Syncro series inverter

Inverter for three-phase synchronous motors with powers of up to 6 kW

⚠ **WARNING**

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

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

Hardware Manual

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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 (with the exception of the front panel).
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.

DISPOSAL

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

CONSIDER THE ENVIRONMENT

The company works towards protecting the environment, while taking account of customer requirements, technological innovations in 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.

SYMBOLS USED IN THIS MANUAL

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.

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

SAFETY MESSAGES

⚡ ⚠ 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 the 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.

UNAUTHORISED PERSONNEL

The inverter must **not** be used by persons (including children) with reduced physical, sensory or mental capabilities or persons with no experience or knowledge.

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 minuted 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.

SAFETY INFORMATION RELATING TO THE PRODUCT

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 motor control (for asynchronous motors) or synchronous vector motor control (for synchronous motors or compressors).

It also incorporates flux weakening control.
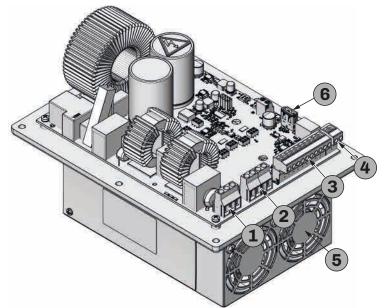
1.2 AVAILABLE MODELS

The **Synchro** series consists of two inverters:

- **Syncro A** - Inverter with powers of 2.3 and 3.8 kW;
- **Syncro B** - Inverter with powers of 4.8 and 6 kW.

1.3 PRODUCT OVERVIEW
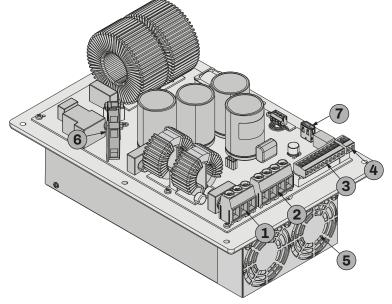
1.3.1 Syncro A

Ref.	Description
1	Power supply input
2	Motor output
3	I/O connections
4	Digital output
5	Cooler fans
6	Service USB input

Fig. 1. Syncro A inverter overview

1.3.2 Syncro B

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. 2. Syncro B inverter overview

1.4 FEATURES

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

- 3 inputs that can be configured as:
    - 3 digital inputs;
    - 2 digital inputs and 1 analogue input;
- 1 safety digital input (for SIL2/SIL3 systems);
- 1 digital output;
- 1 12 Vdc output;
- 1 RS-485 Modbus slave communication serial port;
- Available power levels:

Syncro A	Syncro B
2.3 kW	4.8 kW
3.8 kW	6 kW

- Inverter cooling system via built-in ventilation.

1.5 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 A	Syncro B
Power supply	230 Vac ±10 % single-phase	•	•
Power levels	2.3 kW	EI2K3M2Y04O0VXX	---
	3.8 kW	EI3K8M2Y03O0VXX	---
	4.8 kW	---	EI4K8M2Y04O0VXX
	6 kW	---	EI6K0M2Y04O0VXX
Digital inputs	NPN(*)	2 (or 3)	
Analogue inputs	0...10 V	1 (or 0)	
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 12**.*

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

3. RECEIVING THE PRODUCT

3.1 BEFORE YOU START

<table>
<tr><td>⚠ CAUTION</td></tr>
</table>

IMPROPER HANDLING
- Use all necessary personal protective equipment (PPE), such as safety gloves and shoes, while handling packaging and unpacking.
- Follow the handling instruction given in this manual and any other documentation associated with the product.
- Handle and store the product in its original packaging.
- Do not handle or store the product if the packaging is or seems to be damaged.
- Take all necessary measures to avoid damaging the product and prevent other hazards while handling or opening the packaging.

<table>
<tr><td>NOTICE</td></tr>
</table>

UNEXPECTED EQUIPMENT OPERATION
- Droppages and shocks can damage the equipment beyond repair.
- Tampering with or removing the identification stickers invalidates the warranty.

3.2 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).

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

3.2.2 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):

Syncro A		Syncro B	
2.3 kW	**3.8 kW**	**4.8 kW**	**6 kW**
10 A	17 A	22 A	28 A

Output current (RMS):

Syncro A		Syncro B	
2.3 kW	**3.8 kW**	**4.8 kW**	**6 kW**
6 A	10 A	12.8 A	16 A

Dispersion current to earth: ≥3.5 mA
Cooling method: Forced ventilation

4.2 OTHER TECHNICAL INFORMATION

Input properties (SELV)

Digital inputs: 2 multifunction 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 Vin = 230 Vac
Carrier frequency: 4...12 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: 9600/19200/38400 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.

Images used in this chapter
The images used in this chapter are provided for illustrative purposes only and may differ from the product itself.

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.
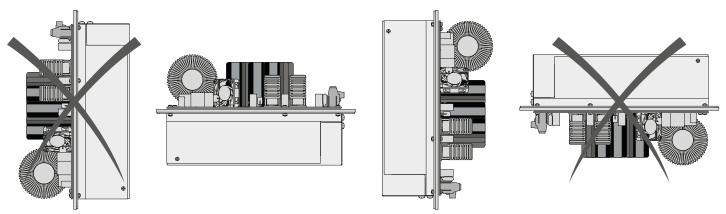

Fig. 3.   *Syncro installation positioning*

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.

Fig. 4.   *Minimum installation distances - side view*

mm (in.)

