• 15P0102B1 •

SINUS PENTA

MULTIFUNCTION AC DRIVE

USER MANUAL

- Installation Instructions -

Updated 05/04/07
R.04

English

• This manual is integrant and essential to the product. Carefully read the instructions contained herein as they provide important hints for use and maintenance safety.
• This device is to be used only for the purposes it has been designed to. Other uses should be considered improper and dangerous. The manufacturer is not responsible for possible damages caused by improper, erroneous and irrational uses.
• Elettronica Santerno is responsible for the device in its original setting.
• Any changes to the structure or operating cycle of the device must be performed or authorized by the Engineering Department of Elettronica Santerno.
• Elettronica Santerno assumes no responsibility for the consequences resulting by the use of non-original spare-parts.
• Elettronica Santerno reserves the right to make any technical changes to this manual and to the device without prior notice. If printing errors or similar are detected, the corrections will be included in the new releases of the manual.
• Elettronica Santerno is responsible for the information contained in the original version of the Italian manual.

ELETTRONICA
SANTERNO

Elettronica Santerno S.p.A.
Via G. Di Vittorio, 3 - 40020 Casalfiumanese (BO) Italy
Tel. +39 0542 668611 - Fax +39 0542 668622
www.elettronicasanterno.it sales@elettronicasanterno.it

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1. GENERAL DESCRIPTION

Inverters are electronic devices capable of powering an AC electric motor and imposing speed and torque values. Inverters of the PENTA series manufactured by Elettronica Santerno SpA allow to adjust speed and torque values of three-phase asynchronous motors and brushless, permanent-magnet AC motors with several control modes. Control modes may be user-defined and allow to obtain the best performance in terms of fine-tuning and energy saving for any industrial application.
The basic control modes that can be selected for PENTA inverters are the following:

IFD: voltage / frequency scalar control for asynchronous motors,
FOC: vector control for asynchronous motors,
VTC: sensorless vector control for asynchronous motors,
SYN: sinusoidal vector control for synchronous motors (brushless motors)

Special application software is also available, including the most well-known automation functions programmable by the user. See section 1.2 for more details.

Available SINUS PENTA models range from 1.3 kW to 2010 kW.

AVAILABLE SINUS PENTA MODELS

NOTE — Products may have different ratings and/or appearance than the ones shown in the picture above. The proportion of one enclosure to the other is shown as an example and is not binding.

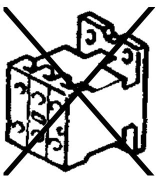
1.1. FEATURE LIST

- One product, five functions:
  - vector-modulation IFD software for general-purpose applications (V/f pattern);
  - sensorless, vector VTC software for high torque demanding performance (direct torque control);
  - vector FOC functionality with an encoder for accurate torque requirements and a wide speed range;
  - vector SYN functionality for applications with brushless, synchronous motors with permanent magnets, requiring very accurate torque values and excellent energy performances;
  - RGN Active Front End function, for power exchange with the mains, with unitary power factor and very low harmonic current;
  - special optional functions for any application (software + instruction manual);

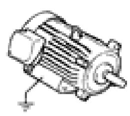
- Wide range of supply voltage values (200 VAC ÷ 690 VAC) both for stand-alone models and cabinet models. Standard power supply, 280 VDC ÷ 970 VDC
- Wide power range: from 1.3 kW to 2010 kW.
- Wide range of voltage values and power values for the electric motors to be connected to any inverter size.

MODEL			LIGHT	STANDARD	HEAVY	STRONG
SINUS PENTA	0025	4TBA2X2	22kW	18.5kW	15kW	11kW

- Built-in filters for the whole SINUS PENTA range in compliance with regulation EN61800-3, issue 2 concerning emission limits.



- No line contactor needed. The new hardware configuration is standard supplied with a safety system including redundant contacts for the inhibition of firing pulses in the power circuit, in compliance with the latest requirements of the safety regulations in force, EN 61800-5-1/EN61800-5-2. (However, respect the specific rules of the field of application).
- Beyond performance enhancement, the new series of SINUS PENTA models is more compact than the prior models; the SINUS PENTA may be installed in cabinets and its design offers a better price/performance ratio.
- Detection of the heatsink temperatures and control component temperatures.
- Automatic control of the cooling system (up to Size S10). The ventilation system activates only when required and indicates any failures of the cooling fan. This ensures a greater energy saving, a minor wear of the cooling fans and reduced noise; In case of equipment failure, it is possible to adjust the system speed in order not to stop the equipment and to limit dissipated power.
- Built-in braking module up to Size S30.
- Noiseless operation ensured by high modulation frequency programmable up to 16 kHz.
- Motor thermal protection to be integrated both through thermal relay function and PTC input (in compliance with DIN44081/2).



- Remotable control panel with a 12-key LCD display showing full words for an easier managing and programming of the displayed measures. Five languages available.
- Function parameter saving to remotable display/keypad and possibility of data transfer to multiple inverters.
- Four access levels to the operation parameters and preset parameters for the most common applications.
- PC interface for WINDOWS environment with REMOTE DRIVE software in six foreign languages.
- PC compiled software for the programming of more than 20 application functions.
- Serial communication RS485 MODBUS RTU for serial links to PCs, PLCs and control interfaces.
- Optional field buses of any type (Profibus DP, Can Bus, Device Net, Ethernet, etc.) through internal communications board.

1.2. SPECIAL APPLICATIONS AVAILABLE ON SINUS PENTA INVERTERS

Beside basic parameterization, PENTA inverters also implement operating modes and optional functional modes named APPLICATIONS, which can be obtained through the firmware updating and/or through additional interface boards.
Optional operating modes available for the inverters of the PENTA series are multipump control application and regenerative inverter control application.

In the future, additional optional operating modes will be available, which include application software, instruction manual and dedicated interface board (if any). They implement the most common automation applications, thus replacing PLCs or dedicated control board, and they reduce to a minimum the electric equipment required, thus ensuring lower maintenance costs.

NOTE — In order to install your application SW and update the firmware packets of your SINUS PENTA, you can use our Remote Drive software. Refer to the user manual for detailed instructions.

1. The multipump application allows to obtain a divided pumping plant, with pressure delivery control, flow control or level control; this application does not need any PLC, because the inverter is capable of controlling multiple pumps at a time.

2. The regenerative application allows PENTA inverters to be used as AC/DC converters for the DC supply of multiple inverters. When operating as an AC/DC converter, the PENTA operates as a bidirectional mains interface both to power connected inverters and to regenerate the braking powers of the connected motors. Mains power supply always provides sinusoidal currents and a unitary power factor, thus allowing to avoid using braking resistors, power factor correction capacitor banks and damping systems of the harmonics delivered to the mains.

Any detail concerning optional functionality is given in separate manuals covering PENTA's optional applications.

0 1 2 3 4 5 6 7 8

2. CAUTION STATEMENTS

This section contains safety statements. The non-observance of these safety instructions may cause serious injury or death and equipment failure. Carefully read the instructions below before installing, starting and operating the inverter.
Only competent personnel must carry out the equipment installation.

SYMBOLS:

DANGER	Indicates operating procedures that, if not correctly performed, may cause serious injury or death due to electrical shock.
CAUTION	Indicates operating procedures that, if not carried out, may cause serious equipment failure.
NOTE	Indicates important hints concerning the equipment operation.

SAFETY STATEMENTS TO FOLLOW WHEN INSTALLING AND OPERATING THE EQUIPMENT:

NOTE

Always read this instruction manual before starting the equipment.

The ground connection of the motor casing should follow a separate path to avoid possible interferences.

DANGER

ALWAYS PROVIDE PROPER GROUNDING OF THE MOTOR CASING AND THE INVERTER FRAME.

The inverter may generate an output frequency up to 1000 Hz; this may cause a motor rotation speed up to 20 (twenty) times the motor rated speed: never use the motor at a higher speed than the max. allowable speed stated on the motor nameplate.

ELECTRICAL SHOCK HAZARD – Never touch the inverter electrical parts when the inverter is on; always wait at least 5 minutes after switching off the inverter before operating on the inverter.

Never perform any operation on the motor when the inverter is on.

Do not perform electrical connections on the motor or the inverter if the inverter is on. Electrical shock hazard exists on output terminals (U,V,W) and resistive braking module terminals (+, -, B) even when the inverter is disabled. Wait at least 5 minutes after switching off the inverter before operating on the electrical connection of the motor or the inverter.

MECHANICAL MOTION – The inverter determines mechanical motion. It is the operator's responsibility to ensure that this does not give rise to any dangerous situation.

EXPLOSION AND FIRE – Explosion and fire hazard exists if the equipment is installed in presence of flammable fumes. Do not install the inverter in places exposed to explosion and fire hazard, even if the motor is installed there.

Do not connect supply voltages exceeding the equipment rated voltage to avoid damaging the internal circuits.

If the inverter is installed in environments exposed to flammable and/or explosive substances (zones AD according to standards IEC 64-2), please refer to IEC 64-2, EN 60079-10 and related standards.

Do not connect the equipment power supply to the output terminals (U,V,W), to the resistive braking module terminals (+, -, B) and to the control terminals. The equipment power supply must be connected only to terminals R,S,T.

Do not short-circuit terminals (+) and (-) and terminals (+) and (B); do not connect any braking resistors with lower ratings than the required ratings.

Do not start or stop the motor using a contactor over the inverter power supply.

Do not install any contactor between the inverter and the motor. Do not connect any power factor correction capacitor to the motor.

Operate the inverter only if a proper grounding is provided.

In case of alarm trip, a comprehensive review of the Diagnostic section in the Programming Manual is recommended; restart the equipment only after removing the cause responsible for the alarm trip.

CAUTION

Do not perform any insulation test between the power terminals or the control terminals.

Make sure that the fastening screws of the control terminal board and the power terminal board are properly tightened.

Do not connect single-phase motors.

Always use a motor thermal protection (use the inverter motor thermal model or a thermoswitch installed in the motor).

Respect the environmental requirements for the equipment installation.

The bearing surface of the inverter must be capable of withstanding high temperatures (up to 90°C).

The inverter electronic boards contain components which may be affected by electrostatic discharges. Do not touch them unless it is strictly necessary. Always be very careful so as to prevent any damage caused by electrostatic discharges.

3. EQUIPMENT DESCRIPTION AND INSTALLATION

The inverters of the SINUS PENTA series are fully digital inverters capable of controlling asynchronous motors and brushless motors up to 2010 kW.
Inverters of the SINUS PENTA series are designed and manufactured in Italy by the technicians of Elettronica Santerno; they incorporate the most advanced features offered by the latest electronic technologies.
SINUS PENTA inverters fit any application thanks to their advanced features, among which: 32-bit multiprocessor control board; vector modulation; power control with the latest IGBTs; high immunity to radio interference; high overload capability.
Any value of the quantities required for the equipment operation may be easily programmed through the keypad, the alphanumeric display and the parameter menus and submenus.
The inverters of the SINUS PENTA series are provided with the following standard features:

- four classes of power supply: 2T (200 – 240 Vac), 4T (380 – 500 Vac), 5T (500 –575 Vac), 6T (575 – 690 Vac);
- EMC filters for industrial environment incorporated in any inverter Size;
- EMC filters for domestic environment incorporated in Sizes S05 and S10;
- DC power supply available as a standard feature;
- built-in braking module up to Size S30;
- serial interface RS485 with communications protocol according to standard MODBUS RTU;
- degree of protection IP20 up to Size S40;
- possibility of providing IP54 up to Size S30;
- 3 analog inputs 0 ± 10 VDC, 0 (4) ÷ 20 mA; one input may be configured as a motor PTC input
- 8 optoisolated digital inputs (PNP inputs);
- 3 configurable analog outputs 0 ÷ 10 V, 4 ÷ 20 mA, 0 ÷ 20 mA;
- 1 optoisolated, "open collector" static digital output;
- 1 optoisolated, "push-pull", high-speed static digital output at high commutation ratio;
- 2 relay digital outputs with reverse contacts;
- Fan control up to size S10.

A comprehensive set of diagnostic messages allows a quick fine-tuning of the parameters during the equipment starting and a quick resolution of any problem during the equipment operation.
The inverters of the SINUS PENTA series have been designed and manufactured in compliance with the requirements of the "Low Voltage Directive", the "Machine Directive", and the "Electromagnetic Compatibility Directive".

3.1. PRODUCTS COVERED IN THIS MANUAL

This manual covers any inverter of the SINUS PENTA, SINUS BOX PENTA, SINUS CABINET PENTA series equipped with the following application software: standard functionality, IFD, VTC, FOC, and SYN.
Any detail concerning optional functionality is given in separate manuals covering PENTA's optional applications.

3.2. INSPECTION UPON RECEIPT OF THE GOODS

Make sure that the equipment is not damaged and that it complies with the equipment you ordered by referring to the nameplate located on the inverter front part. The inverter nameplate is described below. If the equipment is damaged, contact the supplier or the insurance company concerned. If the equipment does not comply with the one you ordered, please contact the supplier as soon as possible.
If the equipment is stored before being started, make sure that the ambient conditions do not exceed the ratings mentioned in Section INSTALLING THE EQUIPMENT. The equipment guarantee covers any manufacturing defect. The manufacturer has no responsibility for possible damages occurred when shipping or unpacking the inverter. The manufacturer is not responsible for possible damages or faults caused by improper and irrational uses; wrong installation; improper conditions of temperature, humidity, or the use of corrosive substances. The manufacturer is not responsible for possible faults due to the inverter operation at values exceeding the inverter ratings and is not responsible for consequential and accidental damages. The equipment is covered by a 3-year guarantee starting from the date of delivery.

Product codification:

SINUS	PENTA	0005	4	T	B	A2	X	2
1	2	3	4	5	6	7	8	9

1	Product line: SINUS stand-alone inverter SINUS BOX inverter contained inside a box SINUS CABINET inverter contained inside a cabinet
2	PENTA control incorporating IFD, VTC, FOC, SYN, RGN functionality
3	Inverter Model
4	Supply voltage 2 = power supply 200÷240VAC; 280÷340VDC. 4 = power supply 380÷500VAC; 530÷705VDC. 5 = power supply 500÷575VAC, 705÷810VDC. 6 = power supply 575÷690VAC; 810÷970VDC.
5	Type of power supply T = three-phase C=direct current S = single-phase (available by request) D=12-pulse bridge
6	Braking module X = no braking chopper (optional external braking chopper) B = built-in braking chopper
7	Type of EMC filter: I = no filter provided, EN50082-1, -2. A1 = integrated filter, EN 61800-3 issue 2 FIRST ENVIRONMENT Category C2, EN55011 gr.1 cl. A for industrial and domestic users, EN50081-2, EN50082-1, -2, EN61800-3-A11. A2 = integrated filter, EN 61800-3 issue 2 SECOND ENVIRONMENT Category C3, EN55011 gr.2 cl. A for industrial and domestic users, EN50081-2, EN50082-1, -2, EN61800-3-A11. B = integrated input filter (type A1) plus external, output toroid filter, EN 61800-3 issue 2 FIRST ENVIRONMENT Category C1, EN55011 gr.1 cl. B for industrial and domestic users, EN50081-1,-2, EN50082-1, -2, EN61800-3-A11.
8	Control panel X = no control panel provided (display/keypad) K = control panel and a back-lit, 16 x 4 character LCD display provided.
9	Degree of protection 0 = IP00 2 = IP20 3 = IP24 4 = IP42 5 = IP54

3.2.1. Inverter Nameplate

Typical nameplate for voltage class 4T:

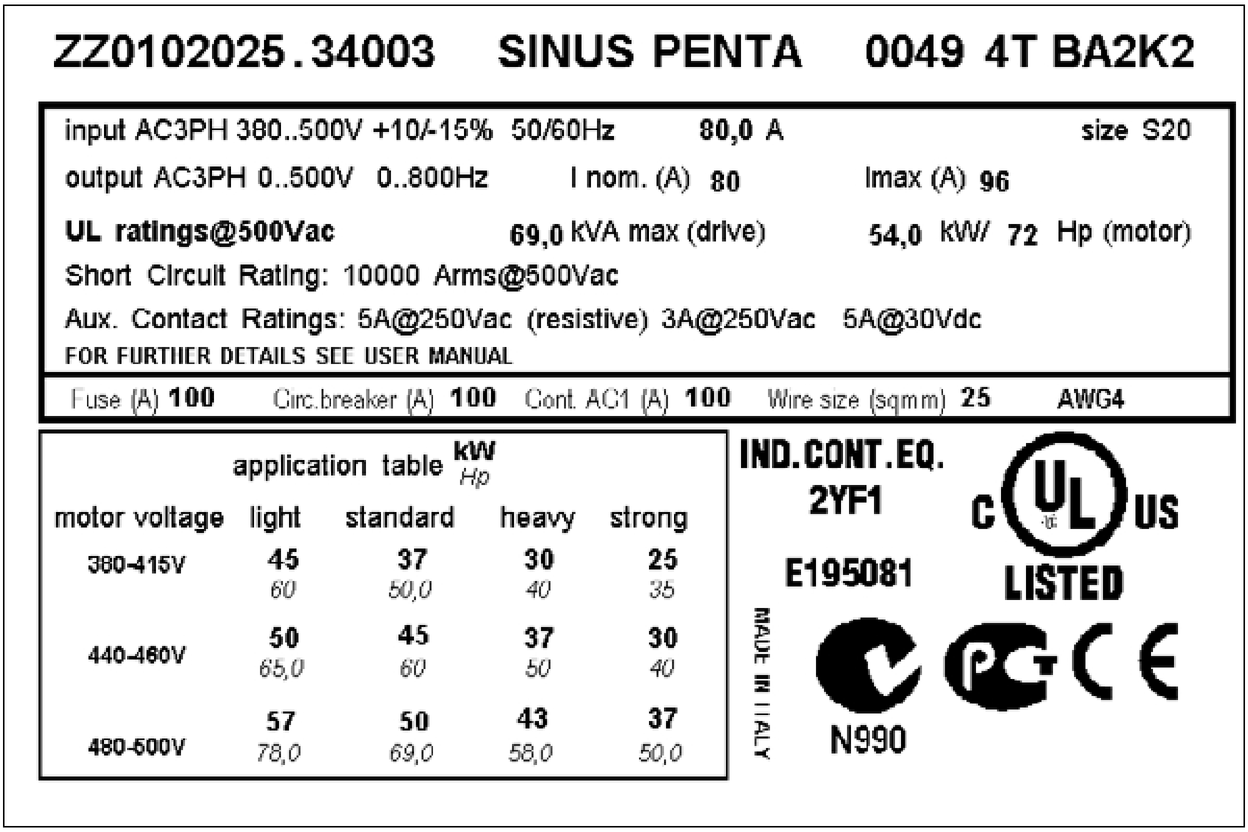


Figure 1: Inverter nameplate

3.3. INSTALLING THE EQUIPMENT

Inverters of the SINUS PENTA series—degree of protection IP20–can be installed inside another enclosure. Only models with degree of protection IP54 may be wall-mounted.
The inverter must be installed vertically.
The ambient conditions, the instructions for the mechanical assembly and the electrical connections of the inverter are detailed in the sections below.

CAUTION Do not install the inverter horizontally or upside-down.

CAUTION Do not mount any heat-sensitive components on top of the inverter to prevent them from damaging due to hot exhaust air.

CAUTION The inverter bottom may reach high temperatures; make sure that the inverter bearing surface is not heat-sensitive.

3.3.1. ENVIRONMENTAL REQUIREMENTS FOR THE EQUIPMENT INSTALLATION, STORAGE AND TRANSPORT

Operating ambient temperatures	0 – 40 °C with no derating from 40°C to 50°C with a 2% derating of the rated current for each degree beyond 40°C
Ambient temperatures for storage and transport	- 25 °C - + 70 °C
Installation environment	Pollution degree 2 or higher. Do not install in direct sunlight and in places exposed to conductive dust, corrosive gases, vibrations, water sprinkling or dripping (except for IP54 models); do not install in salty environments.
Altitude	Up to 1000 m above sea level. For higher altitudes, derate the output current of 1% every 100 m above 1,000 m (max. 4,000 m).
Operating ambient humidity	From 5% to 95%, from 1g/m^3 to 29g/m^3, non condensing and non freezing (class 3k3 according to EN50178)
Storage ambient humidity	From 5% to 95%, from 1g/m^3 to 29g/m^3, non condensing and non freezing (class 1k3 according to EN50178)
Ambient humidity during transport	Max. 95%, up to 60g/m^3; condensation may appear when the equipment is not running (class 2k3 according to EN50178)
Storage and operating atmospheric pressure	From 86 to 106 kPa (classes 3k3 and 1k4 according to EN50178)
Atmospheric pressure during transport	From 70 to 106 kPa (class 2k3 according to EN50178).

CAUTION As ambient conditions strongly affect the inverter life, do not install the equipment in places that do not have the above-mentioned ambient conditions.

3.3.2. AIR COOLING

Make sure to allow adequate clearance around the inverter for the free circulation of air through the equipment. The table below shows the min. clearance to leave with respect to other devices installed near the inverter. The different sizes of the inverter are considered.

Size	A – side clearance (mm)	B – side clearance between two inverters (mm)	C – bottom clearance (mm)	D – top clearance (mm)
S05	20	40	50	100
S10	30	60	60	120
S12	30	60	60	120
S15	30	60	80	150
S20	50	100	100	200
S30	100	200	200	200
S40	100	200	200	300
S50	100	200	200	300
S60	150	300	500	300

Size	Minimum side clearance between two inverter modules (mm)	Maximum side clearance between two inverter modules (mm)	Maximum side clearance between two supply modules (mm)	Maximum side clearance between inverter modules and supply modules (mm)	Top clearance (mm)	Bottom clearance (mm)	Clearance between two inverter units (mm)
S65-S80	20	50	50	400	300	500	300

The air circulation through the enclosure must avoid warm air intake; make sure to provide adequate air-cooling through the inverter. The technical data related to dissipated power is shown in the ratings table.

To calculate the air delivery required for the cabinet cooling consider coefficients for ambient temperature of about 35 °C and altitudes lower than or equal to 1,000 m a.s.l.

The air delivery required is equal to **Q**= (**Pti** – **Pdsu**)/ **Δt**)*3.5 [m^3/h]:

Pti is the overall thermal power dissipated inside the cabinet and expressed in W,
Pdsu is the thermal power dissipated from the cabinet surface,
Δt is the difference between the air temperature inside the cabinet and the air temperature outside the cabinet (temperatures are expressed in degrees centigrade, °C).

For sheet-steel enclosures, power dissipated from the cabinet walls (**Pdsu**) may be calculated as follows: **Pdsu** = 5.5 x **Δt** x **S**
where **S** is equal to the enclosure overall surface in sq m.

Q is the air flow (expressed in m^3 per hour) circulating through the ventilation slots and is the main dimensioning factor to be considered in order to choose the most suitable air-cooling systems.

Example:
Enclosure with a totally free external surface housing a **SINUS PENTA 0113** and a 500 VA transformer dissipating 15 W.

Total power to be dissipated inside the enclosure **(Pti)**:

generated from the inverter	**Pi**	2150
generated from other components	**Pa**	15W
Pti	**Pi + Pa**	2165W

Temperatures:

Max. inside temperature desired	**Ti**	40 °C
Max. outside temperature desired	**Te**	35 °C
Difference between temp. Ti and Te	**Δt**	5 °C

Size of the enclosure (metres):

Width	**W**	0.6m
Height	**H**	1.8m
Depth	**D**	0.6m

Free external surface of the enclosure **S:**
$S = (W \times H) + (W \times H) + (D \times H) + (D \times H) + (D \times W) = 4.68\ m^2$

Thermal power dissipated outside the enclosure **Pdsu** (only for sheet-steel enclosures):
$Pdsu = 5.5 \times \Delta t \times S = 128\ W$

Remaining power to be dissipated:
Pti - Pdsu = 2037 W

To dissipate **Pdiss.** left, provide a ventilation system with the following air delivery **Q**:
$Q = (Pti - Pdsu) / \Delta t) \times 3.5 = 1426\ m^3/h$

The resulting value for air delivery is to be divided by one or multiple fans or air exhausting tower fans.

