

Syncro series inverter

Inverter for high power synchronous motors



WARNING

Make sure you read and fully understand the user manual before using this device.

Non-observance of these instructions will result in death or serious injury.



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IMPORTANT INFORMATION

Liability and residual risks

EVCO assumes no liability for any damage caused by the following (by way of example; this is not an exhaustive list):

- Installation/use for purposes other than those specified and, in particular, not adhering to the safety provisions set out by current regulations in the country in which the product is installed and/or contained in this manual;
- Use in appliances that do not guarantee sufficient protection against electric shocks, water and dust within the installation conditions created;
- Use in appliances that allow access to hazardous parts without the use of a keyed or tooled locking mechanism when accessing the instrument;
- Tampering and/or modifying the product;
- Installation/use in appliances which do not comply with current regulations in the country in which the product is installed.

The customer/manufacturer is responsible for ensuring their machine complies with these regulations.

EVCO's responsibility is limited to the correct and professional use of the product in accordance with regulations and the instructions contained in this manual and other product support documents.

To comply with EMC standards, observe all the electrical connection instructions. As it depends on the wiring configuration as well as the load and the installation type, compliance must be verified for the final machine as specified by the relevant product standard.

Disclaimer

This document is the exclusive property of EVCO. It contains a general description and/or a description of the technical specifications for the services offered by the products listed herein. This document should not be used to determine the suitability or reliability of these products in relation to specific user applications. Each user or integration specialist should conduct their own complete and appropriate risk analysis, in addition to carrying out a product evaluation and test in relation to its specific application or use. Users can send us comments and suggestions on how to improve or correct this publication.

Neither EVCO nor any of its associates or subsidiaries shall be held responsible or liable for improper use of the information contained herein.

EVCO has a policy of continuous development. Therefore, EVCO reserves the right to make changes and improvements to any product described in this document without prior notice.

The images in this document and other documentation supplied with the product are provided for illustrative purposes only and may differ from the product itself.

The technical data in this manual is subject to change without prior notice.

Terms and Conditions of use

Permitted use

The device must be installed and used in accordance with the instructions provided and, in particular, hazardous live parts must not be accessible under normal conditions.

The device must be suitably protected from water and dust with regard to its application and must also only be accessible with the aid of a tool.

Only qualified personnel may install the product or perform technical support procedures on it.

The customer must only use the product as described in the documentation relating to that product.

Prohibited use

Any use other than those described in the "**Permitted use**" section and in the product support documentation is prohibited.

The product must be installed outside hazardous ATEX areas.

Disposal



The device must be disposed of in accordance with local regulations regarding the collection of electrical and electronic appliances.

Consider the environment



With a view to respecting the environment, we strive to adhere to the environmental performance of the company, while taking account of customer requirements, technological innovations in terms of materials and the expectations of the community to which we belong. EVCO places great importance on respecting the environment, encouraging all associates to become involved with company values and guaranteeing safe, healthy and functional working conditions and workplaces.

Please consider the environment before printing this document.

IMPORTANT SAFETY INFORMATION

Please read this document carefully before installation; study all the warnings before using the device. Only use the device in accordance with the methods described in this document. The following safety messages may be repeated several times in the document, to provide information regarding potential hazards or to attract attention to information which may be useful in explaining or clarifying a procedure.



This symbol is used to indicate a risk of electric shock.
It is a safety indication and as such, should be observed to avoid potential accidents or fatalities.



This symbol is used to indicate a risk of serious personal injury.
It is a safety indication and as such, should be observed to avoid potential accidents or fatalities.

DANGER

DANGER indicates a situation of imminent danger which, if not avoided, **will lead to death or serious injury**.

WARNING

WARNING indicates a situation of imminent danger which, if not avoided, **may lead to death or serious injury**.

CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **could cause minor or moderate injury**.

NOTICE

NOTICE indicates a situation not related to physical injuries but which, if not avoided, could damage the equipment.

NOTE: the maintenance, repair, installation and use of electrical equipment must only be entrusted to qualified personnel.

QUALIFIED PERSONNEL

Only suitably trained and experienced personnel capable of understanding the content of this manual and all documentation regarding the product are authorised to work on and with this equipment. Furthermore, the personnel must have completed courses in safety and must be able to recognise and prevent the implied dangers. The personnel must have suitable training, knowledge and experience at a technical level, and be capable of anticipating and detecting potential risks caused by using the product, as well as changing the settings and modifying the mechanical, electric and electronic equipment for the entire system in which the product is used. All personnel working on and with the product must be entirely familiar with the relevant standards and directives, as well as safety regulations.

SAFETY INFORMATION RELATING TO THE PRODUCT

Before carrying out any work on the equipment, read these instructions carefully, making sure you understand everything.

DANGER

RISK OF ELECTRIC SHOCK, EXPLOSION OR ELECTRIC ARC

- Only suitably trained personnel, familiar with and capable of understanding the content of the manual and all relevant documentation, are authorised to work on and with this inverter. Furthermore, the personnel must have completed courses in safety and must be able to recognise and prevent the implied dangers. Installation, adjustment and maintenance must only be carried out by qualified personnel.
- Various product components, including the printed circuits, run at hazardous voltage levels.
- Only use electrically insulated and suitably calibrated measuring devices and equipment.
- Do not handle the equipment while the power supply is connected.
- Do not touch the unshielded components or the terminals while they are live.
- The motors may generate voltage if the shaft is rotated. Before carrying out any work on the inverter, lock the motor shaft to prevent it from rotating.
- Before working on the inverter:
 - Disconnect the power supply.
 - Use a suitably calibrated and electrically insulated Voltmeter to make sure the power supply is disconnected.
 - Wait for 5 minutes after disconnecting the power supply before installing/uninstalling accessories, hardware, cables or wires, to allow the condensers to discharge any residual voltage.
- Do not open, disassemble, repair or modify the product.
- Before handling the product, make sure you are wearing all the necessary personal protective equipment (PPE).
- Do not expose the equipment to liquids or chemicals.
- Before applying voltage to the inverter:
 - Make sure the running period has been completed and no parts of the system can become hazardous.
 - If the mains power supply terminals and the motor output terminals have been earthed and circuited, remove the earth and short circuits on these terminals.
 - Make sure all the equipment is properly earthed.
 - Make sure all protective elements, such as covers, hatches and grilles, are fitted and/or closed.
 - Check all wiring connections.

For installation in accordance with standard EN 61800-5-1, a device cutting off the circuit between the power supply and the inverter is required.

DANGER

RISK OF ELECTRIC SHOCK

Use the required safety interlocks (fuses and/or magnetothermal switches) of a suitable size between the power supply and the inverter.

DANGER

RISK OF ELECTRIC SHOCK AND FIRE

- Do not use the device with loads greater than those indicated in the technical data section.
- Do not exceed the temperature and humidity ranges indicated in the technical data section.

DANGER

RISK OF ELECTRIC SHOCK OR MALFUNCTIONING OF THE EQUIPMENT

Do not use damaged products or accessories.

This device was designed to operate in non-hazardous environments, excluding applications that generate, or could potentially generate, hazardous atmospheres. Only install this device in areas and for applications which are reliably free from hazardous atmospheres.

DANGER

RISK OF EXPLOSION

- Only install and use this device in sites that are not at risk.
- Do not install or use this device in applications which are capable of generating hazardous atmospheres, such as applications that use flammable refrigerants.

The end application utilises a wide range of mechanical, electrical and electronic components connected to one another and the inverter is only one part of the application.

The inverter, as an individual machine, is not capable of providing all the functions necessary to satisfy all the safety requirements relating to the end application. Depending on the application and the corresponding risk analysis to be performed, a series of additional equipment will be required.

As a machine designer/manufacturer, it is necessary to be familiar with and observe all standards applicable to the machine. It is also essential to carry out a risk assessment and to determine the appropriate Performance Level (PL) and/or Safety Integrity Level (SIL) in order to design and construct the machine in compliance with all applicable standards. The interaction between all machine components must be considered, and it is essential to provide operating instructions which allow the user (qualified personnel) to safely carry out any type of work on the machine, such as operation and maintenance.

This document assumes familiarity with all standards and regulatory requirements relating to the application. As the inverter is not capable of providing all safety-related functions for the entire application, it is essential that the required performance level and/or safety integrity level is guaranteed through the installation of all necessary additional equipment.

WARNING

INSUFFICIENT PERFORMANCE LEVEL AND/OR SAFETY INTEGRITY LEVEL AND/OR MALFUNCTIONING OF THE EQUIPMENT

- Carry out a risk assessment in accordance with all other standards relating to your application.
- Use redundant components and/or control lines for all critical control functions identified in the risk assessment.
- Make sure that the useful life of all components used in the application is sufficient for the anticipated duration of the entire application.
- Carry out in-depth start-up tests for all potential error situations in order to check the effectiveness of the safety and monitoring functions implemented, such as speed monitoring via encoder, short-circuit monitoring for all connected equipment and correct brake and protective device operation.
- Carry out in-depth start-up tests for all potential error situations in order to make sure the load can be safely brought to a stop in all conditions.

The **Syncro** inverter must be installed in a suitably ventilated environment to allow heat to dissipate. The temperature of the device can exceed 80 °C (176 °F) during operation.

WARNING

HOT SURFACES

- Avoid all contact with hot surfaces.
- Do not leave flammable or heat-sensitive components on or near hot surfaces.
- Make sure the product has cooled sufficiently before handling it.
- Make sure sufficient heat dissipation takes place by performing a test under maximum load conditions.

WARNING

MALFUNCTIONING OF THE EQUIPMENT

- Perform the wiring carefully, in compliance with electromagnetic compatibility requirements.
- Do not operate the product with unknown or incorrect settings or data.
- Carry out a full start-up test.
- Make sure the wiring is correct for the settings.
- Use shielded cables for all I/O signal and communication cables.
- Use double-shielded cables for motor wiring.
- Minimise the length of the connections as much as possible, to avoid winding the cables around electrically connected parts.
- The signal (communication and corresponding power supplies) and power cables for the device must be routed in separate ducts.
- Use ferrite couplings for the connection cables running to the motor and for the earth connection cable.
- Before applying the power supply, check all the wiring connections.
- Do not connect wires to unused terminals and/or terminals marked with the text "No connection" (N.C.).

1. INTRODUCTION

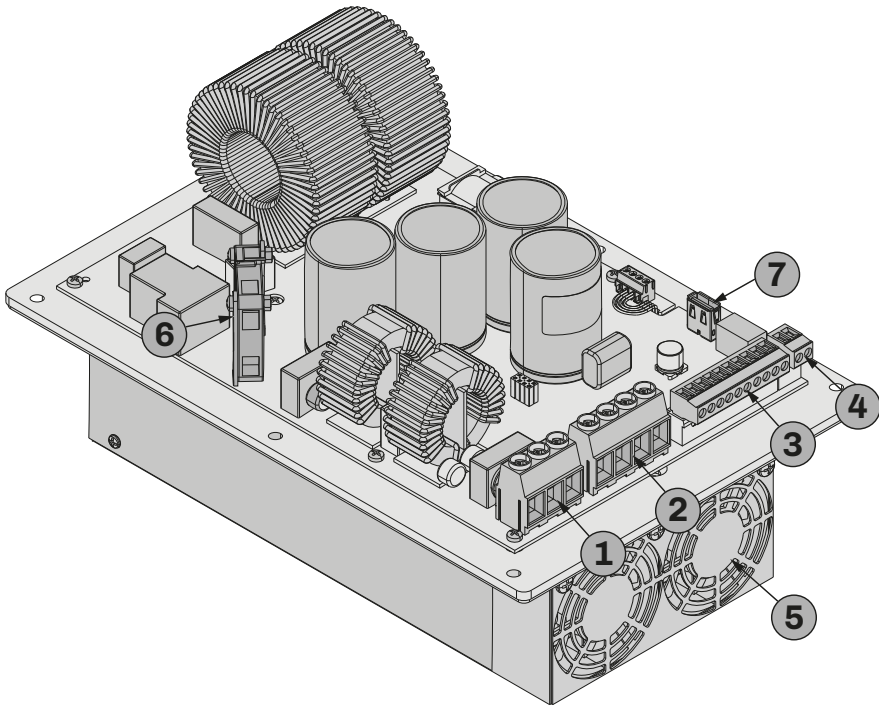
1.1 DESCRIPTION

The series of **Syncro** inverters is designed to control three-phase permanent magnet synchronous motors with a power of up to 6 kW. Operating environments for the **Syncro** series of products are:

- Three-phase permanent magnet synchronous motors (BLDC);
- Three-phase asynchronous motors;
- Controlling HVAC-R compressors.

It uses scalar or vector motor control, depending on application requirements.

1.2 PRODUCT OVERVIEW



| Ref. | Description |
|------|--------------------|
| ① | Power supply input |
| ② | Motor output |
| ③ | I/O connections |
| ④ | Digital Output |
| ⑤ | Cooler fans |
| ⑥ | PCB fan |
| ⑦ | Service USB input |

Fig. 1. Syncro Inverter overview

1.3 FEATURES

The main features of the **Syncro** series inverter are:

- 3 digital inputs;
- 1 safety digital input (for SIL2/SIL3 systems);
- 1 analogue input:
 - Can be configured as an NTC/PTC probe or 0...10 V input;
- 1 digital output;
- 1 12 Vdc output;
- 1 RS-485 Modbus slave communication serial port;
- Available power levels:
 - 4.8 kW;
 - 6 kW.
- Inverter cooling system via built-in ventilation.

1.4 GENERAL COMPLIANCE

| Directive | Harmonised standard |
|-------------------------------------|---|
| LVD Directive 2014/35/EU | EN61800-5-1:2007-09: Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – Electrical, thermal and energy safety. |
| EMC Directive 2014/30/EU | EN61800-3 (EMC): Adjustable speed electrical power drive systems. Class C2. EN61000-3-12 (EMC): Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase. |
| Machine Directive 2006/42/EC | EN61800-5-2: Adjustable speed electrical power drive systems. Safety requirements – Functional safety. |

2. PURCHASING CODES

2.1 PURCHASING CODES TABLE

The table below illustrates the main features of available **Syncro** series inverters and the corresponding purchasing codes:

| Features | | Syncro |
|------------------------|--|-----------------|
| Power supply | 230 Vac \pm 10 % | • |
| Power levels | 4.8 kW | EI4K8M2Y0400VXX |
| | 6 kW | EI6K0M2Y0400VXX |
| Digital inputs | NPN(*) | 3 |
| Analogue inputs | 0...10 V | 1 |
| Digital outputs | 1 A relay at 230 Vac | 1 |
| Powered outputs | 12 Vdc output, 100 mA (reinforced insulation) | 1 |
| Indicator LED | Yellow LED | 1 |
| | Red LED | 1 |
| | Green LED | 1 |
| Installation | Panel | • |
| Terminal blocks | Quick-disconnect screw type | • |
| Communication ports | RS-485 MODBUS SLAVE | • |

NOTE: for further information, consult chapter "**Chapter 4. Technical data**" on page 11.

(*) = PNP on request; contact the sales office for more information.