40 (1.57)

40 (1.57)

40 (1.57)

40 (1.57)
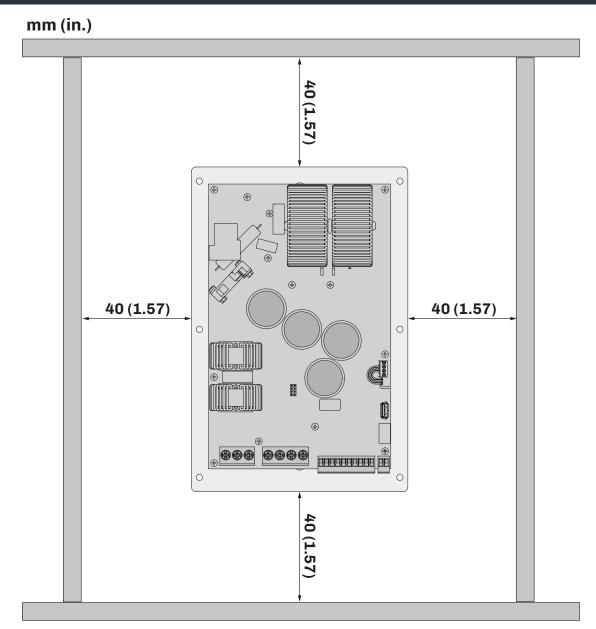
Fig. 5. *Minimum installation distances - front view*

5.4 INSTALLATION METHOD

5.4.1 Syncro A

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

Fig. 6. **Syncro A** *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)

5.4.2 Syncro B

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

6 x M5

135 (5.31)

255 (10.04)
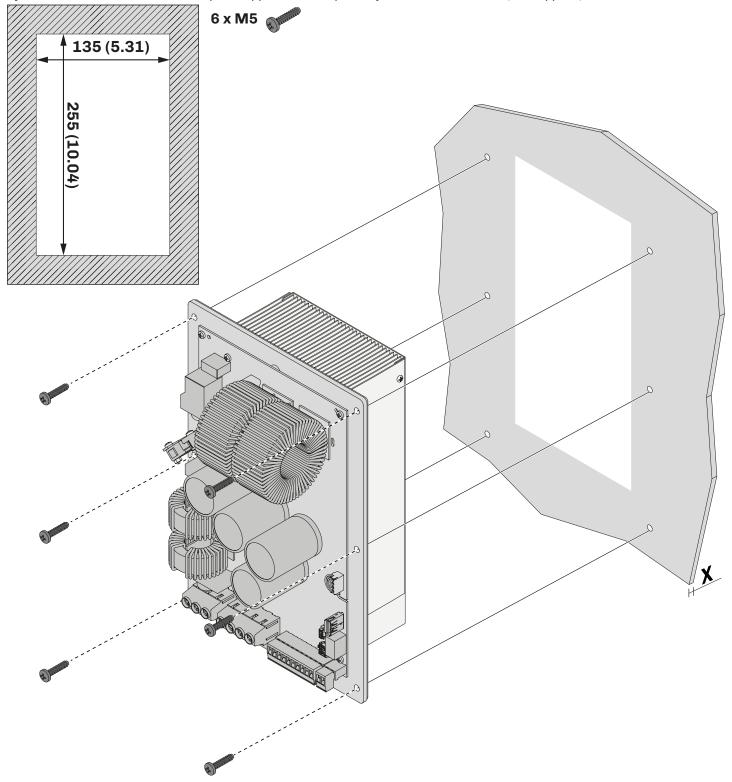
*Fig. 7.   **Syncro B** inverter installation method*

Panel thickness

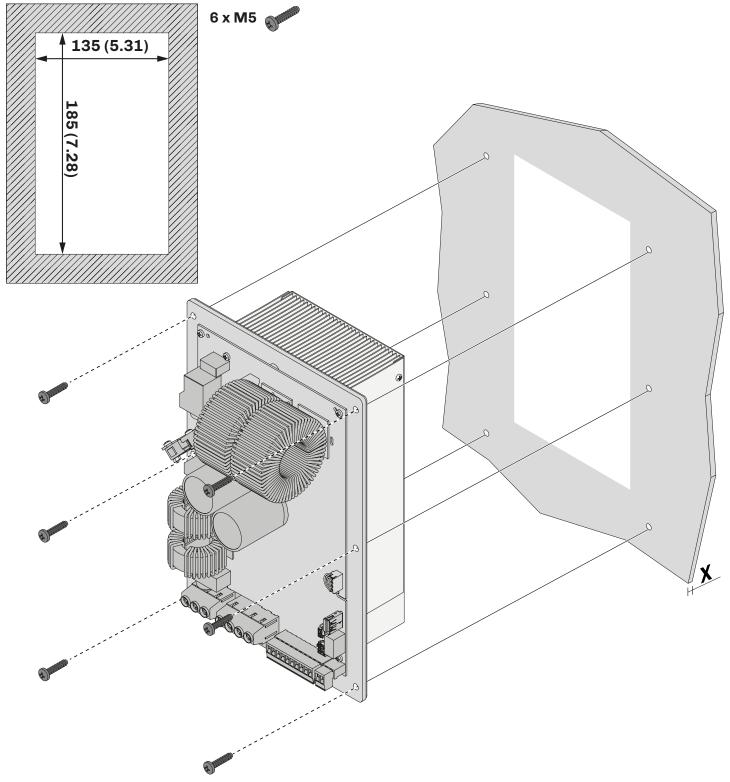This panel thickness varies depending on the material used to make it:

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

5.5 DIMENSIONS AND WEIGHT

5.5.1 Syncro A

mm (in.)
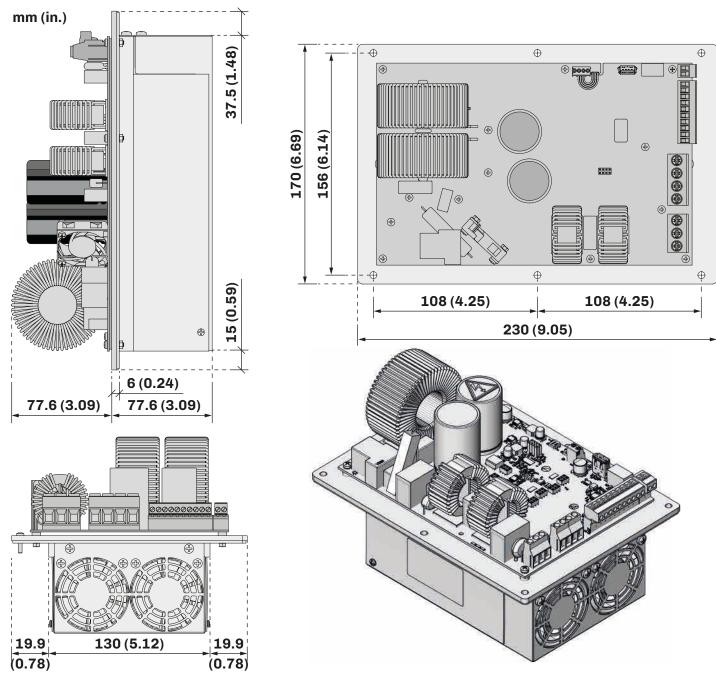
Fig. 8. ***Syncro A*** *inverter dimensions*

Weight

Reference	Weight in kg (lb)
Syncro A	~3 kg (6.61)

5.5.2 Syncro B

mm (in.)
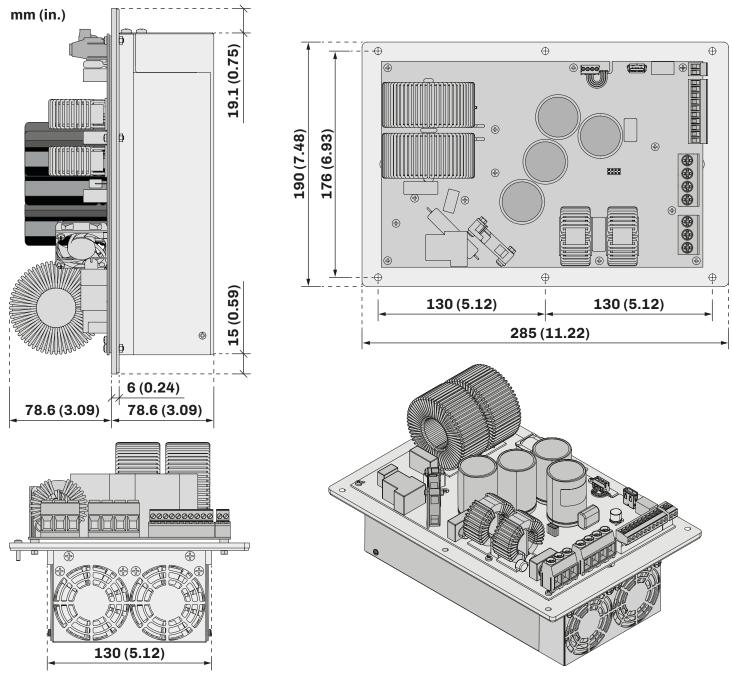
Fig. 9.   *Syncro B* inverter dimensions

Weight

Reference	Weight in kg (lb)
Syncro B	~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 minuted 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 power supply and motor output

Syncro A
Step 6,35 mm (0.249 in.)

mm / in.	9 / 0.35								Ø 4 mm (0.157 in.)	M4	N•m	0.5...0.8
mm²	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...6	2 x 0.5...6			lb-in	4.42...7.08
AWG	20...6	20...6	20...6	20...6	2 x 20...10	2 x 20...10	2 x 20...10	2 x 20...10				

Syncro B
Step 10,16 mm (0.399 in.)

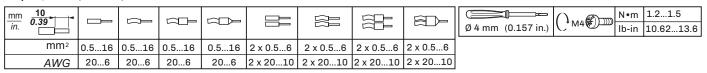| mm / in.	10 / 0.39								Ø 4 mm (0.157 in.)	M4	N•m	1.2...1.5
mm²	0.5...16	0.5...16	0.5...16	0.5...16	2 x 0.5...6	2 x 0.5...6	2 x 0.5...6	2 x 0.5...6			lb-in	10.62...13.6
AWG	20...6	20...6	20...6	20...6	2 x 20...10	2 x 20...10	2 x 20...10	2 x 20...10				

Fig. 10. Suitable wiring for power supply and motor output

Suitable wiring for I/O SELV

Step 5,08 mm (0.199 in.)

mm / in.	7 / 0.28								Ø 3.5 mm (0.14 in.)	C	N•m	0.5...0.6
mm²	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			lb-in	4.42...5.31
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. 11. Suitable wiring for I/O SELV

Suitable wiring for earthing

Step 5,08 mm (0.199 in.)
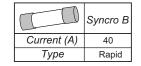
mm / in.	7 / 0.28				Ø 3.5 mm (0.14 in.)	C	N•m	0.5...0.6
mm²	2.5	2.5	2.5	2 x 1.5			lb-in	4.42...5.31
AWG	14	14	14	2 x 16				

