

# Polarity Inverters

## 200 A, 400 A, 600 A, 1000 A

### Polarity Inverters



## User's Manual



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POLARITY INVERTERS

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This product is  &  compliant.



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## POLARITY INVERTERS - USER'S MANUAL

*This manual covers the following standard models:*

**WPOLINV200XA**

**WPOLINV400XA**

**WPOLINV600XA**

**WPOLINV1KAXA**



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Document Revision	Date	Comment
1.0	December 11 <sup>th</sup> , 2017	First Release
1.1	June 26 <sup>th</sup> , 2022	Added 400/600 A models. N.B. mechanical draws are still missing.
1.2	November 22 <sup>nd</sup> , 2022	Added UKCA compliance logo. N.B. mechanical draws are still missing.
1.3	July, 2023	Updated NGPS Configuration
1.4	February 8 <sup>th</sup> , 2024	Added 1-kA version on this same manual, correction of errors and adding of mechanical dimensions
2	August 8 <sup>th</sup> , 2024	Updated address and revision numbering

## Safety information


The following table shows the general environmental requirements for a correct operation of referred instruments in this User's Manual:

Environmental Conditions	Requirements
Environment	Indoor Use
Operating Temperature	0°C to 45°C
Operating Humidity	20% to 80% RH (non-condensing)
Altitude	Up to 2000 m
Pollution degree	2
Overvoltage Category	II
Storage Temperature	-10°C to 60°C
Storage Humidity	5% to 90% RH (non-condensing)

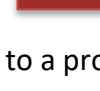
The following symbols are used within this manual or are reported in the box and along this manual:

-  Caution: Documentation must be consulted in all cases where this symbol is marked

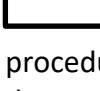
-  Off (Power)

-  On (Power)

### WARNING

-  The WARNING sign denotes a hazard. An attention to a procedure is called. Not following procedure correctly could result in personal injury. AWARNING sign should not be skipped and all indicated conditions must be fully understood and met.

### CAUTION

-  The CAUTION sign denotes a hazard. An attention to a procedure is called. Not following procedure correctly could result in damage to the equipment. Do not proceed beyond a CAUTION sign until all indicated conditions are fully understood and met.

CAEN ELS will repair or replace any product within the guarantee period if the Guarantor declares that the product is defective due to workmanship or materials and has not been caused by mishandling, negligence on behalf of the User, accident or any abnormal conditions or operations.

**Please read carefully the manual before operating any part of the instrument**

**WARNING**

**Do NOT open the boxes**

**CAEN ELS s.r.l. declines all responsibility for damages or injuries caused by an improper use of the Modules due to negligence on behalf of the User. It is strongly recommended to read thoroughly this User's Manual before any kind of operation.**

CAEN ELS s.r.l. reserves the right to change partially or entirely the contents of this Manual at any time and without giving any notice.

**Disposal of the Product**

The product must never be dumped in the Municipal Waste. Please check your local regulations for disposal of electronics products.



**WARNING**

- Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in this manual.
- Do not use the device if it is damaged. Before you use the device, inspect the instrument for possible cracks or breaks before each use.
- Do not operate the device around explosives gas, vapor or dust.
- Always use the device with the cables provided.
- Turn off the device before establishing any connection.
- Do not operate the device with the cover removed or loosened.
- Do not install substitute parts or perform any unauthorized modification to the product.
- Return the product to the manufacturer for service and repair to ensure that safety features are maintained



# 1. Introduction

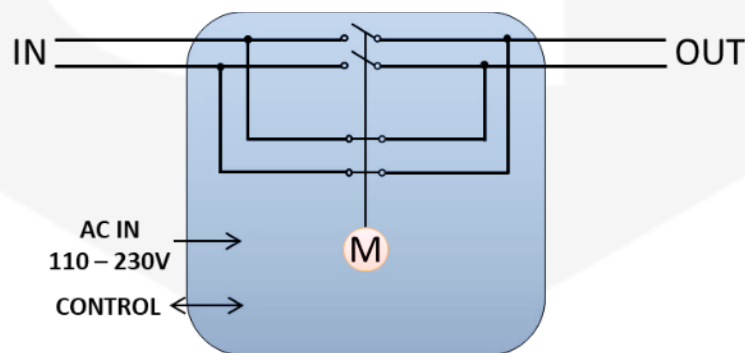
This chapter describes the general characteristics and main features of the Polarity Inverters WPOLINV200XA, WPOLINV400XA, WPOLINV600XA and WPOLINV1KAXA.

## 1.1 Polarity Inverter Overview

Extreme reliability and easiness of configuration and maintenance are the key features of these polarity inverters.

These polarity inverters are able to reverse currents up to 1.000 A and so they represent the perfect fit for the CAEN ELS NGPS unipolar power supplies and other COTS power converters, both in single or paralleled configurations.

The 200-A, 400-A and 600-A polarity inverters fit in a single 19" 6U space while the 1.000-A is housed in a 19"-10U crate and they can be controlled via dry contacts while providing to the user information about the correct working of the system and the selected polarity.



**Figure 1:** Schematic of the unit

Polarity inversion is achieved with a linear motor acting as commutator, this avoiding any possible problem even in case of e.g. black out – which represents an issue if inversion is obtained via relays-based commutators.

**Figure 1** represents the schematic operation of the unit. A linear motor is responsible for the polarity switching, e.g. in **Figure 1** the selected polarity is reversed.

These polarity inverters have the following ratings listed in **Table 1**:

Model	Description	Maximum Voltage	Maximum Current
WPOLINV200XA	200 A Polarity Inverter	250 V	200 A
WPOLINV400XA	420 A Polarity Inverter	250 V	420 A
WPOLINV600XA	630 A Polarity Inverter	250 V	630 A
WPOLINV1KAXA	1.000 A Polarity Inverter	250 V	1.000 A

**Table 1:** Main ratings of the polarity inverters

### WARNING

If the rear power connections of the Polarity Inverter are accessible, IN and OUT connections result in HAZARDOUS LIVE parts and must be isolated or confined following local regulations.

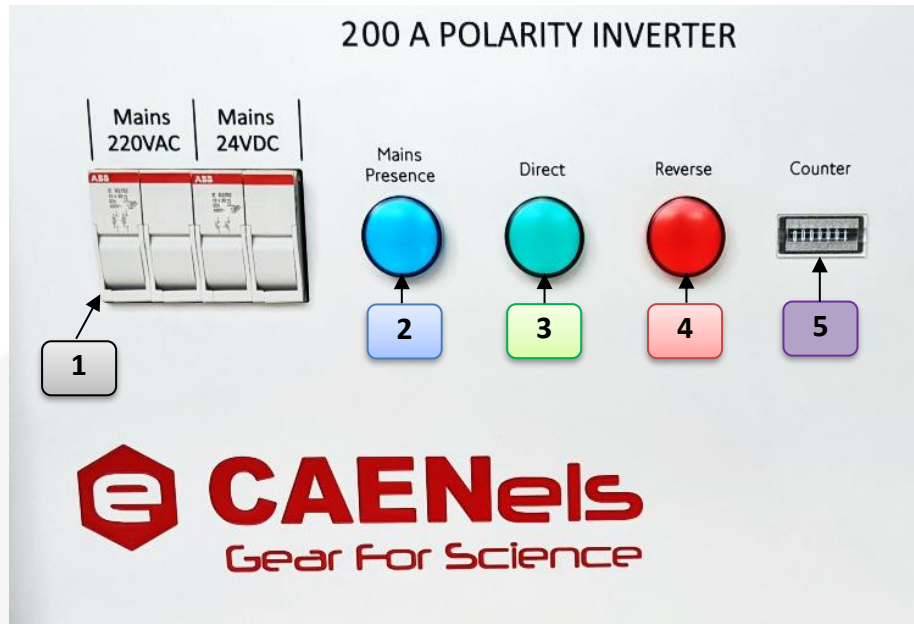
If the Maximum Voltage level is below 70 V<sub>DC</sub> further isolations are not required.