0 1 2 3 4 5 6 7 8

3.3.3. Size, Weight and Dissipated Power

3.3.3.1. IP20 and IP00 STAND-ALONE Models (S05 – S60) 2T Class

Size	MODEL	L	H	D	Weight	Power Dissipated at Inom
		mm	mm	mm	kg	W
S05	SINUS PENTA 0007	170	340	175	7	160
	SINUS PENTA 0008				7	170
	SINUS PENTA 0010				7	220
	SINUS PENTA 0013				7	220
	SINUS PENTA 0015				7	230
	SINUS PENTA 0016				7	290
	SINUS PENTA 0020				7	320
S10	SINUS PENTA 0016	215	391	218	10.5	350
	SINUS PENTA 0017				10.5	380
	SINUS PENTA 0020				10.5	420
	SINUS PENTA 0025				11.5	525
	SINUS PENTA 0030				11.5	525
	SINUS PENTA 0035				11.5	525
S12	SINUS PENTA 0023	215	401	225	11	390
	SINUS PENTA 0033				12	500
	SINUS PENTA 0037				12	560
S15	SINUS PENTA 0038	225	466	331	22.5	750
	SINUS PENTA 0040				22.5	820
	SINUS PENTA 0049				22.5	950
S20	SINUS PENTA 0060	279	610	332	33.2	950
	SINUS PENTA 0067				33.2	1250
	SINUS PENTA 0074				36	1350
	SINUS PENTA 0086				36	1500
S30	SINUS PENTA 0113	302	748	421	51	2150
	SINUS PENTA 0129				51	2300
	SINUS PENTA 0150				51	2450
	SINUS PENTA 0162				51	2700
S40	SINUS PENTA 0179	630	880	381	112	3200
	SINUS PENTA 0200				112	3650
	SINUS PENTA 0216				112	4100
	SINUS PENTA 0250				112	4250
S50	SINUS PENTA 0312	666	1000	421	148	4900
	SINUS PENTA 0366				148	5600
	SINUS PENTA 0399				148	6400
S60	SINUS PENTA 0457	890	1310	530	260	7400
	SINUS PENTA 0524				260	8400

3.3.3.2. IP20 and IP00 STAND-ALONE Models (S05 – S60) 4T Class

Size	MODEL	L	H	D	Weight	Power Dissipated at Inom
		mm	mm	mm	kg	W
S05	SINUS PENTA 0005	170	340	175	7	215
	SINUS PENTA 0007				7	240
	SINUS PENTA 0009				7	315
	SINUS PENTA 0011				7	315
	SINUS PENTA 0014				7	315
S10	SINUS PENTA 0016	215	391	218	10.5	350
	SINUS PENTA 0017				10.5	380
	SINUS PENTA 0020				10.5	420
	SINUS PENTA 0025				11.5	525
	SINUS PENTA 0030				11.5	525
	SINUS PENTA 0035				11.5	525
S12	SINUS PENTA 0016	215	401	225	10.5	430
	SINUS PENTA 0017				10.5	490
	SINUS PENTA 0020				10.5	490
	SINUS PENTA 0025				11.5	520
	SINUS PENTA 0030				11.5	520
	SINUS PENTA 0034				12.5	680
	SINUS PENTA 0036				12.5	710
S15	SINUS PENTA 0038	225	466	331	22.5	750
	SINUS PENTA 0040				22.5	820
	SINUS PENTA 0049				22.5	950
S20	SINUS PENTA 0060	279	610	332	33.2	950
	SINUS PENTA 0067				33.2	1250
	SINUS PENTA 0074				36	1350
	SINUS PENTA 0086				36	1500
S30	SINUS PENTA 0113	302	748	421	51	2150
	SINUS PENTA 0129				51	2300
	SINUS PENTA 0150				51	2450
	SINUS PENTA 0162				51	2700
S40	SINUS PENTA 0179	630	880	381	112	3200
	SINUS PENTA 0200				112	3650
	SINUS PENTA 0216				112	4100
	SINUS PENTA 0250				112	4250
S50	SINUS PENTA 0312	666	1000	421	148	4900
	SINUS PENTA 0366				148	5600
	SINUS PENTA 0399				148	6400
S60	SINUS PENTA 0457	890	1310	530	260	7400
	SINUS PENTA 0524				260	8400

3.3.3.3. MODULAR IP00 STAND-ALONE MODELS (S64 – S80)

To obtain high-power inverters, the following individual modules are matched together:

- Control unit, containing ES821 control board and ES842 control board
- Feeder module, composed of a 3-phase power rectifier and its control and power supply circuits
- Inverter module, composed of an inverter phase and its control circuits
- Braking unit.

Four types of inverter modules are available:

Basic version
Version with integrated control unit
Version with integrated auxiliary supply unit (to be used for those models which are not equipped with the power supply module, i.e. S64 and S74)
Version with integrated splitter unit (to be used for the Penta sizes where parallel-connected inverter modules are installed).

Match the elements above to obtain the proper inverter dimensioning for your application.

CAUTION **Properly configure control board ES842 inside the control unit. When ordering the inverter, always state the inverter configuration you want to obtain.**

a) control unit

The control unit can be installed separately from the inverter modules or inside an inverter module (this option must be stated when ordering the inverter). Dimensions of the control unit (separate from the inverter).

EQUIPMENT	W	H	D	Weight	Dissipated power
	mm	mm	mm	kg	W
Control unit	222	410	189	6	100

NOTE In the standard configuration, the control unit is installed on an inverter module.

b) Inverter modules and supply modules

Configuration: power supply delivered from the mains

Models where no parallel-connected inverter modules are installed (S65 and S70)

Size	SINUS PENTA Model	Voltage Class	Modules		Dimensions		Weight			Power dissipated at Inom		
			Power Supply Modules	Inverter Modules	Single Module	Min. Overall Dimensions	Power Supply Module	Inverter Module	Overall Weight	Power Supply Module	Inverter Module	Overall Dissipated Pwr
					LxHxD	LxHxD	kg	kg	kg	kW	kW	kW
S65	0598	2T-4T	1	3	230x1400x480(*)	980x1400x560	110	110	440	2.25	2.5	9.75
	0748	2T-4T	1	3						2.5	2.75	10.75
	0831	2T-4T	1	3						3.0	3.3	12.9
	0250	5T-6T	1	3						1.1	1.3	5.0
	0312	5T-6T	1	3						1.3	1.6	6.1
	0366	5T-6T	1	3						1.5	1.8	6.9
	0399	5T-6T	1	3						1.7	2.1	8.0
	0457	5T-6T	1	3						1.95	2.4	9.15
	0524	5T-6T	1	3						2.0	2.6	9.8
	0598	5T-6T	1	3						2.4	2.95	11.25
	0748	5T-6T	1	3						2.7	3.25	12.45
S70	0831	5T-6T	2	3		1230x1400x560			550	1.6	3.9	14.9

(*): When housing the control unit, the module depth becomes 560 mm.

Models including parallel-connected inverter modules (S75 and S80)

Size	SINUS PENTA Model	Voltage Class	Modules		Dimensions		Weight			Power dissipated at Inom		
			Power Supply Modules	Inverter Modules (**)	Single Module	Min. Overall Dimensions	Power Supply Module	Inverter Module	Overall Weight	Power Supply Module	Inverter Module	Overall Dissipated Pwr
					LxHxD	LxHxD	kg	kg	kg	kW	kW	kW
S75	0964	2T-4T	2	6	230x1400x480(*)	1980x1400x560	110	110	880	1.1	2.2	15.4
	1130	2T-4T	2	6						1.3	2.4	17.0
	1296	2T-4T	2	6						1.5	2.6	18.6
	0964	5T-6T	2	6						1.6	2.4	17.6
S80	1130	5T-6T	3	6		2230x1400x560			990	1.3	3.0	21.9
	1296	5T-6T	3	6						1.6	3.2	24.0

(*): When housing the control unit or the splitter unit, the module depth becomes 560 mm.
(**): Three inverter modules must be provided with an integrated splitter unit.

0 1 2 3 4 5 6 7 8

c) Inverter, feeder and braking unit

Configuration: power supply delivered from the mains; integrated braking unit

Models where no parallel-connected inverter modules are installed (S65 and S70)

Size	SINUS PENTA Model	Voltage Class	Modules			Dimensions		Weight				Power dissipated at Inom		Power Dissipated with 50% Braking Duty Cycle	Overall Dissipated Power
			Power Supply Modules	Inverter Modules	Braking Modules	Single Module	Min. Overall Dimensions	Power Supply Module	Inverter Module	Braking Module	Overall Weight	Power Supply Module	Inverter Module	Braking Module	
						LxHxD	LxHxD	kg	kg	kg	kg	kW	kW	kW	kW
S65	0598	2T-4T	1	3	1	230x1400 x480 (*)	1230x1400 x560	110	110	110	550	2.25	2.5	0.8	10.55
	0748	2T-4T	1	3	1							2.5	2.75	0.9	11.65
	0831	2T-4T	1	3	1							3.0	3.3	1.0	13.9
	0250	5T-6T	1	3	1							1.1	1.3	0.5	5.5
	0312	5T-6T	1	3	1							1.3	1.6	0.6	6.7
	0366	5T-6T	1	3	1							1.5	1.8	0.7	7.6
	0399	5T-6T	1	3	1							1.7	2.1	0.8	8.8
	0457	5T-6T	1	3	1							1.95	2.4	0.9	10.05
	0524	5T-6T	1	3	1							2.0	2.6	1.0	10.8
	0598	5T-6T	1	3	1							2.4	2.95	1.2	12.45
	0748	5T-6T	1	3	1							2.7	3.25	1.3	13.75
S70	0831	5T-6T	2	3	1		1480x1400 x560				660	1.6	3.9	1.5	14.9

(*): When housing the control unit, the module depth becomes 560 mm.

Models including parallel-connected inverter modules (S75 and S80)

Size	SINUS PENTA Model	Voltage Class	Modules			Dimensions		Weight				Power Dissipated at Inom		Power Dissipated with 50% Braking Duty Cycle	Overall Dissipated Power
			Power Supply Modules	Inverter Modules(**)	Braking Modules	Single Module	Min. Overall Dimensions	Power Supply Module	Inverter Module	Braking Module	Overall Weight	Power Supply Module	Inverter Module	Braking Module	
						LxHxD	LxHxD	kg	kg	kg	kg	kW	kW	kW	kW
S75	0964	2T-4T	2	6	1	230x1400 x480(*)	2230x1400 x560	110	110	110	990	1.1	2.2	1.3	16.7
	1130	2T-4T	2	6	1							1.3	2.4	1.5	18.5
	1296	2T-4T	2	6	1							1.5	2.6	1.8	20.4
	0964	5T-6T	2	6	1							1.6	2.4	1.9	19.5
S80	1130	5T-6T	3	6	1		2480x1400 x560				1100	1.3	3.0	2.2	24.1
	1296	5T-6T	3	6	1							1.6	3.2	2.4	26.4

(*): When housing the control unit or the splitter unit, the module depth is 560 mm.
(**): Three inverter modules must be provided with an integrated splitter unit.

d) Inverter modules only

Configuration:
- inverter powered directly from a DC power supply source;
- inverter used as a regenerative feeder (for more details, please refer to the technical documentation relating to the Regenerative Penta Drive)

Models where no parallel-connected inverter modules are installed (S64)

Size	SINUS PENTA Model	Voltage Class	Modules		Dimensions		Weight			Power Dissipated at Inom	
			Inverter Modules with Auxiliary Power Supply Unit	Inverter Modules (**)	Single Module	Min. Overall Dimensions	Inverter Modules with Auxiliary Power Supply Unit	Inverter Module	Overall Weight	Single Inverter Module	Overall Dissipated Power
					LxHxD	LxHxD	kg	kg	kg	kW	kW
S64	0598	2T-4T	1	2	230x1400 x480(*)	730x1400 x560	118	110	338	2.5	7.5
	0748	2T-4T	1	2						2.75	8.25
	0831	2T-4T	1	2						3.3	9.9
	0250	5T-6T	1	2						1.3	3.9
	0312	5T-6T	1	2						1.6	4.8
	0366	5T-6T	1	2						1.8	5.4
	0399	5T-6T	1	2						2.1	6.3
	0457	5T-6T	1	2						2.4	7.2
	0524	5T-6T	1	2						2.6	7.8
	0598	5T-6T	1	2						2.95	8.85
	0748	5T-6T	1	2						3.25	9.75
	0831	5T-6T	1	2						3.9	11.7

(*): When housing the control unit or the auxiliary power supply unit, the module depth is 560 mm.
(**): One inverter module must be provided with an integrated auxiliary power supply unit.

Models including parallel-connected inverter modules (S74)

Size	SINUS PENTA Model	Voltage Class	Modules		Dimensions		Weight			Power Dissipated at Inom	
			Inverter Modules with Auxiliary Power Supply Unit	Inverter Modules (**)	Single Module	Min. Overall Dimensions	Inverter Modules with Auxiliary Power Supply Unit	Inverter Module	Overall Weight	Single Inverter Module	Overall Dissipated Power
					LxHxD	LxHxD	kg	kg	kg	kW	kW
S74	0964	2T-4T	2	4	230x1400 x480(*)	1480x1400 x560	118	110	776	2.2	12.2
	1130	2T-4T	2	4						2.4	14.4
	1296	2T-4T	2	4						2.6	15.6
	0964	5T-6T	2	4						2.4	14.4
	1130	5T-6T	2	4						3.0	18.0
	1296	5T-6T	2	4						3.2	19.2

(*): When housing the control unit or the splitter unit or the auxiliary power supply unit, the module depth is 560 mm.
(**): Three inverter modules must be provided with an integrated splitter unit. Two inverter modules must be provided with an integrated auxiliary power supply unit.

e) Inverter modules and braking module only

Configuration: inverter powered directly from a DC power supply source with a braking unit.

Models where no parallel-connected inverter modules are installed (S64)

Size	SINUS PENTA Model	Voltage Class	Modules			Dimensions		Weight				Power Dissipated at Inom	Power Dissipated with 50% Braking Duty Cycle	Overall Dissipated Power
			Inverter Modules with Auxiliary Power Supply Unit	Inverter Modules (**)	Braking Module	Single Module	Min. Overall Dimensions	Inverter Modules with Auxiliary Power Supply Unit	Inverter Module	Braking Module	Overall Weight	Inverter Module	Braking Module	
						LxHxD	LxHxD	kg	kg	kg	kg	kW	kW	kW
S64	0598	2T-4T	1	2	1	230x1400 x480 (*)	980x1400x560	118	110	110	448	2.5	0.8	8.3
	0748	2T-4T	1	2	1							2.75	0.9	9.15
	0831	2T-4T	1	2	1							3.3	1.0	10.9
	0250	5T-6T	1	2	1							1.3	0.5	4.4
	0312	5T-6T	1	2	1							1.6	0.6	5.4
	0366	5T-6T	1	2	1							1.8	0.7	6.1
	0399	5T-6T	1	2	1							2.1	0.8	7.1
	0457	5T-6T	1	2	1							2.4	0.9	8.1
	0524	5T-6T	1	2	1							2.6	1.0	8.8
	0598	5T-6T	1	2	1							2.95	1.2	10.05
	0748	5T-6T	1	2	1							3.25	1.3	11.05
	0831	5T-6T	1	2	1							3.9	1.5	13.2

(*): When housing the control unit or the auxiliary power supply unit, the module depth is 560 mm.
(**): One inverter module must be provided with an integrated auxiliary power supply unit.

Models including parallel-connected inverter modules (S74)

Size	SINUS PENTA Model	Voltage Class	Modules			Dimensions		Weight				Power Dissipated at Inom	Power Dissipated with 50% Braking Duty Cycle	Overall Dissipated Power
			Inverter Modules with Auxiliary Power Supply Unit	Inverter Modules (**)	Braking Module	Single Module	Min. Overall Dimensions	Inverter Modules with Auxiliary Power Supply Unit	Inverter Module	Braking Module	Overall Weight	Inverter Module	Braking Module	
						LxHxD	LxHxD	kg	kg	kg	kg	kW	kW	kW
S74	0964	2T-4T	2	4	1	230x1400 x480 (*)	1730x1400x560	118	110	110	786	2.2	1.3	14.5
	1130	2T-4T	2	4	1							2.4	1.5	15.9
	1296	2T-4T	2	4	1							2.6	1.8	17.4
	0964	5T-6T	2	4	1							2.4	1.9	16.3
	1130	5T-6T	2	4	1							3.0	2.2	20.2
	1296	5T-6T	2	4	1							3.2	2.4	21.6

(*): When housing the control unit or the splitter unit or the auxiliary power supply unit, the module depth is 560 mm.
(**): Three inverter modules must be provided with an integrated splitter unit. Two inverter modules must be provided with an integrated auxiliary power supply unit.

3.3.3.4. IP54 STAND-ALONE MODELS (S05-S30) 2T CLASS

Size	MODEL	L	H	D	Weight	Power Dissipated at Inom.
		mm	mm	mm	kg	W
S05	SINUS PENTA 0007	214	577	227	15.7	160
	SINUS PENTA 0008				15.7	170
	SINUS PENTA 0010				15.7	220
	SINUS PENTA 0013				15.7	220
	SINUS PENTA 0015				15.7	230
	SINUS PENTA 0016				15.7	290
	SINUS PENTA 0020				15.7	320
S10	SINUS PENTA 0016	250	622	268	22.3	350
	SINUS PENTA 0017				22.3	380
	SINUS PENTA 0020				22.3	420
	SINUS PENTA 0025				23.3	525
	SINUS PENTA 0030				23.3	520
	SINUS PENTA 0035				23.3	525
S12	SINUS PENTA 0023	250	622	268	23.3	390
	SINUS PENTA 0033				23.3	500
	SINUS PENTA 0037				23.8	560
S15	SINUS PENTA 0038	288	715	366	40	750
	SINUS PENTA 0040				40	820
	SINUS PENTA 0049				40	950
S20	SINUS PENTA 0060	339	842	366	54.2	1050
	SINUS PENTA 0067				54.2	1250
	SINUS PENTA 0074				57	1350
	SINUS PENTA 0086				57	1500
S30	SINUS PENTA 0113	359	1008	460	76	2150
	SINUS PENTA 0129				76	2300
	SINUS PENTA 0150				76	2450
	SINUS PENTA 0162				76	2700

OPTIONAL FEATURES:

Front key-operated selector switch for
LOCAL/REMOTE control and EMERGENCY pushbutton.

NOTE

When housing optional features, depth becomes 40mm.

0 1 2 3 4 5 6 7 8

3.3.3.5. IP54 STAND-ALONE MODELS (S05-S30) 4T CLASS

Size	MODEL	L	H	D	Weight	Power Dissipated at Inom
		mm	mm	mm	kg	W
S05	SINUS PENTA 0005	214	577	227	15.7	215
	SINUS PENTA 0007				15.7	240
	SINUS PENTA 0009				15.7	315
	SINUS PENTA 0011				15.7	315
	SINUS PENTA 0014				15.7	315
S10	SINUS PENTA 0016	250	622	268	22.3	350
	SINUS PENTA 0017				22.3	380
	SINUS PENTA 0020				22.3	420
	SINUS PENTA 0025				23.3	525
	SINUS PENTA 0030				23.3	520
	SINUS PENTA 0035				23.3	525
S12	SINUS PENTA 0016	250	622	268	22.3	430
	SINUS PENTA 0017				22.3	490
	SINUS PENTA 0020				22.3	490
	SINUS PENTA 0025				23.3	520
	SINUS PENTA 0030				23.3	520
	SINUS PENTA 0034				24.3	680
	SINUS PENTA 0036				24.3	710
S15	SINUS PENTA 0038	288	715	366	40	750
	SINUS PENTA 0040				40	820
	SINUS PENTA 0049				40	950
S20	SINUS PENTA 0060	339	842	366	54.2	1050
	SINUS PENTA 0067				54.2	1250
	SINUS PENTA 0074				57	1350
	SINUS PENTA 0086				57	1500
S30	SINUS PENTA 0113	359	1008	460	76	2150
	SINUS PENTA 0129				76	2300
	SINUS PENTA 0150				76	2450
	SINUS PENTA 0162				76	2700

OPTIONAL FEATURES:

Front key-operated selector switch for
LOCAL/REMOTE control and EMERGENCY pushbutton.

NOTE

When housing optional features, depth becomes 40mm.

3.3.3.6. IP54 BOX MODELS (S05-S20) 2T CLASS

Size	MODEL	L	H	D	Weight	Power Dissipated at Inom.
		mm	mm	mm	kg	W
	SINUS BOX PENTA 0007				27.9	160
	SINUS BOX PENTA 0008				27.9	170
	SINUS BOX PENTA 0010				27.9	220
S05B	SINUS BOX PENTA 0013	400	600	250	27.9	220
	SINUS BOX PENTA 0015				27.9	230
	SINUS BOX PENTA 0016				27.9	290
	SINUS BOX PENTA 0020				27.9	320
	SINUS BOX PENTA 0016				48.5	350
	SINUS BOX PENTA 0017				48.5	380
S10B	SINUS BOX PENTA 0020	500	700	300	48.5	420
	SINUS BOX PENTA 0025				49.5	525
	SINUS BOX PENTA 0030				49.5	525
	SINUS BOX PENTA 0035				49.5	525
	SINUS BOX PENTA 0023				48.5	390
S12B	SINUS BOX PENTA 0033	500	700	300	49.5	500
	SINUS BOX PENTA 0037				49.5	560
	SINUS BOX PENTA 0038	600	1000	400	78.2	750
S15B	SINUS BOX PENTA 0040				78.2	820
	SINUS BOX PENTA 0049				78.2	950
	SINUS BOX PENTA 0060				109.5	1050
S20B	SINUS BOX PENTA 0067	600	1200	400	109.5	1250
	SINUS BOX PENTA 0074				112.3	1350
	SINUS BOX PENTA 0086				112.3	1500

OPTIONAL FEATURES:

Disconnecting switch with line fast fuses.
Line magnetic circuit breaker with release coil.
Line contactor in AC1.
Front key-operated selector switch for
LOCAL/REMOTE control and EMERGENCY push-button.
Line input impedance.
Motor-side output impedance.
Output toroid filter.
Motor forced-cooling circuit.
Anticondensation resistance.
Additional terminal board for input/output wires.

NOTE Dimensions and weights may vary depending on optional components required.

3.3.3.7. IP54 BOX MODELS (S05-S20) 4T CLASS

Size	MODEL	L	H	D	Weight	Power Dissipated at Inom.
		mm	mm	mm	kg	W
S05B	SINUS BOX PENTA 0005	400	600	250	27.9	215
	SINUS BOX PENTA 0007				27.9	240
	SINUS BOX PENTA 0009				27.9	315
	SINUS BOX PENTA 0011				27.9	315
	SINUS BOX PENTA 0014				27.9	315
S10B	SINUS BOX PENTA 0016	500	700	300	48.5	350
	SINUS BOX PENTA 0017				48.5	380
	SINUS BOX PENTA 0020				48.5	420
	SINUS BOX PENTA 0025				49.5	525
	SINUS BOX PENTA 0030				49.5	525
	SINUS BOX PENTA 0035				49.5	525
S12B	SINUS BOX PENTA 0016	500	700	300	48.5	430
	SINUS BOX PENTA 0017				48.5	490
	SINUS BOX PENTA 0020				48.5	490
	SINUS BOX PENTA 0025				49.5	520
	SINUS BOX PENTA 0030				49.5	520
	SINUS BOX PENTA 0034				50.5	680
	SINUS BOX PENTA 0036				50.5	710
S15B	SINUS BOX PENTA 0038	600	1000	400	78.2	750
	SINUS BOX PENTA 0040				78.2	820
	SINUS BOX PENTA 0049				78.2	950
S20B	SINUS BOX PENTA 0060	600	1200	400	109.5	1050
	SINUS BOX PENTA 0067				109.5	1250
	SINUS BOX PENTA 0074				112.3	1350
	SINUS BOX PENTA 0086				112.3	1500

OPTIONAL FEATURES:

Disconnecting switch with line fast fuses.
Line magnetic circuit breaker with release coil.
Line contactor in AC1.
Front key-operated selector switch for
LOCAL/REMOTE control and EMERGENCY push-button.
Line input impedance.
Motor-side output impedance.
Output toroid filter.
Motor forced-cooling circuit.
Anticondensation resistance.
Additional terminal board for input/output wires.

NOTE Dimensions and weights may vary depending on optional components required.

