconnect the power cables terminals from the condenser connection points.



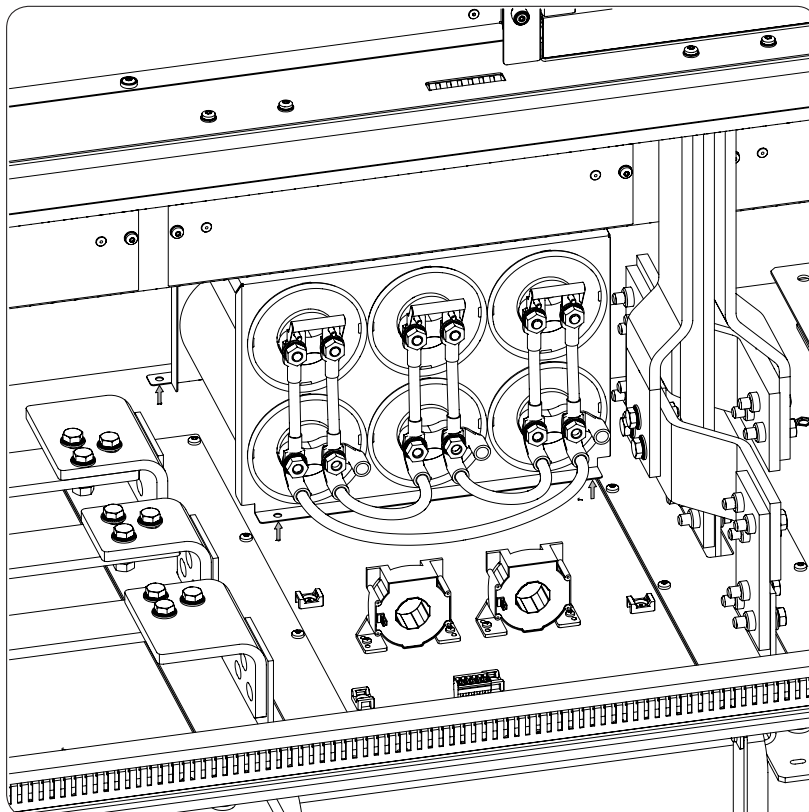
3. Disconnect the cable connectors from the current sensors.



4. Uninstall the four bolts fastening the unit's harmonics filter.



5. Remove the harmonics filter.



6. Install the new harmonics filter.

7. Screw in the fastening bolts applying a tightening torque 10 Nm with NLGI 1 anti-seize lubricant.
8. Connect the cable connectors from the current sensors.
9. Connect the power wiring terminals to the condensers, respecting the phases.

22.4.7. Replacement of fuses

See section “9.5. *Connection/disconnection of the DC fuses*”.

22.4.8. DC switch

Contact Ingeteam.

23. Waste handling

These units use components that are harmful to the environment (electronic cards, batteries or cells, etc.).



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

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

The elements indicated below are dangerous waste at the end of their working life and should be processed according to the applicable law in the country.

- Electrolytic condensers or condensers containing PCB
- Printed circuit board cards.
- Liquid crystal displays.

Said elements are indicated with ^(WH) in section “2.6. Location of components”.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Notes

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