All these polarity inverters are already supplied with the signal cable that allows connecting them directly to an NGPS power supply.

## 1.2 System Parts

### 1.2.1 WPOLINV200XA

The WPOLINV200XA is housed in a 6U – 19" crate (**Figure 2**).

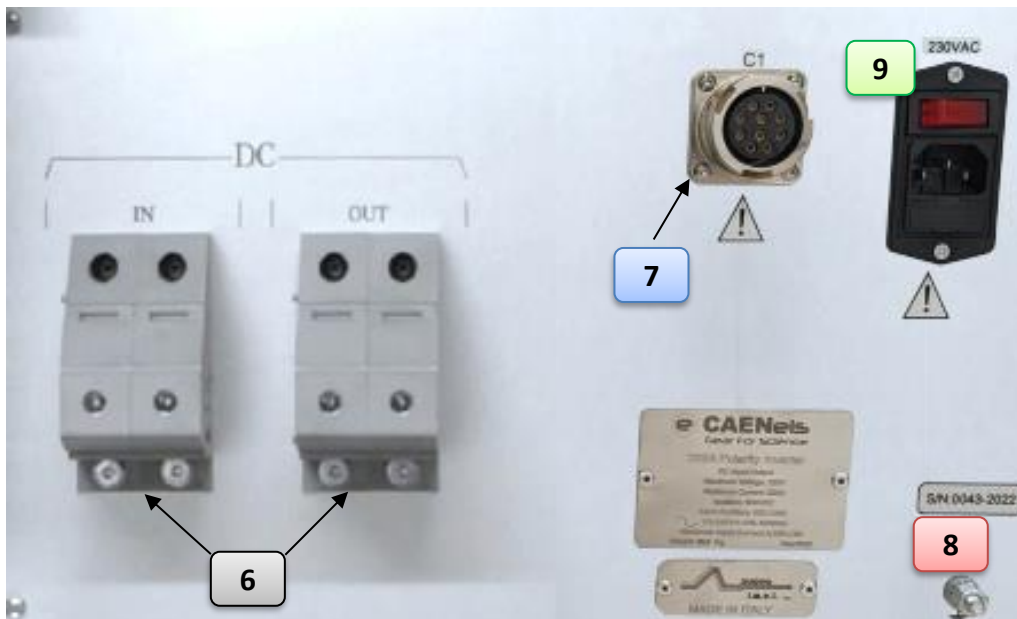


**Figure 2:** Front panel of the WPOLINV200XA

The main parts on the front panel of the WPOLINV200XA polarity inverter are listed below:

- 1** - Four fuses are installed, two of them connected to the AC mains and the other ones to the rectified 24V mains. Fuses are 10.3 x 38 mm and value:
  - Mains 220 VAC → 2 A T 500 V CH10 (1421002)
  - Mains 24 VDC → 6 A T 500 V CH10 (1421006)
- 2** - **MAIN PRESENCE** - if ON it signals the presence of the Mains VAC;
- 3** - **DIRECT** polarity - if ON it signals that the polarity is direct;
- 4** - **REVERSE** polarity - if ON it signals that the polarity is reversed;
- 5** - **COUNTER** - it indicates the number of times the polarity has been reversed.

The rear panel of the polarity inverter contains the parts related to the control and monitoring of the unit, see **Figure 3**.



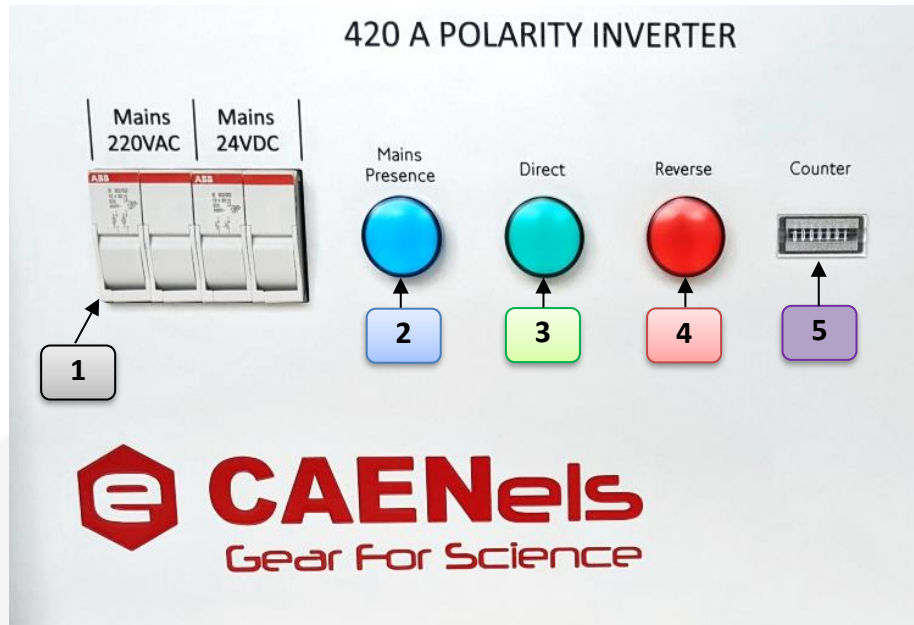
**Figure 3:** Rear panel of the WPOLINV200XA

The main parts on the rear panel of the WPOLINV200XA polarity inverter are listed below:

- 6** - POWER CABLES from the power unit have to be connected to the DC-IN and the load to DC-OUT. DC-IN left connector corresponds to DC-OUT left connector in case of direct polarity, otherwise it corresponds to DC-OUT right connector. The same is true for DC-IN right connector, which corresponds to DC-OUT right one in case of direct polarity;
- 7** - CONTROL AND MONITORING connector (C1);
- 8** - EARTH stud connection;
- 9** - AC Mains connector with its corresponding ON/OFF button and Fuse. Fuse must be 5 x 20 mm, 5 A T 250 V.

### 1.2.2 WPOLINV400XA / WPOLINV600XA

The WPOLINV400XA/600XA is housed in a 6U – 19" (Figure 4).



**Figure 4:** Front panel of the WPOLINV400XA/600XA

The main parts on the front panel of the WPOLINV400XA/600XA polarity inverter models are listed below:

- 1** - Four fuses are installed, two of them connected to the AC mains and the other ones to the rectified 24V mains. Fuses are 10.3 x 38 mm and value:
  - Mains 220 VAC → 2 A T 500 V CH10 (1421002)
  - Mains 24 VDC → 6 A T 500 V CH10 (1421006)
- 2** - **MAIN PRESENCE** - if ON it signals the presence of the Mains;
- 3** - **DIRECT** polarity - if ON it signals that the polarity is direct;
- 4** - **REVERSE** polarity - if ON it signals that the polarity is reversed;
- 5** - **COUNTER** - it indicates the number of times the polarity has been reversed.