3.3.3.8. IP24 - IP54 CABINET MODELS (S15-S80)

Size	MODEL		Voltage Class	L	H	D	WEIGHT	Power Dissipated at Inom.
				mm	mm	mm	kg	W
S15C	SINUS CABINET PENTA	0049	2T-4T	600	2000	500	130	950
S20C	SINUS CABINET PENTA	0060	2T-4T				140	1050
	SINUS CABINET PENTA	0067						1250
	SINUS CABINET PENTA	0074					143	1350
	SINUS CABINET PENTA	0086						1500
S30C	SINUS CABINET PENTA	0113	2T-4T			600	162	2150
	SINUS CABINET PENTA	0129						2300
	SINUS CABINET PENTA	0150						2450
	SINUS CABINET PENTA	0162						2700
S40C	SINUS CABINET PENTA	0179	2T-4T	1000			279	3200
	SINUS CABINET PENTA	0200						3650
	SINUS CABINET PENTA	0216						4100
	SINUS CABINET PENTA	0250						4250
S50C	SINUS CABINET PENTA	0312	2T-4T	1200			350	4900
	SINUS CABINET PENTA	0366						5600
	SINUS CABINET PENTA	0399						6400
S60C	SINUS CABINET PENTA	0457	2T-4T	1600	2350	800	586	7400
	SINUS CABINET PENTA	0524						8400
S65C	SINUS CABINET PENTA	0598	2T-4T	2000			854	9750
	SINUS CABINET PENTA	0748						10750
	SINUS CABINET PENTA	0831						12900
	SINUS CABINET PENTA	0250	5T-6T					5000
	SINUS CABINET PENTA	0312						6100
	SINUS CABINET PENTA	0366						6900
	SINUS CABINET PENTA	0399						8000
	SINUS CABINET PENTA	0457						9150
	SINUS CABINET PENTA	0524						9800
	SINUS CABINET PENTA	0598						11250
	SINUS CABINET PENTA	0748						12450

(continued)

(continued)

S70C	SINUS CABINET PENTA	0831	5T-6T	2200	2350	800	1007	14900
S75C	SINUS CABINET PENTA	0964	2T-4T				1468	15400
	SINUS CABINET PENTA	1130	2T-4T					17000
	SINUS CABINET PENTA	1296	2T-4T					18600
	SINUS CABINET PENTA	0964	5T-6T	3000				17600
S80C	SINUS CABINET PENTA	1130	5T-6T				1700	21900
	SINUS CABINET PENTA	1296	5T-6T	3400				24000

NOTE Dimensions and weights may vary depending on optional components required.

AVAILABLE OPTIONAL FEATURES:
- Disconnecting switch with line fast fuses.
- Line magnetic circuit breaker with release coil.
- Line contactor in AC1.
  Front key-operated selector switch for LOCAL/REMOTE control and EMERGENCY pushbutton.
- Line input impedance.
- Motor-side output impedance.
- Additional terminal board for input/output wires.
- Output toroid filter. Motor forced-cooling circuit.
- Braking unit for size ≥ S40.
- Anticondensation resistance.
- PT100 instruments for motor temperature control.
- Optional features/components by request.

3.3.4. Standard Mounting And Fixing Points (Stand-Alone Models IP20 And IP00 S05 – S60)

SINUS PENTA Size	Fixing Templates (mm) (Standard Mounting)					
	X	X1	Y	D1	D2	Fastening screws
S05	156	-	321	4.5	-	M4
S10	192	-	377	6	12.5	M5
S12	192	-	377	6	12.5	M5
S15	185	-	449	7	15	M6
S20	175	-	593	7	15	M6
S30	213	-	725	9	20	M8
S40	540	270	857	9	20	M8
S50	560	280	975	11	21	M8-M10
S60	570	285	1238	13	28	M10-M12

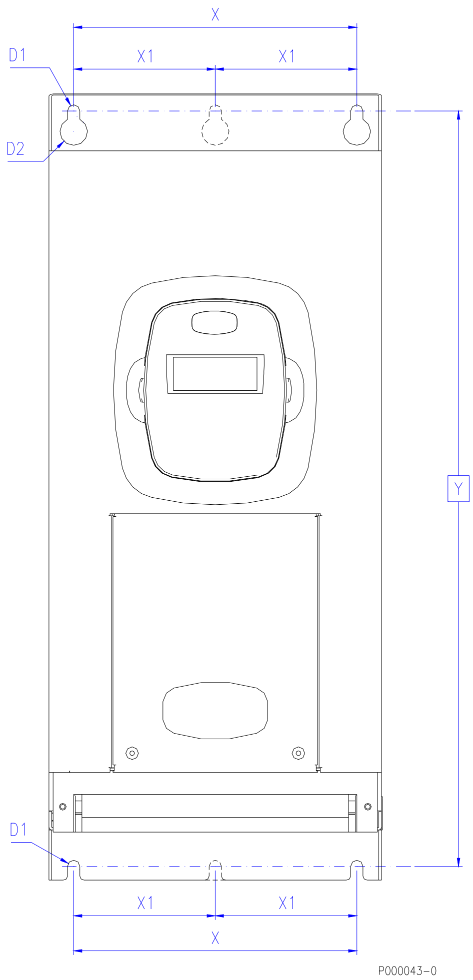


Figure 2: Fixing points for STAND-ALONE models from S05 to S50 included

Size S60 has an IP00 open cabinet and can be installed only inside the equipment enclosure.

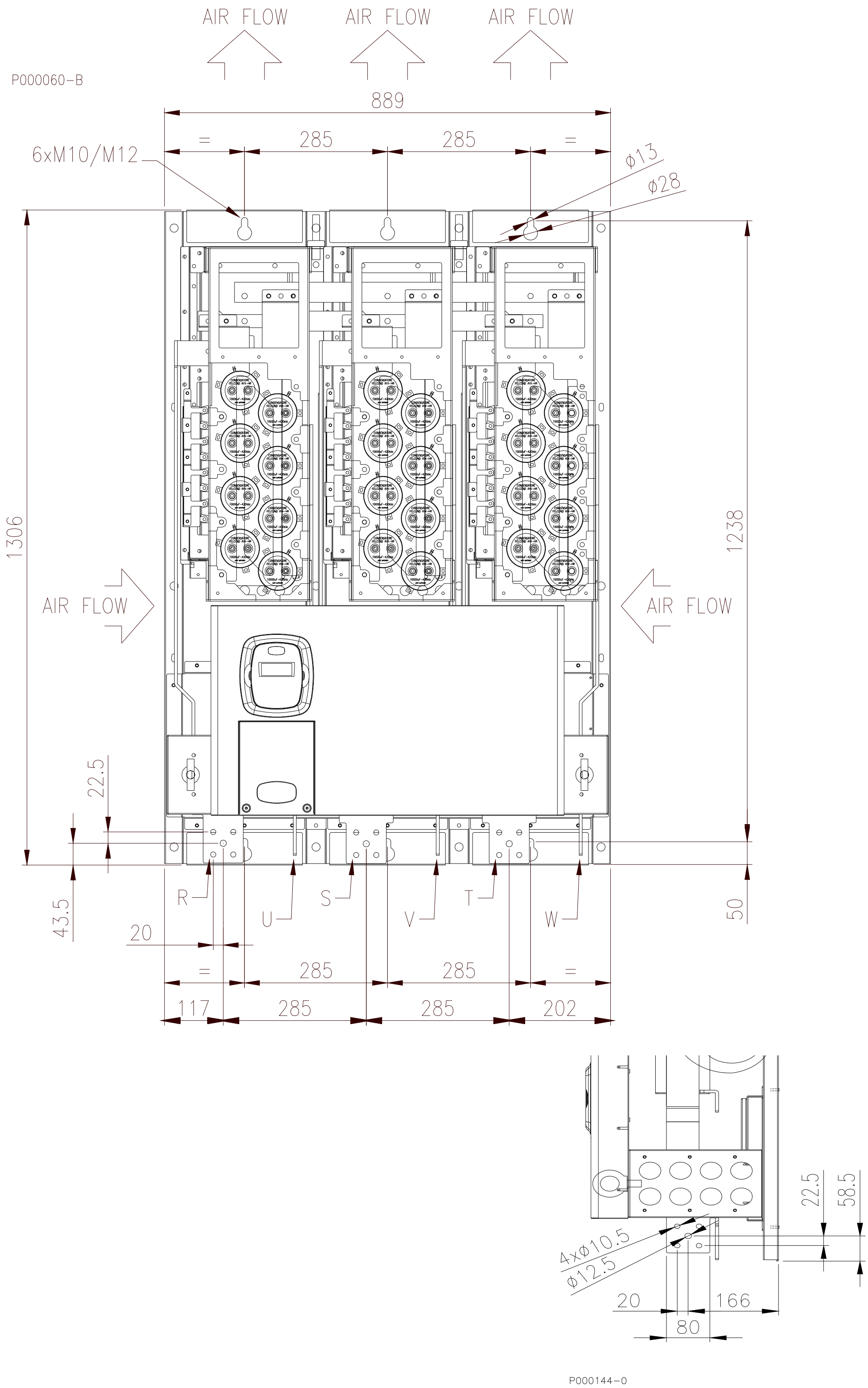


Figure 3: Piercing template for size S60

3.3.5. THROUGH-PANEL ASSEMBLY AND PIERCING TEMPLATES (STAND-ALONE MODELS S05 TO S50)

The through-panel assembly allows to segregate the air flow cooling the power section in order to avoid dissipating power related to inverter loss inside the inverter case. The inverters available for through-panel assembly are from size S05 to S50, both IP20 and IP00. As a result, unless other features are included, IP44 rating becomes IP40.

3.3.5.1. SINUS PENTA S05

For this inverter size, no actual through-panel assembly is used, but the air flow of the power section is segregated from the air flow of the control section by installing two optional mechanical parts to be assembled with five (5) M4 self-forming screws.

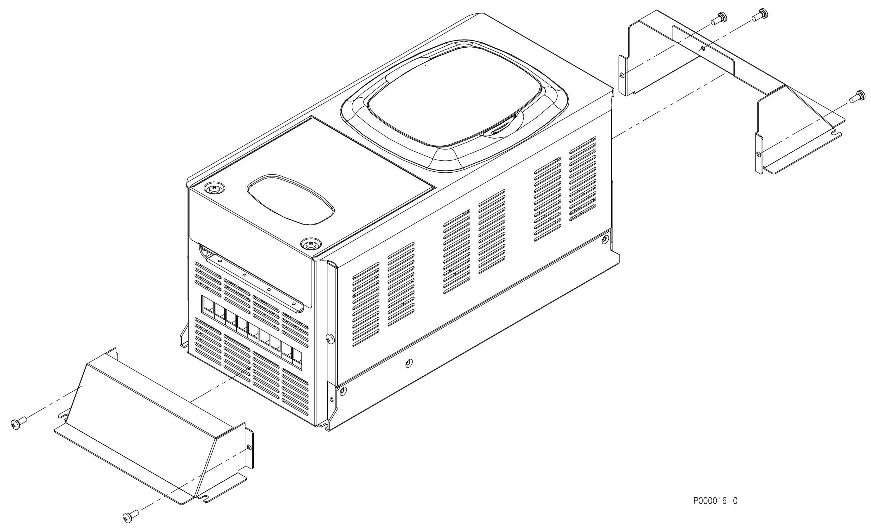


Figure 4: Fittings for through-panel assembly for SINUS PENTA S05

The equipment height becomes 488 mm with the two additional components (see figure on the left below). The same figure below also shows the piercing template of the mounting panel, including four M4 holes for the inverter mounting and two slots (142 x 76 mm and 142 x 46 mm) for the air-cooling of the power section.

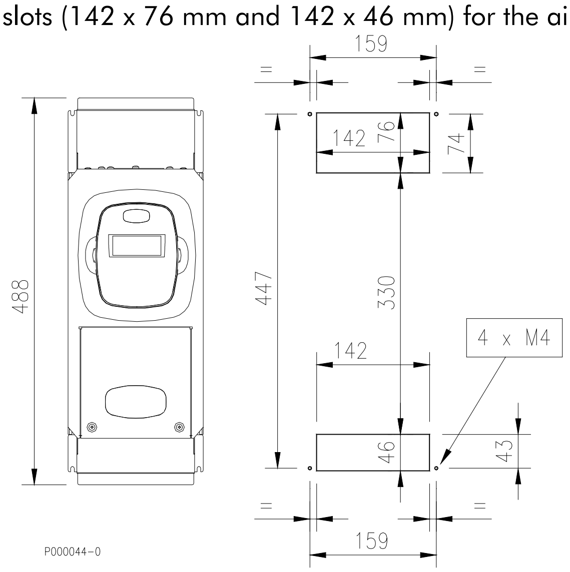


Figure 5: Piercing templates for through-panel assembly for SINUS PENTA S05

0 1 2 3 4 5 6 7 8

3.3.5.2. SINUS PENTA S10

A through-panel assembly kit is provided for this inverter size, to be mounted on the inverter. No. 13 self-forming M4 screws are used for this type of assembly.

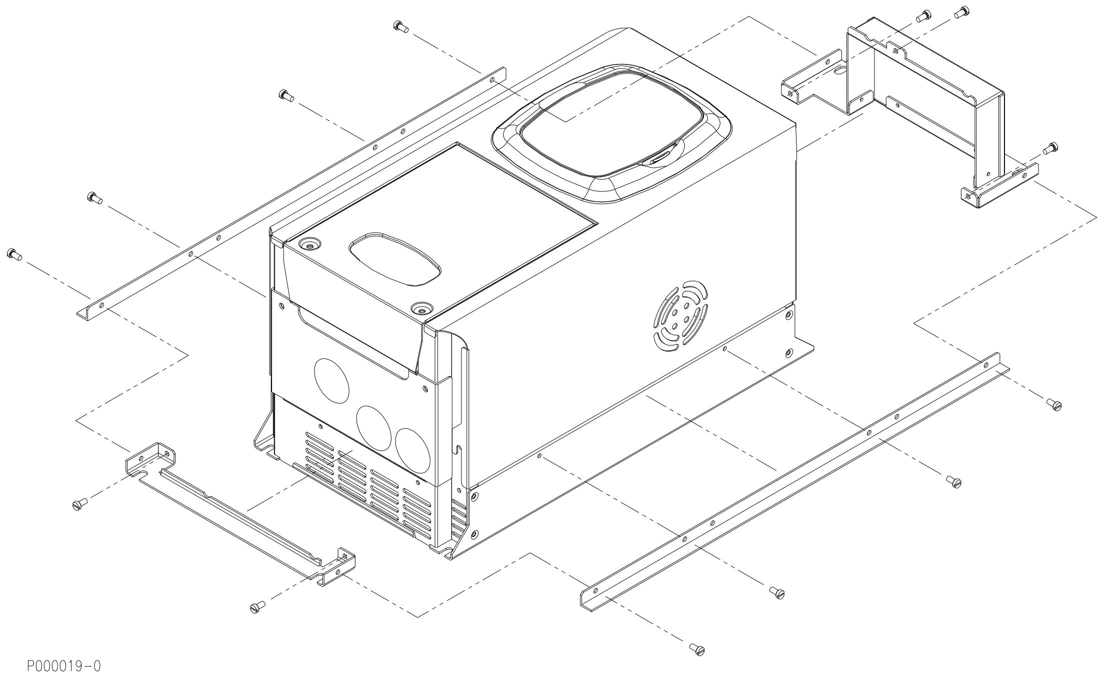


Figure 6: Fittings for through-panel assembly for SINUS PENTA S10

The overall dimensions of the equipment including the through-panel assembly kit are 452 x 238 mm (see figure below). The figure shows the piercing template of the mounting panel, including four holes M5 and a rectangular slot (218 x 420 mm) as well as the equipment side view with two air flows (air flow “A” for the control section and air flow “B” for the power section).

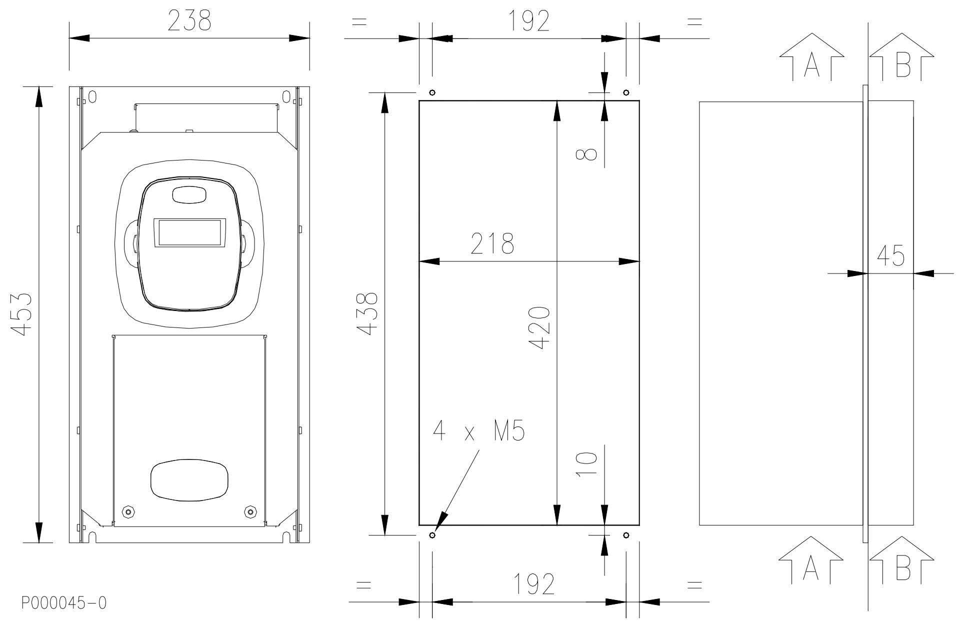


Figure 7: Piercing template for through-panel assembly for SINUS PENTA S10

3.3.5.3. SINUS PENTA S12

For this inverter size, no actual through-panel assembly is used, but the air flow of the power section is segregated from the air flow of the control section by installing two optional mechanical parts to be assembled with five (5) M4 self-forming screws (see figure below).

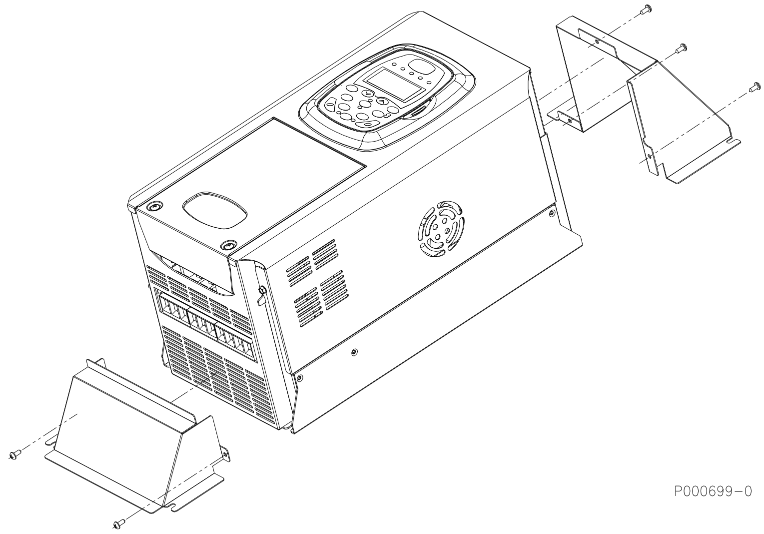


Figure 8: Fittings for through-panel assembly for SINUS PENTA S12

The equipment height becomes 583 mm with the two additional components (see figure on the left below). The same figure below also shows the piercing template of the mounting panel, including four M4 holes for the inverter mounting and two slots (175 x 77 mm and 175 x 61 mm) for the air-cooling of the power section.

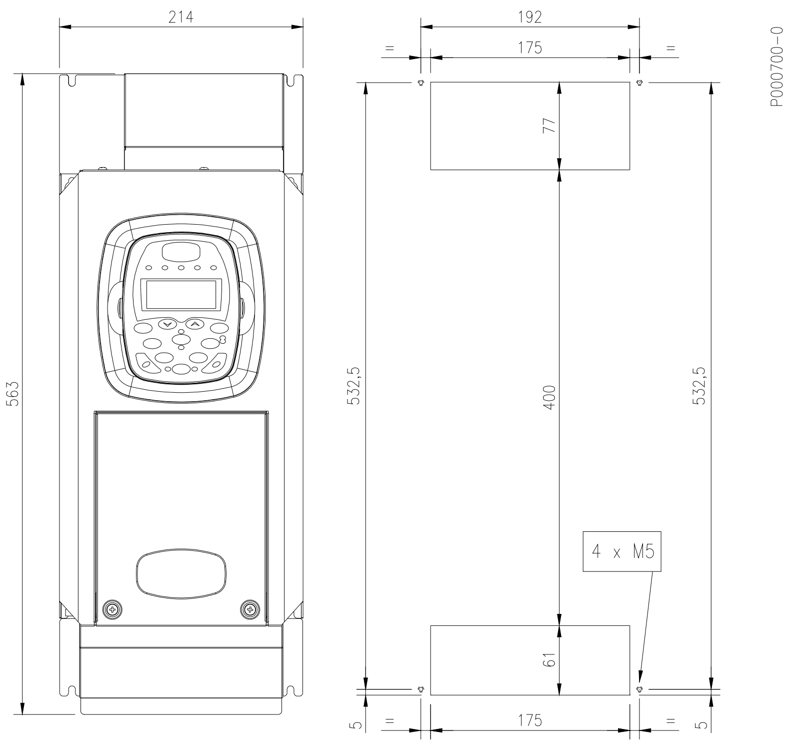


Figure 9: Piercing template for through-panel assembly for SINUS PENTA S12

3.3.5.4. SINUS PENTA S15-S20-S30

No additional mechanical component is required for the through-panel assembly of these three SINUS PENTA sizes. The piercing template shown in the figure below is to be made on the mounting panel. Measures are shown in the table. The figure below also shows the side view of the through-panel assembly of the equipment. The air flows and the front and rear projections are highlighted as well (see measures in the table).

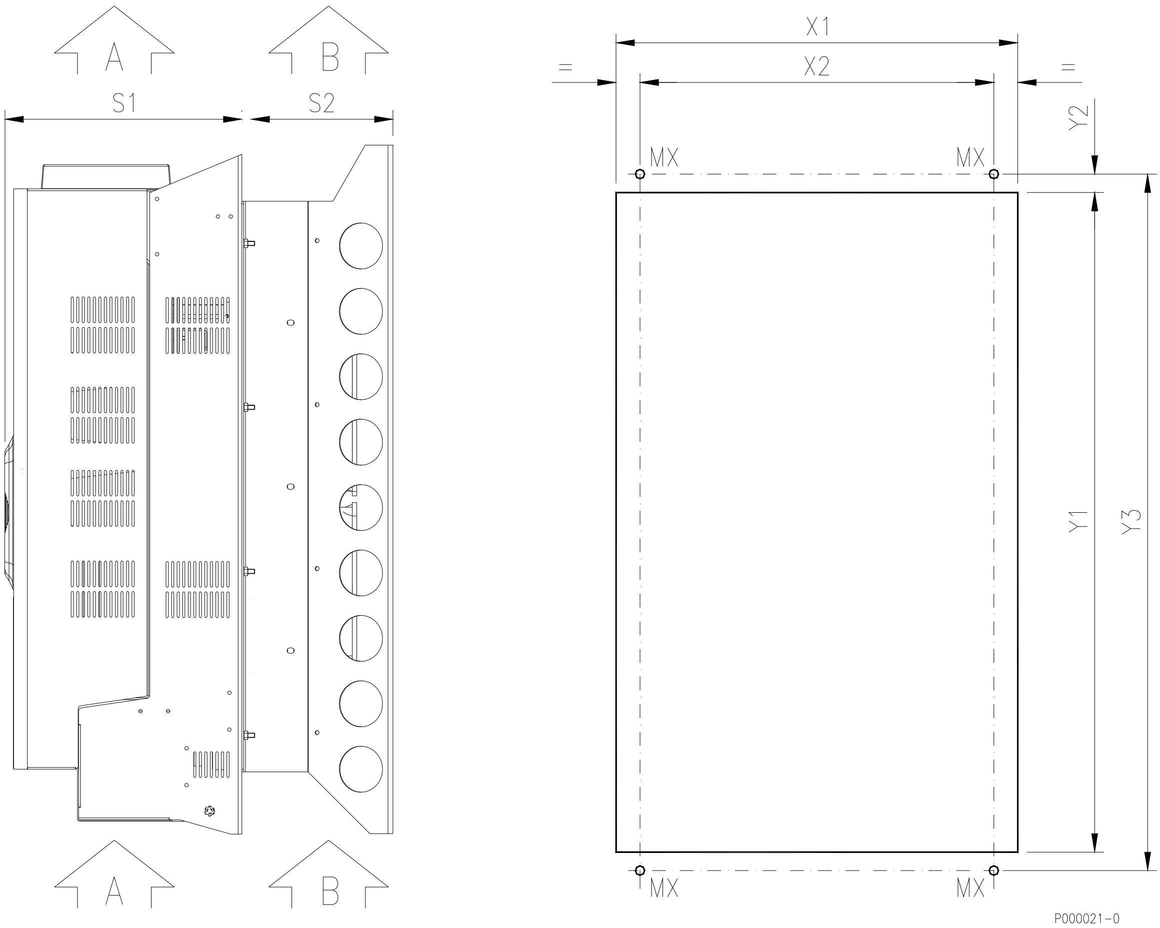
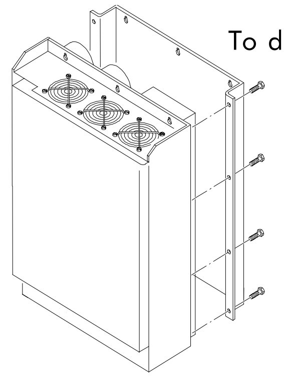


Figure 10: Through-panel assembly and piercing template for Sinus PENTA S15, S20, S30

Inverter size	Front and rear projection		Slot size for through-panel assembly		Templates for fastening holes			Thread and fastening screws
	S1	S2	X1	Y1	X2	Y2	Y3	MX
S15	256	75	207	420	185	18	449	4 x M6
S20	256	76	207	558	250	15	593	4 x M6
S30	257	164	270	665	266	35	715	4 x M8

3.3.5.5. SINUS PENTA S40

For the through-panel assembly of this inverter size, remove the bottom mounting plate. The figure below shows how to disassemble the mounting plate.