Fig. 12. Suitable wiring for earthing

6.1.2 Sizing safety interlocks

	Syncro A
Current (A)	25
Type	Rapid

	Syncro A
Current (A)	25
Type	Type B

Fig. 13. Sizing safety interlocks | **Syncro A**

	Syncro B
Current (A)	40
Type	Rapid

	Syncro B
Current (A)	40
Type	Type B

Fig. 14. Sizing safety interlocks | **Syncro B**

6.2 WIRING DIAGRAM
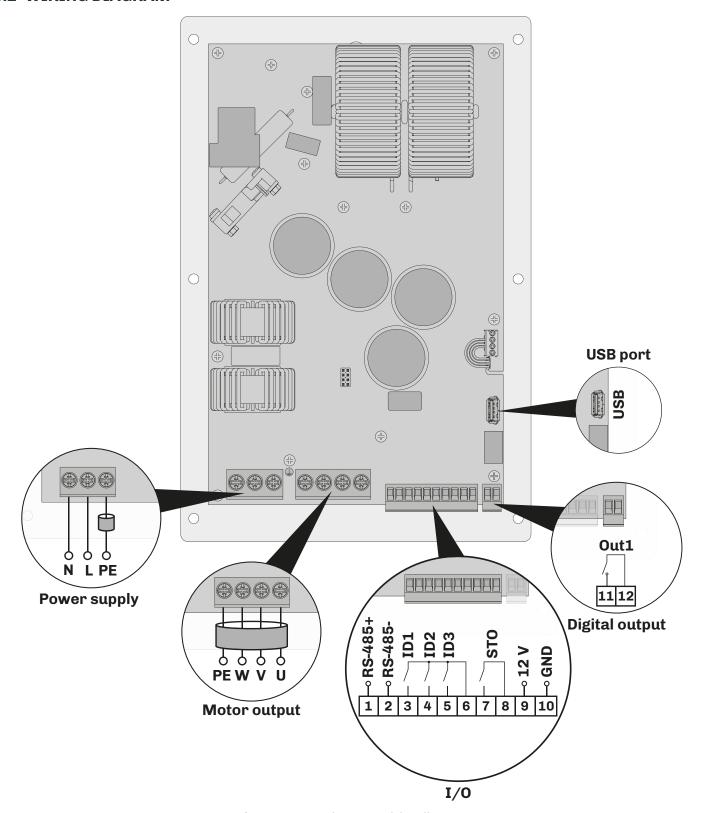
Fig. 15. Syncro inverter wiring diagram

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	Phase U of the motor control output	**5-6**	Digital input **ID3** connection
V	Phase V of the motor control output	**7-8**	Safety digital input **STO** connection
W	Phase W of the motor control output	**9-10**	Auxiliary 12 V power supply output
PE	Motor earth connection	**11-12**	**out1** relay output connection (NO)

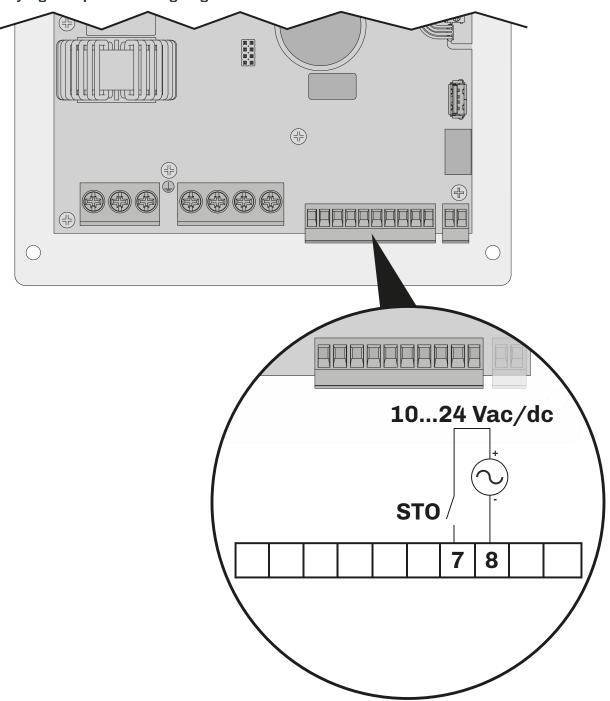### 6.2.1 Safety digital input STO wiring diagram

Fig. 16.   *Syncro inverter wiring diagram*

7. REGULATORS

The **Syncro** inverter can control:
- Three-phase permanent magnet synchronous motors (BLDC);
- Three-phase asynchronous motors.
- HVAC-R compressor control.

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 synchronous 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 40*.
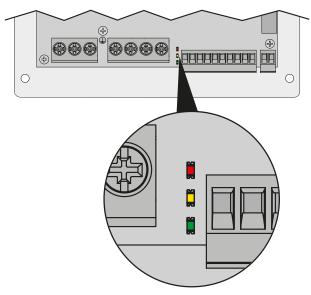
7.3 LED INTERFACE

Fig. 17. *LED*

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

Green LED	Yellow LED	Red LED	Inverter status description
OFF	OFF	OFF	No inverter boot firmware
OFF	OFF	Flashing(*)	Inverter in alarm without communication
OFF	OFF	ON	Inverter stopped without serial communication
OFF	ON	OFF	Inverter application programming/updating
OFF	ON	Flashing(*)	Inverter in alarm with serial communication
OFF	ON	ON	Inverter stopped with serial communication
Flashing	OFF	OFF	Remove the programming/updating USB flash drive
Flashing	Flashing	Flashing	Inverter application programming/updating not done or error
ON	OFF	OFF	Inverter running without serial communication
ON	ON	OFF	Inverter running with serial communication
ON	ON	ON	Inverter boot firmware present

(*****) **NOTE**: if there is a flashing Red LED, please refer to *"CHAPTER 11. ALARMS" ON PAGE 40*.