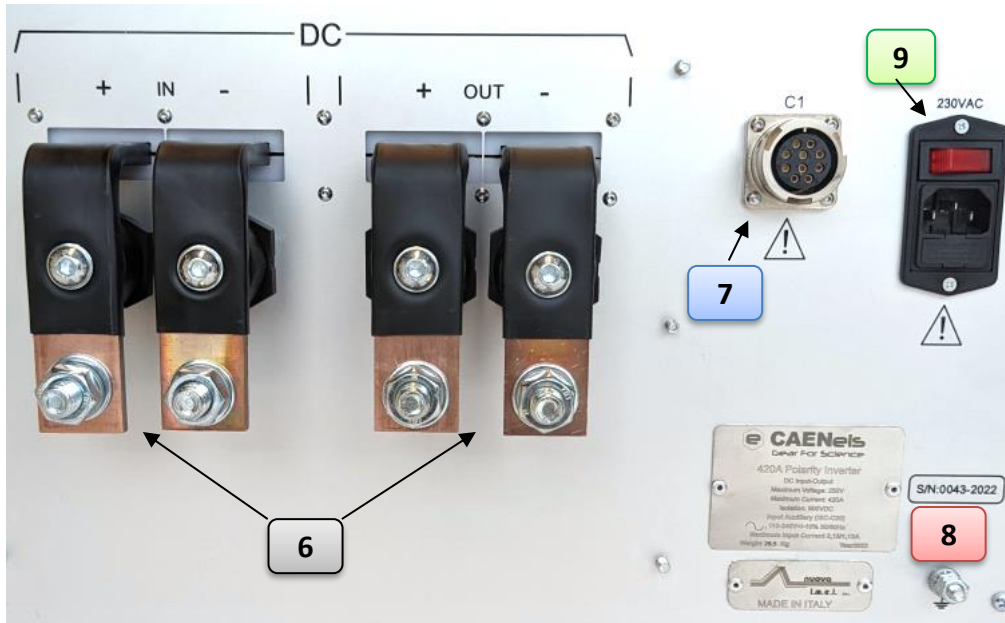
The WPOLINV400XA/600XA polarity inverter models are delivered with a cover, shown in **Figure 5**, to protect the user from accidental contacts on the DC busbars (see **Figure 6**) during the normal operation.



**Figure 5:** Rear panel of the WPOLINV400XA/600XA with the cover for the DC busbars

To get access to the underlying DC busbars, the six screwcaps indicated by the red arrows in **Figure 5** must be removed from the rear panel.

The rear panel without the cover is shown in **Figure 6**.



**Figure 6:** Rear panel of the WPOLINV400XA/600XA without the cover for the DC busbars

The main parts on the rear panel of the WPOLINV400XA/600XA polarity inverter models are listed below:

**6** - POWER CABLES from the power unit have to be connected to the DC-IN and the load to DC-OUT. DC-IN left bar corresponds to DC-OUT left bar in case of direct polarity, otherwise it corresponds to DC-OUT right bar. The same is true for DC-IN right bar, which corresponds to the DC-OUT right one in case of direct polarity;

**7** - CONTROL AND MONITORING connector (C1);

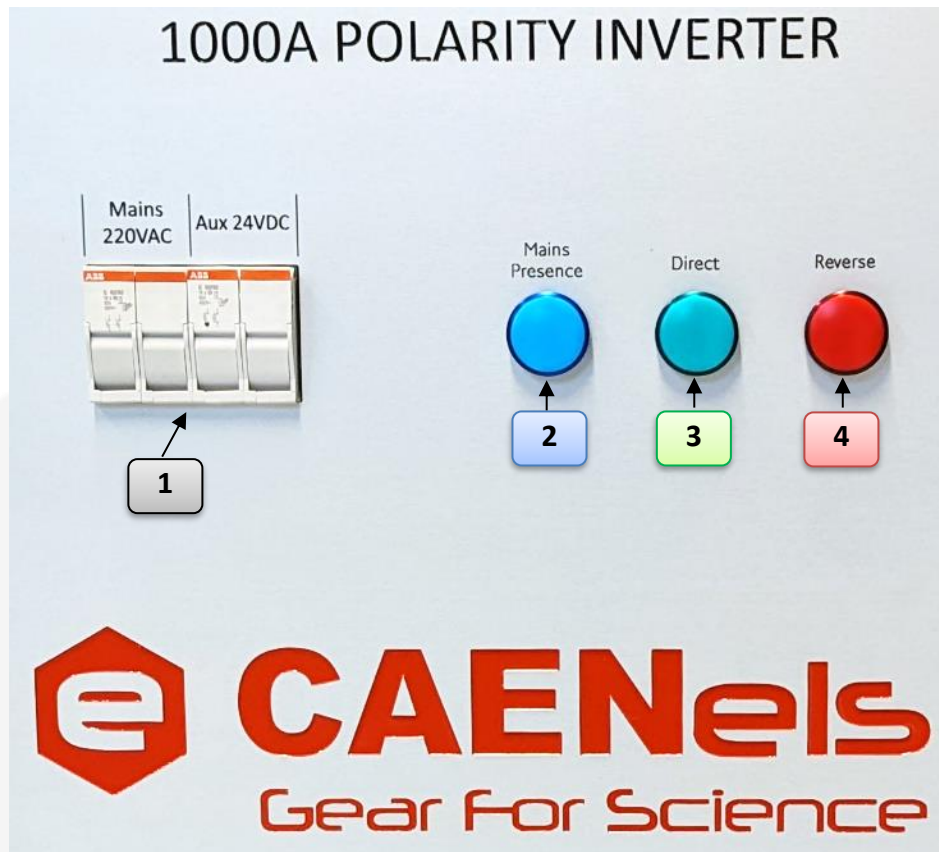
**8** - EARTH stud connection;

**9** - AC Mains connector with its corresponding ON/OFF button and Fuse. Fuse must be 5 x 20 mm, 5 A T 250 V.



### 1.2.3 WPOLINV1KAXA

The WPOLINV1KAXA, rated at 1.000 A maximum, is housed in a 10U – 19” crate (Figure 7).



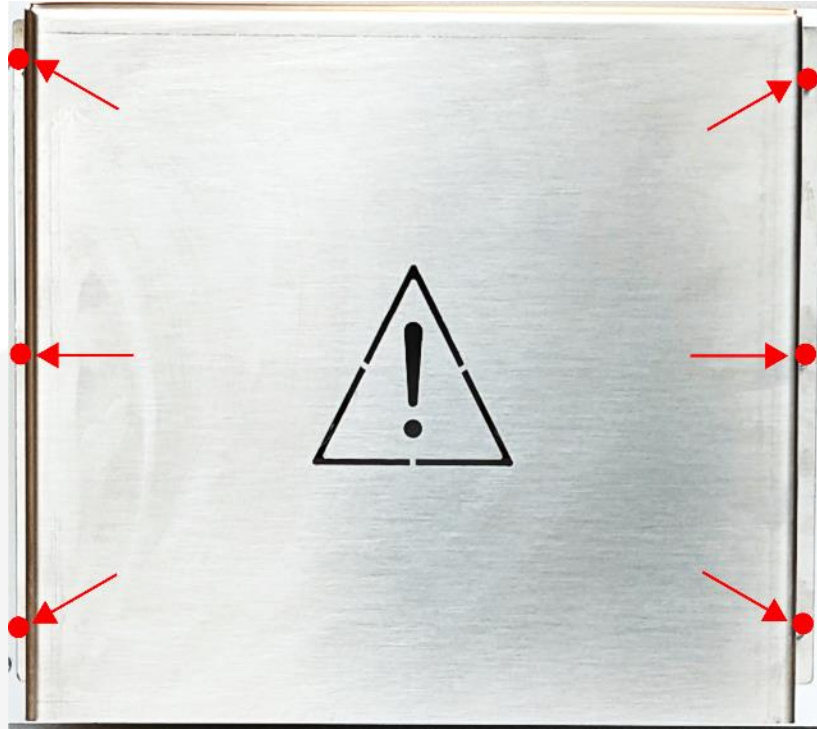
**Figure 7:** Front panel of the WPOLINV1KAXA

The main parts on the front panel of the WPOLINV1KAXA polarity inverter are listed below:

- 1** - Four fuses are installed, two of them connected to the AC mains and the other ones to the rectified 24V mains. Fuses are 10.3 x 38 mm and value:
  - Mains 220 VAC → 2 A T 500 V CH10 (1421002)
  - Mains 24 VDC → 6 A T 500 V CH10 (1421006)
- 2** - **MAIN PRESENCE** – if ON it signals the presence of the Mains;
- 3** - **DIRECT** polarity - if ON it signals that the polarity is direct;
- 4** - **REVERSE** polarity - if ON it signals that the polarity is reversed;

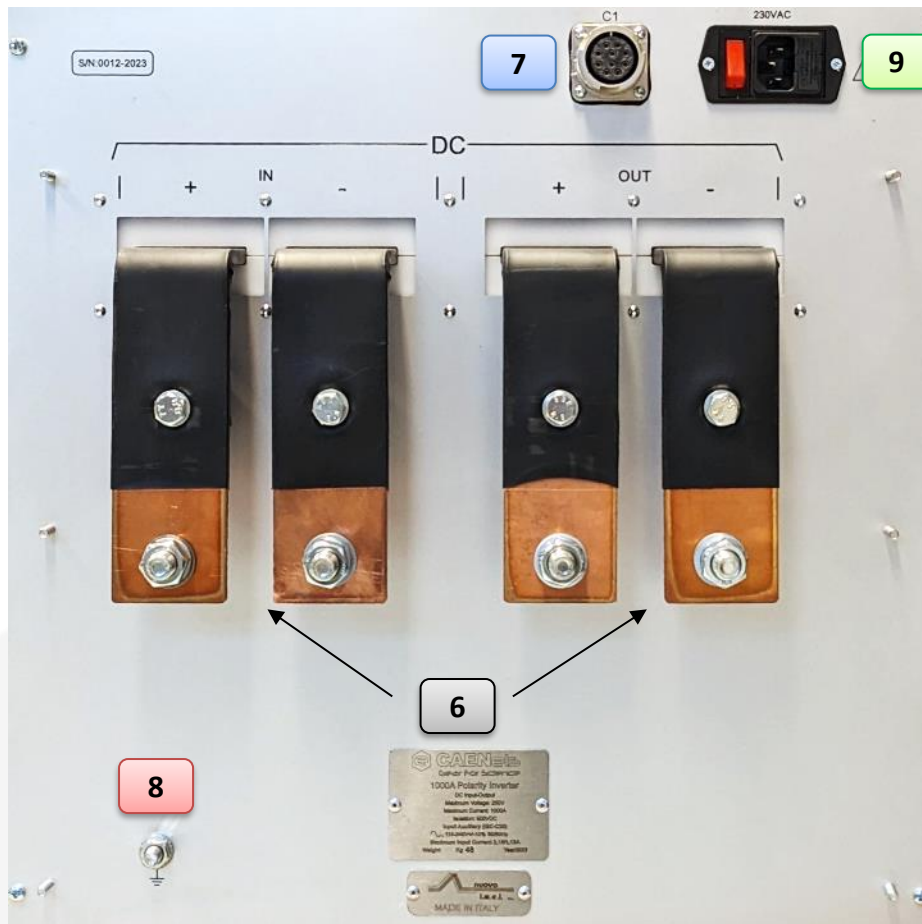


The WPOLINV1KAXA polarity inverter is provided with a metallic cover (shown in **Figure 8**), to protect the user from accidental contacts with the DC busbars (see Errore. L'origine riferimento non è stata trovata.) during normal operation.



**Figure 8:** Rear panel of the WPOLINV1KAXA with the cover for the DC busbars

To get access to the underlying DC busbars, the six screwcaps indicated by the red arrows in **Figure 8** must be removed from the rear panel. The rear panel without the protective cover is shown in **Figure 9**.



**Figure 9:** Rear panel of the WPOLINV1KAXA without the cover for the DC busbars

The main parts of the rear panel of the WPOLINV1KAXA polarity inverter model are listed below:

**6 - POWER CABLES:** the power supply unit has to be connected to the DC-IN terminals while the load to DC-OUT ones. The DC-IN left bar corresponds to DC-OUT left bar in case of direct polarity, otherwise it corresponds to DC-OUT right bar (identical operation is for the DC-IN and DC-OUT right bars);

**7 - CONTROL AND MONITORING** connector (C1);

**8 - EARTH** stud connection;

**9 - AC** Mains connector with its corresponding ON/OFF button and corresponding fuse. Fuse must be 5 x 20 mm, 5 A T 250 V.

## 2. Installation

Please read carefully this general safety and installation information before using the product.

### 2.1 Preparation for Use

In order to get ready, the polarity inverter must be connected to an appropriate source. The source voltage should be within the polarity inverter specification. Do not apply power before reading, **Secs. 2.2, 2.3, 2.4 and 2.5.**

**Table 2** describes the basic setup procedure: follow the instructions in the listed sequence to prepare the polarity inverter for use.

Step	Checklist	Description
1	Initial inspection	Physical inspection of the polarity inverter
2	Mounting	Installing the polarity inverter
3	Connections	Carry out the different connections required
4	AC Input Power Connection	Connect the polarity inverter to the AC source
5	First switch-on	Switch-on checkout procedure

**Table 2:** Installation procedure checklist.

### 2.2 Initial Inspection

Prior to shipment, the polarity inverter has been inspected and found free of mechanical or electrical defects. Upon unpacking of the unit, inspect for any damage which may have occurred in transit.

The inspection should confirm that there is no exterior damage to the polarity inverter such as broken connectors and that the mechanic parts are not scratched or cracked. Keep all packing material until the inspection has been completed. If any damage is detected, please compile the RMA form available on CAEN ELS' website.



## 2.3 Mounting

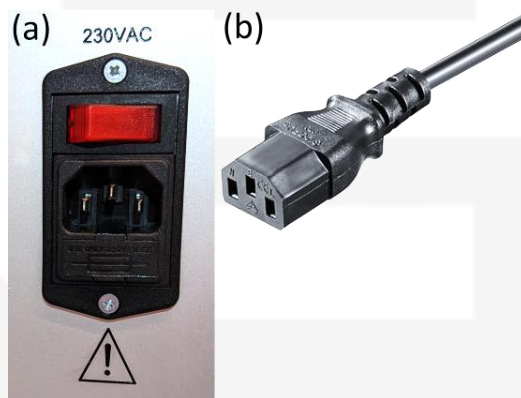
The polarity inverter is designed to fit in a standard 19" equipment rack.

### CAUTION

*Always use L-shelves to correctly sustain the polarity inverter.*

## 2.4 AC Input Power Connections

The AC line input connector on the rear panel is the same for all the polarity inverter models, namely an IEC C14 socket [shown in **Figure 10(a)**].



**Figure 10:** AC Power Line input socket of the polarity inverter.

The polarity inverter is shipped with a mating IEC C13 power cable [**Figure 10(b)**].

### 2.4.1 AC Input Requirements

The units are designed for universal AC input range; indeed, they can operate with an input voltage value ranging from 110 V to 230 V and an input frequency ranging from 47 Hz to 63 Hz. Installation Category shall be **CAT II**, so maximum impulse voltage on the network mains must be below 250 V.

### 2.4.2 AC Input Cord

The polarity inverters are directly shipped with the corresponding AC power cord (suitable for the destination country of the purchase).

The polarity inverter side connector is a standard IEC C14 plug on all models. Wire size for detachable power supply cord shall be at least 0.75 mm<sup>2</sup>. Wire size for fixed installation shall be at least 1 mm<sup>2</sup>.