To disassemble the mounting plate, remove 8 screws M6 (the figure shows 4 screws on one side of the inverter).

Figure 11: Removing the mounting plate in SINUS PENTA S40 for through-panel assembly.

The fixing points shown in the figure below are to be made on the mounting panel (see relevant measures). The following figure also shows the side view of the equipment through-panel assembly. The air flows and the front and rear projections are highlighted as well (with relevant measures).

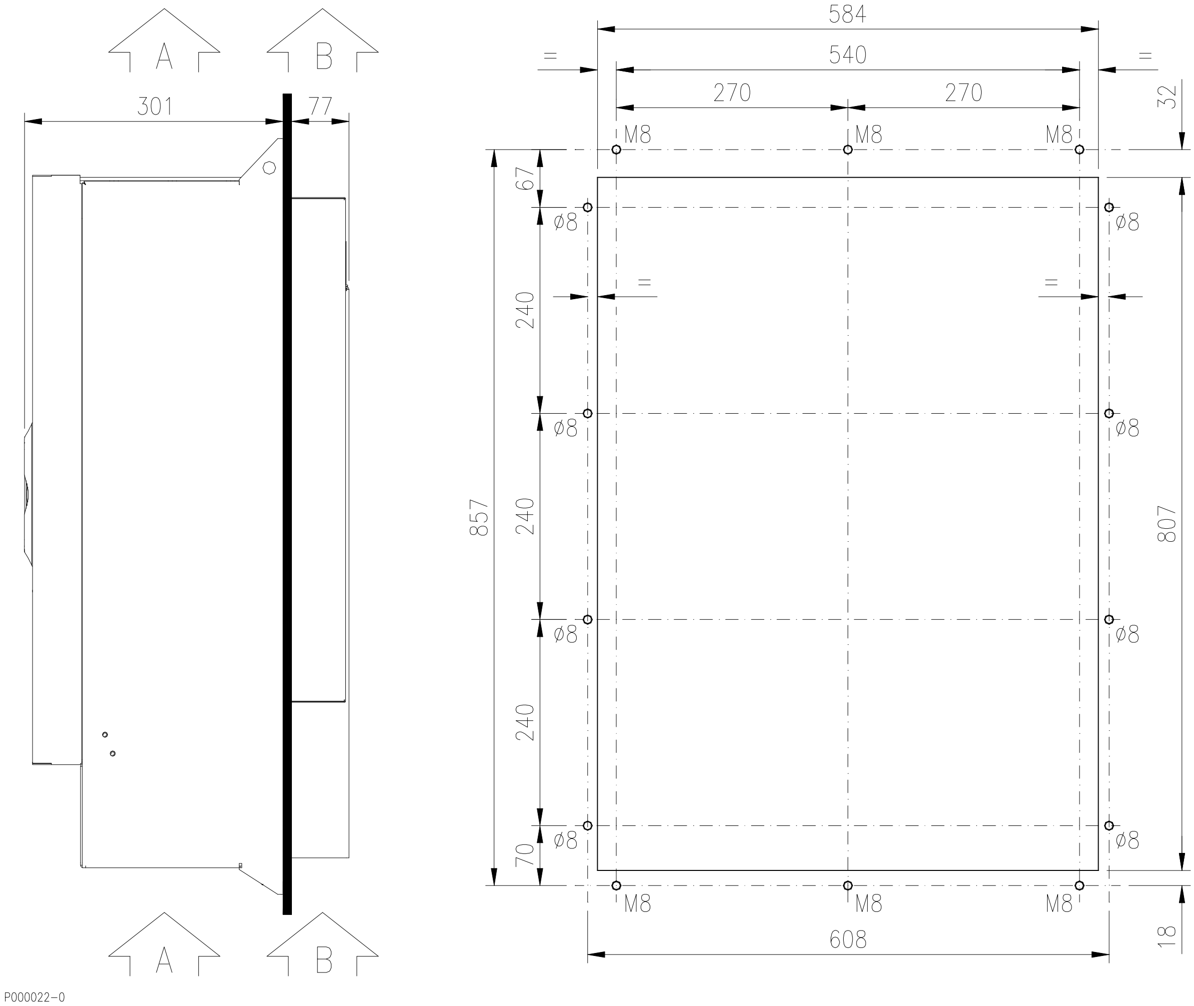


Figure 12: Through-panel assembly and piercing templates for SINUS PENTA S40

3.3.5.6. SINUS PENTA S50

For the through-panel assembly of this inverter size, remove the bottom mounting plate. The figure below shows how to disassemble the mounting plate.
To disassemble the bottom mounting plate, remove 6 screws M8 (the figure shows the three screws in one side of the inverter).

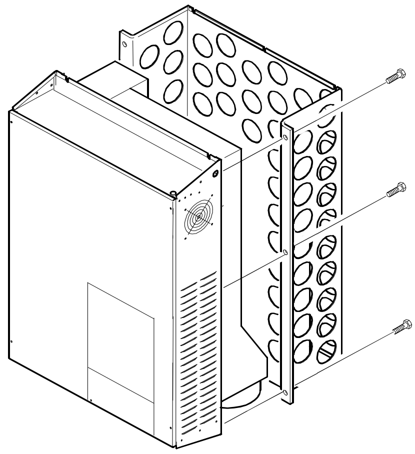


Figure 13: Removing the mounting plate in SINUS PENTA S50 for through-panel assembly

The fixing points shown in the figure below (right) are to be made on the mounting plate (see relevant measures). The figure also shows the side view of the through-panel assembly of the equipment. The air flows and the front and rear projections are highlighted as well (see measures in the table).

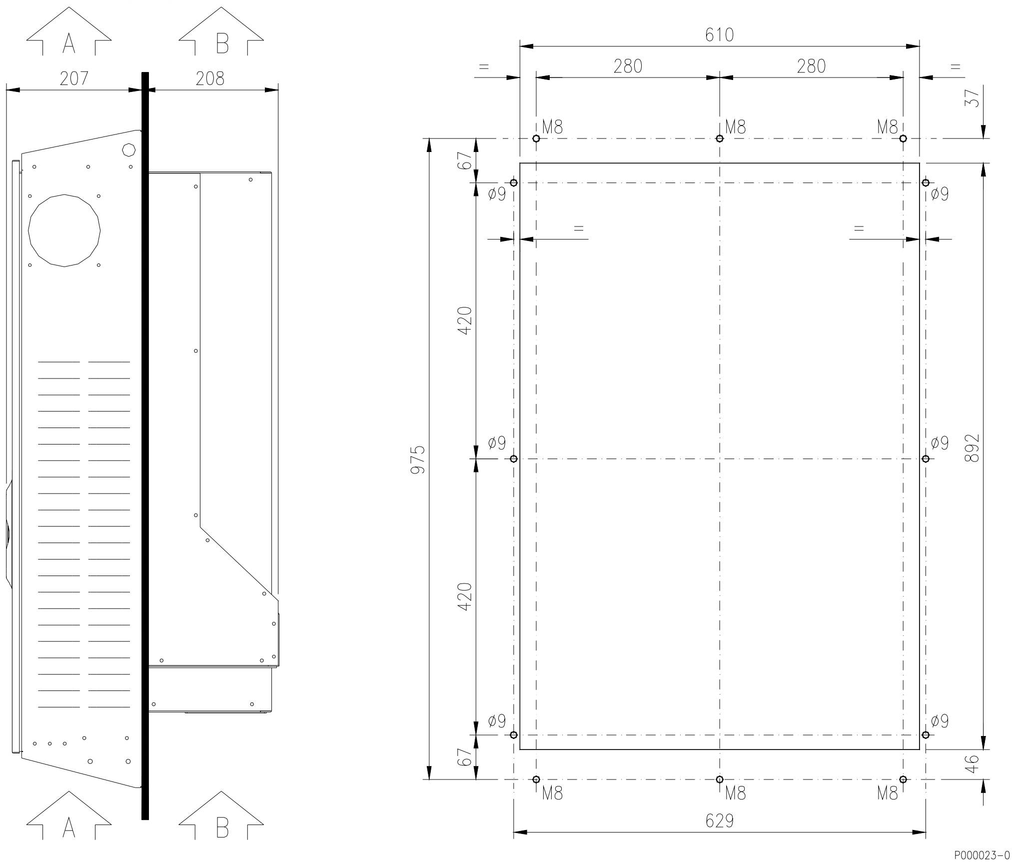


Figure 14: Through-panel assembly and piercing templates for SINUS PENTA S50

3.3.6. STANDARD MOUNTING AND PIERCING TEMPLATES FOR IP00 MODULAR MODELS (S64-S80)

High-power inverters include single function modules.
The control unit may be installed separately or inside a module.
Mounting options are shown below:

a) Control unit integrated into the inverter

MODULE	Fixing Templates (mm) (Single Module)					Modules Fitted Inverter Size					
	X	Y	D1	D2	Fastening Screws	S64	S65	S70	S74	S75	S80
FEEDER	178	1350	11	25	M10	-	1	2	-	2	3
INVERTER	178	1350	11	25	M10	1	2	2	-	2	2
INVERTER WITH INTEGRATED CONTROL UNIT	178	1350	11	25	M10	1	1	1	1	1	1
INVERTER WITH INTEGRATED AUXILIARY POWER SUPPLY UNIT	178	1350	11	25	M10	1	-	-	2	-	-
INVERTER WITH INTEGRATED SPLITTER UNIT	178	1350	11	25	M10	-	-	-	3	3	3

b) Control unit separate from the inverter module

MODULE	Fixing Templates (mm) (Single Module)					Modules Fitted Inverter Size					
	X	Y	D1	D2	Fastening Screws	S64	S65	S70	S74	S75	S80
FEEDER	178	1350	11	25	M10	-	1	2	-	2	3
INVERTER	178	1350	11	25	M10	2	3	3	1	3	3
INVERTER WITH INTEGRATED AUXILIARY POWER SUPPLY UNIT	178	1350	11	25	M10	1	-	-	2	-	-
INVERTER WITH INTEGRATED SPLITTER UNIT	178	1350	11	25	M10	-	-	-	3	3	3
CONTROL UNIT	184	396	6	14	M5	1	1	1	1	1	1

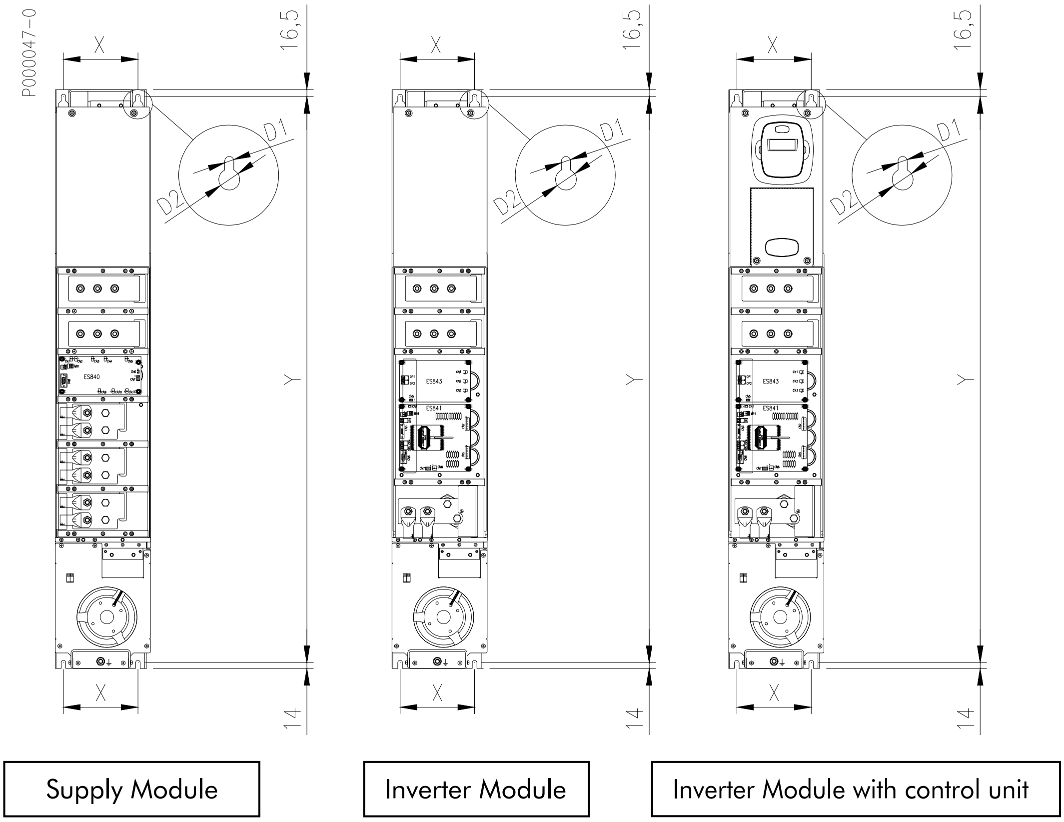


Figure 15: Piercing templates for modular units

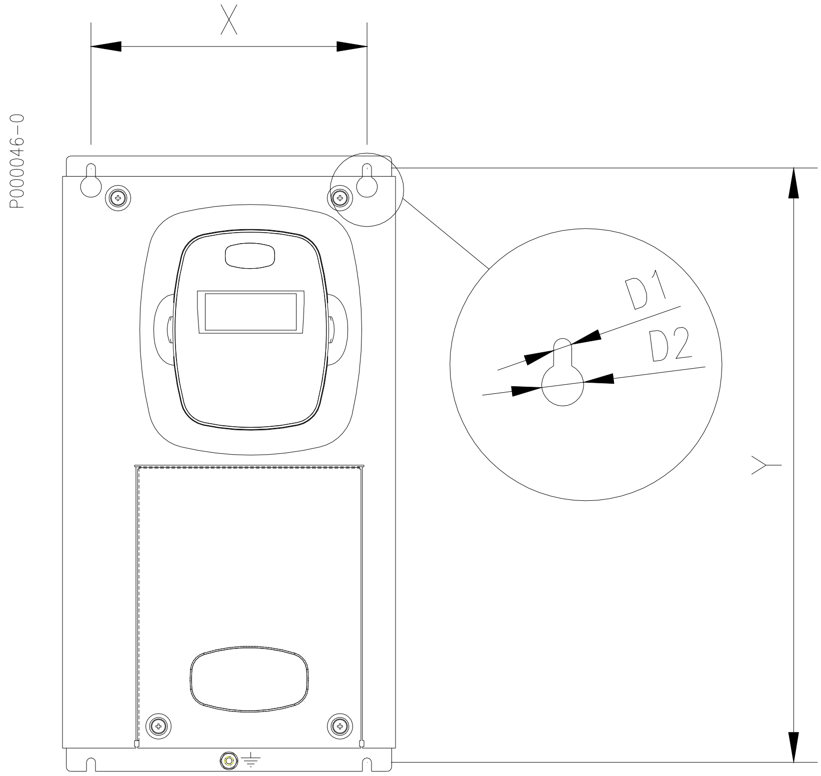


Figure 16: Piercing templates for control unit (stand-alone model)

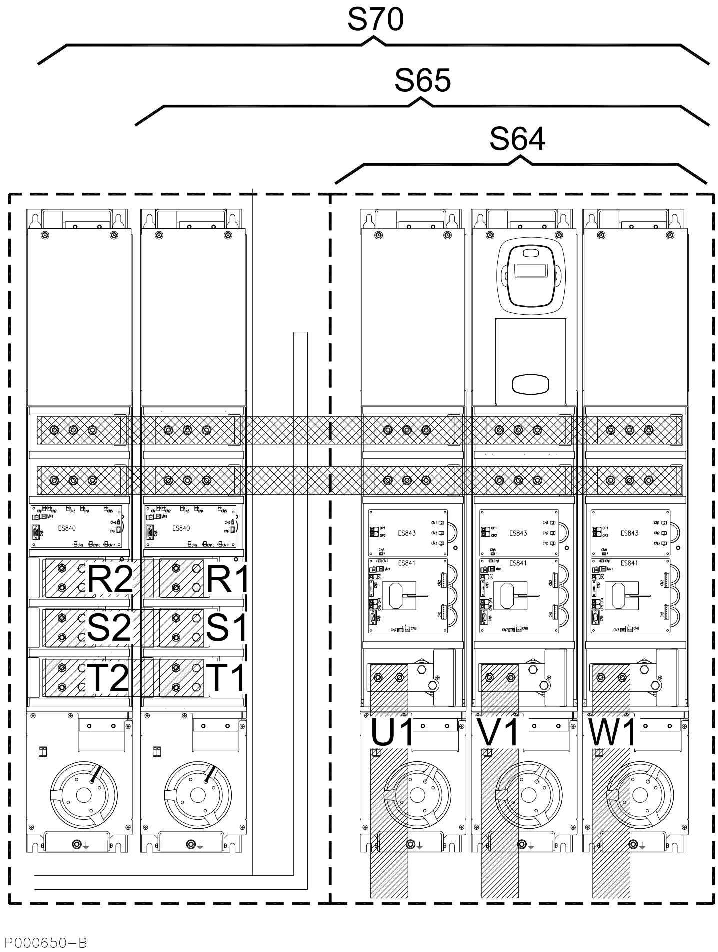


Figure 17: Installation example of a SINUS Penta S64/S70

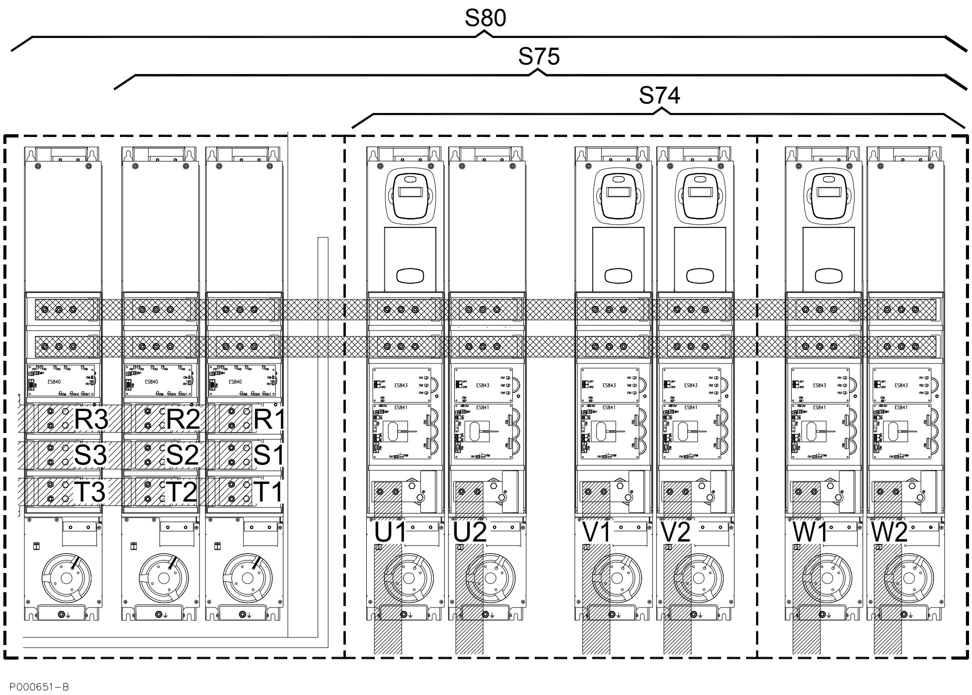


Figure 18: Installation example of a SINUS Penta S74/S80

3.3.6.1. INSTALLATION AND LAY-OUT OF THE CONNECTIONS OF A MODULAR INVERTER (S65)

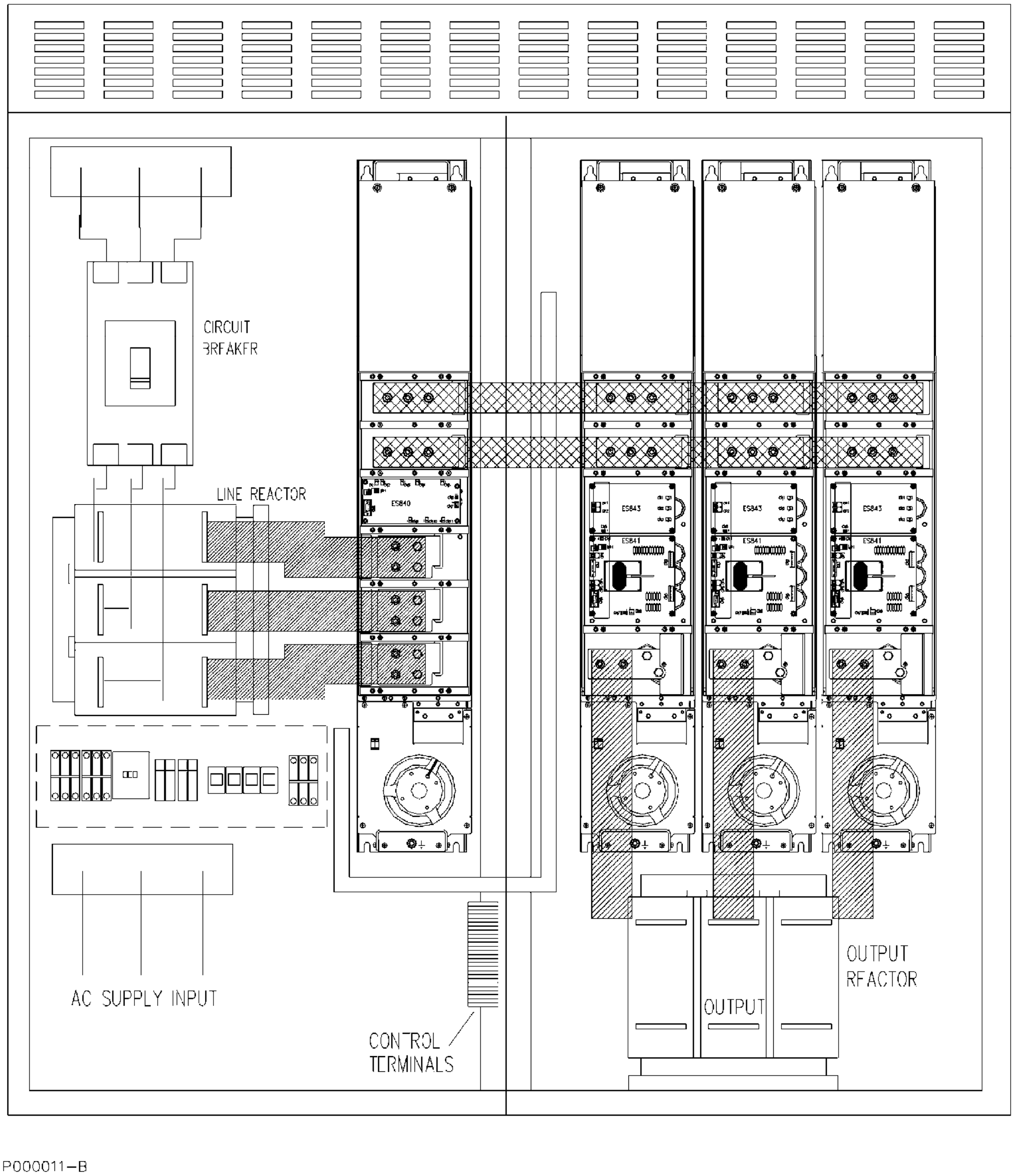


Figure 19: Installation example for Sinus Penta S65 (in cabinet)