3. RECEIVING THE PRODUCT

| |
|---------------|
| NOTICE |
|---------------|

| |
|--|
| MALFUNCTIONING OF THE EQUIPMENT |
|--|

- | |
|---|
| <ul style="list-style-type: none">• Droppages and shocks can damage the product beyond repair.• Tampering with or removing the identification stickers invalidates the warranty. |
|---|

2.2 CHECKING THE PACKAGING

- Make sure the packaging is intact;
- Make sure the inverter is intact upon delivery and inform the courier immediately, in writing, of any problems caused by careless or improper transportation (accept the package conditionally).

2.2.1 Opening the packaging

- Take the package to the installation site;
- Open the cardboard box, removing the polystyrene corner protectors;
- Slide out the inverter.

2.2.2 Checking the packaging contents

The standard product package contains:

- **Syncro** series inverter;
- Instruction sheet for installation and assembly.

4. TECHNICAL DATA

All the system components of the **Syncro** inverter satisfy European Community (EC) requirements for electrical equipment. They must be installed in casing or another location designated on the basis of specific environmental conditions and in order to minimise the risk of involuntary contact with hazardous voltage. Use metal casing to improve **Syncro** system immunity to electromagnetic fields. This equipment satisfies the EC requirements as indicated in the tables below.

⚠ WARNING

MALFUNCTIONING OF THE EQUIPMENT

Do not exceed any of the nominal values specified in this section.

4.1 TECHNICAL SPECIFICATIONS

| | |
|--|--|
| Ambient operating conditions: | -10...50 °C (14...122 °F) 10 ... 90 % RH non-condensing |
| Transportation and storage conditions: | -20...60 °C (-4...140 °F) 10 ... 90 % RH non-condensing |
| Altitude: | Maximum 1000 m (3.28 ft) |
| Pollution category: | 2 |
| Protection degree: | IP00 conforming to IEC 60529 (installation on panel) IP44 conforming to IEC 60529 (installation with external cooler fan) |
| Overvoltage category: | III in TT/TN systems |
| Power supply: | 230 Vac ±10 % 50/60 Hz (single-phase) |
| Input current (RMS): | 4.8 kW: 22 A 6 kW: 28 A |
| Output current (RMS): | 4.8 kW: 12 A 6 kW: 16 A |
| Dispersion current to earth: | ≥3.5 mA |
| Cooling method: | Forced ventilation |

4.2 OTHER TECHNICAL INFORMATION

Input properties (SELV)

| | |
|------------------------------|--|
| Digital inputs: | 3 multifunctional configurable digital inputs |
| Analogue inputs: | 1 input that can be configured as: Analogue: 0...10 V / PTC probe Digital: Digital input |
| STO (Safe Torque Off) input: | 1 safety digital input (*) |

(*) Power supply 10...24 Vac/dc, 10 mA, can be integrated into control systems falling into categories **SIL2** and **SIL3**.

Output properties

| | |
|--------------------|--|
| Digital outputs: | 1 relay output 1 A at 230 Vac (configurable) |
| Motor output: | 0...265 Vac, 3 ph at $V_{in} = 230$ Vac |
| Carrier frequency: | 4...8 kHz |
| Nominal overload: | Limited at maximum current |
| Output frequency: | 0...400 Hz |

Serial communication port properties (SELV)

| | |
|---------------------|--|
| RS-485 serial port: | 1 opto-isolated RS-485 MODBUS RTU Slave serial port, reinforced for remote connection Baud rate: 9600/19200 baud - Maximum cable length (shielded): 1000 m (3280 ft.) |
|---------------------|--|

Cable properties

Minimum operating temperature: 85 °C (185 °F)

Compliance

CE in accordance with standards:

- EN61800-3 in category C2;
- EN61800-5-1;
- EN61800-5-2.

5. MECHANICAL ASSEMBLY

5.1 INTRODUCTION TO INSTALLATION

Syncro inverter installation anticipates application to a panel by means of M5 screws (not supplied).

In particular, the safety instructions, electrical requirements and current regulations for the machine or the process in which this device is involved must be observed.

The presence of dust, liquids or conductive foreign objects, or damaged parts, may cause parasitic voltage draw.

DANGER

RISK OF ELECTRIC SHOCK, EXPLOSION OR ELECTRIC ARC

- Do not use damaged products.
- Before handling the product, make sure you are wearing all the necessary personal protective equipment (PPE).
- Do not handle the equipment while the power supply is connected.
- The motors may generate voltage if the shaft is rotated. Before carrying out any work on the inverter, lock the motor shaft to prevent it from rotating.
- Do not expose the equipment to liquids or chemicals.
- Before applying voltage to the inverter:
 - Make sure the running period has been completed and no parts of the system can become hazardous.
 - If the mains power supply terminals and the motor output terminals have been earthed and circuited, remove the earth and short circuits on these terminals.
 - Make sure all the equipment is properly earthed.
 - Make sure all protective elements, such as covers, hatches and grilles, are fitted and/or closed.
- Check all wiring connections.

This device was designed to operate in non-hazardous environments, excluding applications that generate, or could potentially generate, hazardous atmospheres. Only install this device in areas and for applications which are reliably free from hazardous atmospheres.

DANGER

RISK OF EXPLOSION

- Only install and use this device in sites that are not at risk.
- Do not install or use this device in applications which are capable of generating hazardous atmospheres, such as applications that use flammable refrigerants.

WARNING

HOT SURFACES

- Avoid all contact with hot surfaces.
- Do not leave flammable or heat-sensitive components on or near hot surfaces.
- Make sure the product has cooled sufficiently before handling it.
- Make sure sufficient heat dissipation takes place by performing a test under maximum load conditions.

Inverters can generate strong localised electrical and magnetic fields. They may cause electromagnetic interference in sensitive devices.

WARNING

ELECTROMAGNETIC FIELDS

- Do not allow wearers of medical devices such as pacemakers to approach the equipment.
- Do not place devices which are sensitive to electromagnetic interference near the equipment.

5.2 PERMITTED INSTALLATION POSITIONING

CAUTION

OVERHEATING CAUSED BY POSITIONING WHICH IS NOT PERMITTED

- Install the inverter in accordance with the permitted positioning.
- If you apply positioning which is not permitted, the power drive systems may overheat and become damaged.

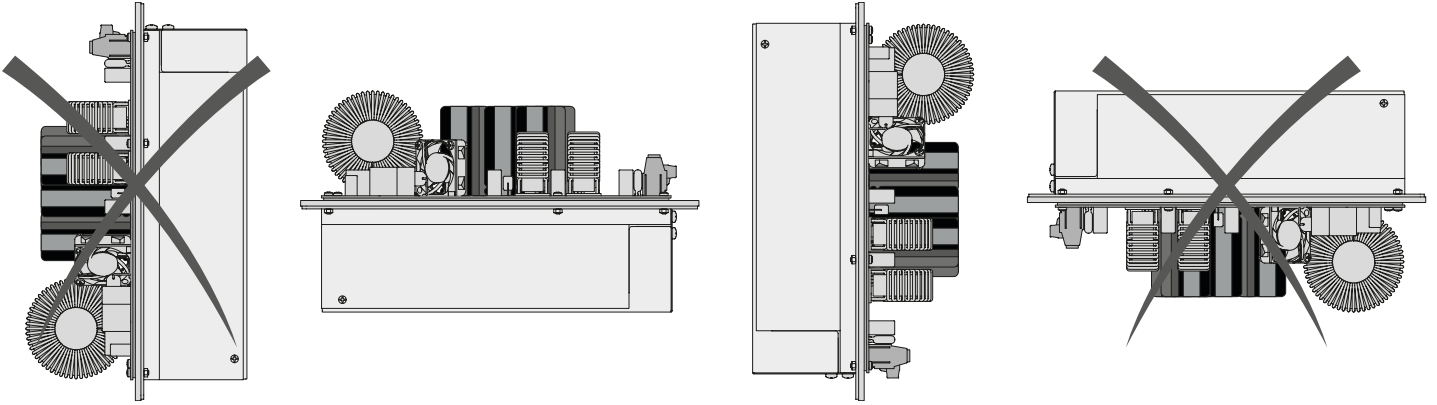


Fig. 2. Syncro installation positioning

5.3 MINIMUM INSTALLATION DISTANCES

Install the **Syncro** inverter observing the minimum distance of 40 mm (1.57 in.) on each side, so as to guarantee adequate ventilation and aeration of the system. Make sure there is a distance of at least 10 mm (0.39 in.) between the support base and the cooler.

⚠ WARNING

HOT SURFACES

- Avoid all contact with hot surfaces.
- Do not leave flammable or heat-sensitive components on or near hot surfaces.
- Make sure the product has cooled sufficiently before handling it.
- Make sure sufficient heat dissipation takes place by performing a test under maximum load conditions.

mm (in.)

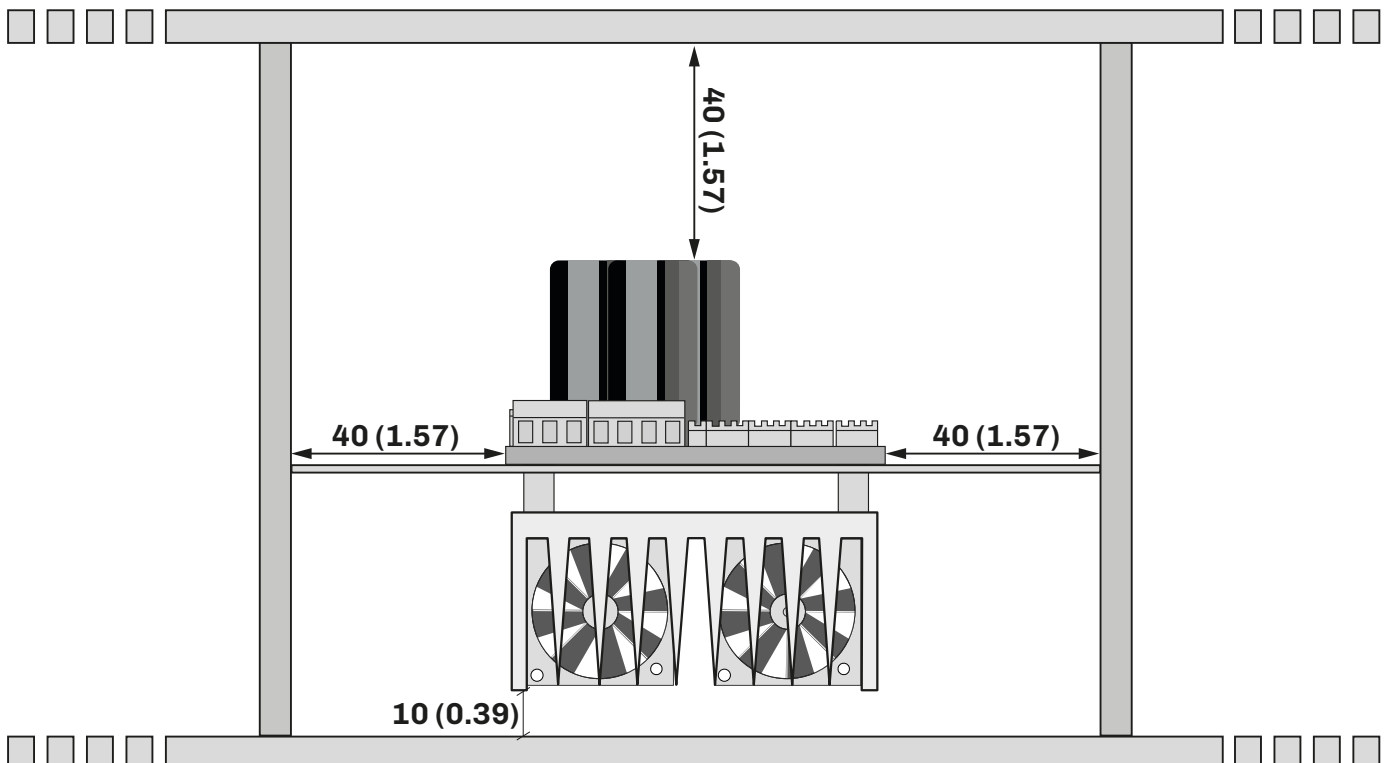


Fig. 3. Minimum installation distances - side view

mm (in.)

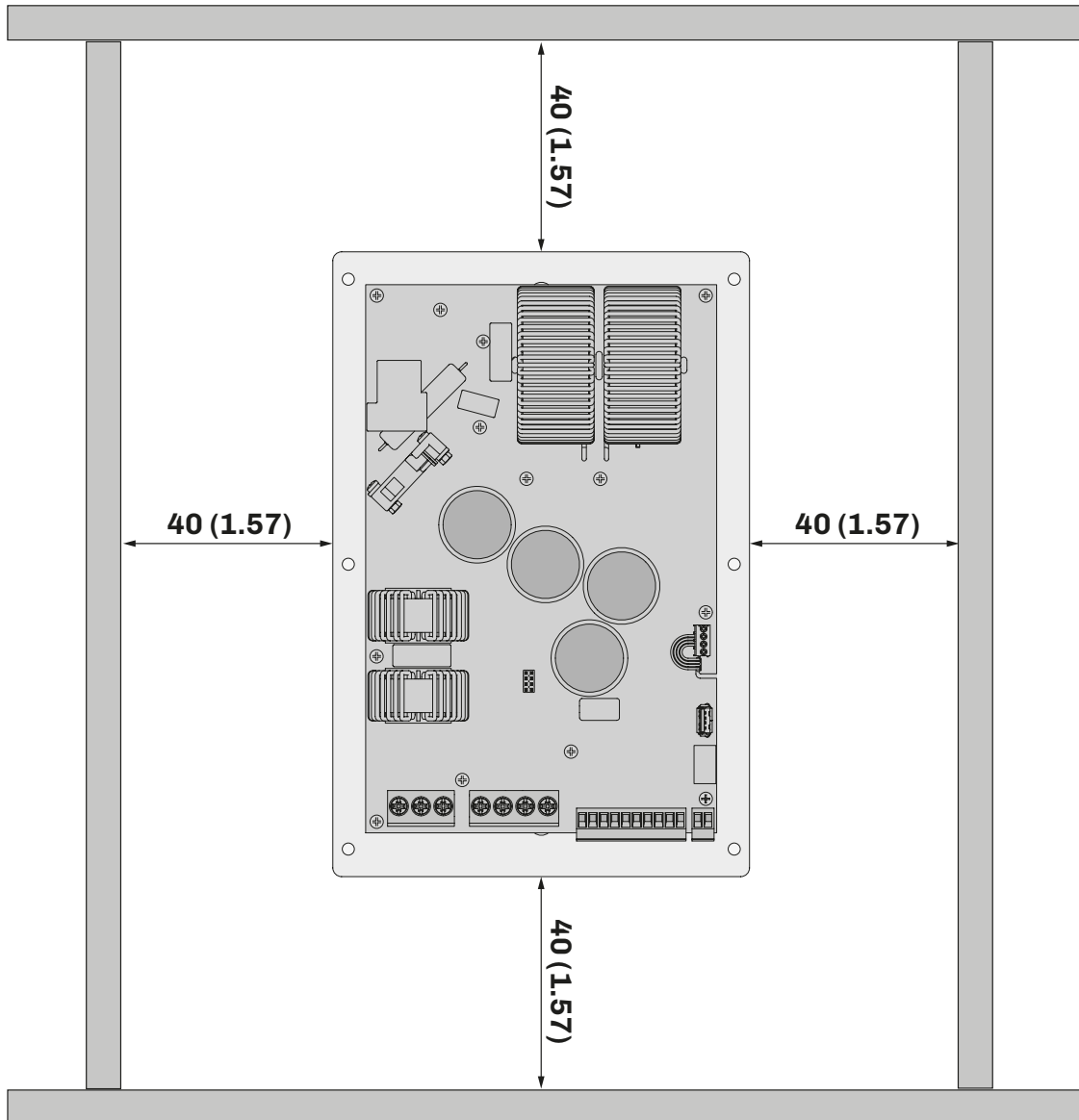


Fig. 4. Minimum installation distances - front view

5.4 INSTALLATION METHOD

Syncro inverter installation anticipates application to a panel by means of M5 screws (not supplied).