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.
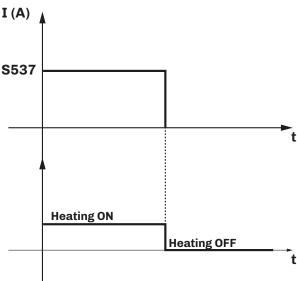

Fig. 18. *Compressor heating management*

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.
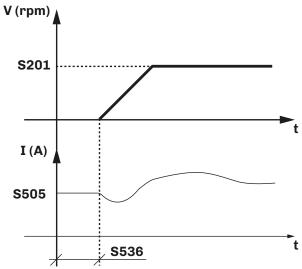

Fig. 19. *Motor control logic at start-up*

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 75...8000 [rpm]
1	Theoretical rpm	600...24000	Theoretical frequency	0.02...133.33
	Limited rpm	600...**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 75...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.
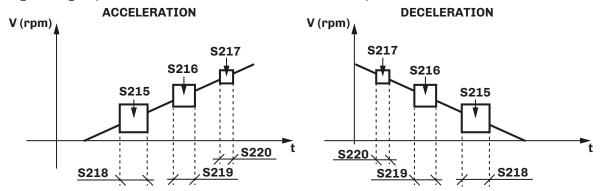

Fig. 20. *Speed jump*

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.
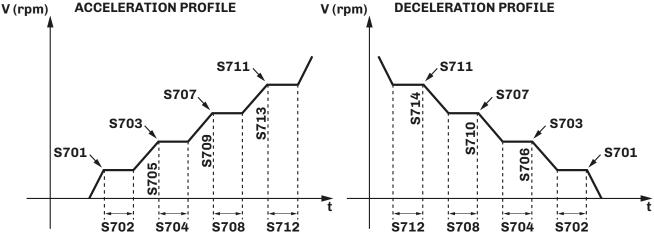

Fig. 21. *Speed profile*

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.
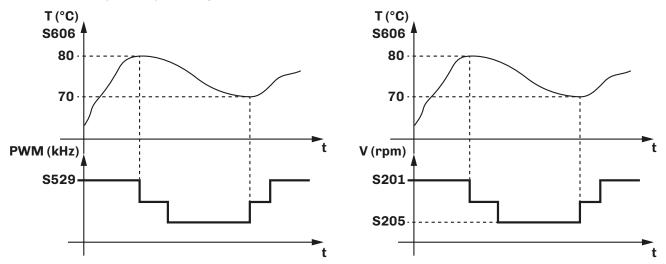
Fig. 22. *Reducing carrier frequency and/or speed*

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.
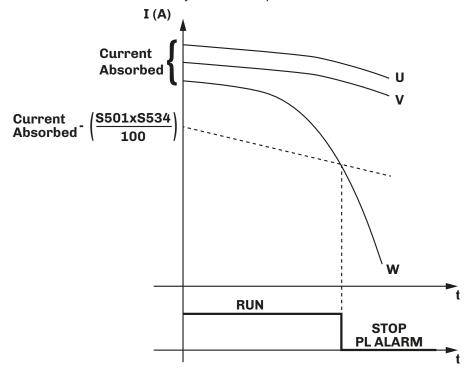
Fig. 23. *Motor phase loss alarm sensitivity*

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.
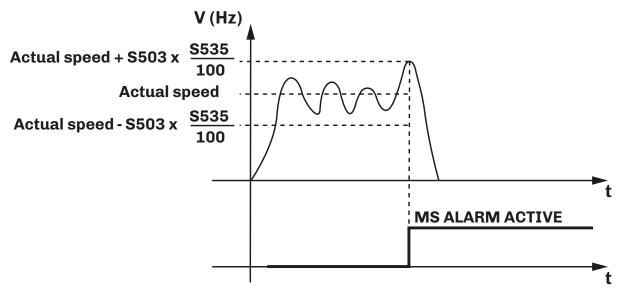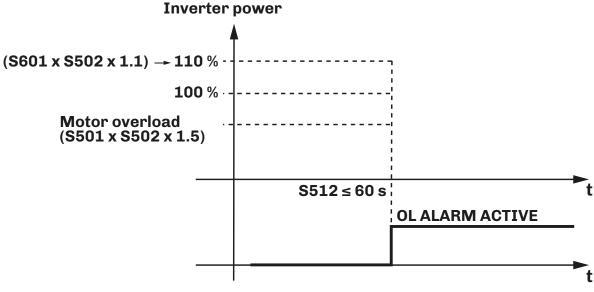
Fig. 24.   Motor phase loss alarm sensitivity

7.4.10 Motor overload

The motor overload check is done using the formula: **I** x **t**, where the calculation is based on parameters **S511** and **S512**.

The **OL** alarm is triggered in the event of a motor overload.

Fig. 25.   Motor overload

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:

Fig. 26. *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	3
S520	Stator resistance.	Ω	0.00 ... 50.00	2.5
S521	Stator inductance / Ld.	mH	0.0 ... 800.0	0.0
S523	Rotor inductance / Lq.	mH	0.0 ... 800.0	0.0

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:
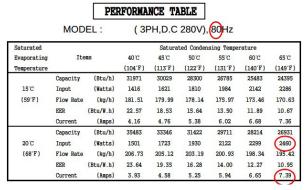
Fig. 27. *Example of compressor rating label data*

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	240 (**)
S506	Nominal motor revolutions.	rpm	1 ... 8000	4800 (***)

(*): 192 = 2460 W/(√3 x **S501**)
(**): 240 = (80 rps x **S504**)
(***): 4800 = (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 the RS-485 serial line (see *"CHAPTER 10.2 TABLE OF MODBUS COMMANDS" ON PAGE 36*).