3.3.7. STANDARD MOUNTING AND PIERCING TEMPLATES (MODELS IP54 S05-S30)

IP54 SINUS PENTA Size	Fixing templates (mm) (standard mounting)				
	X	Y	D1	D2	Fastening screws
S05	177	558	7	15	M6
S10/S12	213	602,5	7	15	M6
S15	223	695	10	20	M8
S20	274	821	10	20	M8
S30	296	987	10	20	M8

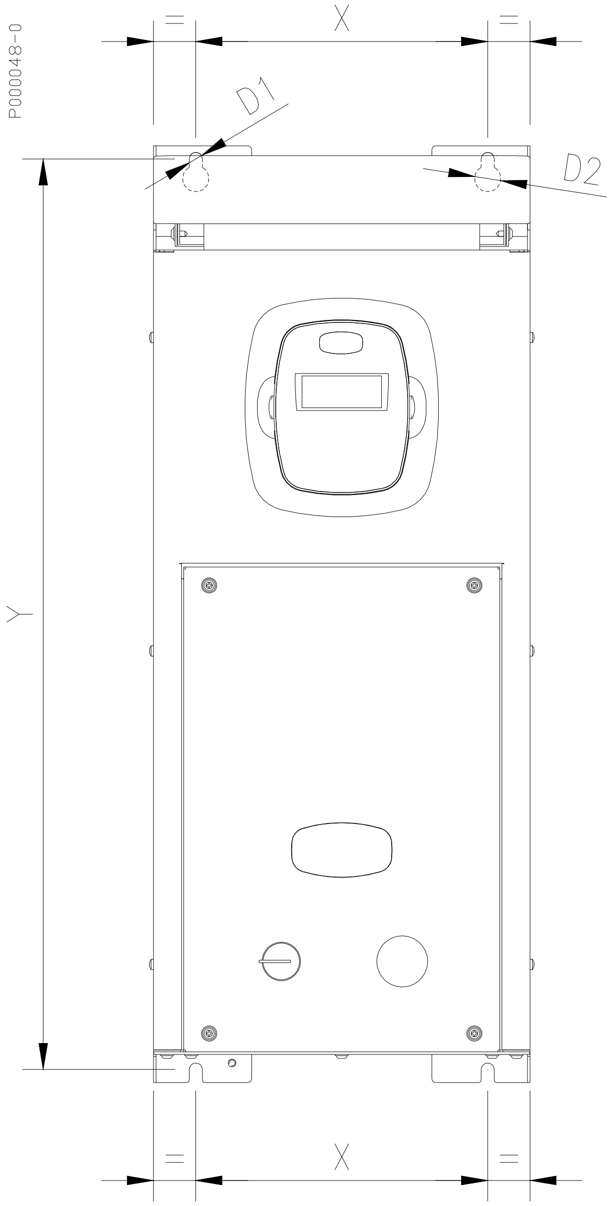


Figure 20: Piercing template for inverter IP54

0 1 2 3 4 5 6 7 8

3.4. POWER CONNECTIONS

The inverters of the SINUS PENTA series are designed both for DC and AC power supply. The wiring diagrams below show the inverter connection to a low-voltage 3-phase mains; the 12-phase connection (12-pulse) is available for sizes S70 and S75 using a dedicated transformer, the power supply modules and the interphase reactance. The 18-phase (18-pulse) connection is available for Size S80 using a dedicated transformer, the power supply modules and the interphase reactance.
VDC direct connection is also available with no need to change the inverter layout; only, a safety fuse is to be installed in the VDC supply line.
No external precharge system is required (except for size S60, S64 and S74), because a precharge circuit is fitted inside the inverter.
Please refer to section Cross-sections of the Power Cables and Sizes of the Protecting Devices for the safety fuses to be installed.
DC voltage supply is normally used for a parallel connection of multiple inverters inside the same cubicle. DC output feeders (both one-way and two-way, with power ratings ranging from 5kW to 2000kW for 200Vac to 690Vac rated voltage) can be supplied by Elettronica Santerno.

DANGER

Before changing the equipment connections, shut off the inverter and wait at least 5 minutes to allow for the discharge of the heatsinks in the DC-link.

Use only B-type differential circuit breakers.

Connect power supply only to the power supply termination logs. The connection of power supply to any other terminal can cause the inverter fault.

Always make sure that the supply voltage ranges between the limits stated in the inverter nameplate.

Always connect the ground terminal to avoid electrical shock hazard and to limit disturbance. Always provide a grounding connection to the motor; if possible, ground the motor directly to the inverter.
The user has the responsibility to provide a grounding system in compliance with the regulations in force.

After connecting the equipment, check the following:
- all wires must be properly connected;
- no link is missing;
- no short-circuit is occurring between the terminals and between the terminals and the ground.

CAUTION

Do not start or stop the inverter using a contactor installed over the inverter power supply line.

The inverter power supply must always be protected by fast fuses or by a thermal/magnetic circuit breaker.

Do not apply single-phase voltage.

Always mount antidisturbance filters on the contactor coils and the solenoid valve coils.

At power on, if the inverter commands "ENABLE" (terminal 15) and "START" (terminal 14) are active, the motor will immediately start when the main reference is other than zero. This may be very dangerous. To prevent the motor from accidentally starting, see the Programming Manual to set configuration parameters accordingly. In that case, the motor will start only after opening and closing the command contact on terminal 15.

3.4.1. WIRING DIAGRAM FOR INVERTERS S05 – S60

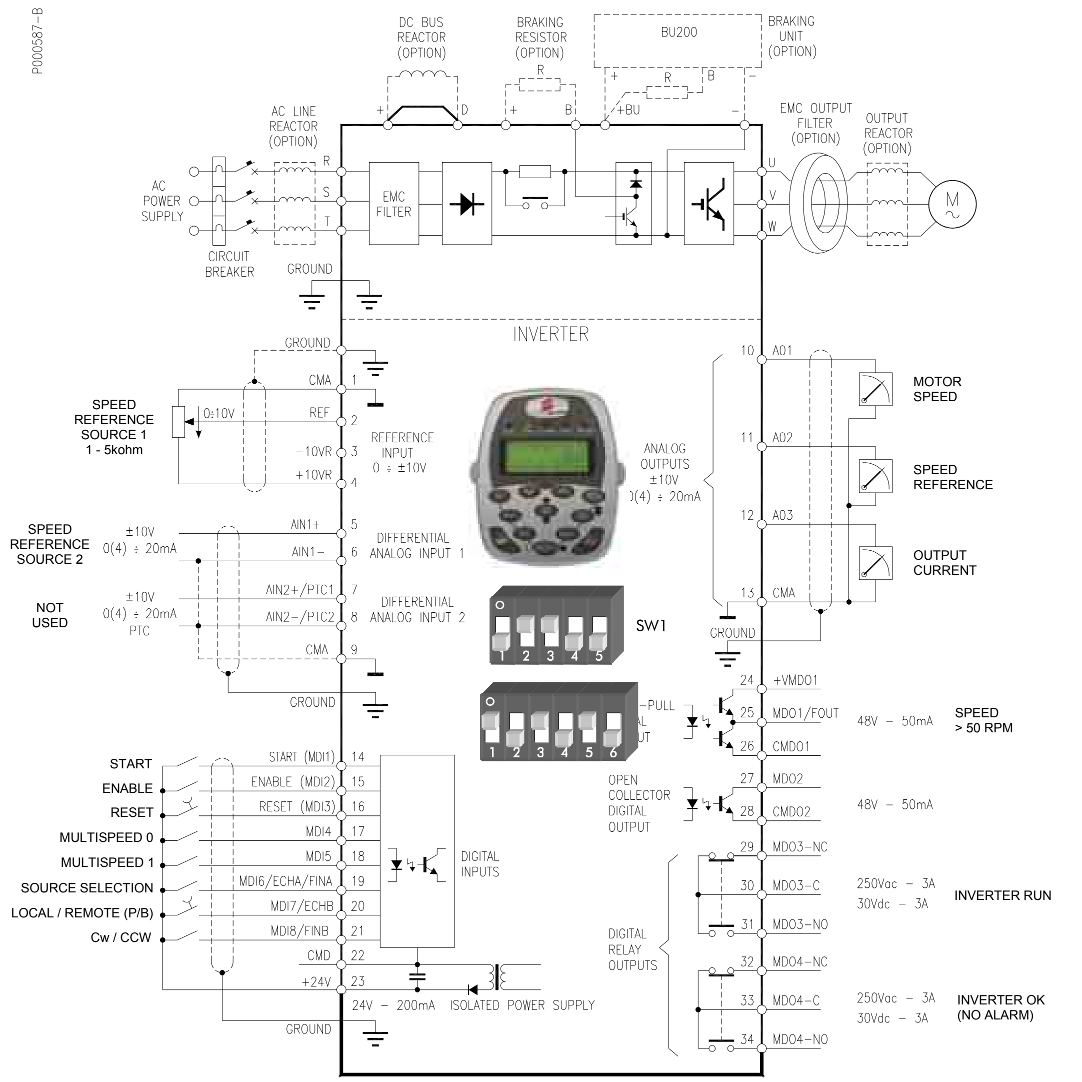


Figure 21: Wiring diagram.

CAUTION In case of fuse line protection, always install the fuse failure detection device, that disables the inverter, to avoid single-phase operation of the equipment.

NOTE Please refer to the REACTORS section for the applicable input and output reactors. When ordering Sinus Penta drives ranging from S20 to S60, please state if reactors are to be installed on the equipment.

NOTE The wiring diagram relates to factory-setting. Please refer to the Power Terminal Layout section for the ID numbers of the wiring terminals.

NOTE When no DC reactor is used, terminals 47D and 47+ must be short-circuited (factory setting).

CAUTION For S60 inverters only: if the supply voltage is other than 400Vac, the wiring of the internal auxiliary transformer must be changed accordingly (see Figure 37).

3.4.2. Wiring Diagram for Modular Inverters S64-S80

3.4.2.1. External Connections for Modular Inverters S65-S70-S75-S80

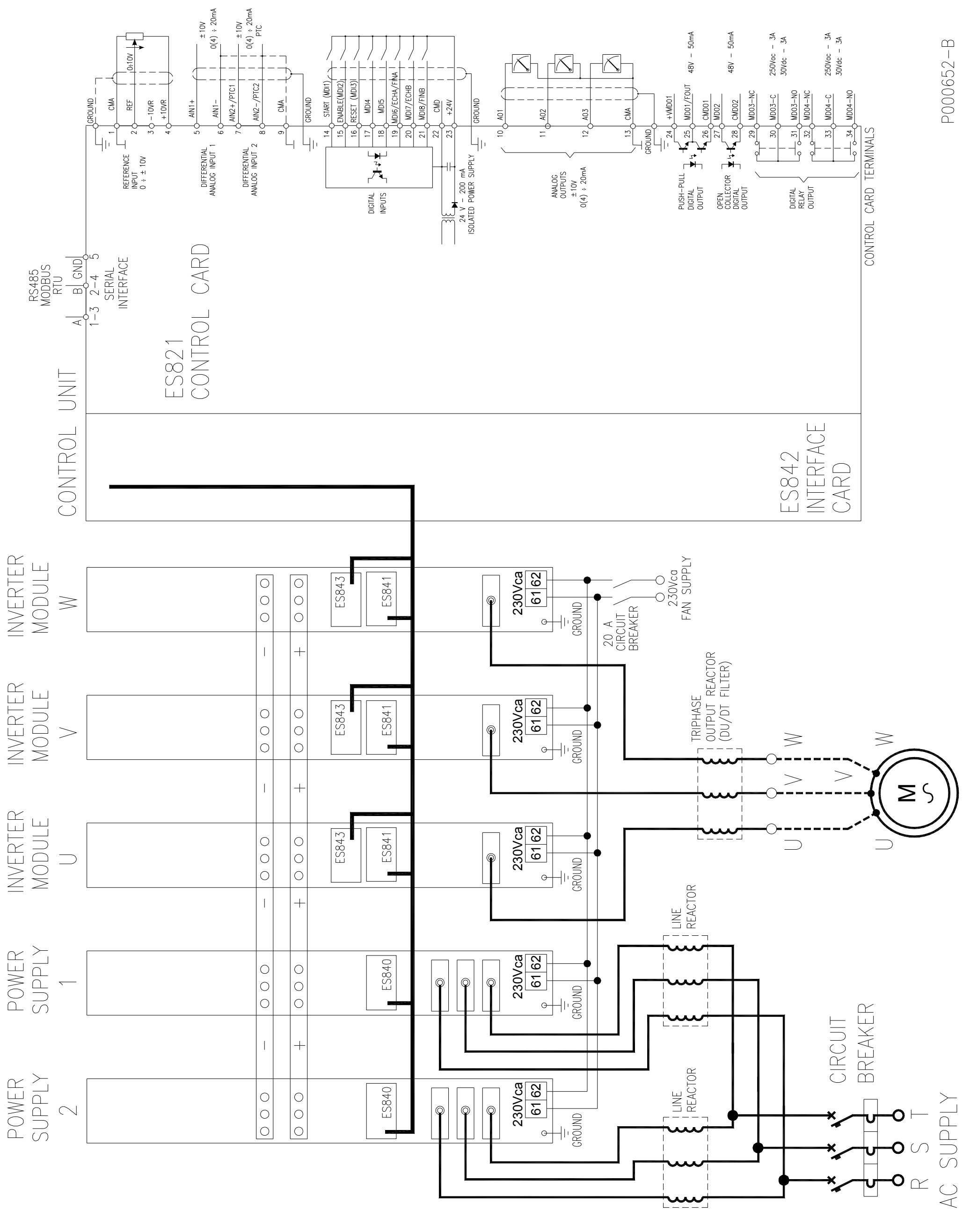


Figure 22: External connections for modular inverters S65-S70

NOTE Feeder n.2 (power supply 2) is available for size S70 only.

NOTE For the installation of a BU, see the section covering the braking unit.

0 1 2 3 4 5 6 7 8

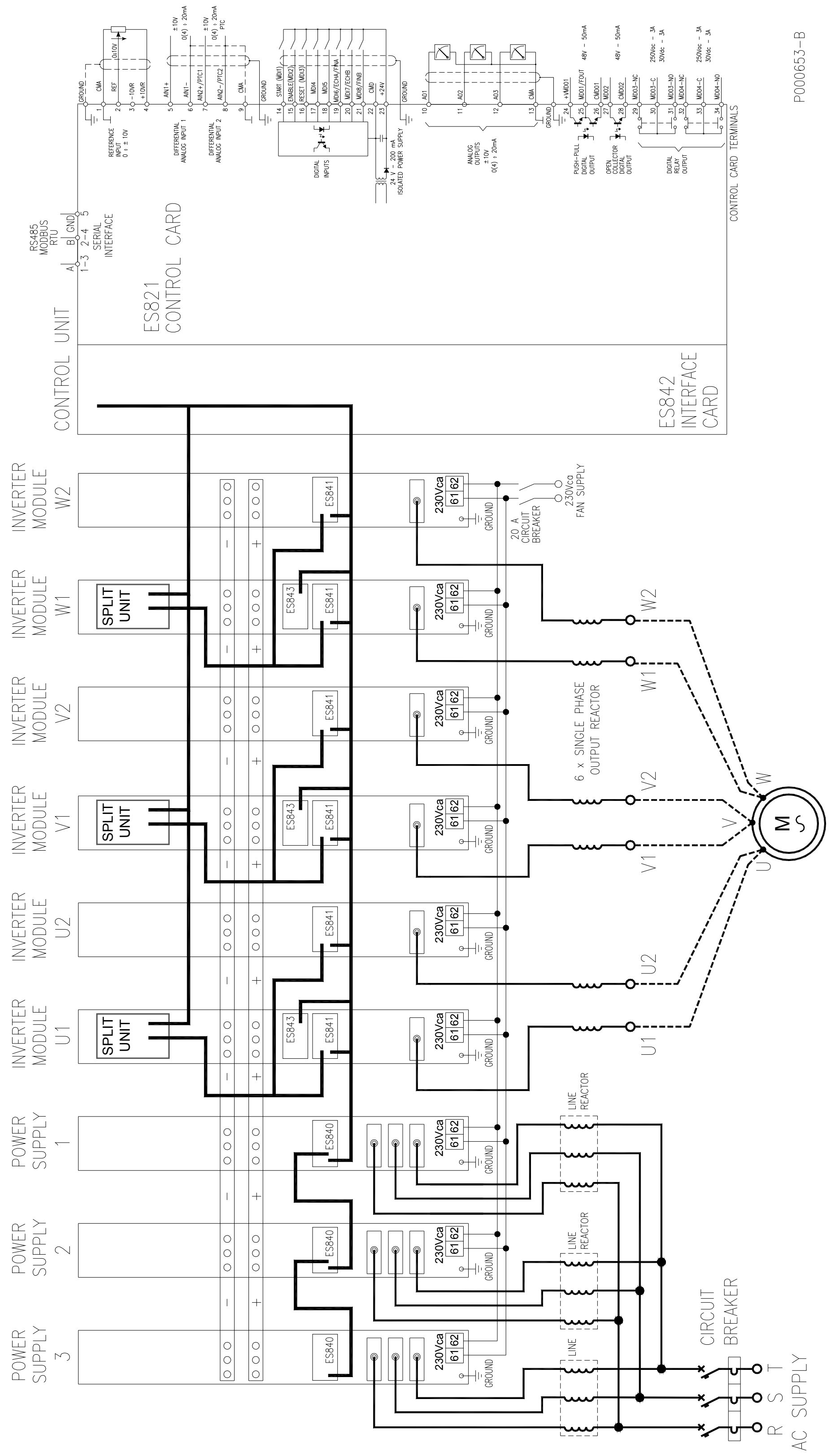


Figure 23: External connections for modular inverters S75-S80

NOTE Feeder n.3 (power supply 3) is available for size S80 only.

NOTE For the installation of a BU, see the section covering the braking unit.

CAUTION In case of fuse line protection, always install the fuse failure detection device, that disables the inverter, to avoid single-phase operation of the equipment.

NOTE Please refer to the REACTORS section.

3.4.2.2. EXTERNAL CONNECTIONS FOR MODULAR INVERTERS S64

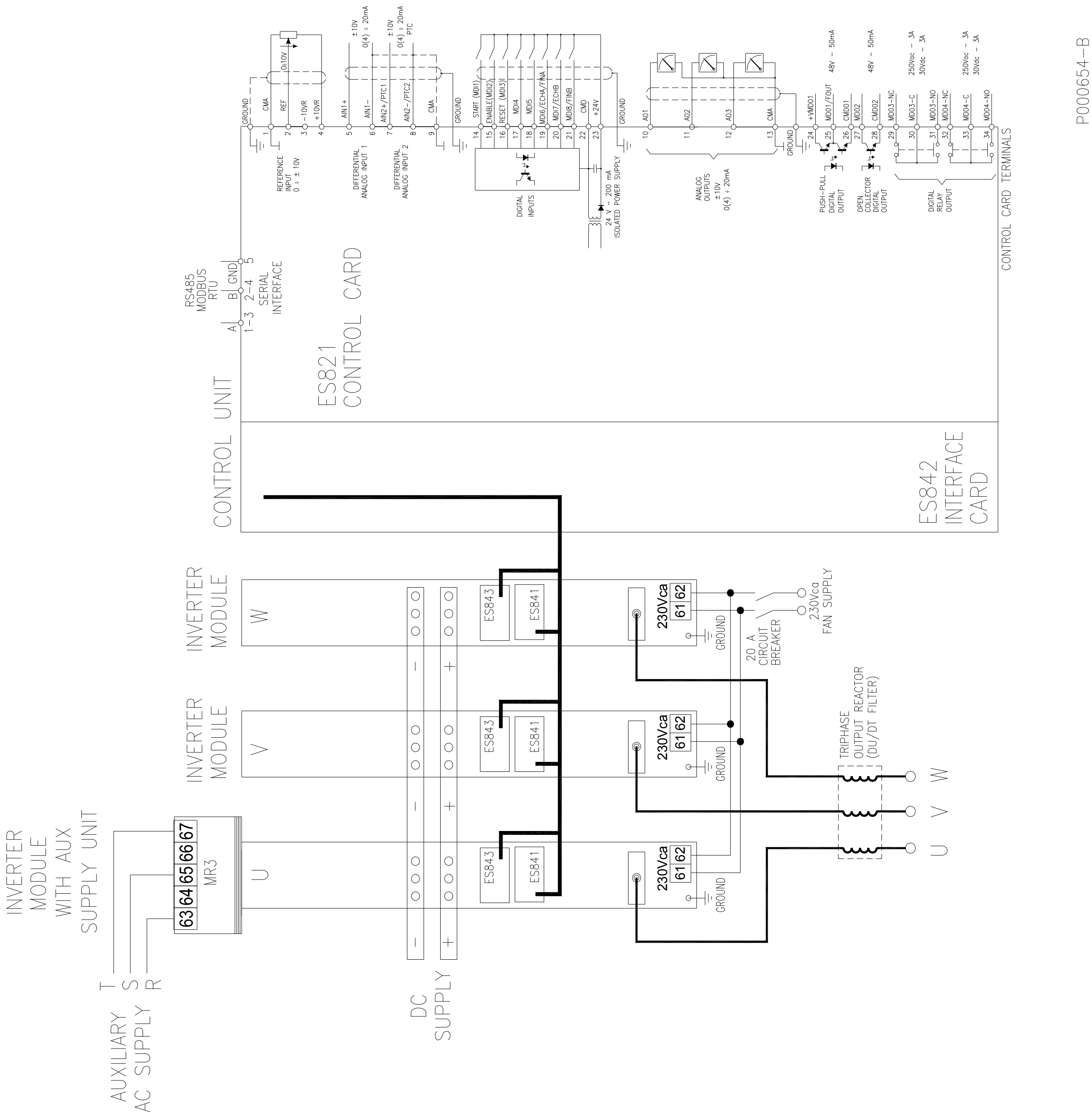


Figure 24: External connections for modular inverters S64

CAUTION The capacitors inside the DC power supply unit must always be precharged. Failure to do so will damage the inverter as well as its power supply unit.

NOTE Please refer to the REACTORS section.

3.4.2.3. External Connections for Modular Inverters S74

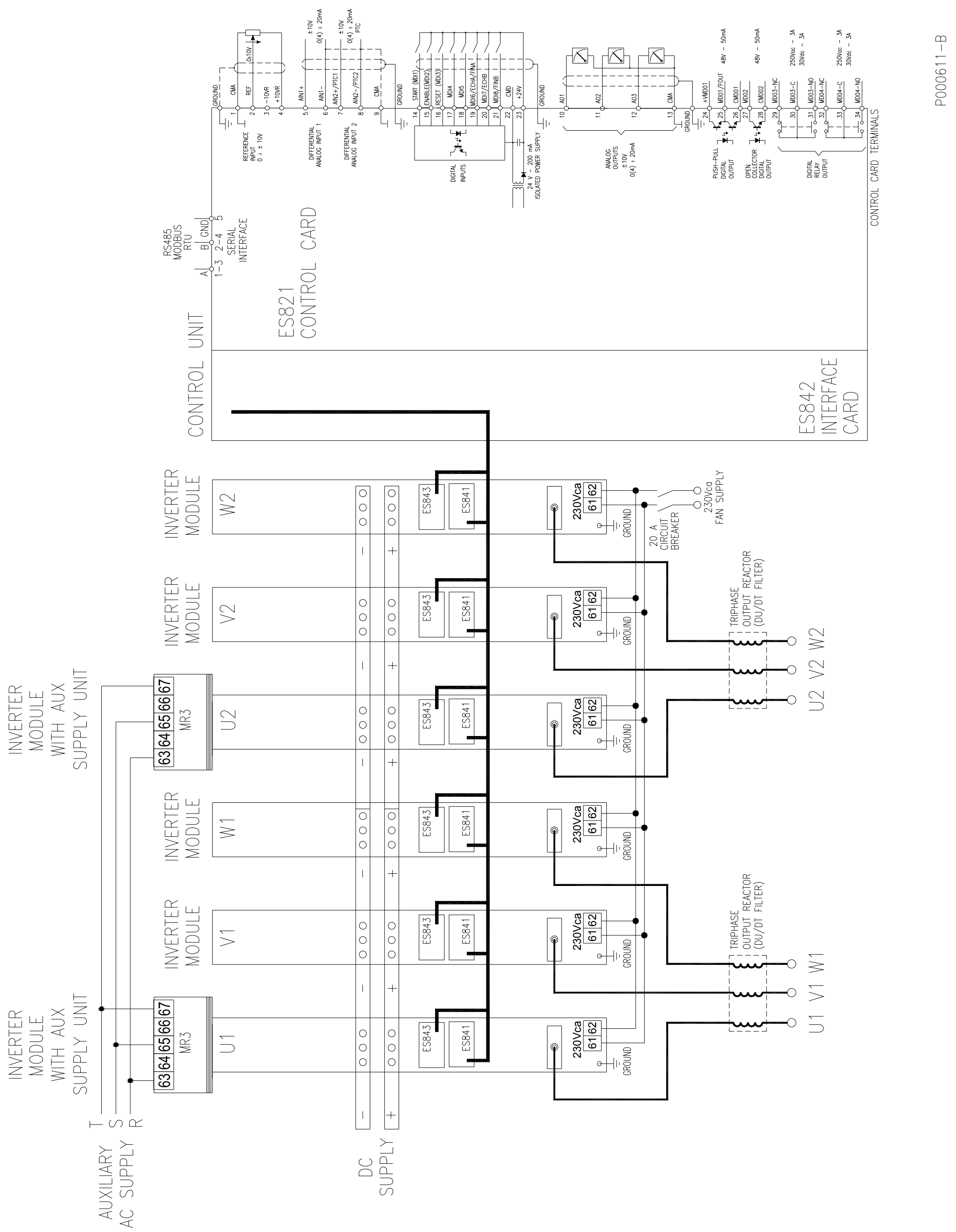


Figure 25: External connections for modular inverters S74

CAUTION The capacitors inside the DC power supply unit must always be precharged. Failure to do so will damage the inverter as well as its power supply unit.