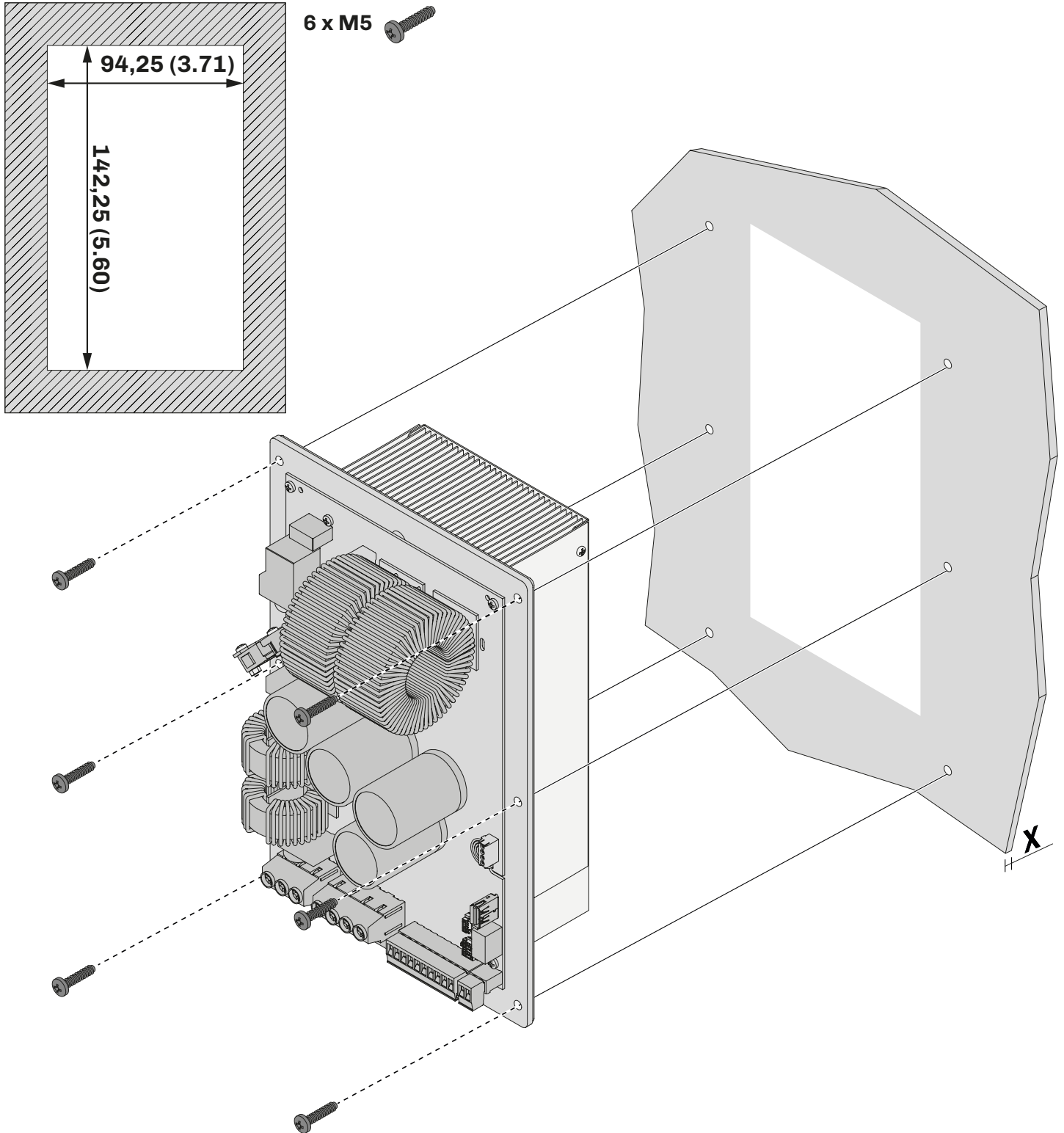


Fig. 5. Syncro inverter installation method

Panel thickness

This panel thickness varies depending on the material used to make it:

| Material | Thickness (X) [mm (in.)] |
|----------|--------------------------|
| Metal | 1...2 (0.04...0.08) |

5.5 DIMENSIONS AND WEIGHT

mm (in.)

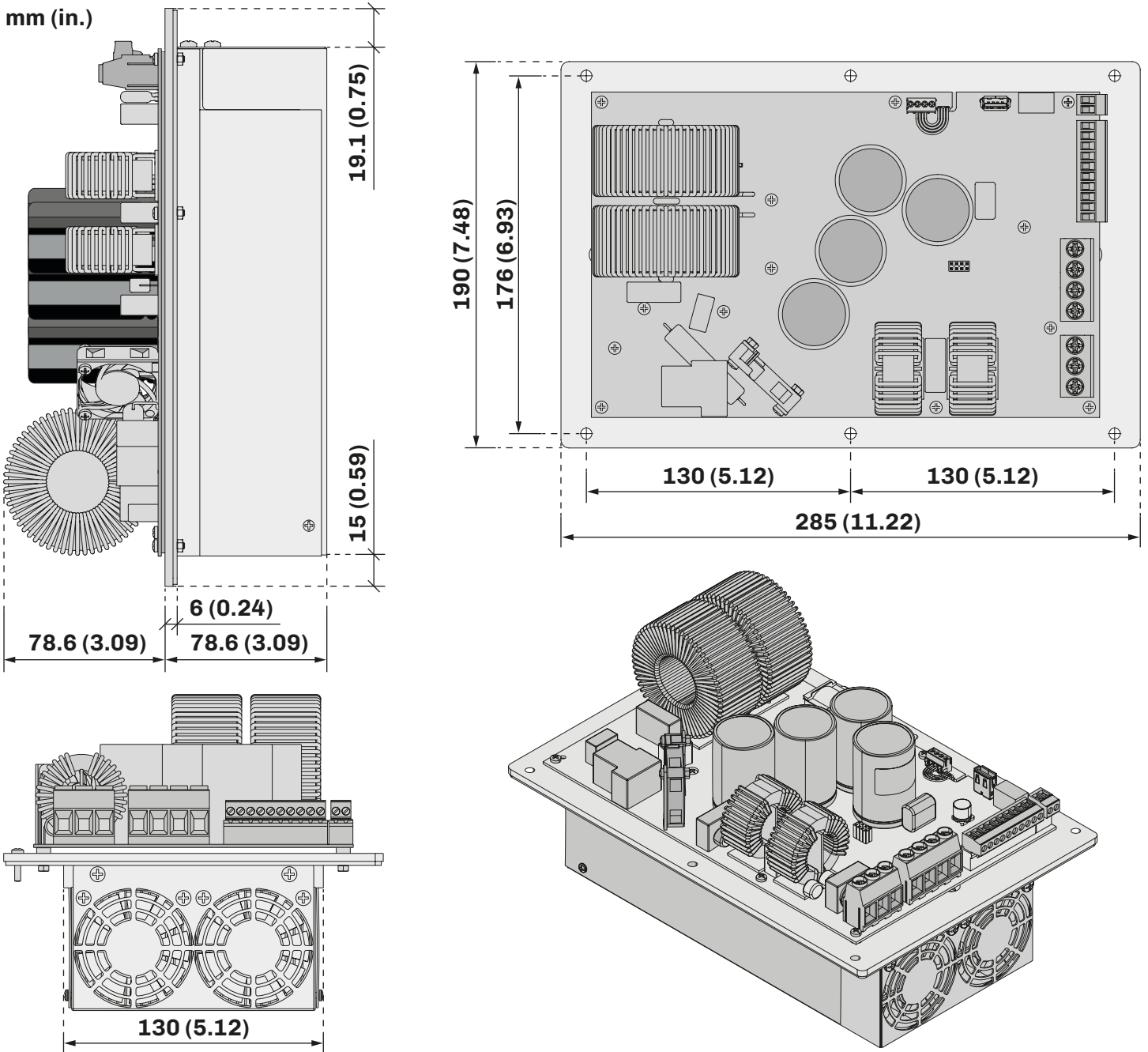


Fig. 6. Syncro Inverter dimensions

Weight

| Reference | Weight in kg (lb) |
|-----------|-------------------|
| Syncro | ~6 kg (13.22) |

6. ELECTRICAL CONNECTIONS

Within the European Union, all machines incorporating an inverter must conform to the machines directive 2006/42/EC. The machine manufacturer is, in particular, responsible for installing a general switch and ensuring compliance with standard EN 60204-1.

6.1 CONNECTION BEST PRACTICE

The following information describes the wiring guidelines and best practices which should be observed when using the inverter.

DANGER

RISK OF ELECTRIC SHOCK, EXPLOSION OR ELECTRIC ARC

- Only suitably trained personnel, familiar with and capable of understanding the content of the manual and all relevant documentation, are authorised to work on and with this inverter. Furthermore, the personnel must have completed courses in safety and must be able to recognise and prevent the implied dangers. Installation, adjustment and maintenance must only be carried out by qualified personnel.
- Various product components, including the printed circuits, run at hazardous voltage levels.
- Only use electrically insulated and suitably calibrated measuring devices and equipment.
- Do not handle the equipment while the power supply is connected.
- Do not touch the unshielded components or the terminals while they are live.
- The motors may generate voltage if the shaft is rotated. Before carrying out any work on the inverter, lock the motor shaft to prevent it from rotating.
- Before working on the inverter:
 - Disconnect the power supply.
 - Use a suitably calibrated and electrically insulated Voltmeter to make sure the power supply is disconnected.
 - Wait for 5 minutes after disconnecting the power supply before installing/uninstalling accessories, hardware, cables or wires, to allow the condensers to discharge any residual voltage.
- Do not open, disassemble, repair or modify the product.
- Before handling the product, make sure you are wearing all the necessary personal protective equipment (PPE).
- Do not expose the equipment to liquids or chemicals.
- Before applying voltage to the inverter:
 - Make sure the running period has been completed and no parts of the system can become hazardous.
 - If the mains power supply terminals and the motor output terminals have been earthed and circuited, remove the earth and short circuits on these terminals.
 - Make sure all the equipment is properly earthed.
 - Make sure all protective elements, such as covers, hatches and grilles, are fitted and/or closed.
 - Check all wiring connections.

DANGER

RISK OF ELECTRIC SHOCK, EXPLOSION OR ELECTRIC ARC

Make sure all the equipment is properly earthed.

DANGER

RISK OF ELECTRIC SHOCK AND FIRE

- Do not use the device with loads greater than those indicated in the technical data section.
- Do not exceed the temperature and humidity ranges indicated in the technical data section.
- Only use cables with a suitable cross-section as indicated in the section "Wiring best practices".

For installation in accordance with standard EN 61800-5-1, a device cutting off the circuit between the power supply and the inverter is required.

DANGER

RISK OF ELECTRIC SHOCK

Use the required safety interlocks (fuses and/or magnetothermal switches) of a suitable size between the power supply and the inverter.

When the inverter is in standby and the motor is not running, the latter remains live.

DANGER

RISK OF ELECTRIC SHOCK

Do not handle the motor when the inverter is in standby.

6.1.1 Wiring best practices

When wiring the controllers, observe the following instructions:

- The I/O and communication wiring must be kept separate from the power supply wiring. These two types of wiring must be routed in separate ducts.
- Make sure the operating environment and conditions fall within the specified values.
- Use wires with the correct diameter, suited to the voltage and current requirements.
- Use copper conductors (compulsory).
- Use shielded twisted pair cables for analogue I/O connections.
- Use shielded twisted pair cables for network and RS-485 serial connections.

Use correctly earthed shielded cables for all inputs or analogue outputs, for communication connections and for motor wiring.

⚠ WARNING

MALFUNCTIONING OF THE EQUIPMENT

- Perform the wiring carefully, in compliance with electromagnetic compatibility requirements.
- Carry out a full start-up test.
- Make sure the wiring is correct for the settings.
- Use shielded cables for all I/O signal and communication cables.
- Use double-shielded cables for motor wiring.
- Minimise the length of the connections as much as possible, to avoid winding the cables around electrically connected parts.
- The signal (communication and corresponding power supplies) and power cables for the device must be routed separately.
- Before applying the power supply, check all the wiring connections.
- Do not connect wires to unused terminals and/or terminals marked with the text "No connection" (N.C.).