#### **WARNING**

*There is a potential shock hazard if the chassis is not connected to an electrical safety ground via the safety ground in the AC input connector or the EARTH stud!*

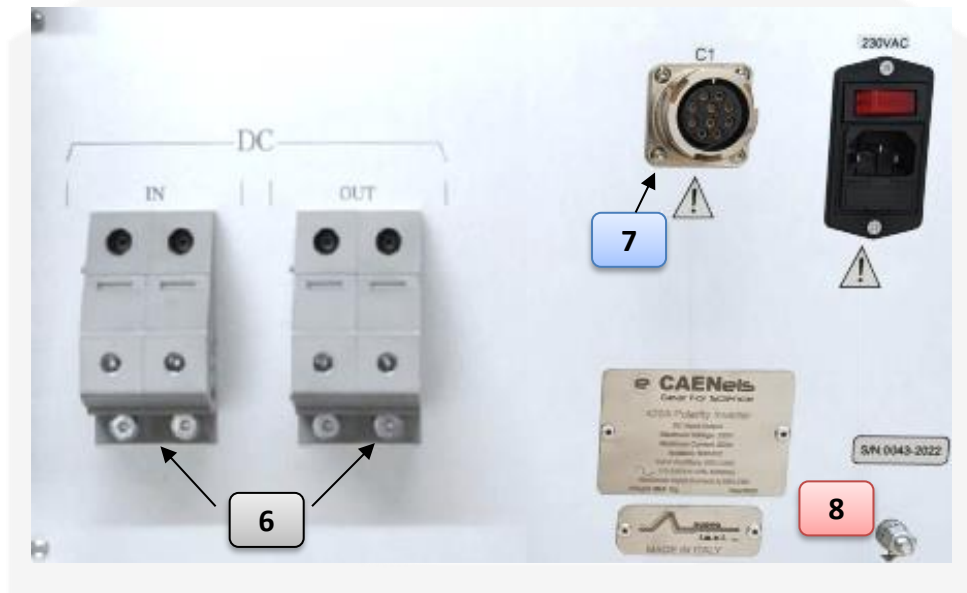
## 2.5 Connections

### WARNING

*Turn off the input power before making or changing any rear panel connection. Ensure that all connections are securely tightened before applying power.*

The connections mentioned in **Section 1.2** are hereafter shown again.

### WPOLINV200XA



**Figure 11:** Rear panel of the WPOLINV200XA model

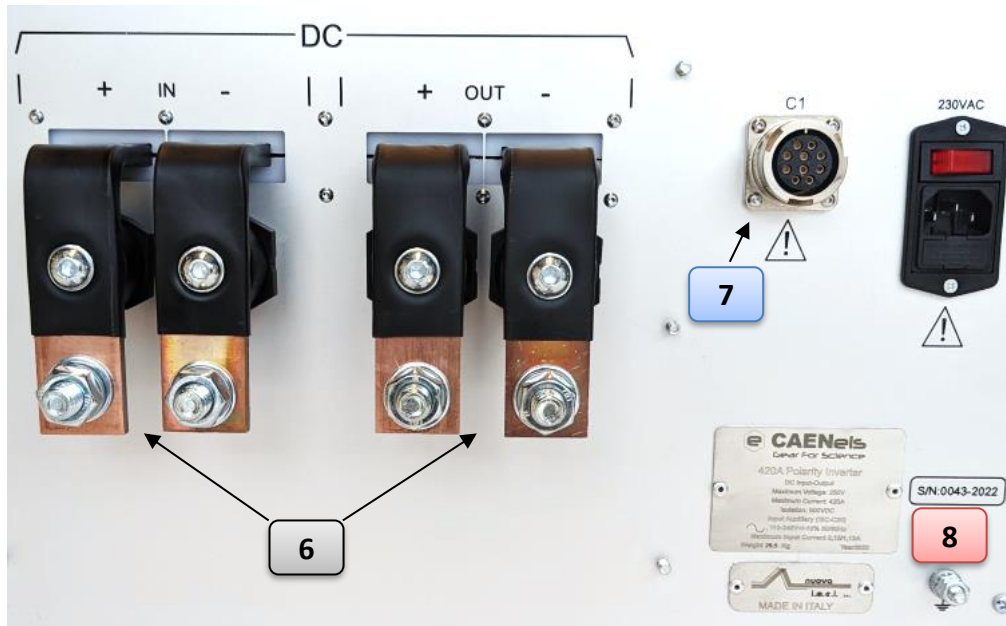
The main parts on the rear panel of the WPOLINV200XA polarity inverter are listed below (see **Figure 11**):

**6** - POWER CABLES from the power unit have to be connected to the DC-IN and the load to DC-OUT. DC-IN left connector corresponds to DC-OUT left connector in case of direct polarity, otherwise it corresponds to DC-OUT right connector. The same is true for DC-IN right connector, which corresponds to DC-OUT right one if the polarity is direct;

**7** - CONTROL AND MONITORING connector (C1);

**8** - EARTH stud connection.

## WPOLINV400XA/600XA



**Figure 12:** Rear panel of the WPOLINV400XA/600XA models

The main parts on the rear panel of the WPOLINV400XA/600XA polarity inverter models are listed below (see **Figure 12**):

**6** - POWER CABLES from the power unit have to be connected to the DC-IN and the load to DC-OUT. DC-IN left bar corresponds to DC-OUT left bar in case of direct polarity, otherwise it corresponds to DC-OUT right bar. The same is true for DC-IN right bar, which corresponds to DC-OUT right one if the polarity is direct;

**7** - CONTROL AND MONITORING connector (C1);

**8** - EARTH stud connection.



## WPOLINV1KAXA



**Figure 13:** Rear panel of the WPOLINV1KAXA

The main parts on the rear panel of the WPOLINV1KAXA polarity inverter are listed below (see **Figure 13**):

**6** - POWER CABLES from the power unit have to be connected to the DC-IN and the load to DC-OUT. DC-IN left bar corresponds to DC-OUT left bar in case of direct polarity, otherwise it corresponds to DC-OUT right bar. The same is true for DC-IN right bar, which corresponds to DC-OUT right one if the polarity is direct;

**7** - CONTROL AND MONITORING connector (C1);

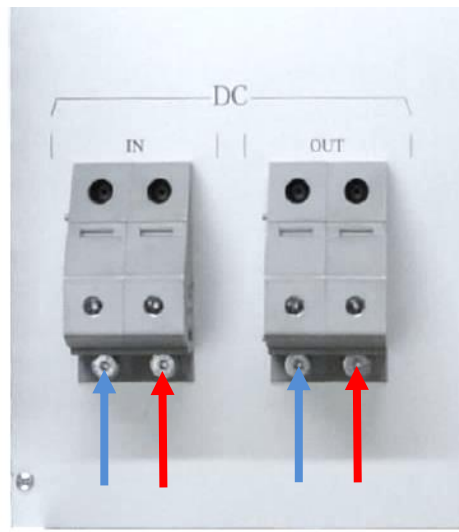
**8** - EARTH stud connection.

## 2.5.1 Power Connectors

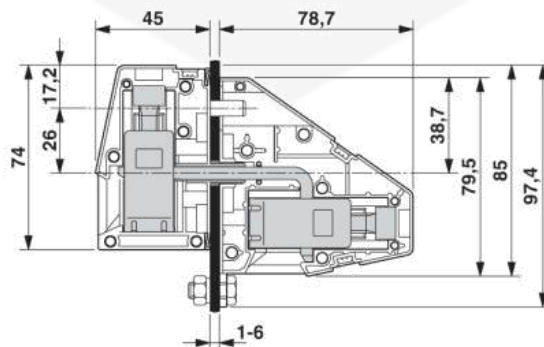
The chosen connections for the power cables, IN and OUT, are different for different models and are described hereafter.