NOTE Please refer to the REACTORS section.

3.4.2.4. 12-PHASE CONNECTION FOR MODULAR INVERTERS

12-phase connection allows to reduce current harmonics in the inverter supply line.
The basic wiring diagram of 12-phase connection is shown below:

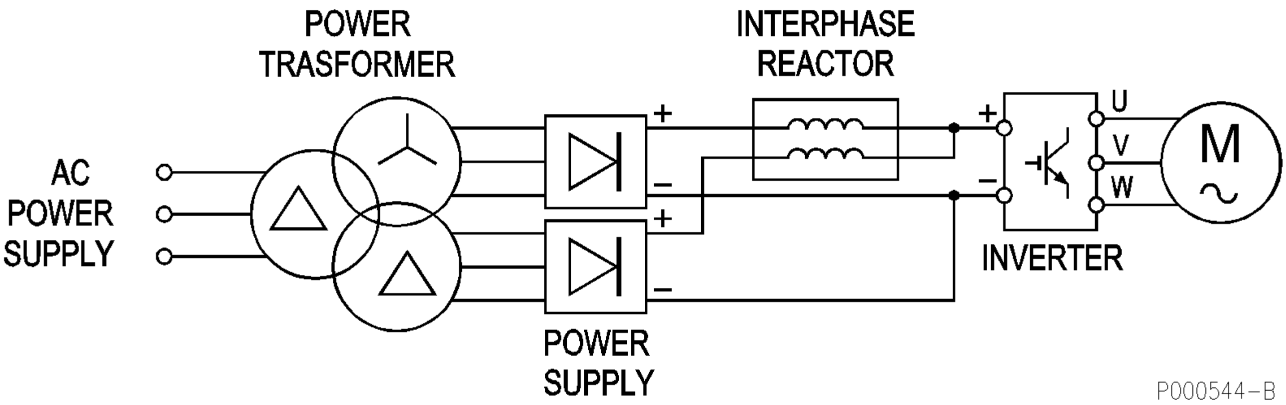


Figure 26: Layout of 12-phase connection

For more details, refer to the REACTANCE section. For 12-phase connection, only two feeder modules are required to obtain size 1130 and size 1296, class 6T.

3.4.2.5. INTERNAL CONNECTIONS FOR MODULAR SINUS PENTA INVERTERS S65 – S80

The following connections are needed:

N. 2 power connections to copper bar 60*10mm between power supply and inverter arms for DC supply.
N. 5 connections with 9-pole screened cable (S70) or N. 4 connections with 9-pole screened cable (S65) for analog measures.

Type of cable: screened cable
n. of wires: 9
diameter of each wire: AWG20÷24 (0.6÷0.22mm^2)
connectors: 9-pole female SUB-D connectors;

connections inside the cable:

connector	Female SUB-D conn.	Female SUB-D conn.
pin	1 →	1
pin	2 →	2
pin	3 →	3
pin	4 →	4
pin	5 →	5
pin	6 →	6
pin	7 →	7
pin	8 →	8
pin	9 →	9

The following connections are required:
- from control unit to supply 1 (supply 1 control signals)
- from control unit to supply 2 (size S70 only) (supply 2 control signals)
- from control unit to inverter arm U (phase U control signals)
- from control unit to inverter arm V (phase V control signals)
- from control unit to inverter arm W (phase W control signals)

N° 4 connections with unipolar cable pairs, type AWG17-18 (1 mm^2), for AC, low voltage supply.
- from supply 1 to control unit (power supply + 24 V control unit)
- from supply 1 to driver boards of each power arm (supply line can run from supply to one driver board—e.g. arm U—to arm V, then to arm W) (24 V supply for IGBT driver boards)

N° 4 optical fibre connections, 1mm, standard single plastic material (typical damping: 0.22dB/m), with connectors type Agilent HFBR-4503/4513.

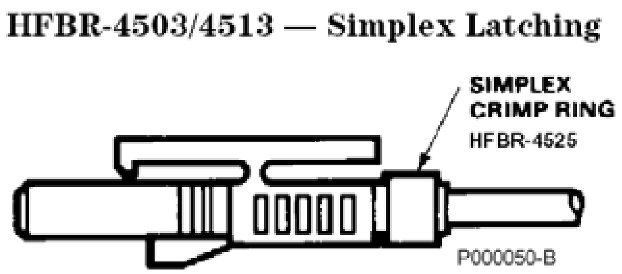


Figure 27: Single optical fibre connector

Connections required:

- from control unit to arm U driver board (fault U signal)
- from control unit to arm V driver board (fault V signal)
- from control unit to arm W driver board (fault W signal)
- from control unit to bus voltage reading board assembled on inverter arm U (VB signal)

N° 4 optical fibre connections, 1mm, standard double plastic material (typical damping 0.22dB/m), with connectors type Agilent HFBR-4516.

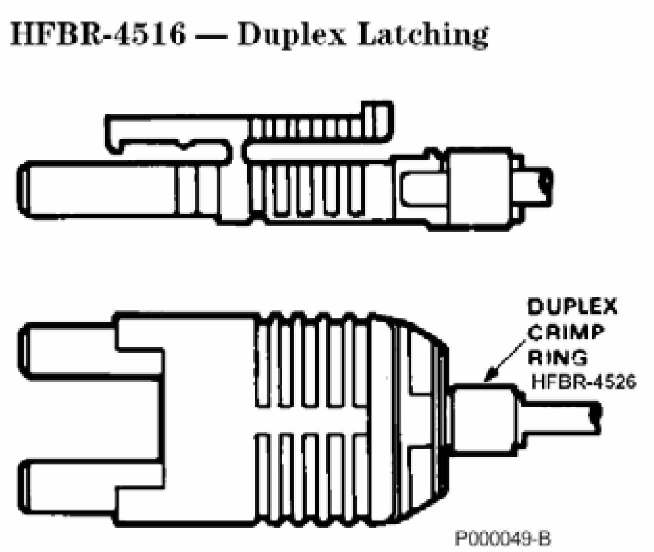


Figure 28: Double optical fibre connector

Connections required:

- from control unit to arm U driver board (IGBT top and bottom control signals)
- from control unit to arm V driver board (IGBT top and bottom control signals)
- from control unit to arm W driver board (IGBT top and bottom control signals)

INTERNAL CONNECTIONS (S65-S70)

Signal	Type of connection	Cable marking	Component	Board	Connector	Component	Board	Connector
control signals, supply 1	9-pole screened cable	C-PS1	control unit	ES842	CN4	supply 1	ES840	CN8
control signals, supply 2 (*)	9-pole screened cable	C-PS2	control unit	ES842	CN3	supply 2	ES840	CN8
control signals, phase U	9-pole screened cable	C-U	control unit	ES842	CN14	phase U	ES841	CN3
control signals, phase V	9-pole screened cable	C-V	control unit	ES842	CN11	phase V	ES841	CN3
control signals, phase W	9-pole screened cable	C-W	control unit	ES842	CN8	phase W	ES841	CN3
+24V Power supply, control unit	unipolar cable, 1mm^2	24V-CU	supply 1	ES840	MR1-1	control unit	ES842	MR1-1
0VD Power supply, control unit	unipolar cable, 1mm^2		supply 1	ES840	MR1-2	control unit	ES842	MR1-2
+24VD Power supply, driver boards ES841	unipolar cable, 1mm^2	24V-GU	supply 1	ES840	MR1-3	phase U	ES841	MR1-1
0VD Power supply, driver boards ES841	unipolar cable, 1mm^2		supply 1	ES840	MR1-4	phase U	ES841	MR1-2
+24VD Power supply, driver boards ES841	unipolar cable, 1mm^2	24V-GV	phase U	ES841	MR1-3	phase V	ES841	MR1-1
0VD Power supply, driver boards ES841	unipolar cable1, mm^2		phase U	ES841	MR1-4	phase V	ES841	MR1-2
+24VD Power supply, driver boards ES841	unipolar cable, 1mm^2	24V-GW	phase V	ES841	MR1-3	phase W	ES841	MR1-1
0VD Power supply, driver boards ES841	unipolar cable, 1mm^2		phase V	ES841	MR1-4	phase W	ES841	MR1-2
IGBT command, phase U	double optical fibre	G-U	control unit	ES842	OP19-OP20	phase U	ES841	OP4-OP5
IGBT command, phase V	double optical fibre	G-V	control unit	ES842	OP13-OP14	phase V	ES841	OP4-OP5
IGBT command, phase W	double optical fibre	G-W	control unit	ES842	OP8-OP9	phase W	ES841	OP4-OP5
IGBT fault, phase U	single optical fibre	FA-U	control unit	ES842	OP15	phase U	ES841	OP3
fault IGBT phase V		FA-V	control unit	ES842	OP10	phase V	ES841	OP3
IGBT fault, phase W	single optical fibre	FA-W	control unit	ES842	OP5	phase W	ES841	OP3
bus bar voltage reading	single optical fibre	VB	control unit	ES842	OP2	one phase	ES843	OP2
IGBT fault, phase U	single optical fibre	ST-U	control unit	ES842	OP16	phase U	ES843	OP1
IGBT status, phase V	single optical fibre	ST-V	control unit	ES842	OP11	phase V	ES843	OP1
IGBT fault, phase W	single optical fibre	ST-W	control unit	ES842	OP6	phase W	ES843	OP1

(*) Available for S70 only

CAUTION Carefully check that connections are correct. Wrong connections can adversely affect the equipment operation.

CAUTION NEVER supply voltage to the equipment if optical fibre connectors are disconnected.

0 1 2 3 4 5 6 7 8

The diagram below illustrates the connections required for the components of the modular inverter model.

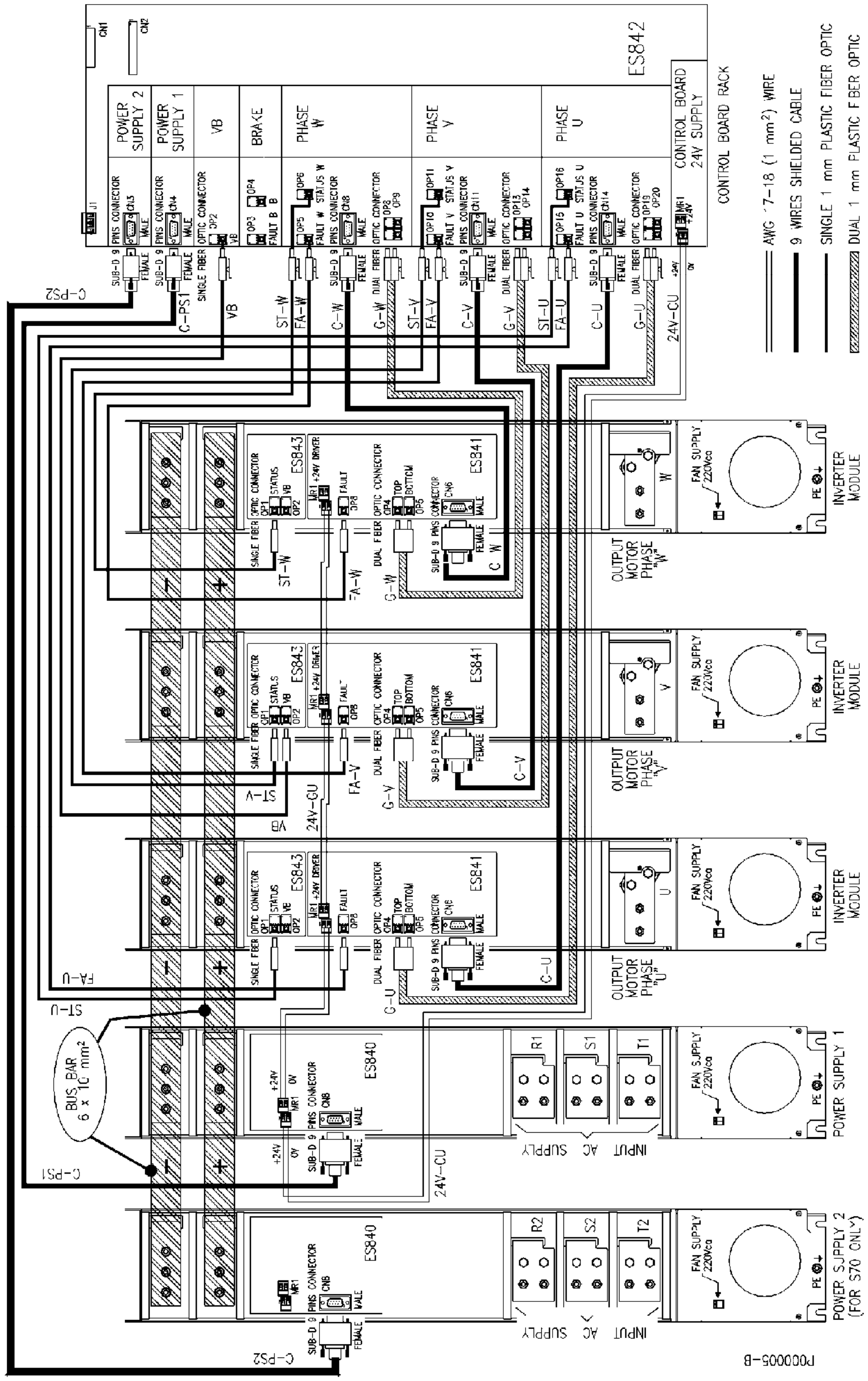


Figure 29: Internal wiring for SINUS PENTA S65-S70

Do the following to obtain internal wiring:

1) Gain access to boards ES840, ES841 and ES843. The first board is located on the front part of the supply module; the remaining two boards are located on the front part of each inverter module. Remove the front covers made of Lexan by loosening the cover fastening screws;

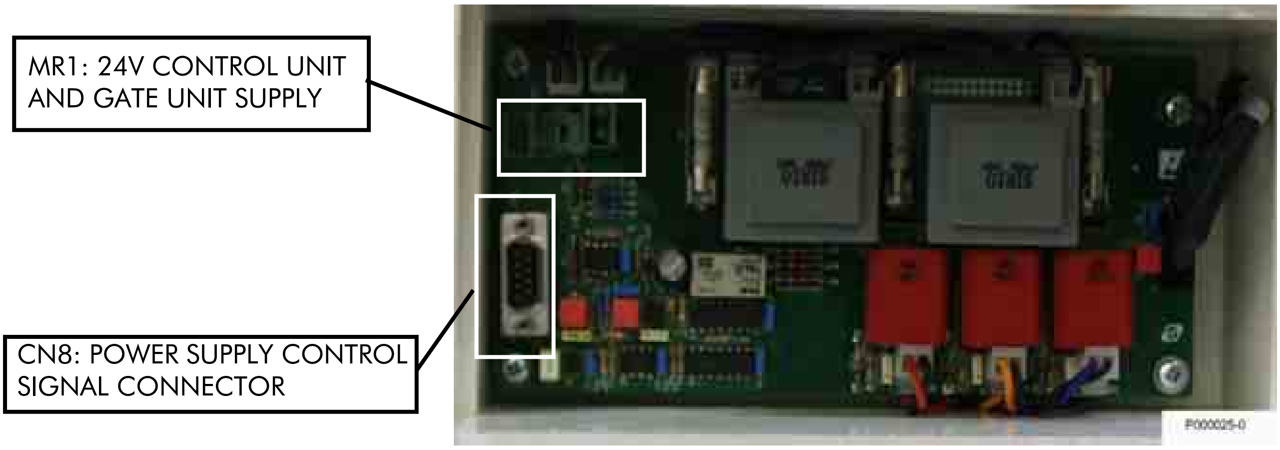


Figure 30: ES840 Supply Control Board

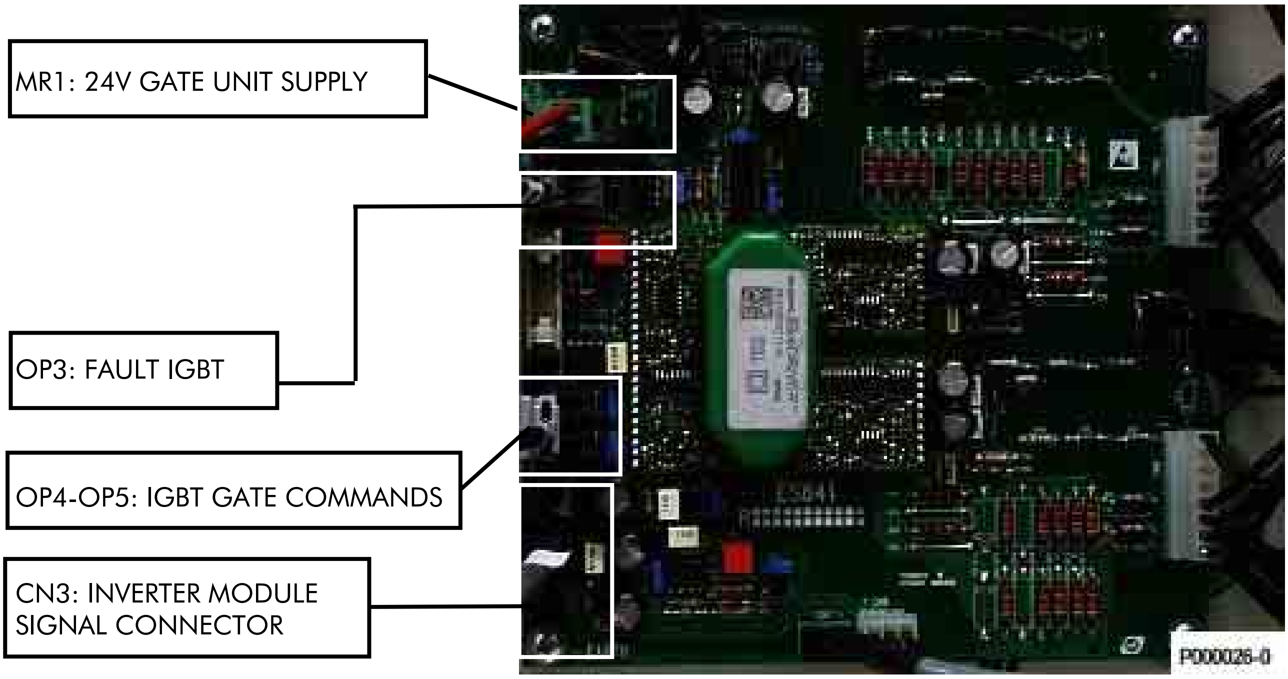


Figure 31: ES841 Inverter Module Gate Unit Board

0 1 2 3 4 5 6 7 8

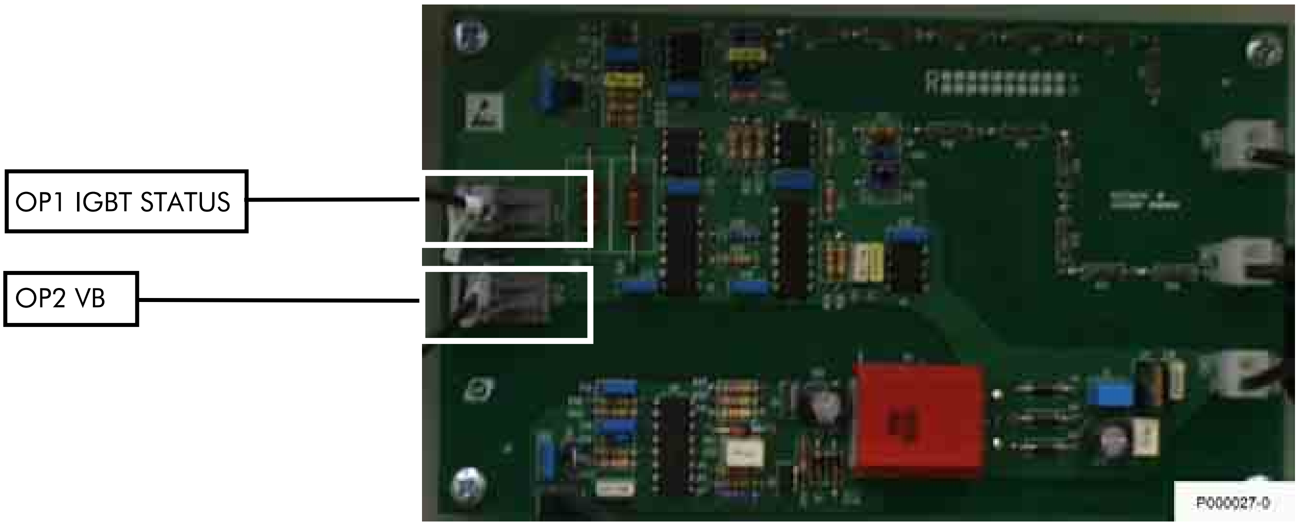
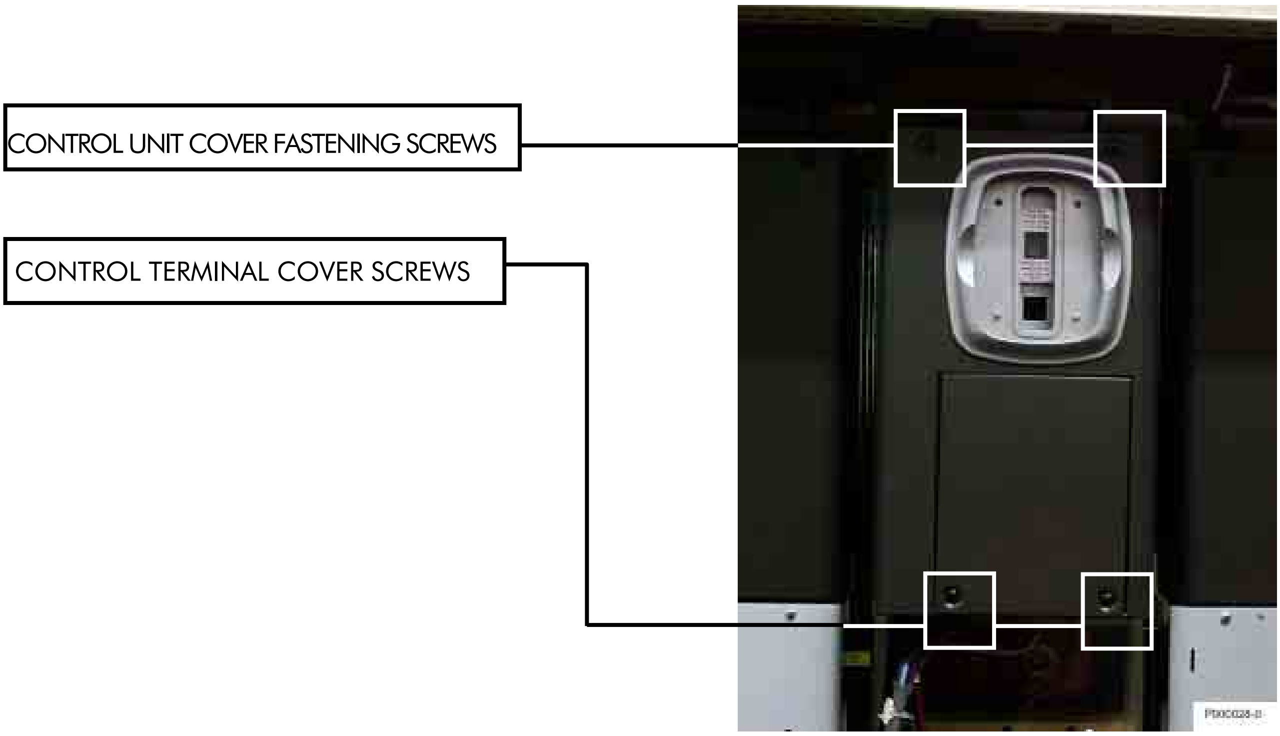