Suitable wiring for the power supply

Passo 10,16 mm (0.399 in.)

| | | | | | | | | | | | | |
|--|----------|----------|----------|----------|-------------|-------------|-------------|-------------|--------------------|----|-------|--------------|
| | | | | | | | | | | | N•m | 1.2...1.5 |
| $\frac{\text{mm}}{\text{in.}}$ 10 / 0.39 | | | | | | | | | Ø 4 mm (0.157 in.) | M4 | lb-in | 10.62...13.6 |
| mm ² | 0.5...16 | 0.5...16 | 0.5...16 | 0.5...16 | 2 x 0.5...6 | 2 x 0.5...6 | 2 x 0.5...4 | 2 x 0.5...6 | | | | |
| AWG | 20...6 | 20...6 | 20...6 | 20...6 | 2 x 20...10 | 2 x 20...10 | 2 x 20...12 | 2 x 20...10 | | | | |

Fig. 7. Suitable wiring for the power supply

Suitable wiring for I/O SELV

Step 5.08 mm (0.199 in.)

| | | | | | | | | | | | | |
|---|-----------|-----------|------------|------------|-------------|---------------|--------------|---------------|---------------------|---|-------|-------------|
| | | | | | | | | | | | N•m | 0.5...0.6 |
| $\frac{\text{mm}}{\text{in.}}$ 5.08 / 0.199 | | | | | | | | | Ø 3.5 mm (0.14 in.) | C | lb-in | 4.42...5.31 |
| mm ² | 0.2...2.5 | 0.2...2.5 | 0.25...2.5 | 0.25...2.5 | 2 x 0.2...1 | 2 x 0.2...1.5 | 2 x 0.25...1 | 2 x 0.5...1.5 | | | | |
| AWG | 24...14 | 24...14 | 22...14 | 22...14 | 2 x 24...18 | 2 x 24...16 | 2 x 22...18 | 2 x 20...16 | | | | |

Fig. 8. Suitable wiring for I/O SELV

Suitable wiring for earthing

Step 5.08 mm (0.199 in.)

| | | | | | | | | |
|---|-----|-----|-----|---------|---------------------|---|-------|-------------|
| | | | | | | | N•m | 0.5...0.6 |
| $\frac{\text{mm}}{\text{in.}}$ 5.08 / 0.199 | | | | | Ø 3.5 mm (0.14 in.) | C | lb-in | 4.42...5.31 |
| mm ² | 2.5 | 2.5 | 2.5 | 2 x 1.5 | | | | |
| AWG | 14 | 14 | 14 | 2 x 16 | | | | |

Fig. 9. Suitable wiring for earthing

6.1.2 Sizing safety interlocks

| | | | |
|-------------|--------|-------------|--------|
| | Syncro | | Syncro |
| Current (A) | 40 | Current (A) | 40 |
| Type | Rapid | Type | Type B |

Fig. 10. Sizing safety interlocks

6.2 WIRING DIAGRAM

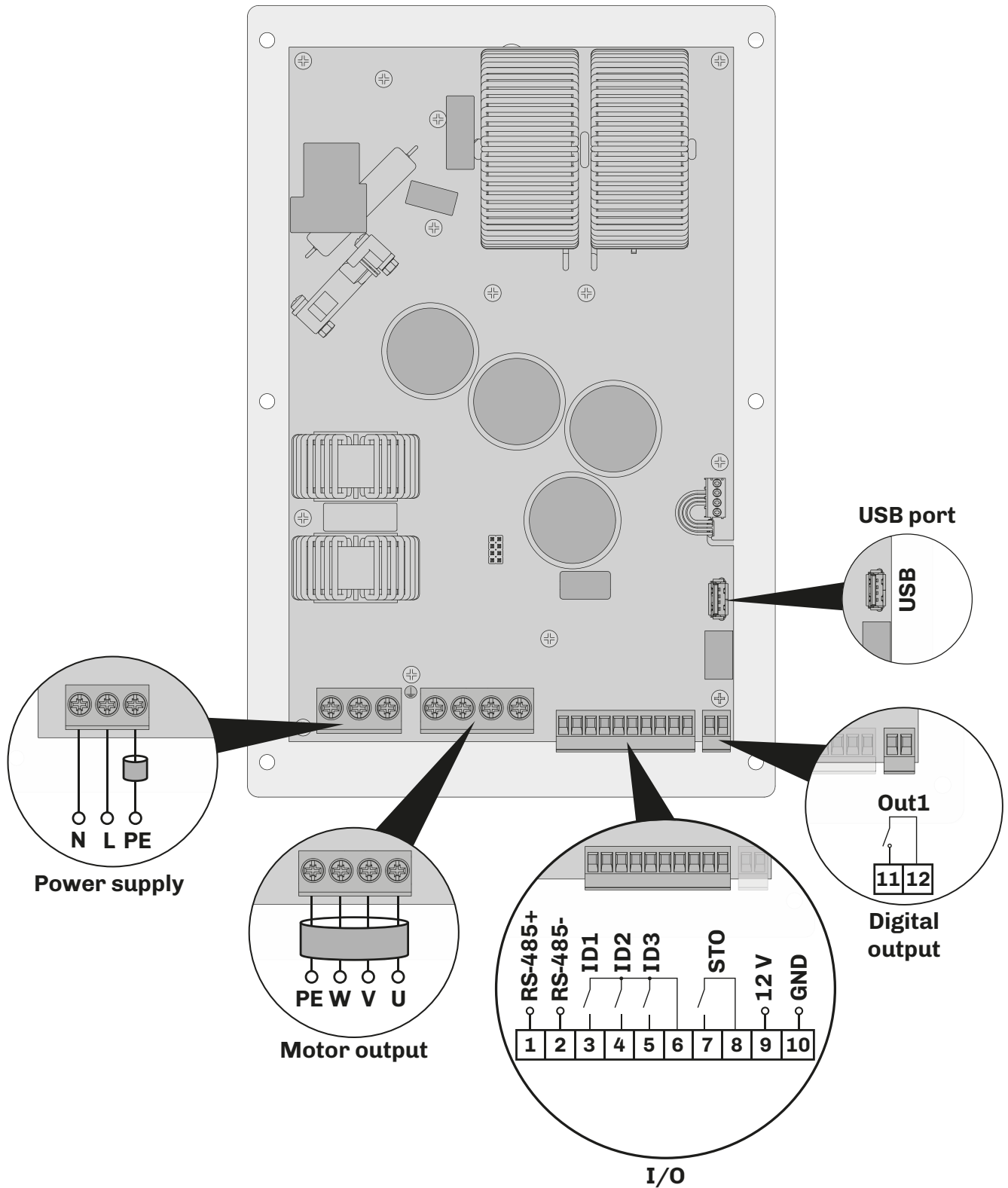


Fig. 11. Syncro inverter wiring diagram

| TERMINALS | | | |
|-----------|------------------------------|--------------|--|
| N | NEUTRAL - Power supply input | 1-2 | RS-485 serial input for remote connection |
| L | PHASE - Power supply input | 3-6 | Digital input ID1 connection |
| PE | EARTH - Power supply input | 4-6 | Digital input ID2 connection |
| U | Motor control output | 5-6 | Digital input ID3 connection |
| V | Motor control output | 7-8 | Safety digital input STO connection |
| W | Motor control output | 9-10 | Auxiliary 12 V power supply output |
| PE | Motor earth connection | 11-12 | out1 relay output connection (NO) |

6.2.1 Safety digital input STO wiring diagram

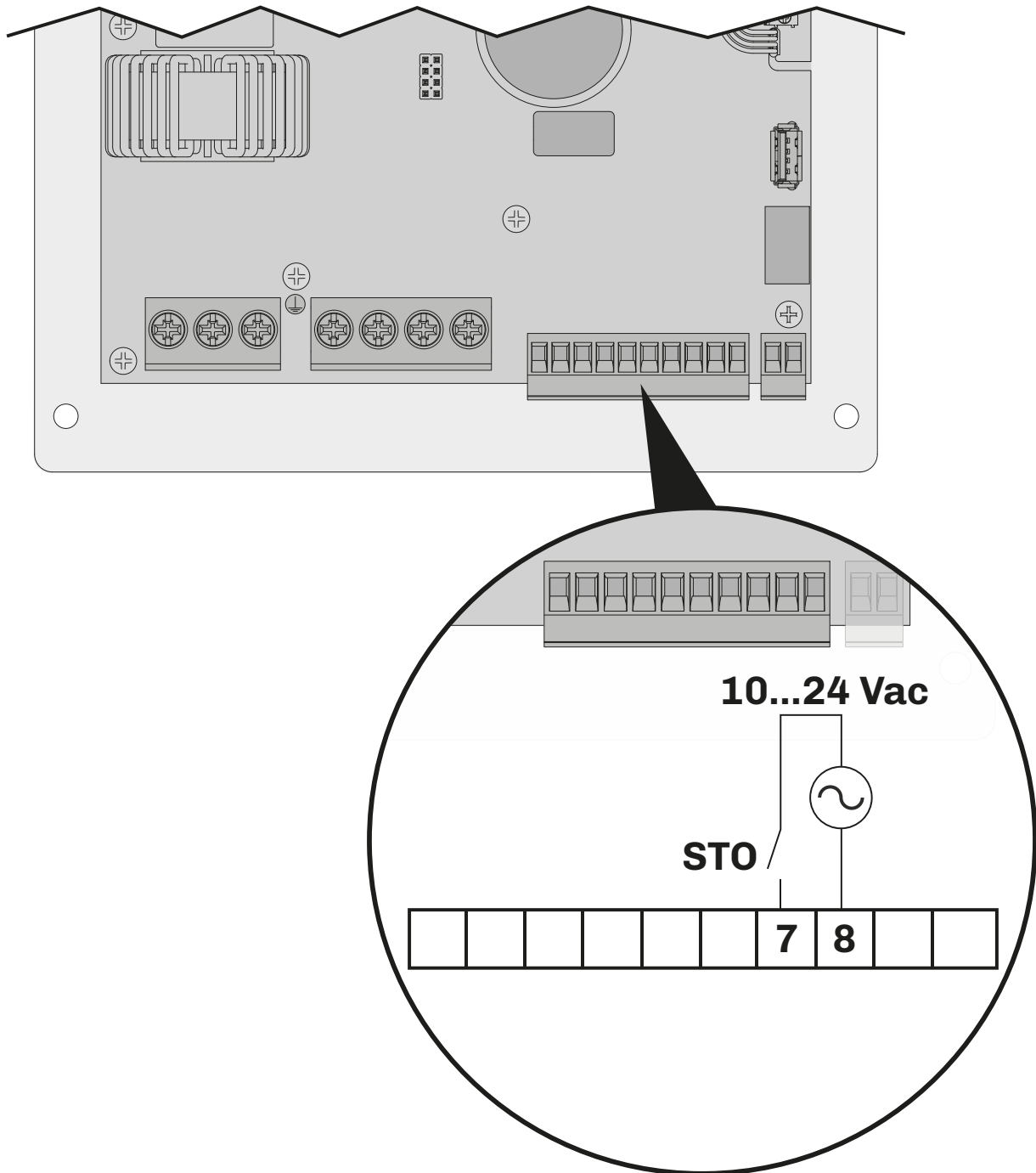


Fig. 12. Syncro inverter wiring diagram

7. REGULATORS

The **Syncro** inverter can control:

- Three-phase permanent magnet synchronous motors (BLDC);
- Three-phase asynchronous motors;
- Controlling HVAC-R compressors.

7.1 CONTROL TYPES

Depending on the field of application, parameter **S103** can be used to choose one of the following control types:

- Scalar control (V/f) with an open loop;
- Sensorless vector control.

7.2 PROTECTION

The inverter is protected against:

- Overcurrent;
- Overvoltage;
- Undervoltage;
- Overload;
- Overtemperature (the inverter automatically reduces the motor speed in the event of overtemperature).

For more details on these and other faults, please refer to "**Chapter 11. Alarms**" on page 36.

7.3 LED INTERFACE

The operation and meaning of the LEDs on the **Syncro** inverter is described in the table below:

| | Lit steadily | Flashing | OFF |
|-------------------|---------------|-----------------------------|-------|
| Green LED | STOP/Standby | Inverter running | Other |
| Yellow LED | Not envisaged | Serial communication active | Other |
| Red LED | Not envisaged | Inverter in alarm (*) | Other |

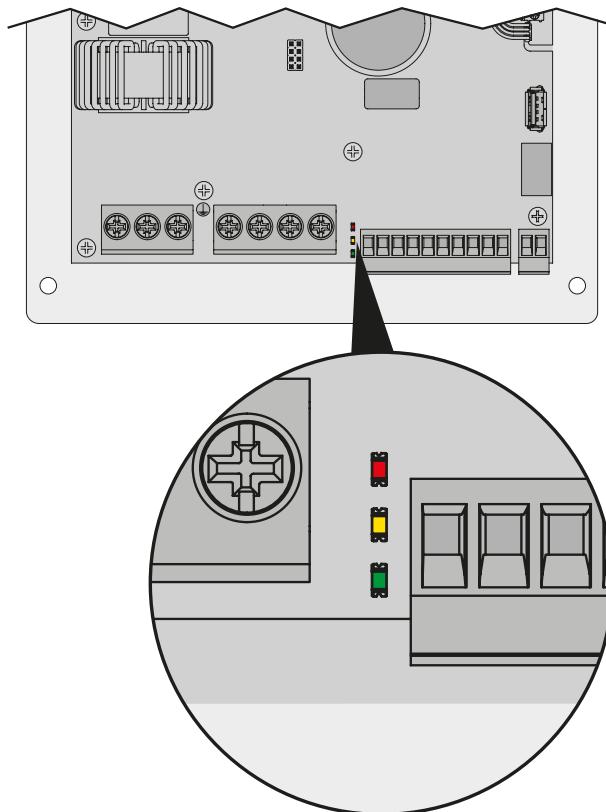


Fig. 13. Compressor heating management

(*) **NOTE:** if there is a flashing Red LED, please refer to "**Chapter 11. Alarms**" on page 36.

7.4 OPERATION

7.4.1 Rotation direction reversal

During installation, it may happen that electrical connection to the motor does not observe the desired rotation direction. Parameter **S206** can be used to change the motor rotation direction without adjusting the actual wiring.

7.4.2 Compressor heating

To keep the compressor heated in low temperature conditions, preventing the lubricating oil from freezing, use parameter **S537** to set the motor heating current.

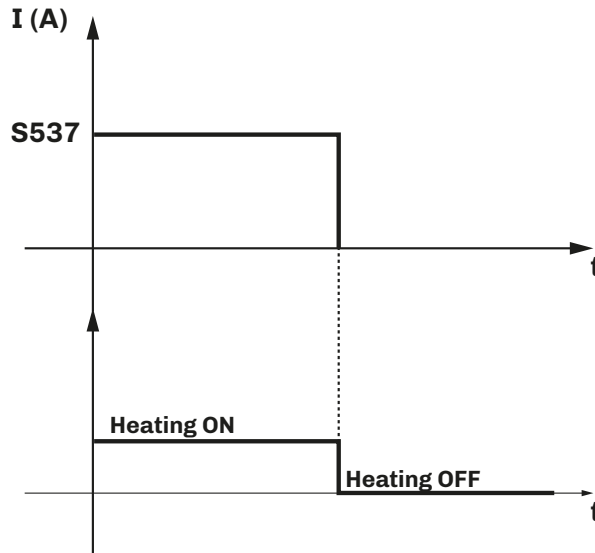


Fig. 14. Compressor heating management

7.4.3 Motor control at start-up

Parameter **S536** can be used to determine the time during which the power drive provides the motor with a magnetising current as set by parameter **S505** at a speed of 0 rpm.