### 2.5.1.1 WPOLINV200XA

The 200 A Polarity Inverter model has Phoenix Contact model HDFKW-95-F/7 output connections. The cables have to be connected from below of the connector as schematically shown in **Figure 14** blue DC-IN corresponds to blue DC-OUT if the polarity is direct; with respect to the power supply polarity, the blue connection can be either positive or negative.



**Figure 14:** Phoenix Contact HDFKW-95-F/7 (WPOLINV200XA)



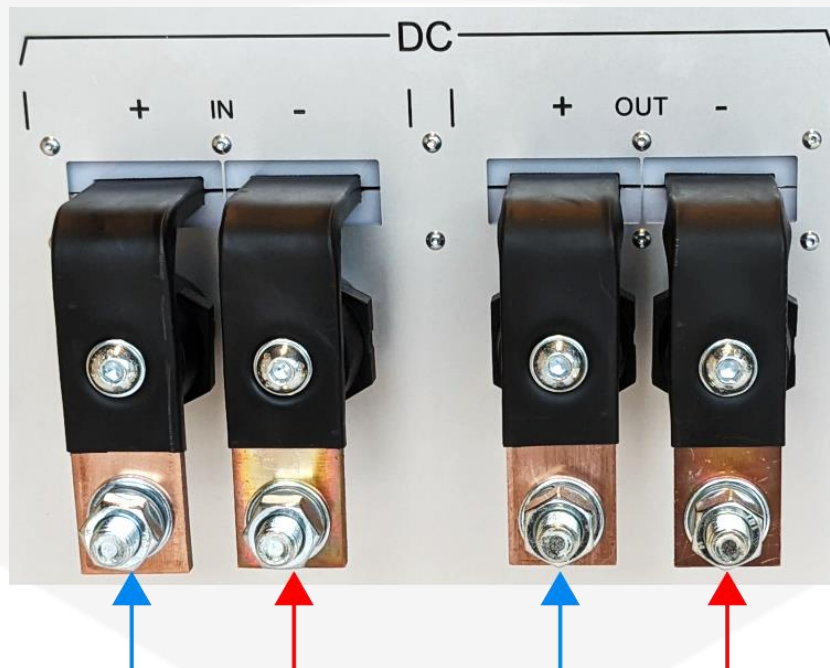
**Figure 15:** Phoenix Contact HDFKW-95-F/7 mechanics

Hereafter the parameters to be used on such connector are listed:

- the acceptable wire section is from 25 to 95 mm<sup>2</sup>;
- peeling length is 27 mm;
- tight force is 20 Nm;
- Hex Key is 6 mm;

#### 2.5.1.2 WPOLINV400XA / WPOLINV600XA

The 420 A (WPOLINV400XA) and 630 A (WPOLINV600XA) Polarity Inverter models, having higher current ratings, are designed with busbar output connections (M12 screws). To get access to these connectors, firstly remove the cover mentioned in **Sec.1.2.2** and shown in **Figure 5**.



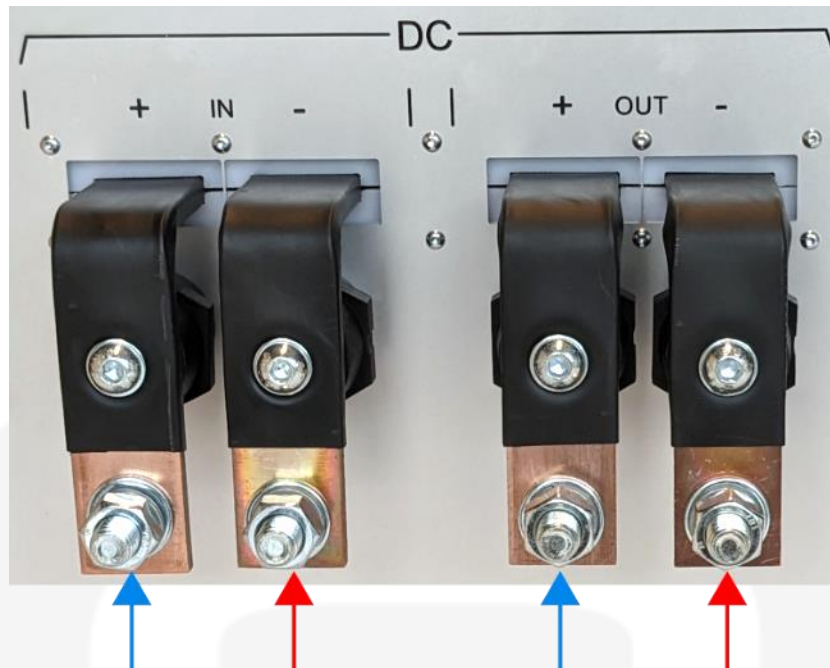
**Figure 16:** Busbars for DC Input and Output connections

With reference to **Figure 16**, blue DC-IN corresponds to blue DC-OUT if the polarity is direct.

With respect to the power supply polarity, the blue connection can be either positive or negative.

#### 2.5.1.3 WPOLINV1KAXA

The WPOLINV1KAXA Polarity Inverter model is provided with busbar output connections (M12 screws). First remove the cover shown in **Figure 8** in order to access these connectors.



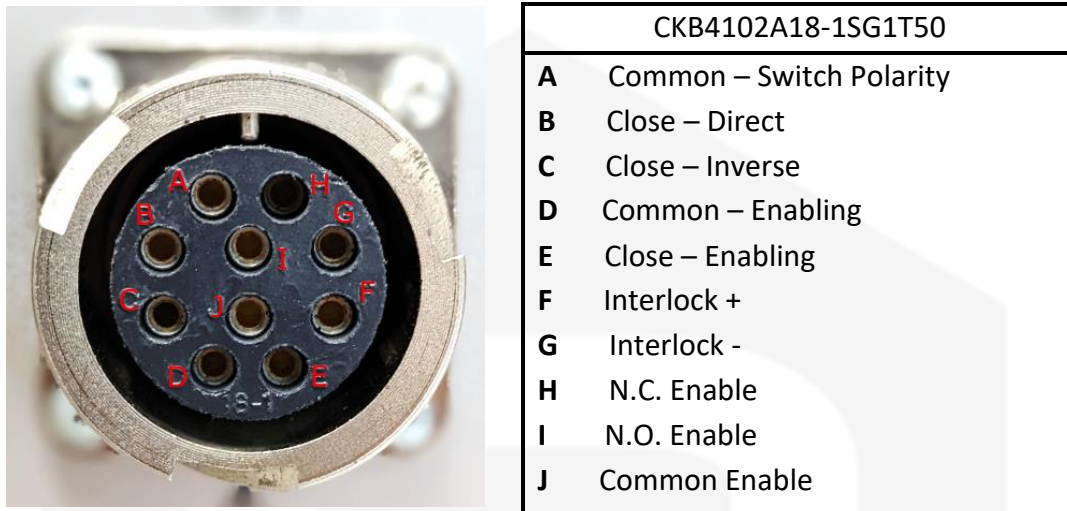
**Figure 17:** Busbars for DC Input and Output connections

With reference to **Figure 17**, the blue DC-IN terminal corresponds to blue DC-OUT one if the polarity is direct.

With respect to the power supply polarity, the blue connection can be either positive or negative.

## 2.5.2 Control and Monitoring Connector

All the polarity inverter models have the same Control and Monitoring connector mounted on the rear panel and labeled as C1. The cited connector is a Connitek CKB4102A18-1SG1T50 type and the mating connector to be used with the cable is the CKB3106AF18-1PT50 model.