Figure 32: ES843 Inverter Module

2) Gain access to board ES842 located on the control unit; do the following:
remove keypad (if fitted) (see section 1.5.1 "Remoting the Keypad")
remove the cover of the terminal board after removing its fastening screws
remove the cover of the control unit after removing its fastening screws



3) You can then access to connectors in control board ES842

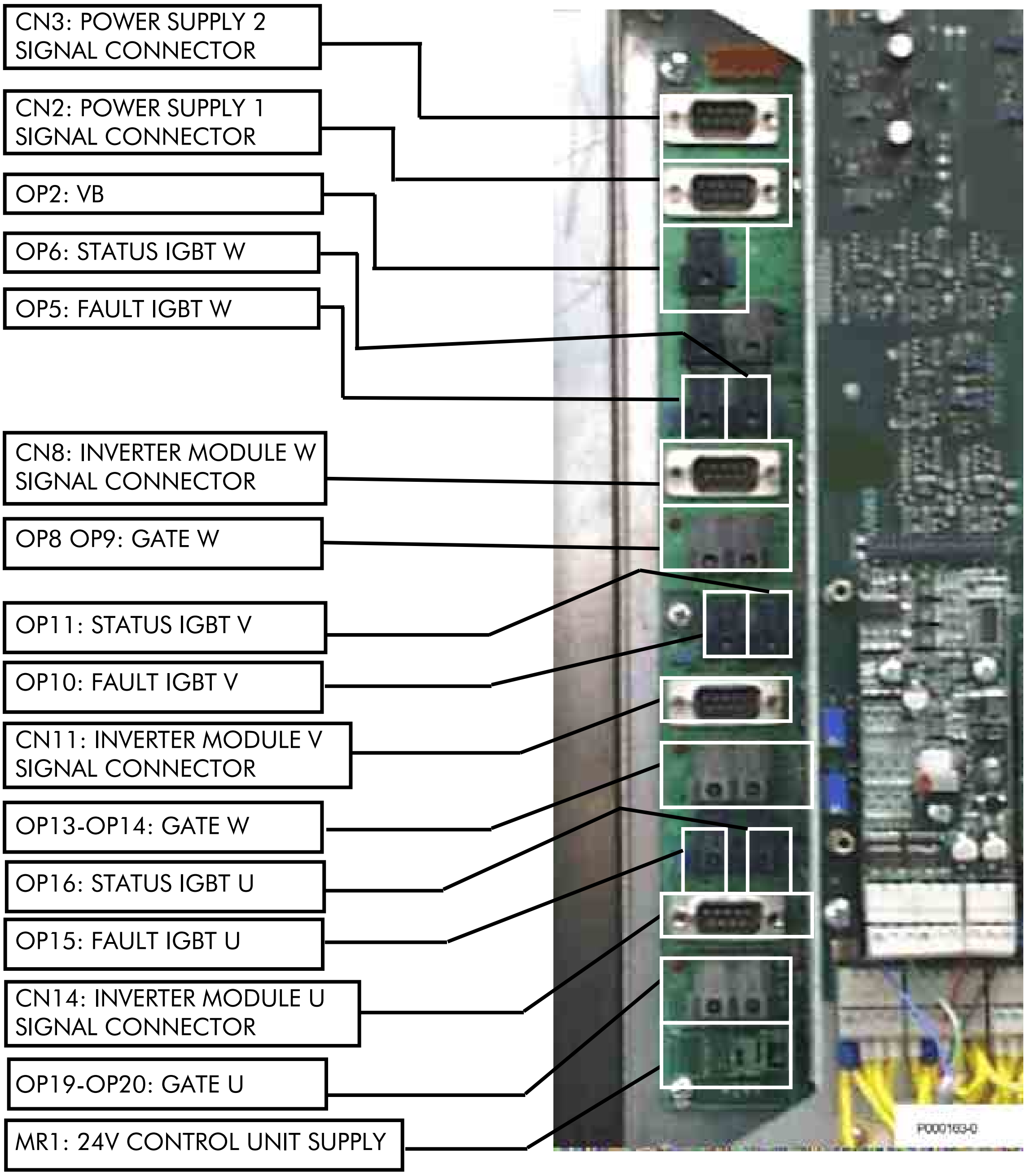


Figure 33: ES842 Control Unit

4) Use the connection cable kit to connect the inverter components to each other. Make sure that the tab of the optical fibre connectors is turned outwards to the connector fixed in the control board.

5) Reassemble the covers made of Lexan and the covering of the control unit, making sure not to flatten any cable/optical fibre.

3.4.2.6. INTERNAL CONNECTIONS FOR MODULAR INVERTERS S64

The following links are required:

N. 2 power connections with 60*10mm copper bar between the inverter arms in order to deliver DC voltage.
N. 4 connections with 9-pole shielded cable.
Type of cable: shielded cable
N. of conductors: 9
Diameter of each conductor: AWG20÷24 (0.6÷0.22sqmm)
Connectors: 9-pole SUB-D female connectors

Connections within the cable:

Connector	SUB-D female connector	SUB-D female connector
pin	1→	1
pin	2→	2
pin	3→	3
pin	4→	4
pin	5→	5
pin	6→	6
pin	7→	7
pin	8→	8
pin	9→	9

The following links are required:
- from control unit to inverter arm with auxiliary power supply unit (control signals for auxiliary power supply)
- from control unit to inverter arm U (phase U control signals)
- from control unit to inverter arm V (phase V control signals)
- from control unit to inverter arm W (phase W control signals)

N. 4 connections with AWG17-18 (1sqmm) unipolar cable pairs delivering low-voltage DC power supply.
- from inverter arm with auxiliary power supply unit to control unit (control unit +24V voltage supply)
- from inverter arm with auxiliary power supply unit to driver boards of each power arm of the inverter (the power supply can be transferred from the supply unit to a driver board, in arm U for instance, then to arm V, finally to arm W). (IGBT driver board 24V power supply.)

N. 4 optical-fibre connections, 1mm, single standard plastics (0.22dB/m typical attenuation) with Agilent HFBR-4503/4513 connectors.

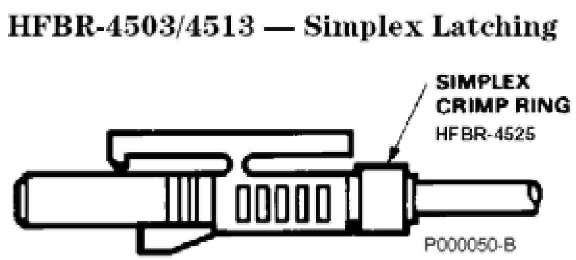


Figure 34: Single optical-fibre connector

The following links are required:

- from control unit to driver board in inverter arm U (U fault signal)
- from control unit to driver board in inverter arm V (V fault signal)
- from control unit to driver board in inverter arm W (W fault signal)
- from control unit to bus voltage detecting board installed on inverter arm U (VB signal)

N. 4 optical-fibre connections, 1mm, double standard plastics (0.22dB/m typical attenuation) with Agilent HFBR-4516 connectors.

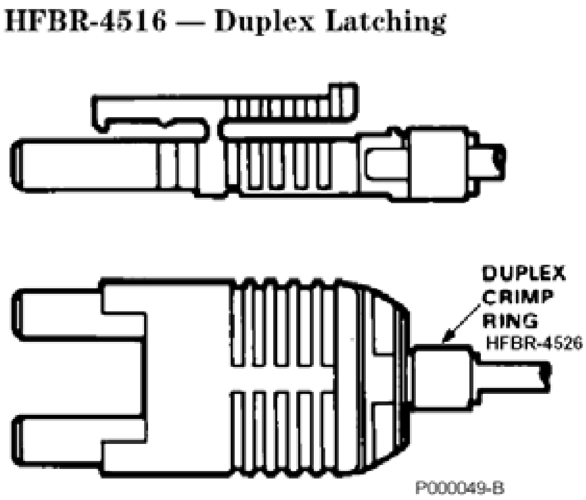


Figure 35: Double optical-fibre connector

The following links are required:

- from control unit to driver board in inverter arm U (top and bottom IGBT control signals)
- from control unit to driver board in inverter arm V (top and bottom IGBT control signals)
- from control unit to driver board in inverter arm W (top and bottom IGBT control signals)

INTERNAL CONNECTIONS FOR S64

Signal	Type of Connection	Cable Marking	Component	Board	Connector	Component	Board	Connector
control signals for auxiliary power supply	9-pole shielded cable	CPS-1	control unit	ES842	CN4	inverter arm with auxiliary power supply unit	auxiliary power supply unit	CN3
control signals for phase U	9-pole shielded cable	C-U	control unit	ES842	CN14	phase U	ES841	CN3
control signals for phase V	9-pole shielded cable	C-V	control unit	ES842	CN11	phase V	ES841	CN3
control signals for phase W	9-pole shielded cable	C-W	control unit	ES842	CN8	phase W	ES841	CN3
+24V control unit power supply	1 sqmm unipolar cable	24V-CU	inverter arm with auxiliary power supply unit	auxiliary power supply unit	MR1-1	control unit	ES842	MR1-1
0V control unit power supply	1 sqmm unipolar cable		inverter arm with auxiliary power supply unit	auxiliary power supply unit	MR1-2	control unit	ES842	MR1-2
ES841 driver board +24VD power supply	1 sqmm unipolar cable (*)	24V-GU	inverter arm with auxiliary power supply unit	auxiliary power supply unit	MR2-1	phase U	ES841	MR1-1
ES841 driver board +0VD power supply	1 sqmm unipolar cable (*)		inverter arm with auxiliary power supply unit	auxiliary power supply unit	MR2-1	phase U	ES841	MR1-2
ES841 driver board +24VD power supply	1 sqmm unipolar cable	24V-GV	phase U	ES841	MR1-3	phase V	ES841	MR1-1
ES841 driver board +0VD power supply	1 sqmm unipolar cable		phase U	ES841	MR1-4	phase V	ES841	MR1-2
ES841 driver board +24VD power supply	1 sqmm unipolar cable	24V-GW	phase V	ES841	MR1-3	phase W	ES841	MR1-1
ES841 driver board +0VD power supply	1 sqmm unipolar cable		phase V	ES841	MR1-4	phase W	ES841	MR1-2
IGBT command, phase U	double optical fibre	G-U	control unit	ES842	OP19-OP20	phase U	ES841	OP4-OP5
IGBT command, phase V	double optical fibre	G-V	control unit	ES842	OP13-OP14	phase V	ES841	OP4-OP5
IGBT command, phase W	double optical fibre	G-W	control unit	ES842	OP8-OP9	phase W	ES841	OP4-OP5
IGBT fault, phase U	single optical fibre	FA-U	control unit	ES842	OP15	phase U	ES841	OP3
IGBT fault, phase V	single optical fibre	FA-V	control unit	ES842	OP10	phase V	ES841	OP3
IGBT fault, phase W	single optical fibre	FA-W	control unit	ES842	OP5	phase W	ES841	OP3
Vbus readout	single optical fibre	VB	control unit	ES842	OP2	one phase	ES843	OP2
IGBT status, phase U	single optical fibre	ST-U	control unit	ES842	OP16	phase U	ES843	OP1
IGBT status, phase V	single optical fibre	ST-V	control unit	ES842	OP11	phase V	ES843	OP1
IGBT status, phase W	single optical fibre	ST-W	control unit	ES842	OP6	phase W	ES843	OP1

(*): Factory-set connection provided in the inverter

CAUTION Make sure that links are correct, as incorrect links cause the inverter malfunctioning.

CAUTION NEVER power the inverter when the optical-fibre connectors are not connected.

The figure below shows the links required for the components of the modular inverter.

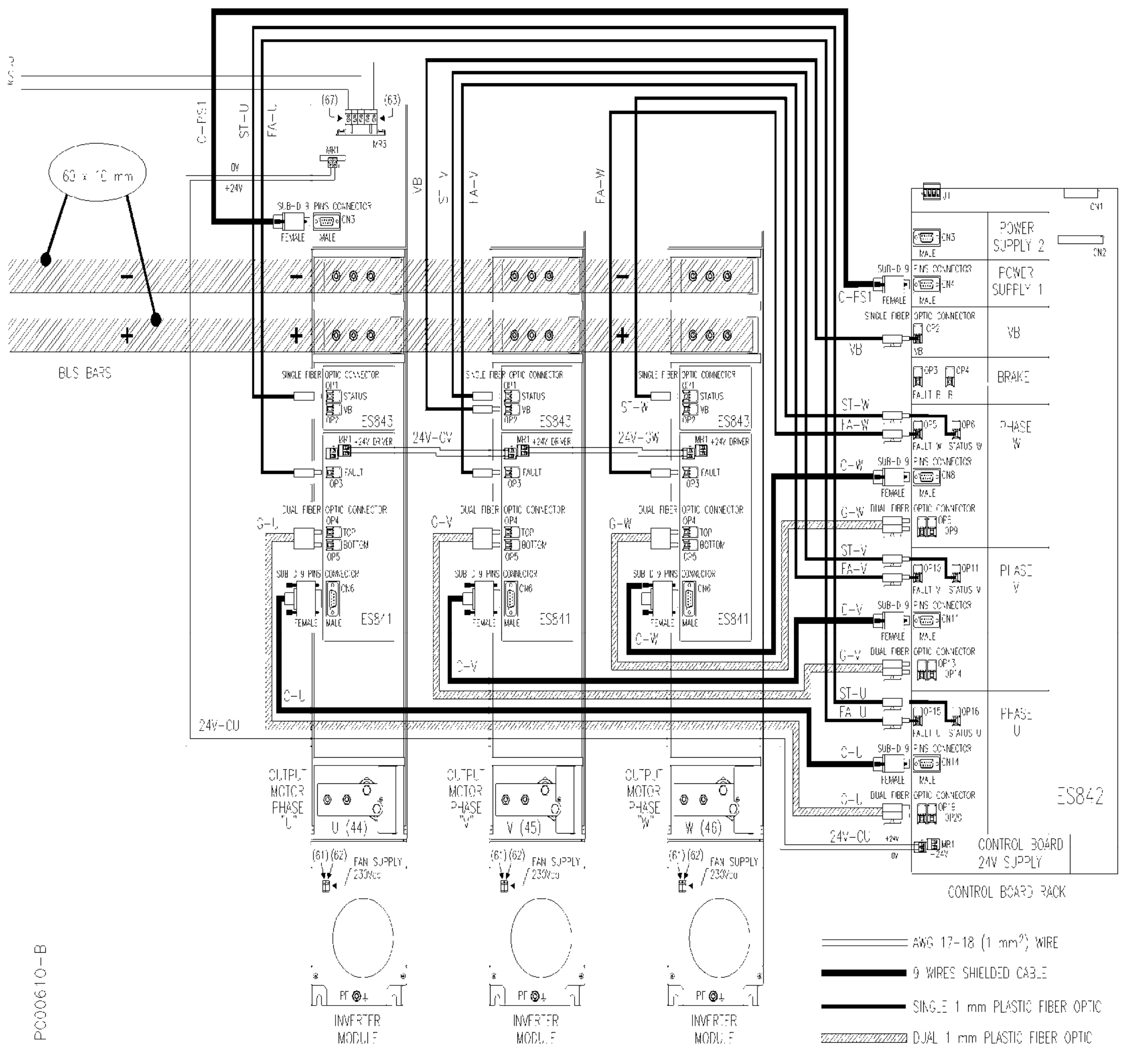


Figure 36: Internal wiring for inverters S64

3.4.3. LAY-OUT OF THE POWER TERMINALS

SYMBOLS	
41/R – 42/S – 43/T	Inputs for three-phase supply (the phase sequence is not important)
44/U – 45/V – 46/W	Three-phase motor outputs
47/+	Link to the DC voltage positive pole. It can be used for DC voltage supply, the DC reactor, the external braking resistor and the external braking unit (for the inverter models where it is not built-in).
47/D	Link to the positive pole of the continuous AC rectified voltage. It can be used for the DC reactor—if no DC reactor is used, terminal 47/D must be short-circuited to terminal 47/+ using a cable having the same cross-section as the cables used for power supply; factory setting).
48/B	When available, it can be used to connect the IGBT brake for braking resistors.
49/-	Link to the negative pole of the DC voltage. It can be used for DC power supply and the external braking resistor.
50/+	When available, it can be used to connect the positive pole of the DC voltage to be used for the external braking resistor only.
51/+	When available, it can be used to connect the positive pole of the DC voltage to be used for the external braking unit only.
52/-	When available, it can be used to connect the negative pole of the DC voltage to be used for the external braking unit only.

S05 (4T) S10-S15-S20 Terminal board:

41/R	42/S	43/T	44/U	45/V	46/W	47/+	48/B	49/-

S05 (2T) Terminal board:

41/R	42/S	43/T	44/U	45/V	46/W	47/+	47/D	48/B	49/-

S12 Terminal board:

41/R	42/S	43/T	47/+	47/D	48/B	49/-	44/U	45/V	46/W

S30 Terminal board:

41/R	42/S	43/T	44/U	45/V	46/W	47/+	49/-	48/B	50/+

NOTE

Connect the braking unit to terminals **50/+** and **48/B**.
Avoid using terminals 48 and 50 for DC power supply.

S40 Terminal board:

41/R	42/S	43/T	44/U	45/V	46/W	47/+	49/-	51/+	52/-

NOTE

Connect the external braking unit to terminals 51/+ and 52/-.
Avoid using terminals 51 and 52 for DC power supply.

S50 Connection bars:

49/-	47/+	41/R	42/S	43/T	44/U	45/V	46/W

3.4.4. S60 CONNECTION BARS FOR INVERTER S60

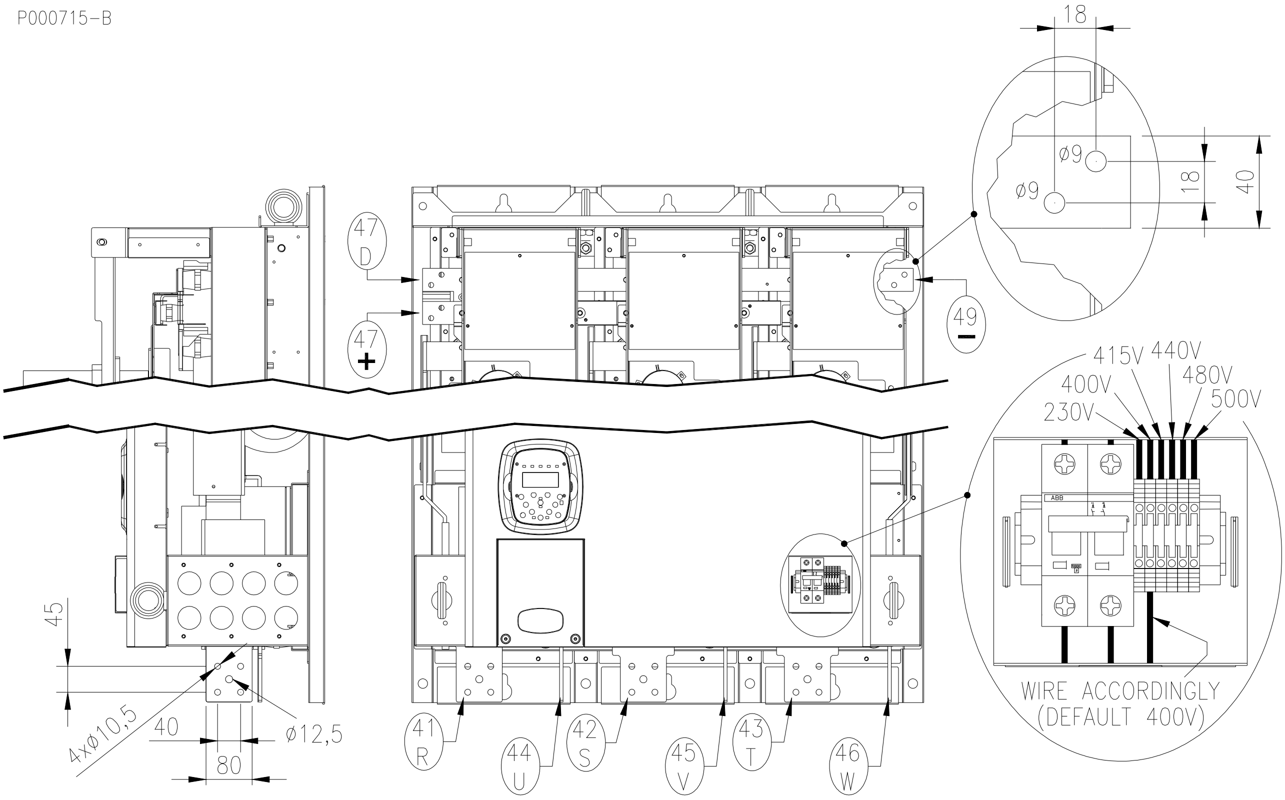


Figure 37: S60 Connection bars

Figure 37 shows the location and dimension of the bars connecting S60 SINUS PENTA drives to the mains and the motor. The figure also shows the position and the wiring instructions for the built-in power supply transformer. The trasformer must be wired based on the rated supply voltage being used.

ATTENZIONE — Bars 47/D and 47/+ are short-circuited (factory-setting). The DC inductance if any must be connected between bars 47D and 47+ after removing the short-circuit.

3.4.5. LAY-OUT OF THE AUXILIARY POWER SUPPLY TERMINALS

The auxiliary power supply terminals are provided in the Penta models requiring auxiliary power supply links to be used to power air-cooling systems or to power internal circuits.