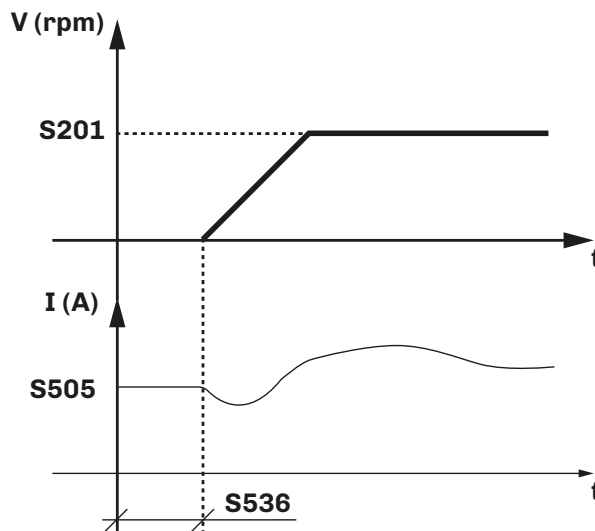


Fig. 15. Motor control logic at start-up

7.4.4 Motor pole pairings

Parameter **S504** can be set to indicate the number of pole pairings for the motor, bearing in mind the limits indicated in the table below will be recalculated automatically.

| Pole pairings | Description | Frequency range 10...400 [Hz] | Description | Speed range 1...8000 [rpm] |
|---------------|-----------------|-------------------------------|-----------------------|----------------------------|
| 1 | Theoretical rpm | 600...24000 | Theoretical frequency | 0.02...133.33 |
| | Limited rpm | 60...8000 | Limited frequency | 10...133.33 |
| 2 | Theoretical rpm | 300...12000 | Theoretical frequency | 0.03...267.67 |
| | Limited rpm | 300...8000 | Limited frequency | 10...267.67 |
| 3 | Theoretical rpm | 200...8000 | Theoretical frequency | 0.05...400 |
| | Limited rpm | 200...8000 | Limited frequency | 10...400 |

| Pole pairings | Description | Frequency range 10...400 [Hz] | Description | Speed range 1...8000 [rpm] |
|---------------|-----------------|-------------------------------|-----------------------|----------------------------|
| 4 | Theoretical rpm | 150...6000 | Theoretical frequency | 0.07...533.33 |
| | Limited rpm | 150...6000 | Limited frequency | 10...400 |
| 5 | Theoretical rpm | 120...4800 | Theoretical frequency | 0.08...666.67 |
| | Limited rpm | 120...4800 | Limited frequency | 10...400 |
| 6 | Theoretical rpm | 100...4000 | Theoretical frequency | 0.10...800 |
| | Limited rpm | 100...4000 | Limited frequency | 10...400 |
| 7 | Theoretical rpm | 86...3429 | Theoretical frequency | 0.12...933.33 |
| | Limited rpm | 86...3429 | Limited frequency | 10...400 |
| 8 | Theoretical rpm | 75...3000 | Theoretical frequency | 0.13...1066.67 |
| | Limited rpm | 75...3000 | Limited frequency | 10...400 |

7.4.5 Speed jump

Some motors/compressors may experience mechanical resonance issues at some speeds.

To overcome this problem, parameters **S215...S220** can be used to define interval limits and the specific speed to avoid (jump) when reaching the target speed in both acceleration and deceleration ramps.

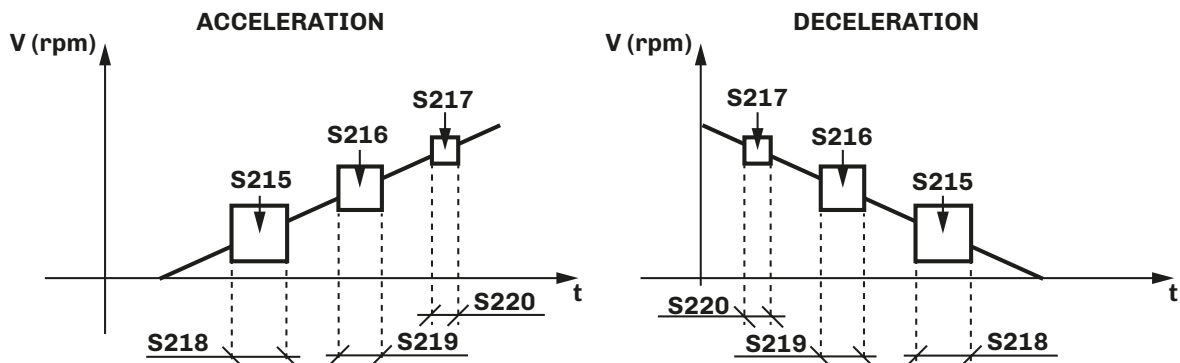


Fig. 16. Speed jump

7.4.6 Speed profile

To adapt inverter power drive to the compressor start-up specifications, parameters **S701** and **S714** must be used to create a speed profile.

The profile is defined by:

- 3 speeds reached in a linear fashion;
- 3 accelerations;
- 3 pauses in which the time spent at the corresponding speed is defined;
- 3 decelerations.

The logic governing speed profile application in order to adapt the power drive to the compressor start-up and stoppage specifications is shown in the chart below.

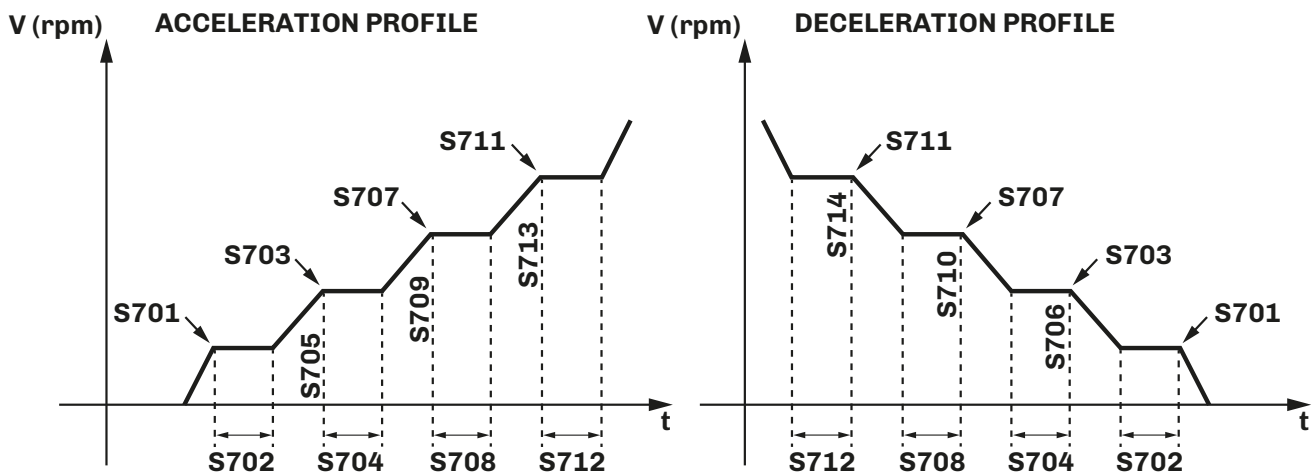


Fig. 17. Speed profile

7.4.7 Reducing the PWM carrier frequency and/or speed

The PWM frequency can be increased from the default values, but this may cause an increase in temperature.

To prevent the overtemperature alarm from being triggered, parameter **S607** can be used to automatically and gradually decrease the PWM frequency and/or to gradually decrease the target speed.

If the temperature then re-stabilises at the nominal values, the switching frequency and/or the target speed will automatically be reset to the values specified previously.

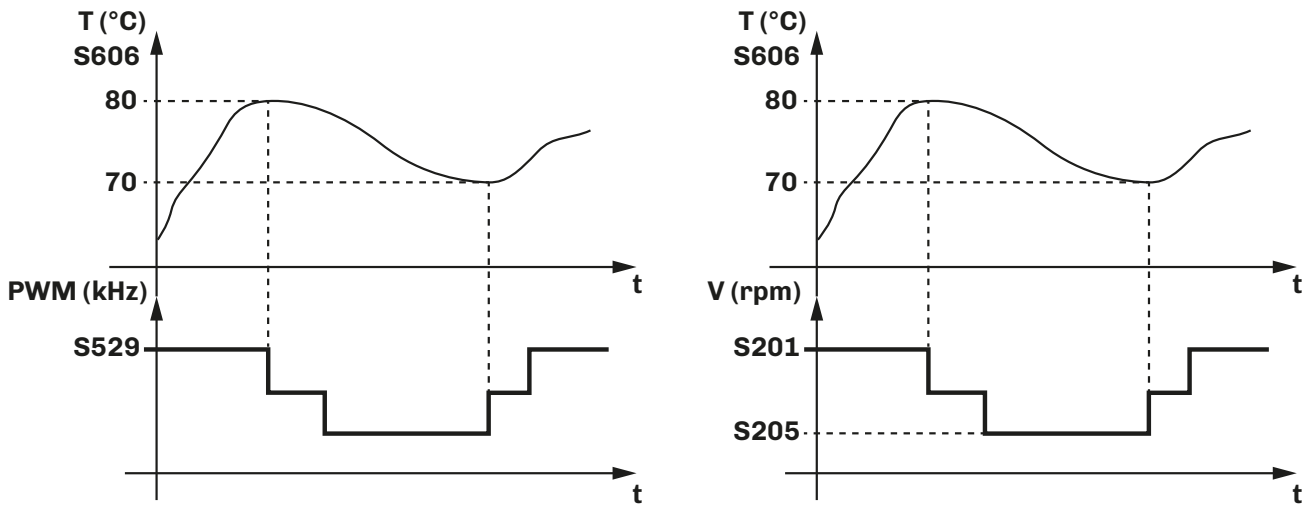


Fig. 18. Reducing carrier frequency and/or speed

7.4.8 Motor phase loss alarm sensitivity

Parameter **S534** can be used to set a sensitivity level for the nominal current, expressed as a percentage %.

For example:

- **S501** = 10 A
- **S534** = 10 %

The sensitivity threshold is 10 % of 10 A = 1 A.

The alarm **PL** intervenes when the current absorbed by one or more phases falls under the threshold of 1 A.

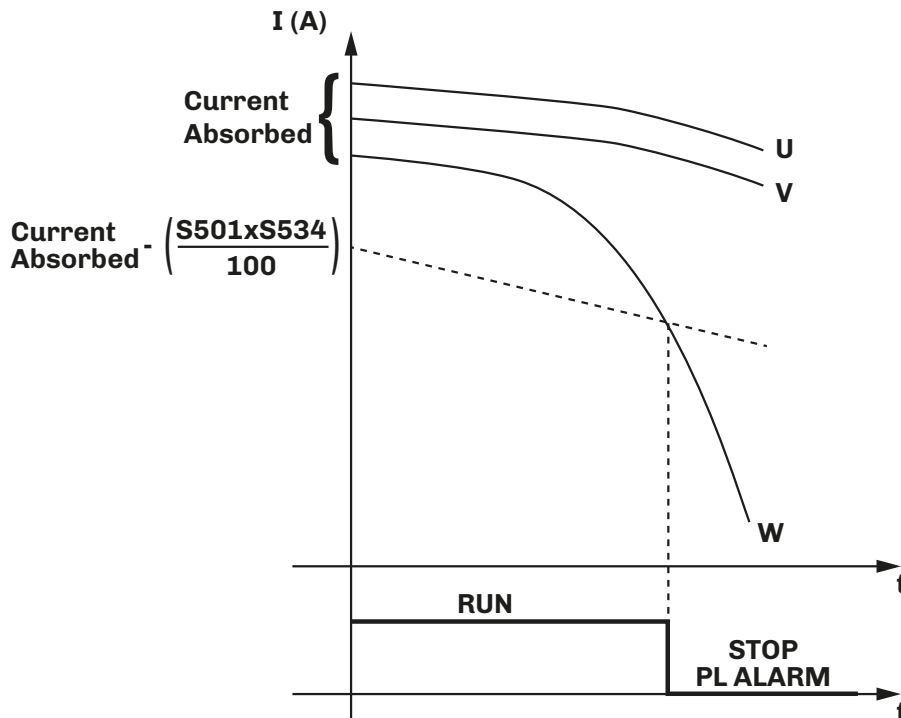


Fig. 19. Motor phase loss alarm sensitivity

7.4.9 Motor stall alarm sensitivity

Parameter **S535** can be used to set a sensitivity level for the frequency, expressed as a percentage %.

For example:

- **S503** = 50 Hz
- **S535** = 20 %

The sensitivity threshold is 20% of 50 Hz = 10 Hz.

The alarm **MS** intervenes when the actual motor speed increases or decreases by 10 Hz.

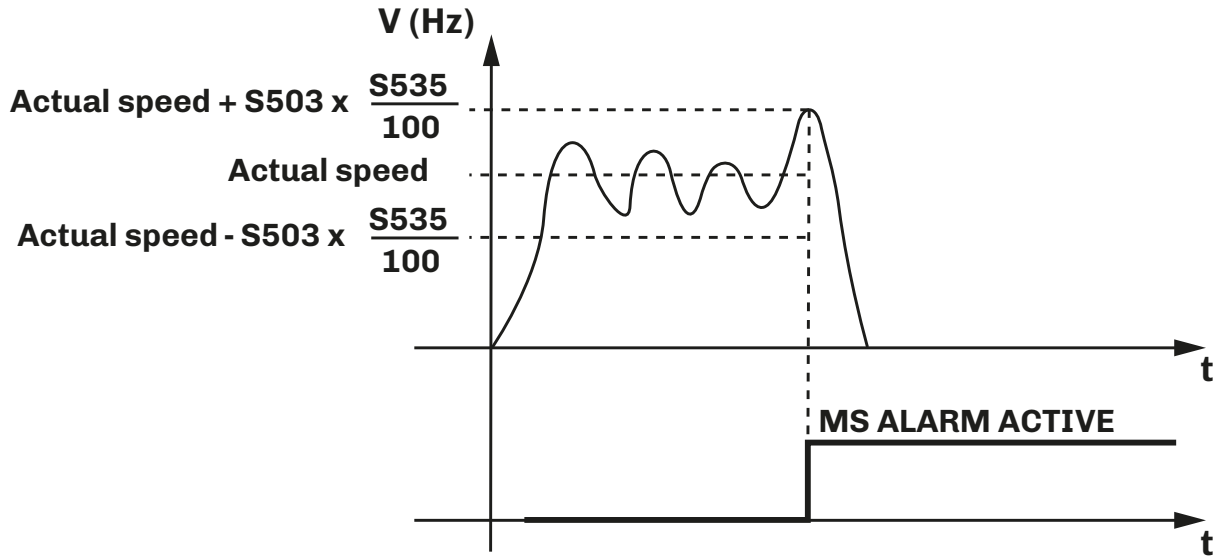


Fig. 20. Motor phase loss alarm sensitivity

8. MANUAL TUNING MODE / AUTOTUNING

The **Syncro** series inverter offers the option, via RS-485 serial port, of configuring motor/compressor data in two ways:

- Manual tuning mode;
- Autotuning mode.

8.1 MANUAL TUNING MODE

When using manual tuning mode, the parameters relating to the motor/compressor to be controlled must be configured manually, retrieving the required data from the motor rating label or from the instruction sheet.

An example of motor rating label data taken from the corresponding instruction sheet is provided below:

| Motor Parameter - DC Brushless Motor Rotary Compressor | | | [at 20°C] | |
|--|----------------------|------------|------------------|-------|
| (Operation Frequency Range) | | (rpm) | 600~7,200 | |
| | | | 4 Poles, 6 Slots | |
| Stator | (Stack Height) | (mm) | 60,0 | |
| | (Winding Resistance) | R-S (U-V) | (Ω) | 0,596 |
| | | R-T (U-W) | (Ω) | 0,600 |
| | | S-T (V-W) | (Ω) | 0,596 |
| (Torque Constant) | | (N·m/Arms) | 0,666 | |
| (Inertia Constant) | | (Kg·m2) | 5.05 x 10-4 | |
| (Inductive Voltage Constant - Terminal to Terminal) | | Vrms/krpm | 40,0 | |
| (Inductance-Ld - Per Phase) | | (mH) | 6,33 | |
| (Inductance-Lq - Per Phase) | | (mH) | 6,86 | |
| (Armature Flux Linkage - Of a Phase, Effective Value) | | (mWb) | 1,449 | |

Fig. 21. Example of compressor rating label data

NOTE: the rating label data in Fig. 20 is provided for illustration purposes only. None of the information provided in the figure above should be used to perform inverter configuration manually. Only use the rating label data corresponding to the motor/compressor to be controlled.