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	0.00 ... 50.00	Autotuning
S525	Rotor time constant.	ms	0 ... 9999	Autotuning
S526	WTS. Parameter calculated by autotuning.	-	0 ... 9999	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	240
S504	Number of pole pairs.	-	1 ... 8	2
S506	Nominal motor revolutions.	rpm	1 ... 8000	4800

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 starting the procedure, 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 be rebooted.
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: **(S502x1000)/S506**

NOTE: To configure parameter **S503**, use the *actual rotation per second frequency (rps) x 60* and not the mechanical frequency.

9. CONFIGURATIONS

The **Syncro** 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
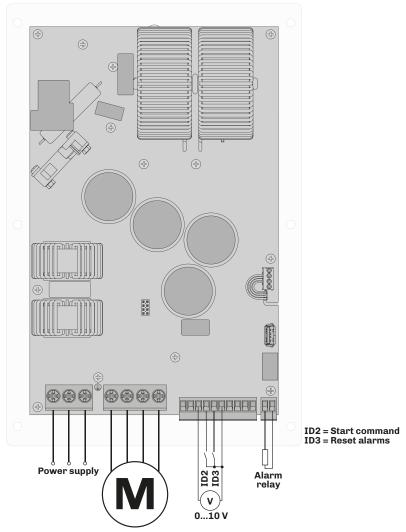
Fig. 28. *Wiring for inverter control via potentiometer*

9.1.2 Parameter configuration

The parameter configuration required for **Syncro** 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	6600
S205	Minimum motor speed.	rpm	75 ... **S204**	1800
S304	Digital input 1 function.	-	0 ... 9	0
S305	Digital input 2 function.	-	0 ... 9, 17	2
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
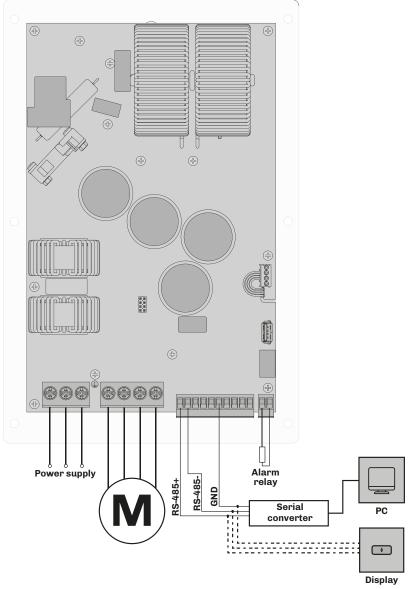

Fig. 29. *Wiring for inverter control via Slave Serial port*

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	6600
S205	Minimum motor speed.	rpm	75 ... **S204**	1800
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	10.0
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	Model default [kW] 2.3	3.8	4.8	6	Modbus address
	CONTROL Group S1··							
S101	Selection of source for motor speed regulation. **1** = Analogue input; **2** = RS-485 serial port;	-	1/2	2	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	2	2	102
S103	Selection of control type applied to the motor. **1** = Scalar; **2** = Synchronous vector.	-	1/2	2	2	2	2	103
S105	Delay time for restarting after a mains power failure.	s	0.1 ... 120.0	5.0	5.0	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	0	0	107
	SPEED Group S2··							
S201	Nominal target speed if **S101** = 2.	rpm	**S205** ... **S204**	3600	3600	3600	3600	201
S202	Acceleration ramp. Time required to reach the nominal speed from 0 rpm/s.	rpm/s	1 ... 1000	60	60	60	60	202
S203	Deceleration ramp. Time required to reach 0 rpm/s from the nominal speed.	rpm/s	1 ... 1000	60	60	60	60	203
S204	Maximum motor speed [1].	rpm	**S205** ... 8000	6600	6600	6600	6600	204
S205	Minimum motor speed [1].	rpm	75 ... **S204**	1800	1800	1800	1800	205
S206	Select the motor rotation direction [2]. **0** = Clockwise; **1** = Anticlockwise.	-	0 /1	0	0	0	0	206
S215	Target speed 1 to jump.	rpm	**S205** ... **S204**	1800	1800	1800	1800	215
S216	Target speed 2 to jump.	rpm	**S205** ... **S204**	1800	1800	1800	1800	216
S217	Target speed 3 to jump.	rpm	**S205** ... **S204**	1800	1800	1800	1800	217
S218	Speed jump 1 band. Interval size for target speeds 1 to be jumped. **0** = Disabled.	rpm	0 ... **S205**	0	0	0	0	218
S219	Speed jump 2 band. Interval size for target speeds 2 to be jumped. **0** = Disabled.	rpm	0 ... **S205**	0	0	0	0	219
S220	Speed jump 3 band. Interval size for target speeds 3 to be jumped. **0** = Disabled.	rpm	0 ... **S205**	0	0	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	0.00	0.00	301