**Figure 18:** C1 connector with pinout

With reference to **Figure 18**, the following information on the Pinout are provided:

1. to allow the commutation of the polarity inverter, pins D and E must form a closed path; If pins D and E are not connected any change in pins A, B and C will have no effect at all;
2. when pin A and B form a closed contact, the polarity inverter works in direct polarity. It is highly recommended to use a single relay to switch between pins B and C;
3. when pin A and C form a closed contact, the polarity inverter works in inverse polarity. It is highly recommended to use a single relay to switch between pins B and C;
4. when the polarity inverter is working correctly and the internal relay is seated to be Direct or Inverse polarity, pins F and G create a closed contact. These pins can be used to generate an interlock status in order to turn off the power supply when pins F and G form an open contact;

5. Pins H, I and J are connected to a magnetic relay (250 V – 5 A) that is energized when the pins D and E are closed. This can be used as an external status of the power supply connected to the Polarity Inverter in order to check the status of the enable pins (D and E).

### 2.5.3 Earth connection

With reference to **Figure 11**, **Figure 12** and **Figure 13** for the WPOLINV200XA, the WPOLINV400XA/600XA and the WPOLINV1KAXA models respectively, the earth connector (label 8) has to be connected to protective earth as an additional safety procedure.

When the connection procedure is concluded, mount again the cover shown in **Figure 5** for the WPOLINV400XA/600XA models and in **Figure 8** for the WPOLINV1KAXA.

### 3. Technical Specifications

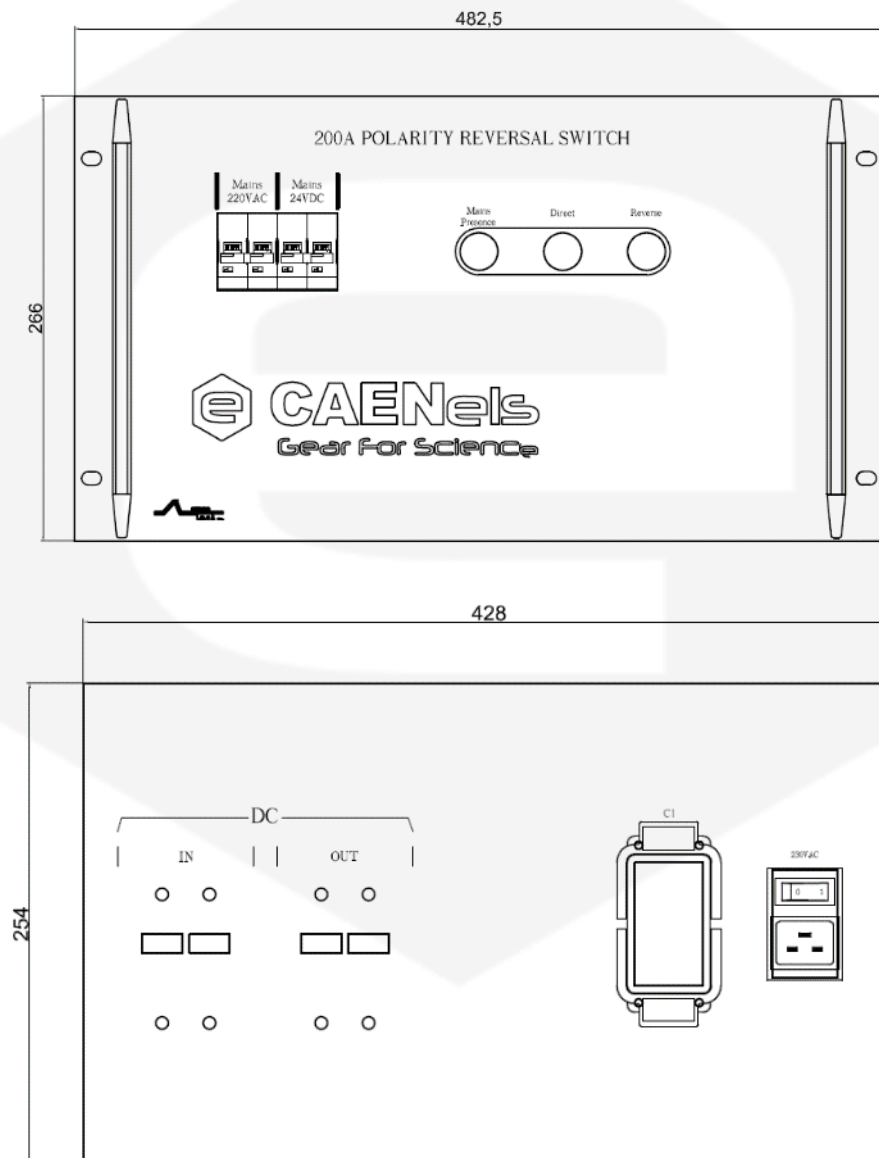
The main technical Specifications for this series of Polarity Inverters are hereafter presented:

	200 A	400 A	600 A	1.000 A
Rated Current	200 A	420 A	630 A	1.000 A
Rated Voltage	250 V			
Auxiliary Input Voltage	100 – 240 V <sub>AC</sub> @ 50 – 60 Hz			
Auxiliary Input Power	350 W			
DC Input/Output Connection	Phoenix Contact HDFKW-95-F/7	Bus-bars		
Max Interlock Rating (pin 6 – 7)	240 V – 16 A			
Max Enable Rating (pin 8, 9 & 10)	240 V – 10 A			
Total weight	28 kg	35 kg		48 kg
Dimensions w/out output connections	19" × 6U × 550 mm			19" × 10U × 573 mm
Input Fuses (230 V)	2 x IW 1421002 2 A – 500 V (38 x 10.3 mm)			
Input Fuses (24 V)	2 x IW 1421006 6 A – 500 V (38 x 10.3 mm)			