The parameters to be configured manually are:

| Par. | Description | MU | Range | Default |
|------|-------------------------|----|----------------|---------|
| S504 | Number of pole pairs. | - | 1 ... 8 | 2 |
| S520 | Stator resistance. | Ω | 0.00 ... 50.00 | 0.60 |
| S521 | Stator inductance / Ld. | mH | 0.0 ... 800.0 | 6.33 |
| S523 | Rotor inductance / Lq. | mH | 0.0 ... 800.0 | 6.86 |

In addition to the abovementioned data, the parameters relating to motor/compressor performance must also be configured manually. This data should be sourced from the *Performance Table* in the motor/compressor rating label data or the instruction sheet.

An example of a motor *Performance Table* taken from the corresponding instruction sheet is provided below:

| PERFORMANCE TABLE | | | | | | | |
|-----------------------------------|------------------|----------------------------------|--------------|--------------|--------------|--------------|--------------|
| MODEL : (3PH,D.C 280V), 80Hz | | | | | | | |
| Saturated Evaporating Temperature | Items | Saturated Condensing Temperature | | | | | |
| | | 40°C (104°F) | 45°C (113°F) | 50°C (122°F) | 55°C (131°F) | 60°C (140°F) | 65°C (149°F) |
| 15°C (59°F) | Capacity (Btu/h) | 31971 | 30029 | 28300 | 26785 | 25483 | 24395 |
| | Input (Watts) | 1416 | 1621 | 1810 | 1984 | 2142 | 2286 |
| | Flow Rate (kg/h) | 181.51 | 179.99 | 178.14 | 175.97 | 173.46 | 170.63 |
| | EER (Btu/W.h) | 22.57 | 18.53 | 15.64 | 13.50 | 11.89 | 10.67 |
| | Current (Amps) | 4.16 | 4.76 | 5.38 | 6.02 | 6.68 | 7.36 |
| 20°C (68°F) | Capacity (Btu/h) | 35483 | 33346 | 31422 | 29711 | 28214 | 26931 |
| | Input (Watts) | 1501 | 1723 | 1930 | 2122 | 2299 | 2460 |
| | Flow Rate (kg/h) | 206.73 | 205.12 | 203.19 | 200.93 | 198.34 | 195.42 |
| | EER (Btu/W.h) | 23.64 | 19.35 | 16.28 | 14.00 | 12.27 | 10.95 |
| | Current (Amps) | 3.93 | 4.58 | 5.25 | 5.94 | 6.65 | 7.39 |

Fig. 22. Example of compressor rating label data

NOTE: the data in Fig. 21 is provided for illustration purposes only. None of the information provided in the figure above should be used to perform inverter configuration manually. Only use the rating label data corresponding to the motor/compressor to be controlled.

The parameters to be configured manually are:

| Par. | Description | MU | Range | Default |
|------|--|-----|--------------|------------|
| S501 | Nominal motor current. | A | 0.1 ... S601 | 7.4 |
| S502 | Nominal motor voltage. | V | 50 ... 400 | 192 (*) |
| S503 | Nominal motor frequency. Refer to the rotation per second frequency (rps). | Hz | 10 ... 400 | 160 (**) |
| S506 | Nominal motor revolutions. | rpm | 1 ... 8000 | 2400 (***) |

(*): 192 = 2460 W/(√3 x S501)

(**): 160 = (80 rps x S504)

(***): 2400 = (60 x (S503/S504))

8.2 AUTOTUNING MODE

Autotuning mode can be used for optimised automatic configuration of the parameters relating to the motor/compressor to be controlled.

The autotuning procedure for the motor/compressor is started by setting bit 8 of register 986 to 1 via serial RS-485 (see "Chapter 10.2 Table of Modbus commands" on page 33).

The motor may rotate slightly during autotuning. This rotation may cause safety problems.

WARNING

UNWANTED MOTOR ROTATIONS

Lock the motor with a mechanical brake to avoid unwanted motor rotations during autotuning configuration.

Motor data calculation is not influenced by motor rotation.

The procedure consists of automatic learning of the following parameters:

| Par. | Description | MU | Range | Default |
|------|--|----|------------|------------|
| S520 | Stator resistance. | Ω | 0 ... 9999 | Autotuning |
| S525 | Rotor time constant. | ms | 0 ... 9999 | Autotuning |
| S526 | WTS. Parameter calculated by autotuning. | - | 0 ... 5000 | Autotuning |

8.2.1 Autotuning procedure

1. Connect the motor/compressor to the inverter (the inverter should be off and disconnected from the power supply);
2. Connect the power supply to the inverter;
3. Configure the following parameters (in accordance with the data in the manufacturer's *Performance Table*):

| Par. | Description | MU | Range | Default |
|------|----------------------------|-----|--------------|---------|
| S501 | Nominal motor current. | A | 0.1 ... S601 | 7.4 |
| S502 | Nominal motor voltage. | V | 50 ... 400 | 192 |
| S503 | Nominal motor frequency. | Hz | 10 ... 400 | 160 |
| S504 | Number of pole pairs. | - | 1 ... 8 | 2 |
| S506 | Nominal motor revolutions. | rpm | 1 ... 8000 | 2400 |

4. Set bit 8 of register 986 to 1.
During this phase the compressor/motor is activated by the inverter; bit 0 of register 980 is set to 0 (not ready to receive commands);
5. 60 s after the procedure starts, the inverter reverts to being ready and available to control the motor/compressor; bit 0 of register 980 is set to 1 (ready to receive commands);
The device does not need to restart.
6. Parameters S520, S525 and S526 are configured automatically;
7. The autotuning procedure is complete.

If you want to stop the autotuning procedure, you can set bit 8 of register 986 to 0 at any time; doing so will stop the autotuning procedure.

NOTE: make sure the value of parameter S527 is close to the result given by the formula: $(S502 \times 1000) / S506$

NOTE: to configure parameter S503, use the actual rotation per second frequency data (rps) and not the mechanical frequency.

9. CONFIGURATIONS

The **Synco** inverter can be used in 2 configurations:

- Via analogue input 0...10 V and Digital input (start/stop);
- Via RS-485 serial port (Slave Serial port).

9.1 CONTROL VIA ANALOGUE AND DIGITAL INPUT

9.1.1 Wiring diagram

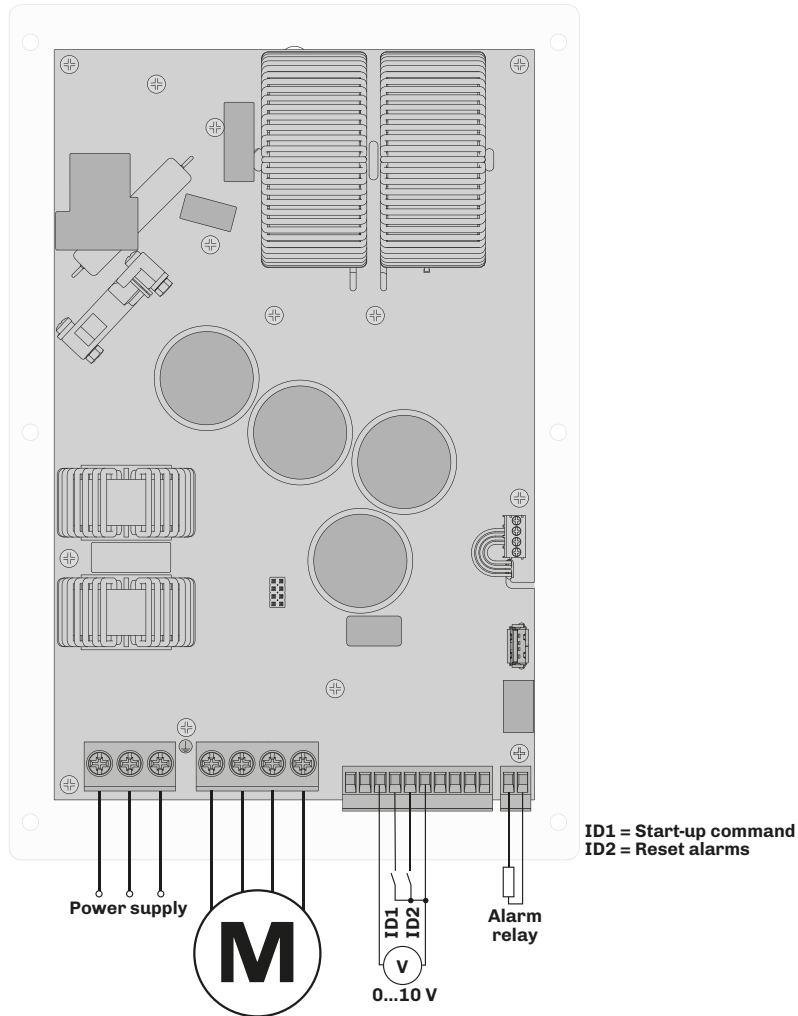


Fig. 23. Wiring for inverter control via potentiometer

9.1.2 Parameter configuration

The parameter configuration required for **Synco** inverter control via potentiometer is as follows:

| Par. | Description | MU | Range | Setting |
|-------------|---|-----|----------------------|---------|
| S101 | Selection of source for motor speed regulation. | - | 1/2 | 1 |
| S102 | Selection of source for start-up command. | - | 1 ... 3 | 1 |
| S204 | Maximum motor speed. | rpm | S205 ... 8000 | 5400 |
| S205 | Minimum motor speed. | rpm | 150 ... S204 | 900 |
| S304 | Digital input 1 function. | - | 0 ... 9, 17 | 2 |
| S305 | Digital input 2 function. | - | 0 ... 9, 17 | 5 |
| S306 | Digital input 3 function. | - | 0 ... 9, 17 | 8 |
| S501 | Nominal motor current. | A | 0.1 ... S601 | (*) |
| S502 | Nominal motor voltage. | V | 50 ... 400 | (*) |
| S503 | Nominal motor frequency. | Hz | 10 ... 400 | (*) |
| S504 | Number of pole pairs. | - | 1 ... 8 | (*) |

(*) depending on the motor rating label.

9.2 CONTROL VIA SLAVE SERIAL PORT

9.2.1 Wiring diagram

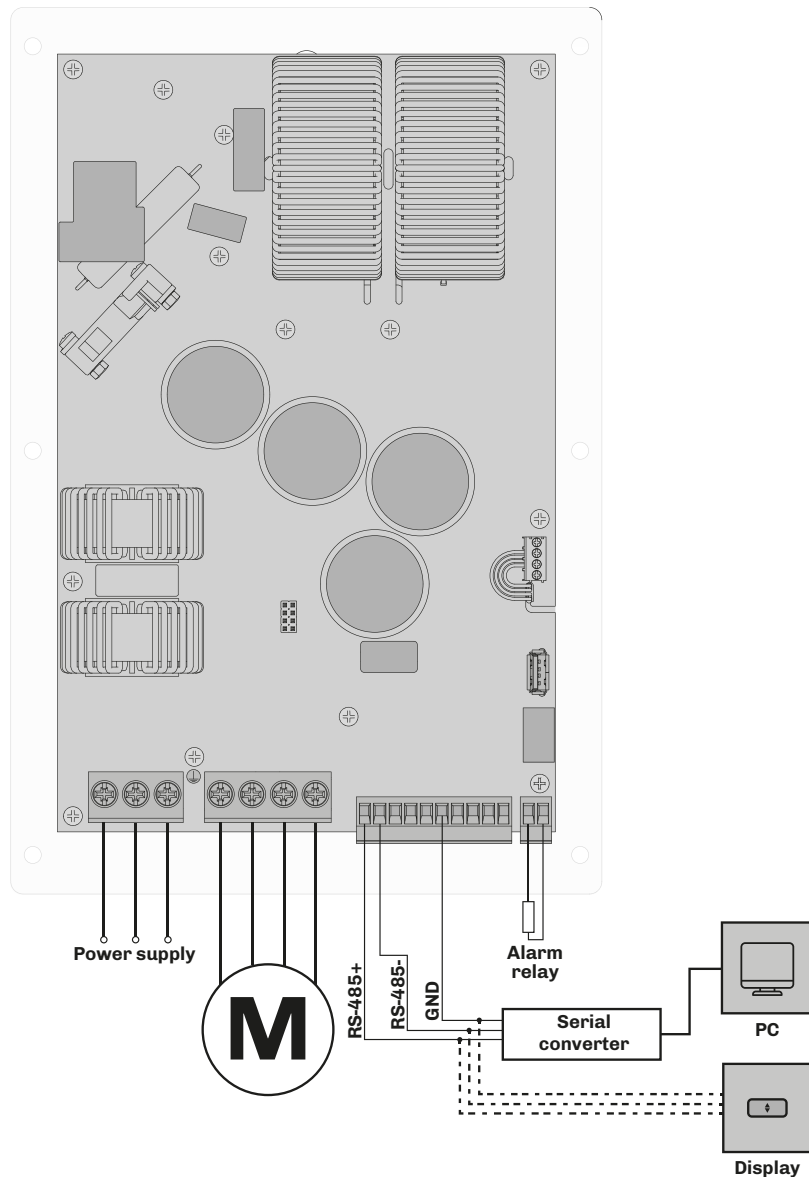


Fig. 24. Wiring for inverter control via Slave Serial port

9.2.2 Parameter configuration

The parameter configuration required for **Syncro** inverter control via Slave serial port is as follows:

| Par. | Description | MU | Range | Setting |
|-------------|---|------|----------------------|---------|
| S101 | Selection of source for motor speed regulation. | - | 1/2 | 2 |
| S102 | Selection of source for start-up command. | - | 1 ... 3 | 2 |
| S204 | Maximum motor speed. | rpm | S205 ... 8000 | 5400 |
| S205 | Minimum motor speed. | rpm | 150 ... S204 | 900 |
| S401 | Modbus communication protocol device address. | - | 1 ... 247 | 1 |
| S402 | Baud rate. Transmission speed. | Baud | 1 ... 3 | 1 |
| S403 | Time limit beyond which, if communication is not working, the device enters timeout alarm mode. | s | 0.0 ... 60.0 | 2.0 |
| S501 | Nominal motor current. | A | 0.1 ... S601 | (*) |
| S502 | Nominal motor voltage. | V | 50 ... 400 | (*) |
| S503 | Nominal motor frequency. | Hz | 10 ... 400 | (*) |
| S504 | Number of pole pairs. | - | 1 ... 8 | (*) |

(*) depending on the motor rating label.

10. PARAMETERS

Syncro series inverter parameters can be configured using **Parameters Manager**, by connecting the inverter to the PC via RS-485 serial port. This means Syncro series inverters are fully configurable according to your own requirements/applications.

NOTE: for PC - Syncro series inverter connection, use an RS-485/USB converter (for example, p/n: **EVIF20SUXI**); for all necessary information on the subject, please refer to instruction sheet code **104SUXIA104**).

The parameters are divided into groups.