Par.	Description	MU	Range	Model default [kW]				Modbus address
				2.3	3.8	4.8	6	
S302	Maximum analogue reference value. Selection of the maximum analogue input or potentiometer voltage.	V	**S301** ... 10.00	10.00	10.00	10.00	10.00	302
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.	-	0 ... 9	0	0	0	0	304
S305	Digital input **ID2** 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	0	0	305
S306	Digital input **ID3** configuration. Same as **S305.**	-	0 ... 9, 17	0	0	0	0	306
S310	Output **out1** configuration. Indicates the function/event that closes the relay contact. **0** = No function; **1** = Inverter ready; **2** = Inverter running; **3** = Inverter in alarm; **4** = Controlled by RS-485 serial port.	-	0 ... 4	3	3	3	3	310
	MODBUS Group S4··							
S401	Modbus communication protocol device address.	-	1 ... 247	1	1	1	1	401
S402	Baud rate. Data communication speed. **1** = 9600; **2** = 19200; **3** = 38400.	Baud	1 ... 3	1	1	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	10.0	10.0	10.0	10.0	403
S404	Modbus protocol (bits/parity/stop bit). **0** = 8 bits/none/1; **1** = 8 bits/odd/1; **2** = 8 bits/even/1; **3** = 8 bits/none/2; **4** = 8 bits/odd/2; **5** = 8 bits/even/2. **NOTE**: The Parameters Manager does not handle protocols with 2 stop bits.	-	0...5	2	2	2	2	404
	Motor Group S5···							
S501	Nominal motor current [3].	A	0.1 ... **S601**	6.6	8.0	8.0	8.0	501
S502	Nominal motor voltage [3].	V	50 ... 400	250	250	250	250	502
S503	Nominal motor frequency [3].	Hz	10 ... 400	180	180	180	180	503
S504	Number of motor pole pairs [3].	-	1 ... 8	3	3	3	3	504
S505	No-load / motor start-up current [3].	A	0.1 ... **S501**	1.6	1.6	1.6	1.6	505
S506	Nominal motor revolutions[3].	rpm	1 ... 8000	3600	3600	3600	3600	506
S507	Nominal motor torque [3].	Nm	0.1 ... 100.0	3.9	5.2	5.2	5.2	507
S508	Cos(phi). Nominal motor power factor [3].	-	0.01 ... 1.00	1.00	1.00	1.00	1.00	508
S509	Motor boost. Percentage overvoltage applied at motor start-up (only if **S103** = 1).	%	0 ... 25	0	0	0	0	509
S510	Motor voltage. Maximum voltage percentage applied to the motor in relation to the nominal value.	%	10 ... 112	100	100	100	100	510
S511	Motor overload. Percentage motor overload permitted by the inverter for the time set in parameter **S512** (only if **S103** = 1).	%	0 ... 50	50	50	50	50	511

Par.	Description	MU	Range	Model default [kW]				Modbus address
				2.3	3.8	4.8	6	
S512	Maximum motor overload time. **0** = Disabled.	s	0 … 60	60	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	0	0	0	0	513
S514	Speed at which to start braking in DC voltage. Only applies when **S513** = 3.	rpm	0 … **S205**	0	0	0	0	514
S515	Duration of DC voltage braking. Only applies when **S513** = 2 or 3.	s	0.0 … 20.0	0.0	0.0	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	0	0	516
S520	Stator winding resistance (phase-phase).	Ω	0.00 … 50.00	2.5	2.5	2.5	2.5	520
S521	Stator inductance / Ld.	mH	0.0 … 800.0	0.0	0.0	0.0	0.0	521
S523	Rotor inductance / Lq.	mH	0.0 … 800.0	0.0	0.0	0.0	0.0	523
S525	Rotor time constant calculated by autotuning.	-	0 … 9999	9	9	9	9	525
S526	WTS. Parameter calculated by autotuning.	-	0 … 9999	1600	1600	1600	1600	526
S527	KM/Ke. Parameter calculated by autotuning / voltage constant Ke.	-	0 … 9999	55	55	55	55	527
S529	Selection of PWM carrier frequency.	kHz	4 … 12	8	8	8	8	529
S530	Kp for current loop. Proportional gain for the PI current controller.	%	1 … 1000	40	40	40	40	530
S531	Ki for current loop. Integral action time for the PI current controller.	ms	0 … 1000	20	20	20	20	531
S532	Kp for speed loop. Proportional gain for the PI speed controller.	%	1 … 1000	40	40	40	40	532
S533	Ki for speed loop. Integral action time for the PI speed controller.	s	0.00 … 10.00	8.00	8.00	8.00	8.00	533
S534	Motor phase loss alarm sensitivity. Indicates the motor phase loss alarm sensitivity percentage. **0** = Disabled; **100** = Maximum sensitivity.	%	0 … 100	0	0	0	0	534
S535	Motor stall alarm sensitivity. Indicates the motor stall alarm sensitivity percentage. **0** = Disabled; **100** = Maximum sensitivity.	%	0 … 100	0	0	0	0	535
S536	Magnetising time. Motor magnetising current duration in start-up (**S505**).	s	0.1 … 10.0	0.2	0.2	0.2	0.2	536
S537	Current for motor heating function.	A	0.1 … **S501**	1.0	1.0	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	6.6	10.0	12.8	16.0	601
S602	Undervoltage level. Alternating voltage value under which the undervoltage error is generated.	V	200 … **S603**	200	200	200	200	602
S603	Overvoltage level. Alternating voltage value over which the overvoltage error is generated.	V	**S602** … 260	260	260	260	260	603
S605	Board alarm temperature (CPU).	°C	50 … 100	90	90	90	90	605
S606	Cooler alarm temperature.	°C	50 … 100	90	90	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	0	0	0	0	607
S608	Enable fans. **0** = Fans disabled; **1** = Fans enabled.	-	0/1	1	1	1	1	608
COMPRESSOR Group S7··								
S701	Start/stop speed before set speed.	rpm	0 … **S204**	1800	1800	1800	1800	701