**Table 3:** Polarity Inverters Technical Specifications

## 4. Mechanical Dimensions

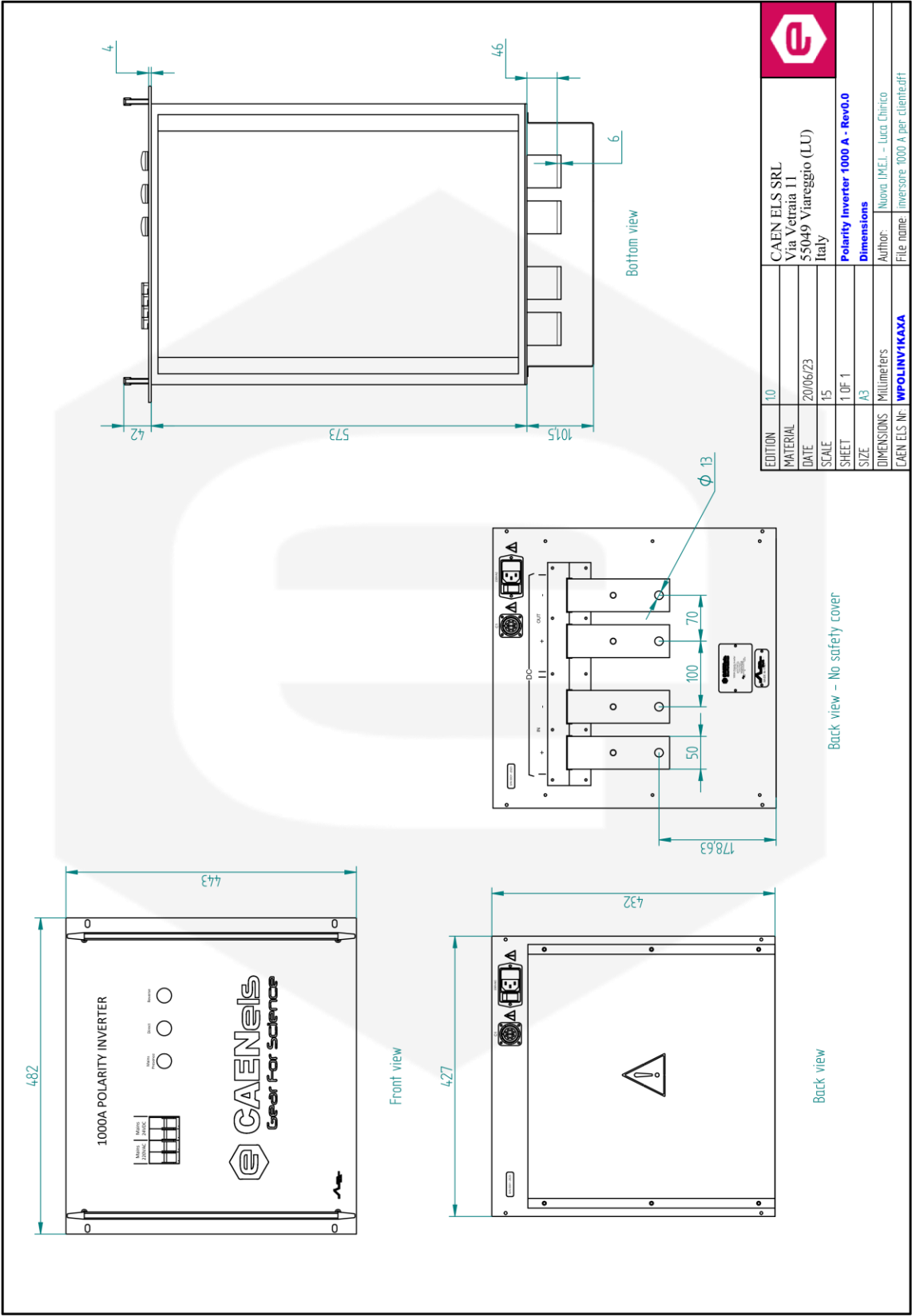
External mechanical dimensions for the WPOLINV200XA model are shown in **Figure 19** (all dimensions in mm).



**Figure 19:** WPOLINV200XA mechanical dimensions



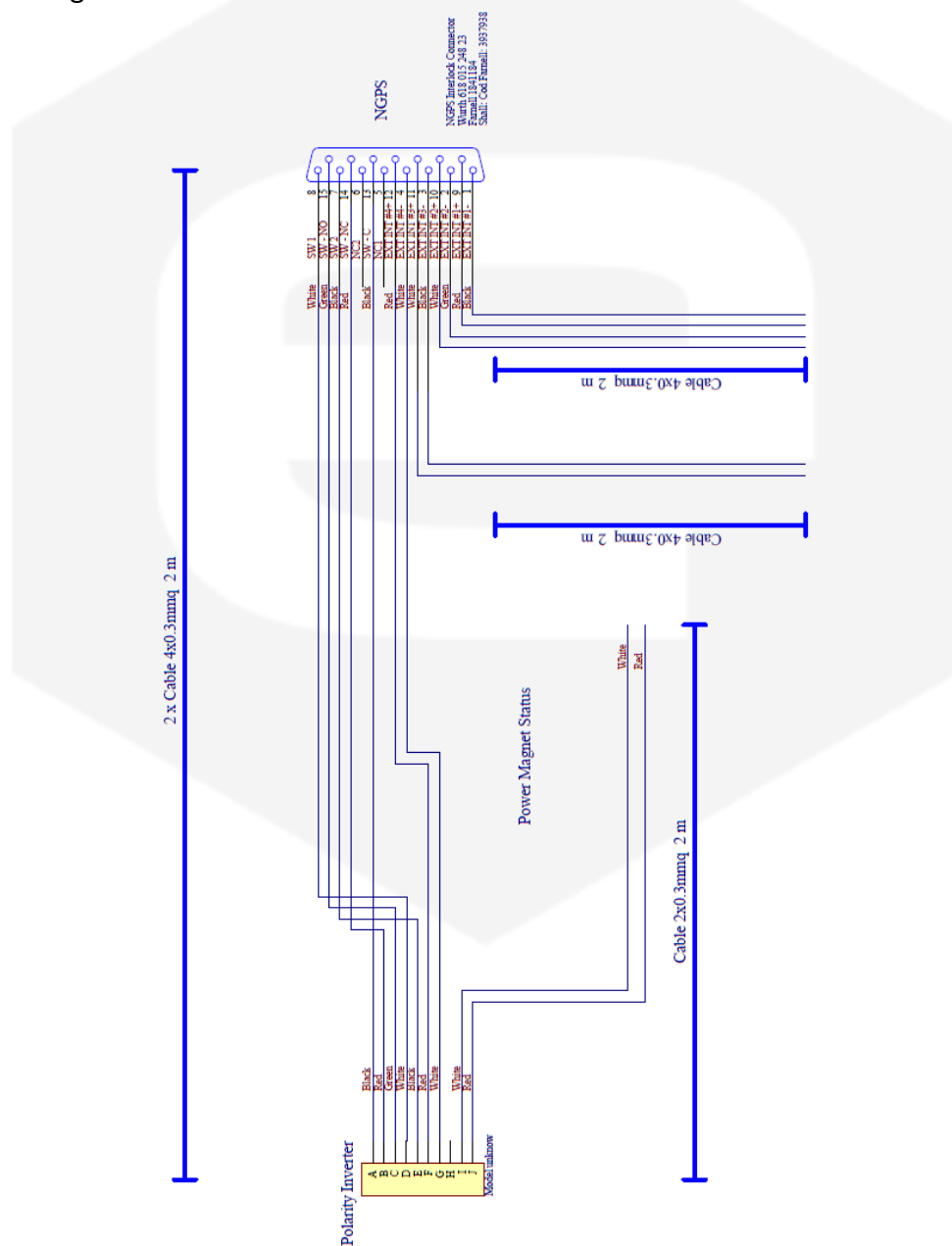
External mechanical dimensions for the WPOLINV1KAXA model are shown in **Figure 20** (all dimensions in mm).



**Figure 20:** WPOLINV1KAXA mechanical dimensions

## 5. Control Cable

The control cable allowing the connection to and the control of the NGPS power supply series is also shipped with the polarity inverter. The cable schematic is shown hereafter in **Figure 21**. See **Section 2.5.2** for the pinout of the control and monitoring connector.



**Figure 21:** schematic of the control cable for NGPS units

## 6. NGPS Configuration

The polarity inverter can be controlled with the NGPS power supply if connected with the dedicated cable. The NGPS shall anyhow be configured to automatically control the polarity inverter depending on the current value required in the following way:

- **Direct:** if a positive current set point is required;
- **Reverse:** if a negative current set point is required.

Two are the configuration to configure/check in the NGPS web interface:

1. the memory cell #130 shall have the text **POLARITY\_INVERTER**

130	Capabilities**	POLARITY_INVERTER
-----	----------------	-------------------

2. the **External Interlock #4** (i.e. Interlock ID n. 4) shall be **Enabled** with a **Delay of 6000 ms**, Interlock Name can be changed with "Polarity Inverter Fault"

External Interlocks Setup					
Interlock ID	Interlock Name *	Enable *	Active High *	Delay [ms] *	Is Editable
1	EXT. INT. 1	<input type="checkbox"/>	<input type="checkbox"/>	100	(ADMIN)
2	EXT. INT. 2	<input type="checkbox"/>	<input type="checkbox"/>	100	(ADMIN)
3	EXT. INT. 3	<input type="checkbox"/>	<input type="checkbox"/>	100	(ADMIN)
4	POLARITY INVERTER F.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	6000	(ADMIN)