Description of columns in the Table of Parameters

- **Par.:** List of configurable device parameters;
- **Description:** Indicates parameter operation and any possible selections;
- **MU:** Measurement unit relating to the parameter;
- **Range:** Describes the interval of values that the parameter can assume. This can be correlated with other instrument parameters (indicated with the parameter code).
NOTE: if the actual value is outside the permitted limits for that parameter (for example, because other parameters defining the aforementioned limits have been altered), the value of the violated limit is displayed instead of the actual value;
- **Default:** Indicates the pre-set factory configuration;
- **Modbus address:** Indicates the address of the Modbus register containing the resource you want to access.

10.1 TABLE OF CONFIGURATION PARAMETERS

| Par. | Description | MU | Range | Default | | Modbus address |
|----------------------------------|---|-------|-----------------------------|---------|-------|----------------|
| | | | | 4.8 kW | 6 kW | |
| CONTROL Group S1.. | | | | | | |
| S101 | Selection of source for motor speed regulation. 1 = Analogue input; 2 = RS-485 serial port. | - | 1/2 | 2 | 2 | 101 |
| S102 | Selection of source for start-up command. 1 = Digital input; 2 = RS-485 serial port; 3 = analogue input (auto-start if S301 > 0.00). | - | 1 ... 3 | 2 | 2 | 102 |
| S103 | Selection of control type applied to the motor. 1 = Scalar; 2 = Vector. | - | 1/2 | 2 | 2 | 103 |
| S105 | Delay time for restarting after a mains power failure. | s | 0.1 ... 120.0 | 5.0 | 5.0 | 105 |
| S107 | Mains power failure management. 0 = No restart; 1 = Restart after failure < 5 s; 2 = Restart after failure ≥ 5 s. | - | 0 ... 2 | 0 | 0 | 107 |
| SPEED Group S2.. | | | | | | |
| S201 | Nominal target speed if S101 = 2. | rpm | S205 ... S204 | 1800 | 1800 | 201 |
| S202 | Acceleration ramp. Time required to reach the nominal speed from 0 rpm/s. | rmp/s | 1 ... 1000 | 60 | 60 | 202 |
| S203 | Deceleration ramp. Time required to reach 0 rpm/s from the nominal speed. | rmp/s | 1 ... 1000 | 60 | 60 | 203 |
| S204 | Maximum motor speed ⁽¹⁾ . | rpm | S205 ... 8000 | 5400 | 5400 | 204 |
| S205 | Minimum motor speed ⁽¹⁾ . | rpm | 150 ... S204 | 900 | 900 | 205 |
| S206 | Select the motor rotation direction ⁽²⁾ . 0 = Clockwise; 1 = Anticlockwise. | - | 0 / 1 | 0 | 0 | 206 |
| S215 | Target speed 1 to jump. | rpm | S205 ... S204 | 900 | 900 | 215 |
| S216 | Target speed 2 to jump. | rpm | S205 ... S204 | 900 | 900 | 216 |
| S217 | Target speed 3 to jump. | rpm | S205 ... S204 | 900 | 900 | 217 |
| S218 | Speed jump 1 band. Interval size for target speeds 1 to be jumped. 0 = Disabled. | rpm | 0 ... S205 | 0 | 0 | 218 |
| S219 | Speed jump 2 band. Interval size for target speeds 2 to be jumped. 0 = Disabled. | rpm | 0 ... S205 | 0 | 0 | 219 |
| S220 | Speed jump 3 band. Interval size for target speeds 3 to be jumped. 0 = Disabled. | rpm | 0 ... S205 | 0 | 0 | 220 |
| INPUTS/OUTPUTS Group S3.. | | | | | | |
| S301 | Minimum analogue reference value. Selection of the minimum analogue input or potentiometer voltage. | V | 0.00 ... S302 | 0.00 | 0.00 | 301 |
| S302 | Maximum analogue reference value. Selection of the maximum analogue input or potentiometer voltage. | V | S301 ... 10.00 | 10.00 | 10.00 | 302 |

| Par. | Description | MU | Range | Default | | Modbus address |
|--------------------------|--|------|---------------------|---------|------|----------------|
| | | | | 4.8 kW | 6 kW | |
| S304 | Digital input ID1 configuration. 0 = Disabled; 1 = Enable running; 2 = Stop/run; 3 = Pulsed run; 4 = Pulsed stop; 5 = Clockwise/anti-clockwise direction; 6 = Stop/run clockwise; 7 = Stop/run anti-clockwise; 8 = Reset alarm; 9 = User alarm; 17 = Motor thermal switch. | - | 0 ... 9, 17 | 0 | 0 | 304 |
| S305 | Digital input ID2 configuration. Same as S304 . | - | 0 ... 9, 17 | 0 | 0 | 305 |
| S306 | Digital input ID3 configuration. Same as S304 . | - | 0 ... 9, 17 | 0 | 0 | 306 |
| S310 | Output out1 configuration. Indicates the function/event that closes the relay contact, if applicable. 0 = No function; 1 = Inverter ready; 2 = Inverter running; 3 = Inverter in alarm; 4 = Controlled by RS-485 serial port. | - | 0 ... 4 | 3 | 3 | 310 |
| MODBUS Group S4-- | | | | | | |
| S401 | Modbus communication protocol device address. | - | 1 ... 247 | 1 | 1 | 401 |
| S402 | baud rate. Transmission speed. 1 = 9600; 2 = 19200; 3 = 38400. | Baud | 1 ... 3 | 1 | 1 | 402 |
| S403 | Time limit beyond which, if communication is not working, the device enters timeout alarm mode. 0 = Disabled. | s | 0.0 ... 60.0 | 2.0 | 2.0 | 403 |
| Motor Group S5-- | | | | | | |
| S501 | Nominal motor current ⁽³⁾ . | A | 0.1 ... S601 | 9.0 | 12.0 | 501 |
| S502 | Nominal motor voltage ⁽³⁾ . | V | 50 ... 400 | 220 | 220 | 502 |
| S503 | Nominal motor frequency ⁽³⁾ . | Hz | 10 ... 400 | 120 | 120 | 503 |
| S504 | Number of motor pole pairs ⁽³⁾ . | - | 1 ... 8 | 2 | 2 | 504 |
| S505 | No-load / motor start-up current ⁽³⁾ . | A | 0.1 ... S501 | 3.0 | 3.0 | 505 |
| S506 | Nominal motor revolutions ⁽³⁾ . | rpm | 1 ... 8000 | 3600 | 3600 | 506 |
| S507 | Nominal motor torque ⁽³⁾ . | Nm | 0.1 ... 100.0 | 6.0 | 10.6 | 507 |
| S508 | Cos(phi). Nominal motor power factor ⁽³⁾ . | - | 0.01 ... 1.00 | 1.00 | 1.00 | 508 |
| S509 | Motor boost. Overvoltage percentage applied at motor start-up. | % | 0 ... 25 | 0 | 0 | 509 |
| S510 | Motor voltage. Maximum voltage percentage applied to the motor in relation to the nominal value. | % | 10 ... 112 | 100 | 100 | 510 |
| S511 | Motor overload. Motor overload percentage permitted by the inverter for a time set using parameter S512 . | % | 0 ... 50 | 50 | 50 | 511 |
| S512 | Maximum motor overload time. | s | 0 ... 60 | 60 | 60 | 512 |
| S513 | Motor stop type. 0 = Free stop; 1 = Stop with ramp; 2 = Stop with DC voltage injection; 3 = Stop with ramp and DC voltage injection. The latter creates a ramp until the braking speed is reached, and then DC voltage is injected in the percentage set via parameter S516 for a duration equal to S515 , finally cutting off the motor power supply. NOTE: in alarm or emergency conditions, stoppage is always the free type. | - | 0 ... 3 | 1 | 1 | 513 |
| S514 | Speed at which to start braking in DC voltage. Only applies when S513 = 3. | rpm | 0 ... S205 | 0 | 0 | 514 |
| S515 | DC voltage braking duration. Only applies when S513 = 2 or 3. | s | 0.0 ... 20.0 | 0.0 | 0.0 | 515 |
| S516 | DC bus voltage percentage applied to the motor during braking with DC voltage. Only applies when S513 = 2 or 3. | % | 0 ... 50 | 0 | 0 | 516 |
| S520 | Stator resistance. | Ω | 0.00 ... 50.00 | 0.72 | 0.66 | 520 |
| S521 | Stator inductance / Ld. | mH | 0.0 ... 800.0 | 2.7 | 4.0 | 521 |

| Par. | Description | MU | Range | Default | | Modbus address |
|------------------------------|--|-------|---------------------|---------|------|----------------|
| | | | | 4.8 kW | 6 kW | |
| S523 | Rotor inductance / Lq. | mH | 0.0 ... 800.0 | 6.5 | 11.0 | 523 |
| S525 | Rotor time constant calculated by autotuning. | - | 0 ... 9999 | 0 | 0 | 525 |
| S526 | WTS. Parameter calculated by autotuning. | - | 0 ... 9999 | 0 | 0 | 526 |
| S527 | KM/Ke. Parameter calculated by autotuning / voltage constant Ke. | - | 0 ... 9999 | 0 | 0 | 527 |
| S529 | Selection of PWM carrier frequency. | kHz | 4 ... 8 | 4 | 4 | 529 |
| S530 | Kp for current loop. Proportional gain for the PI current controller. | % | 1 ... 100 | 40 | 40 | 530 |
| S531 | Ki for current loop. Integral action time for the PI current controller. | ms | 0.0 ... 100.0 | 5.0 | 5.0 | 531 |
| S532 | Kp for speed loop. Proportional gain for the PI speed controller. | % | 1 ... 100 | 20 | 20 | 532 |
| S533 | Ki for speed loop. Integral action time for the PI speed controller. | s | 0.0 ... 10.0 | 1.0 | 1.0 | 533 |
| S534 | Motor phase loss alarm sensitivity. Indicates the motor phase loss alarm sensitivity percentage. 0 = Disabled; 100 = Maximum sensitivity. | % | 0 ... 100 | 0 | 0 | 534 |
| S535 | Motor stall alarm sensitivity. Indicates the motor stall alarm sensitivity percentage. 0 = Disabled; 100 = Maximum sensitivity. | % | 0 ... 100 | 0 | 0 | 535 |
| S536 | Magnetising time. Motor magnetising current duration in start-up (S505). | s | 0.1 ... 10.0 | 0.2 | 0.2 | 536 |
| S537 | Current for motor heating function. | A | 0.1 ... S501 | 1.0 | 1.0 | 537 |
| INVERTER Group S6.. | | | | | | |
| S601 | Maximum current that the inverter can supply to the motor during its operation ⁽⁴⁾ . | A | 0.1 ... 16.0 | 12.0 | 16.0 | 601 |
| S602 | Undervoltage level. Alternating voltage value under which the undervoltage error is generated. | V | 200 ... S603 | 200 | 200 | 602 |
| S603 | Overvoltage level. Alternating voltage value over which the overvoltage error is generated. | V | S602 ... 260 | 260 | 260 | 603 |
| S605 | Board alarm temperature (CPU). | °C | 50 ... 100 | 90 | 90 | 605 |
| S606 | Cooler alarm temperature. | °C | 50 ... 100 | 90 | 90 | 606 |
| S607 | Enable PWM carrier derating. Enables derating with PWM carrier above 4 kHz. 0 = Disabled; 1 = Enabled for PWM > 4 kHz; 2 = Enabled in speed; 3 = Enabled for PWM > 4 kHz and in speed. | - | 0 ... 3 | 1 | 1 | 607 |
| COMPRESSOR Group S7.. | | | | | | |
| S701 | Start-up speed before set speed. | rpm | 0 ... S204 | 0 | 0 | 701 |
| S702 | Start-up speed duration before set speed. | s | 0 ... 600 | 0 | 0 | 702 |
| S703 | Speed above which pause 1 intervenes. | rpm | 0 ... S204 | 0 | 0 | 703 |
| S704 | Pause duration with speed 1 maintained. | s | 0 ... 600 | 0 | 0 | 704 |
| S705 | Acceleration from minimum speed to speed 1. | | 1 ... 1000 | 60 | 60 | 705 |
| S706 | Deceleration from speed 1 to minimum speed. | rpm/s | 1 ... 1000 | 60 | 60 | 706 |
| S707 | Speed above which pause 2 intervenes. | rpm/s | 0 ... S204 | 0 | 0 | 707 |
| S708 | Pause duration with speed 2 maintained. | rpm | 0 ... 600 | 0 | 0 | 708 |
| S709 | Acceleration from speed 1 to speed 2. | s | 1 ... 1000 | 60 | 60 | 709 |
| S710 | Deceleration from speed 2 to speed 1. | rpm/s | 1 ... 1000 | 60 | 60 | 710 |
| S711 | Speed above which pause 3 intervenes. | rpm | 0 ... S204 | 0 | 0 | 711 |
| S712 | Pause duration with speed 3 maintained. | s | 0 ... 600 | 0 | 0 | 712 |
| S713 | Acceleration from speed 2 to speed 3. | rpm/s | 1 ... 1000 | 60 | 60 | 713 |
| S714 | Deceleration from speed 3 to speed 2. | rpm/s | 1 ... 1000 | 60 | 60 | 714 |

⁽¹⁾ The minimum and maximum limits are calculated on the basis of the number of pole pairs for the motor, i.e. between 10 and 400 Hz or between 1 and 8000 rpm;

⁽²⁾ Looking at the motor with the shaft positioned to the front and observing the motor wiring sequence U-V-W;

⁽³⁾ Parameter depends on the motor/compressor rating label at the maximum work point;

⁽⁴⁾ Parameter depends on the inverter model.

10.2 TABLE OF MODBUS COMMANDS

The commands implemented are:

| Command | Description |
|---------|---|
| 03 | Read holding registers (maximum 16 registers) |
| 06 | Write single holding register |
| 16 | Write multiple holding registers (maximum 16 registers) |

10.3 SERIAL COMMUNICATION SETTINGS

The Syncro inverter communicates via serial port with the following settings:

- 8 bit;
- Even parity;
- 1 stop bit;
- Baud rate set by parameter: **S402**.