Par.	Description	MU	Range	Model default [kW]				Modbus address
				2.3	3.8	4.8	6	
S702	Start/stop speed duration before set speed.	s	0 ... **600**	60	60	60	60	702
S703	Speed above which pause 1 intervenes.	rpm	0 ... **S204**	0	0	0	0	703
S704	Pause duration with speed 1 maintained.	s	0 ... 600	0	0	0	0	704
S705	Acceleration from minimum speed to speed 1.	rpm/s	1 ... 1000	60	60	60	60	705
S706	Deceleration from speed 1 to minimum speed.	rpm/s	1 ... 1000	60	60	60	60	706
S707	Speed above which pause 2 intervenes.	rpm/s	0 ... **S204**	0	0	0	0	707
S708	Pause duration with speed 2 maintained.	rpm	0 ... 600	0	0	0	0	708
S709	Acceleration from speed 1 to speed 2.	s	1 ... 1000	60	60	60	60	709
S710	Deceleration from speed 2 to speed 1.	rpm/s	1 ... 1000	60	60	60	60	710
S711	Speed above which pause 3 intervenes.	rpm	0 ... **S204**	0	0	0	0	711
S712	Pause duration with speed 3 maintained.	s	0 ... 600	0	0	0	0	712
S713	Acceleration from speed 2 to speed 3.	rpm/s	1 ... 1000	60	60	60	60	713
S714	Deceleration from speed 3 to speed 2.	rpm/s	1 ... 1000	60	60	60	60	714

[1] *The minimum and maximum limits are calculated on the basis of the number of pole pairs in the motor, i.e. between 10 and 400 Hz or between 75 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	Read only, indicates the inverter operating status: **Bit 0** = Ready **1** = Inverter ready to receive commands; **0** = Inverter in alarm or not ready to receive commands; **Bit 1** = Run **1** = Motor in motion; **0** = Motor stopped; **Bit 2** = Acceleration **1** = Motor in acceleration; **0** = Motor not in acceleration; **Bit 3** = Deceleration **1** = Motor in deceleration; **0** = Motor not in deceleration; **Bit 4** = Alarm **1** = Inverter in alarm; **0** = Inverter not in alarm; **Bit 5** = Overload **1** = Power exceeded 100 %; **0** = Power dropped below 100 %; **Bit 6** = Reserved **Bit 7** = Direction **1** = Clockwise; **0** = Anti-clockwise; **Bit 8** = Target reached **1** = Target speed reached; **0** = Target speed not reached; **Bit 9** = Off **1** = Inverter off; **0** = Normal; **Bit 10** = PWM carrier/speed derating **1** = Derating enabled; **0** = Normal; **Bit 11** = STO – Safe Torque Protection Off **1** = Device enabled; **0** = Device disabled. **Bit 12** = Current limiting **1** = Limiting enabled; **0** = Normal.
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).

Address	Parameter name	R/W	Description
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** (see *"CHAPTER 10.5 MONITOR DATA TABLE" ON PAGE 39*)).
984	Motor speed	R	Motor output speed in rpm (always positive - equal to monitor parameter **no** (see *"CHAPTER 10.5 MONITOR DATA TABLE" ON PAGE 39*)).
985	Set motor target speed (rpm)	R/W	Temporary 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.
988	Set motor target speed (Hz/10)	R/W	Temporary target speed in Hz/10 (positive or negative) set for the motor

[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 MONITOR DATA TABLE

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∅).	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 a.c.) Displays the power supply voltage for the inverter board.	R	21
Tp[2]	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**";
[2] Only available in Syncro B.

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	Number 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	• Motor not connected correctly • Incorrect **S534** sensitivity	• 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	• Motor does not rotate properly with vector algorithm • Incorrect **S535** sensitivity	• Make sure parameters **S500**...**S527** are correct • Change parameter **S535**
PU	PFC undervoltage alarm	15	Very sudden load variation	Check load connected to the motor and/or **S202** value
PO	PFC overvoltage alarm	16		Check load connected to the motor and/or **S203** value

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:

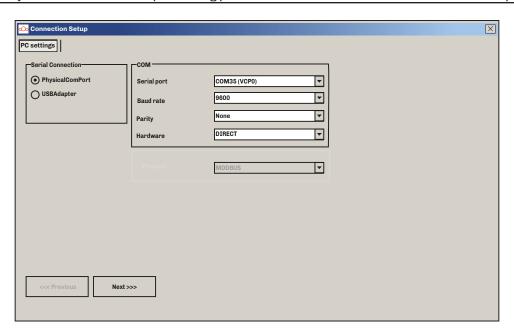| ⚠ WARNING |
|---|
| **MALFUNCTIONING OF THE EQUIPMENT** |
| • Only update inverter parameters while the motor is off. |
| • Do not perform any communication serial port wiring procedures while the motor is on and the inverter powered. |

Fig. 30. *Communication port setting*

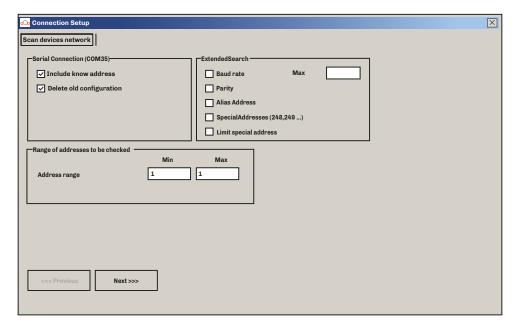Press **NEXT** to continue and configure the network scan settings:

Fig. 31. *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.
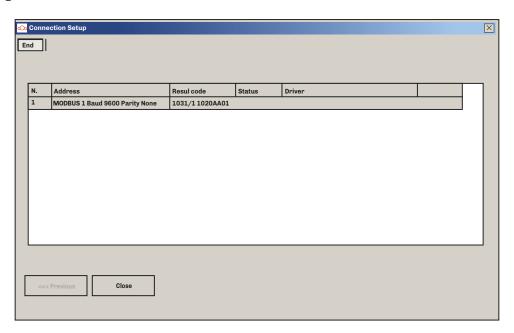

Fig. 32. ***Syncro*** *Inverter detection*

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

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