10.4 TABLE OF MODBUS VARIABLES

| Address | Parameter name | R/W | Description |
|---------|----------------|-----|--|
| 980 | Status word | R | <p>Read only, indicates the inverter operating status:</p> <p>Bit 0 = Ready 1 = Inverter ready to receive commands; 0 = Inverter in alarm or not ready to receive commands;</p> <p>Bit 1 = Run 1 = Motor in motion; 0 = Motor stopped;</p> <p>Bit 2 = Acceleration 1 = Motor in acceleration; 0 = Motor not in acceleration;</p> <p>Bit 3 = Deceleration 1 = Motor in deceleration; 0 = Motor not in deceleration;</p> <p>Bit 4 = Alarm 1 = Inverter in alarm; 0 = Inverter not in alarm;</p> <p>Bit 5 = Overload 1 = Power exceeded 100 %; 0 = Power dropped below 100 %;</p> <p>Bit 6 = Reserved</p> <p>Bit 7 = Direction 1 = Clockwise; 0 = Anti-clockwise;</p> <p>Bit 8 = Target reached 1 = Target speed reached; 0 = Target speed not reached;</p> <p>Bit 9 = Off 1 = Inverter off; 0 = Normal;</p> <p>Bit 10 = PWM carrier/speed derating 1 = Derating enabled; 0 = Normal;</p> <p>Bit 11 = STO – Safe Torque Protection Off 1 = Device disabled; 0 = Device enabled.</p> |

| Address | Parameter name | R/W | Description |
|---------|-----------------------------|-----|--|
| 981 | Alarm Register | R | Read only, indicates active alarms: Bit 0 = Undervoltage (UV); Bit 1 = Overvoltage (OV); Bit 2 = Overcurrent (OC); Bit 3 = Overload (OL); Bit 4 = CPU PCB overtemperature (BT); Bit 5 = Cooler fan overtemperature (OT); Bit 6 = Analogue input (AI); Bit 7 = Data Eeprom (EP); Bit 8 = Communication timeout (TO); Bit 9 = User (US); Bit 10 = STO – Safe Torque Protection Off (ST); Bit 11 = Motor phase loss (PL); Bit 12 = Motor thermal switch (MT); Bit 13 = Motor stall (MS); Bit 14 = PFC Undervoltage (PU); Bit 15 = PFC Overvoltage (PO). |
| 982 | Instant motor speed setting | R | Target speed set for the motor in rpm (equal to monitor parameter nr) which takes account of the rotation direction set in register 985 and parameter S206 . |
| 983 | Motor frequency | R | Motor output frequency (always positive - equal to monitor parameter fo). |
| 984 | Motor speed | R | Motor output speed in rpm (always positive - equal to monitor parameter no). |
| 985 | Set target motor speed | R | Target speed in rpm (positive or negative) set for the motor. |
| 986 | Command Register | R/W | Reading and writing, indicates the possible commands: Bit 0 = Run ¹ 1 = Motor run command; 0 = Motor stop command; Bit 1 = Direction 1 = Clockwise; 0 = Anti-clockwise; Bit 2 = Relay output 1 = Enable relay output (with parameter S310 = 4); 0 = Disable relay output; Bit 4 = Reset Alarms ² 1 = Reset active alarms; 0 = No function; Bit 5 = Restore ¹ 1 = Restore parameters to the factory/default values; 0 = No function; Bit 6 = Reserved; Bit 7 = Restart ^{1,3} 1 = Full restart; 0 = No function; Bit 8 = Autotuning ^{1,4} 1 = Start motor autotuning procedure; 0 = No function; Bit 9 = Motor heating ^{1,5} 1 = Start motor heating; 0 = Deactivate motor heating. |

¹ The bits in question cannot be set at the same time;

² Does not entail automatic motor restart;

³ The board is operational approximately 5 s after the restart command;

⁴ At the end of the procedure, the parameters will be updated after 5 seconds;

⁵ Can only be activated if the motor is in STOP mode.

10.5 TABLE OF MONITOR DATA

| Code | Description | R/W | Modbus address |
|-------------|--|-----|----------------|
| nr | Target speed (rpm) Displays the target speed set for the motor. | R | 1 |
| Fo | Motor frequency (Hz) Displays the motor output frequency. | R | 2 |
| Io | Motor RMS current (A) Displays the motor output RMS current. | R | 3 |
| Vo | Motor voltage (V) Displays the motor output voltage. | R | 4 |
| no | Motor speed (rpm) Displays the motor output speed. | R | 5 |
| T | Motor torque (N) Displays the motor output torque. | R | 6 |
| pf | Power factor Displays the motor output power factor value (Cos ϕ). | R | 7 |
| dir | Rotation direction Displays the direction of the motor revolutions. 0 = Clockwise; 1 = Anti-clockwise. | R | 8 |
| Vdc | Bus voltage (V d.c.) Displays the bus voltage in D.C. for the inverter board. | R | 9 |
| Ti | Device temperature (°C) Displays the temperature inside the board. | R | 10 |
| Te | Cooler temperature (°C) Displays the temperature of the cooler. | R | 11 |
| Ai | Analogue input (V) Displays the voltage value of the signal from the potentiometer, if applicable and if S101 = 1. | R | 12 |
| Di | Digital inputs Displays the status of the digital inputs. X X X = I1 I2 I3 = 0/1 0/1 0/1. | R | 13 |
| Do | Digital Output Displays the status of the Open/Closed relay, if applicable. X = 0/1. | R | 14 |
| Pm | Power (%) Displays an estimate for the mechanical power. | R | 15 |
| Alm0 | Last alarm Displays the code for the last alarm that took place ⁽¹⁾ . | R | 16 |
| Alm1 | Penultimate alarm Displays the code for the penultimate alarm that took place ⁽¹⁾ . | R | 17 |
| Alm2 | Third last alarm Displays the code for the third last alarm that took place ⁽¹⁾ . | R | 18 |
| Ih | Run time (h) Displays the total time for which the device has been on. | R | 19 |
| Mh | Motor run time (h) Displays the total time for which the motor has been running. | R | 20 |
| Vac | Power supply voltage (V d.c.) Displays the power supply voltage for the inverter board. | R | 21 |
| Tp | PFC temperature (°C) Displays the internal temperature of the PFC module. | R | 22 |

⁽¹⁾ See "Alarms" chapter for possible alarm codes shown after "**Alm0, Alm1, Alm2**"

11. ALARMS

The table below lists alarms with corresponding solutions. The main consequence of each alarm is that the device switches off.

11.1 TABLE OF ALARMS

| Code | Description | No. of red LED flashes | Cause | Alarm solution |
|-----------|-------------------------------------|------------------------|---|---|
| UV | Undervoltage alarm | 1 | The voltage value of the device has dropped below the minimum value set via parameter S602 | Reset alarm via suggested input |
| OV | Overvoltage alarm | 2 | The voltage value of the device has exceeded the maximum value set via parameter S603 | |
| OC | Overcurrent alarm | 3 | The device has exceeded the maximum current value set via parameter S601 | |
| OL | Overload alarm | 4 | When the amount of energy according to logic I x t exceeds the value set via parameters S511 and S512 | |
| BT | Circuit board overtemperature alarm | 5 | The device has reached and exceeded maximum temperature S605 | The alarm resets automatically when the temperature of the device < S605 - 10 °C (50 °F) |
| OT | Cooler overtemperature alarm | 6 | The motor has reached and exceeded maximum temperature S606 | The alarm resets automatically when the temperature of the device < S606 - 10 °C (50 °F) |
| AI | Analogue input alarm | 7 | No analogue input reading | Contact the manufacturer |
| EP | Eeprom data alarm | 8 | The data structure is not intact | Parameters reset to the factory values automatically. The parameters changed previously need to be re-configured |
| TO | Communication timeout alarm | 9 | Modbus communication interrupted | Check the modbus connection |
| US | User alarm | 10 | Alarm associated with the corresponding function of an input | Remove the cause of the alarm |
| ST | STO alarm (Safe Torque off) | 11 | Alarm associated with an external power failure at the relevant connectors | Check for power at the ends of the relevant connectors |
| PL | Motor phase loss alarm | 12 | <ul style="list-style-type: none"> Motor not connected correctly Incorrect S534 sensitivity | <ul style="list-style-type: none"> Check the power supply wiring Change parameter S534 |
| MT | Motor thermal switch alarm | 13 | Alarm associated with an input (S304...S306 = 17) or with PTC | Remove the cause of the alarm |
| MS | Motor stall alarm | 14 | <ul style="list-style-type: none"> Motor does not rotate properly with vector algorithm Incorrect S535 sensitivity | <ul style="list-style-type: none"> Make sure parameters S500...S527 are correct Change parameter S535 |

12. PARAMETERS MANAGER

The **Syncro** inverter can be configured using **Parameters Manager**, available to download from the website www.evco.it. To connect the inverter to a PC, an RS-485/USB converter must be used (p/n: **EVIF20SUXI**).

NOTE: for all necessary information on the subject, please refer to the instruction sheet p/n **104SUXIA104**

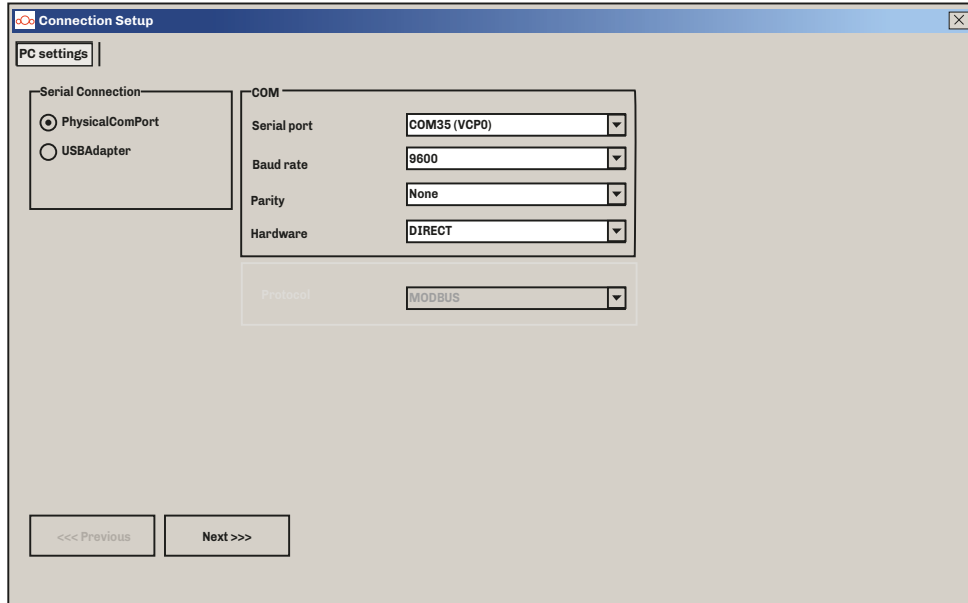
NOTE: make sure you have downloaded the latest versions of the drivers available for **Parameters Manager**.

Once you have started **Parameters Manager**, you will need to configure the settings correctly to connect to the **Syncro** inverter, as shown in the image below:

WARNING

MALFUNCTIONING OF THE EQUIPMENT

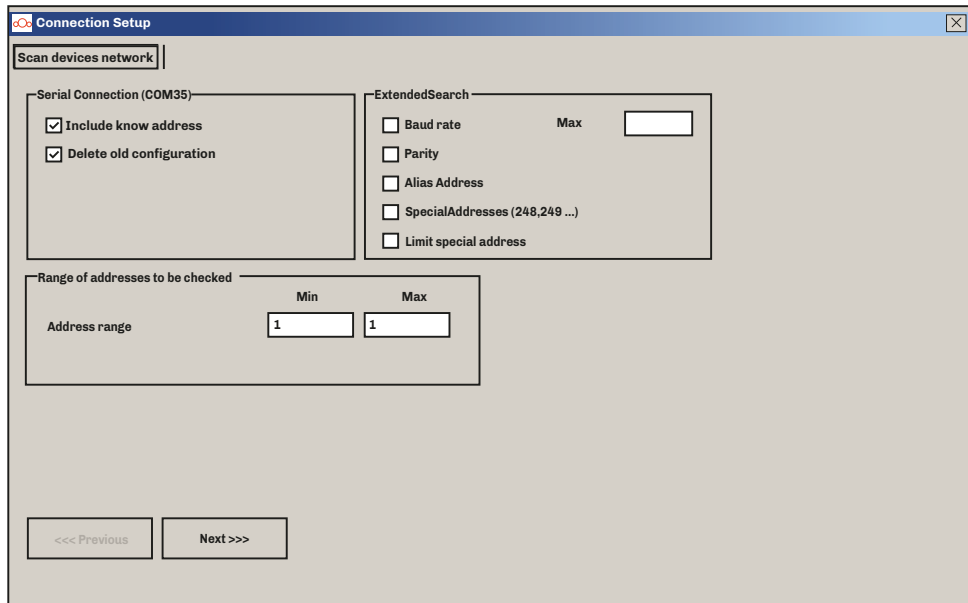
- Only update inverter parameters while the motor is off.
- Do not perform any communication serial port wiring procedures while the motor is on and the inverter powered.



The screenshot shows the 'Connection Setup' dialog box with the 'PC settings' tab selected. Under 'Serial Connection', 'PhysicalComPort' is selected. The 'COM' section includes 'Serial port' (COM35 (VCPD)), 'Baud rate' (9600), 'Parity' (None), and 'Hardware' (DIRECT). The 'Protocol' dropdown is set to 'MODBUS'. Navigation buttons '<< Previous' and 'Next >>' are visible at the bottom.

Fig. 25. Communication port setting

Press **NEXT** to continue and configure the network scan settings:



The screenshot shows the 'Connection Setup' dialog box with the 'Scan devices network' tab selected. Under 'Serial Connection (COM35)', 'Include know address' and 'Delete old configuration' are checked. The 'ExtendedSearch' section includes checkboxes for 'Baud rate', 'Parity', 'Alias Address', 'SpecialAddresses (248,249 ...)', and 'Limit special address'. The 'Range of addresses to be checked' section has 'Min' and 'Max' address range both set to '1'. Navigation buttons '<< Previous' and 'Next >>' are visible at the bottom.

Fig. 26. Communication Modbus address setting

If **Parameters Manager** detects the **Syncro** inverter, the following screen will appear; otherwise you will have to reconfigure the previous settings.

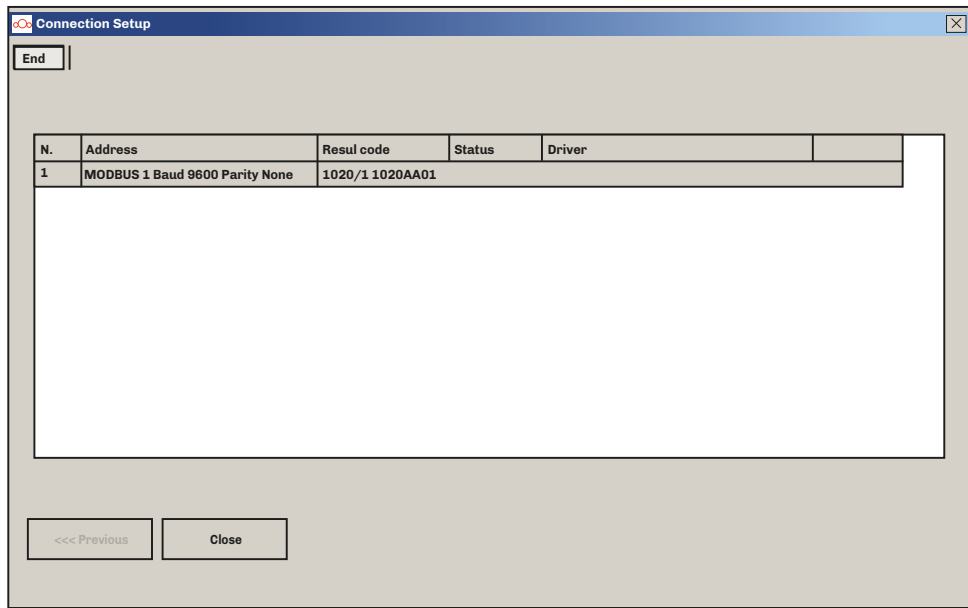


Fig. 27. Syncro Inverter detection

Press **Close** to proceed to the **Syncro** inverter parameter configuration screen.

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