	SYMBOL		
Inverter	Terminal	Description	Ratings
S64-S74	63/Raux – 65/Saux – 67/Taux	Inputs for auxiliary 3-phase power supply	380-500Vac 100mA for 4T-class inverters 660-690Vac 0.5A for 6T-class inverters
S65-S64-S70-S74-S80	61-62	Inputs for fan power supply	230Vac/2A

Connection bars for S64 – S70:

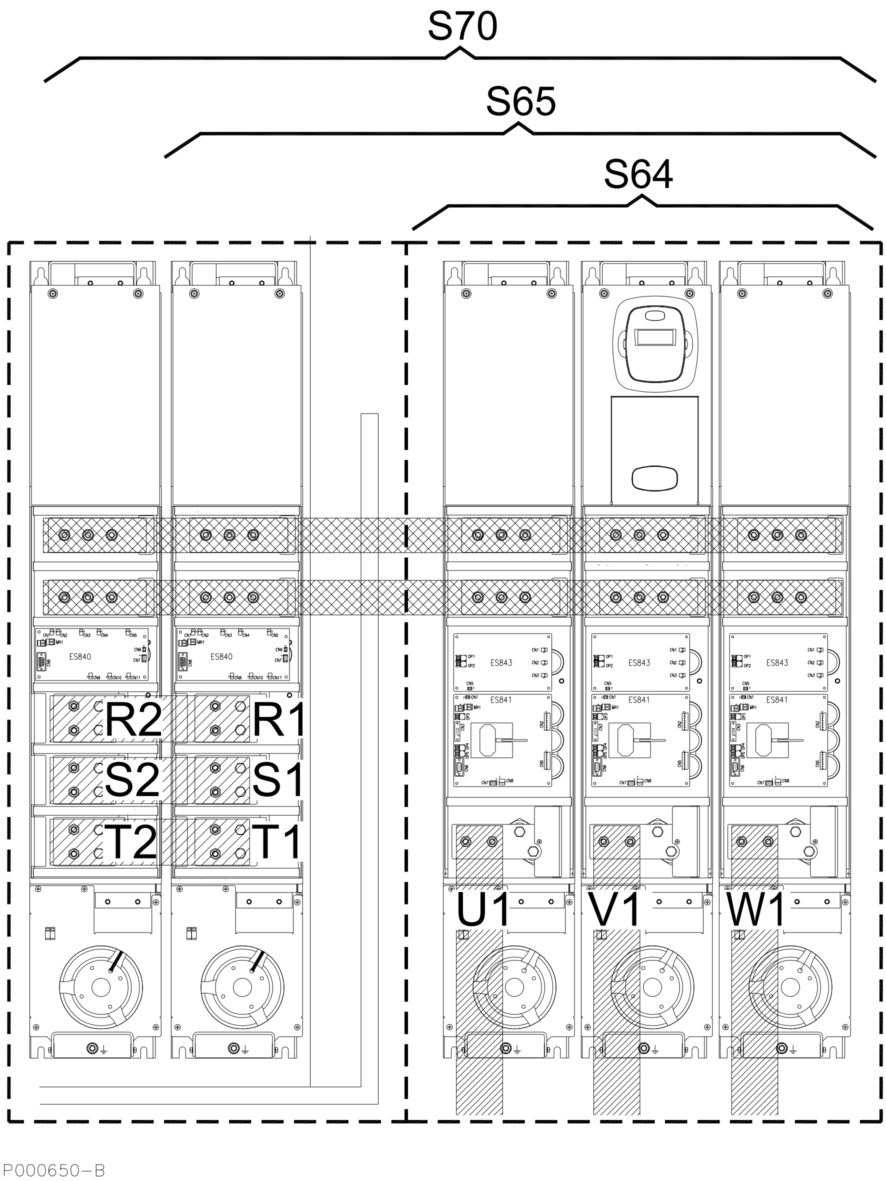


Figure 38: Connection bars for S64 – S70

Connection bars for S74 – S80:

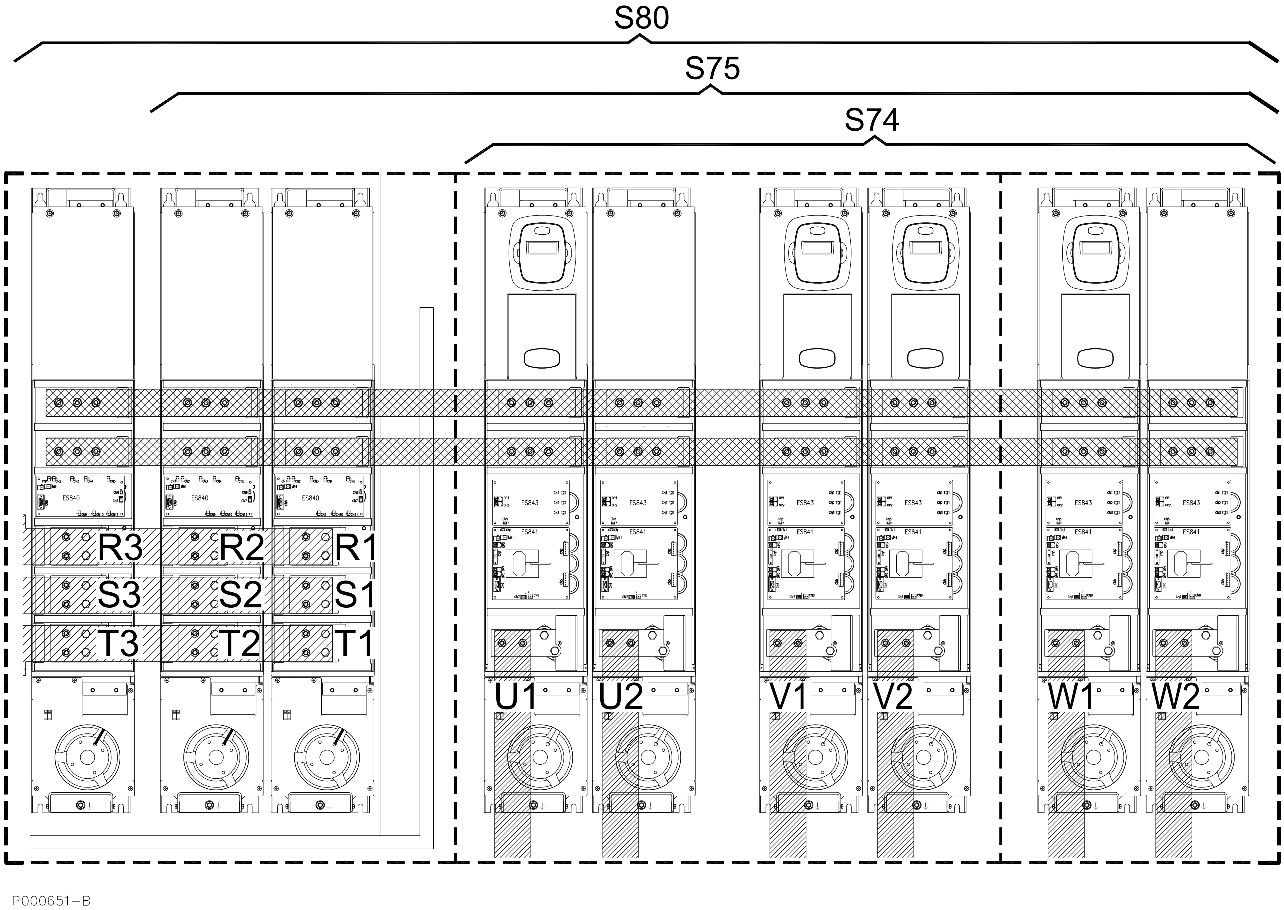


Figure 39: Connection bars for S64 – S70

3.4.6. CROSS-SECTIONS OF THE POWER CABLES AND SIZES OF THE PROTECTING DEVICES

The tables below state the features of the inverter cables and the protecting devices required to protect the system against short-circuits.
For the largest inverter sizes, special links with multiple conductors are provided for each phase. For example, 2x150 in the column relating to the cable cross-section means that two 150sqmm parallel conductors are required for each phase.
Multiple conductors shall have the same length and must run parallel to each others, thus ensuring even current delivery at any frequency value. Paths having the same length but a different shape deliver uneven current at high frequency.
Also, do not exceed the tightening torque for the terminals to the bar connections. For connections to bars, the tightening torque relates to the bolt tightening the cable lug to the copper bar. The cross-section values given in the tables below apply to copper cables.
The links between the motor and the Penta drive must have the same lengths and must follow the same paths. Use 3-phase cables where possible.

0 1 2 3 4 5 6 7 8

3.4.6.1. 2T VOLTAGE CLASS

Size	SINUS PENTA Model	Inverter Rated Current	Cable Cross-section Fitting the Terminal	Cable Peeling	Tightening Torque	Cable Cross-section to Mains and Motor Side	Fast Fuses (700V) + Disc. Switch	Magnetic Circuit Breaker	AC1 Contactor
		A	mm² (AWG/kcmils)	mm	Nm	mm² (AWG/kcmils)	A	A	A
S05	0007	12.5	0.5÷10 (20÷6AWG)	10	1.2-1.5	2.5 (13AWG)	16	16	25
	0008	15		10	1.2-1.5		16	16	25
	0010	17		10	1.2-1.5	4 (10AWG)	25	25	25
	0013	19		10	1.2-1.5		32	32	30
	0015	23		10	1.2-1.5		32	32	30
	0016	27		10	1.2-1.5	10 (6AWG)	40	40	45
	0020'	30		10	1.2-1.5		40	40	45
S10	0016	26	0.5÷10 (20÷6 AWG)	10	1.2-1.5	10 (6AWG)	40	40	45
	0017	30		10	1.2-1.5		40	40	45
	0020	30		10	1.2-1.5		40	40	45
	0025	41		10	1.2-1.5		63	63	55
	0030	41		10	1.2-1.5		63	63	60
	0035	41		10	1.2-1.5		100	100	100
S12	0023	38	0.5÷25 (20÷4 AWG	18	2.5	10 (6AWG)	63	63	60
	0033	51		18	2.5	16 (5WG)	100	100	100
	0037	65		18	2.5	25 (4AWG	100	100	100
S15	0038	65	0.5÷25 (20÷4 AWG)	15	2.5	25 (4AWG)	100	100	100
	0040	72		15	2.5		100	100	100
	0049	80	4÷25 (12÷4 AWG)	15	2.5	25 (4AWG)	125	100	100
S20	0060	88	25÷50 (6÷1/0 AWG	24	6-8	35 (2AWG)	125	125	125
	0067	103		24	6-8	50 (1/0AWG)	125	125	125
	0074	120		24	6-8		160	160	145
	0086	135		24	6-8		200	160	160
S30	0113	180	35÷185 (2/0AWG÷ 350kcmils)	30	10	95 (4/0AWG)	250	200	250
	0129	195		30	10	120 (250kcmils)	250	250	250
	0150	215		30	10		315	400	275
	0162	240		30	10		400	400	275

(continued)

(continued)

Size	SINUS PENTA Model	Inverter Rated Current	Cable Cross-section Fitting the Terminal	Cable Peeling	Tightening Torque	Cable Cross-section to Mains and Motor Side	Fast Fuses (700V) + Disc. Switch	Magnetic Circuit Breaker	AC1 Contactor
		A	mm² (AWG/kcmils)	mm	Nm	mm² (AWG/kcmils)	A	A	A
S40	0179	300	70÷240 (2/0AWG÷ 500kcmils)	40	25-30	185 (400kcmils)	400	400	400
	0200	345		40	25-30	210 (400kcmils)	500	400	450
	0216	375		40	25-30	240 (500kcmils)	500	630	450
	0250	390		40	25-30		630	630	500
S50	0312	480	Bar	-	30	2x150 (2x300kcmils)	800	630	550
	0366	550	Bar	-	30	2x210 (2x400kcmils)	800	800	600
	0399	630	Bar	-	30	2x240 (2x500kcmils)	800	800	700
S60	0457	720	Bar	-	30	2x240 (2x500kcmils)	1000	800	800
	0524	800	Bar	-	35	3x210 (3x400kcmils)	1000	1000	1000
S65	0598	900	Bar	-	35	3x210 (3x400kcmils)	1250	1250	1000
	0748	1000	Bar	-	35	3x240 (3x500kcmils)	1250	1250	1200
	0831	1200	Bar	-	35		1600	1600	1600
S75	0964	1480	Bar	-	35	4x240 (4x500kcmils)	2x1000	2000	2x1000
	1130	1700	Bar	-	35	6x210 (6x400kcmils)	2x1250	2000	2x1200
	1296	1950	Bar	-	35	6x240 (6x500kcmils)	2x1250	2500	2x1200

⚠ CAUTION

Always use the correct cable cross-sections and activate the protecting devices provided for the inverter. Failure to do so will cause the non-compliance to standard regulations of the system where the inverter is installed.

3.4.6.2. 4T Voltage Class

Size	SINUS PENTA Model	Inverter Rated Current	Cable Cross-section Fitting the Terminal	Cable Peeling	Tightening Torque	Cable Cross-section to Mains and Motor Side	Fast Fuses (700V) + Disc. Switch	Magnetic Circuit Breaker	AC1 Contactor
		A	mm^2 (AWG/kcmils)	mm	Nm	mm^2 (AWG/kcmils)	A	A	A
S05	0005	10.5	0.5÷10 (20÷6AWG)	10	1.2-1.5	2.5 (13AWG)	16	16	25
	0007	12.5		10	1.2-1.5		16	16	25
	0009	16.5		10	1.2-1.5	4 (10AWG)	25	25	25
	0011	16.5		10	1.2-1.5		25	25	25
	0014	16.5		10	1.2-1.5		32	32	30
S10	0016	26	0.5÷10 (20÷6 AWG)	10	1.2-1.5	10 (6AWG)	40	40	45
	0017	30		10	1.2-1.5		40	40	45
	0020	30		10	1.2-1.5		40	40	45
	0025	41		10	1.2-1.5		63	63	55
	0030	41		10	1.2-1.5		63	63	60
	0035	41		10	1.2-1.5		100	100	100
S12	0016	26	0.5÷10 (20÷6 AWG	10	1.2-1.5	10 (6AWG)	40	40	45
	0017	30		10	1.2-1.5		40	40	45
	0020	30		10	1.2-1.5		40	40	45
	0025	41		10	1.2-1.5		63	63	55
	0030	41		10	1.2-1.5		63	63	60
	0034	57	0.5÷25 (20÷4 AWG	18	2.5	16 (5AWG)	100	100	100
	0036	60		18	2.5	25 (4AWG)	100	100	100
S15	0038	65	0.5÷25 (20÷4 AWG)	15	2.5	25 (4AWG)	100	100	100
	0040	72		15	2.5		100	100	100
	0049	80	4÷25 (12÷4 AWG)	15	2.5	25 (4AWG)	125	100	100
S20	0060	88	25÷50 (6÷1/0 AWG	24	6-8	35 (2AWG)	125	125	125
	0067	103		24	6-8	50 (1/0AWG)	125	125	125
	0074	120		24	6-8		160	160	145
	0086	135		24	6-8		200	160	160
S30	0113	180	35÷185 (2/0AWG÷ 350kcmils)	30	10	95 (4/0AWG)	250	200	250
	0129	195		30	10	120 (250kcmils)	250	250	250
	0150	215		30	10		315	400	275
	0162	240		30	10		400	400	275

(continued)

(continued)

Size	SINUS PENTA Model	Inverter Rated Current	Cable Cross-section Fitting the Terminal	Cable Peeling	Tightening Torque	Cable Cross-section to Mains and Motor Side	Fast Fuses (700V) + Disc. Switch	Magnetic Circuit Breaker	AC1 Contactor
		A	mm² (AWG/kcmils)	mm	Nm	mm² (AWG/kcmils)	A	A	A
S40	0179	300	70÷240 (2/0AWG÷ 500kcmils)	40	25-30	185 (400kcmils)	400	400	400
	0200	345		40	25-30	210 (400kcmils)	500	400	450
	0216	375		40	25-30	240 (500kcmils)	500	630	450
	0250	390		40	25-30		630	630	500
S50	0312	480	Bar	-	30	2x150 (2x300kcmils)	800	630	550
	0366	550	Bar	-	30	2x210 (2x400kcmils)	800	800	600
	0399	630	Bar	-	30	2x240 (2x500kcmils)	800	800	700
S60	0457	720	Bar	-	30	2x240 (2x500kcmils)	1000	800	800
	0524	800	Bar	-	35	3x210 (3x400kcmils)	1000	1000	1000
S65	0598	900	Bar	-	35	3x210 (3x400kcmils)	1250	1250	1000
	0748	1000	Bar	-	35	3x240 (3x500kcmils)	1250	1250	1200
	0831	1200	Bar	-	35		1600	1600	1600
S75	0964	1480	Bar	-	35	4x240 (4x500kcmils)	2x1000	2000	2x1000
	1130	1700	Bar	-	35	6x210 (6x400kcmils)	2x1250	2000	2x1200
	1296	1950	Bar	-	35	6x240 (6x500kcmils)	2x1250	2500	2x1200

CAUTION

Always use the correct cable cross-sections and activate the protecting devices provided for the inverter. Failure to do so will cause the non-compliance to standard regulations of the system where the inverter is installed.

Size	SINUS PENTA Model	Rated Output Current	Rated Input Current	Cable Cross-section Fitting the Terminal	Tightening Torque	Motor Cable Cross-section
		A	Adc	mm² (AWG/kcmils)	Nm	mm² (AWG/kcmils)
S64	0598	900	1000	Bar	35	3x210 (3x400kcmils)
	0748	1000	1100	Bar	35	3x240 (3x500kcmils)
	0831	1200	1400	Bar	35	3x240 (3x500kcmils)
S74	0964	1480	1750	Bar	35	4x240 (4x500kcmils)
	1130	1700	2000	Bar	35	6x210 (6x400kcmils)
	1296	1950	2280	Bar	35	6x240 (6x500kcmils)

CAUTION

Always use the correct cable cross-sections and activate the protecting devices installed on the DC power supply line. Failure to do so will cause the non-compliance to standard regulations of the system where the inverter is installed.

3.4.6.3. UL-Approved Fuses-2T Voltage Class

UL-approved semiconductor fuses, which are recommended for the SINUS PENTA drives, are listed in the table below.
In multiple cable installations, install one fuse per phase (NOT one fuse per conductor). Fuses suitable for the protection of semiconductors produced by other manufacturers may be used, provided that they have the same ratings and are approved as "UL R/C Special Purpose Fuses (JFHR2)".

Size	SINUS PENTA Model	UL-approved Fuses Manufactured by:							
		SIBA Sicherungen-Bau GmbH (200 kA_{RMS} Symmetrical A.I.C.)				Bussmann Div Cooper (UK) Ltd (100/200 kA_{RMS} Symmetrical A.I.C.)			
		Mod. No.	Ratings			Mod. No.	Ratings		
			Current A_{RMS}	I^2t (500V) A^2sec	Vac		Current A_{RMS}	I^2t (500V) A^2sec	Vac
S05	0007	20 412 04 16	16	49		FWP-15B	15	48	
	0008	20 412 04 25	25	140		FWP-20B	20	116	
	0010								
	0013								
	0015	20 412 20 40	40	350		FWP-40B	40	236	
	0016								
	0020'								
S10	0016	20 412 20 40	40	350		FWP-40B	40	236	
	0017								
	0020								
	0025	20 412 20 63	63	980		FWP-60B	60	685	
	0030								
	0035	20 412 20 100	100	2800		FWP-100B	100	2290	
S12	0023	20 412 20 63	63	980		20 282 20	63	980	
	0033	20 412 20 100	100	2800		FWP-100B	100	2290	
	0037								
S15	0038	20 412 20 100	100	2800		FWP-100B	100	2290	
	0040								
	0049								
S20	0060	20 412 20 125	125	5040		FWP-100B	100	2290	
	0067				700	FWP-125A	125	5655	700
	0074	20 412 20 160	160	10780		FWP-150A	150	11675	
	0086	20 412 20 200	200	19250		FWP-175A	175	16725	
S30	0113	20 412 20 250	250	32760		FWP-225A	225	31175	
	0129								
	0150	20 412 20 315	315	60200		FWP-250A	250	42375	
	0162	20 412 20 400	400	109200		FWP-350A	350	95400	
S40	0179	20 412 20 400	400	109200		FWP-350A	350	95400	
	0200								
	0216	20 622 32 500	550	136500		FWP-450A	450	139150	
	0250	20 622 32 700	700	287000		FWP-700A	700	189000	
S50	0312	20 622 32 800	800	406000		FWP-800A	800	280500	
	0366								
	0399								
S60	0457	20 632 32 1000	1000	602000		FWP-1000A	1000	390000	
	0524	20 632 32 1250	1250	1225000		FWP-1200A	1200	690000	
S65	0598	20 632 32 1400	1400	1540000		170M6067	1400	1700000	
	0748					170M6067	1400	1700000	
	0831	20 688 32 1600	1600	1344000		170M6069	1600	2700000	
S75	0964	20 632 32	2x1000	602000		2xFWP-1000A	2x1000	390000	
	1130		2x1250	1225000		2xFWP-1200A	2x1200	690000	
	1296		2x1400	1540000		2x170M6067	2x1400	1700000	

NOTE In modular sizes S65–S75, each supply arm shall be protected by a separate fuse (see table above).

3.4.6.4. UL-Approved Fuses – 4T Voltage Class

UL-approved semiconductor fuses, which are recommended for the SINUS PENTA drives, are listed in the table below.
In multiple cable installations, install one fuse per phase (NOT one fuse per conductor). Fuses suitable for the protection of semiconductors produced by other manufacturers may be used, provided that they have the same ratings and are approved as "UL R/C Special Purpose Fuses (JFHR2)".

Size	SINUS PENTA Model	UL-approved Fuses Manufactured by:							
		SIBA Sicherungen-Bau GmbH (200 kA_{RMS} Symmetrical A.I.C.)				Bussmann Div Cooper (UK) Ltd (100/200 kA_{RMS} Symmetrical A.I.C.)			
		Mod. No.	Ratings			Mod. No.	Ratings		
			Current A_{RMS}	I^2t (500V) A^2sec	Vac		Current A_{RMS}	I^2t (500V) A^2sec	Vac
S05	0005	20 412 04 16	16	49		FWP-15B	15	48	
	0007								
	0009	20 412 04 25	25	140		FWP-20B	20	116	
	0011								
	0014	20 412 20 40	40	350		FWP-40B	40	236	
S10	0016	20 412 20 40	40	350		FWP-40B	40	236	
	0017								
	0020								
	0025	20 412 20 63	63	980		FWP-60B	60	685	
	0030								
	0035	20 412 20 100	100	2800		FWP-100B	100	2290	
S12	0016	20 412 20 40	40	350		FWP-40B	40	236	
	0017								
	0020								
	0025	20 412 20 63	63	980		FWP-60B	60	685	
	0030								
	0034	20 412 20 100	100	2800		FWP-100B	100	2290	
	0036								
S15	0038	20 412 20 100	100	2800		FWP-100B	100	2290	
	0040								
	0049								
S20	0060	20 412 20 125	125	5040	700	FWP-100B	100	2290	700
	0067					FWP-125A	125	5655	
	0074	20 412 20 160	160	10780		FWP-150A	150	11675	
	0086	20 412 20 200	200	19250		FWP-175A	175	16725	
S30	0113	20 412 20 250	250	32760		FWP-225A	225	31175	
	0129								
	0150	20 412 20 315	315	60200		FWP-250A	250	42375	
	0162	20 412 20 400	400	109200		FWP-350A	350	95400	
S40	0179	20 412 20 400	400	109200		FWP-350A	350	95400	
	0200								
	0216	20 622 32 550	550	136500		FWP-450A	450	139150	
	0250	20 622 32 700	700	287000		FWP-700A	700	189000	
S50	0312	20 622 32 800	800	406000		FWP-800A	800	280500	
	0366								
	0399								
S60	0457	20 622 32 1000	1000	602000		FWP-1000A	1000	390000	
	0524	20 622 32 1250	1250	1225000		FWP-1200A	1200	690000	
S65	0598	20 632 32 1400	1400	1540000		170M6067	1400	1700000	
	0748					170M6067	1400	1700000	
	0831	20 688 32 1600	1600	1344000		170M6069	1600	2700000	
S75	0964	20 622 32	2x1000	602000		2xFWP-1000A	2x1000	390000	
	1130		2x1250	1225000		2xFWP-1200A	2x1200	690000	
	1296		2x1400	1540000		2x170M6067	2x1400	1700000	

NOTA In modular sizes S65–S75, each supply arm shall be protected by a separate fuse (see table above).

3.4.6.5. 5T and 6T Voltage Classes

Size	SINUS PENTA	Invetrer Rated Current	Terminal Cross-section	Cable Peeling	Tightening Torque	Cable Cross-section to Mains and Motor Side	Fast Fuses (700V) + Disc. Switch	Magnetic Circuit Breaker	AC1 Contactor
		A	mm² (AWG or kcmils)	mm	Nm	mm² (AWG or kcmils)	A	A	A
S65	0250	390	Bar	-	35	240 (500kcmils)	630	630	500
	0312	480	Bar	-	35	2x150 (2x300kcmils)	800	630	550
	0366	550	Bar	-	35	2x210 (2x400kcmils)	800	800	600
	0399	630	Bar	-	35	2x240 (2x500kcmils)	800	800	700
	0457	720	Bar	-	35		1000	800	800
	0524	800	Bar	-	35	3x210 (3x400kcmils)	1000	1000	1000
	0598	900	Bar	-	35		1250	1250	1000
	0748	1000	Bar	-	35	3x240 (3x500kcmils)	1250	1250	1200
S70	0831	1200	Bar	-	35	4x185 (3x400kcmils)	2x800	1600	2x800
S75	0964	1480	Bar	-	35	4x240 (4x500kcmils)	2x1000	2000	2x1000
S80	1130	1700	Bar	-	35	6x210 (6x400kcmils)	3x800	2000	3x800
	1296	1950	Bar	-	35	6x240 (6x500kcmils)	3x1000	2500	3x1000

CAUTION

Always use the correct cable cross-sections and activate the protecting devices provided for the inverter. Failure to do so will cause the non-compliance to standard regulations of the system where the inverter is installed.

NOTE

In modular sizes S65–S75, each supply arm shall be protected by a separate fuse (see table above).

Size	SINUS PENTA Model	Rated Output Current	Rated Input Current	Cable Cross-section Fitting the Terminal	Tightening Torque	Motor Cable Cross-section
		A	Adc	mm² (AWG or kcmils)	Nm	mm² (AWG or kcmils)
S64	0250	390	390	Bar	35	240 (500kcmils)
	0312	480	480	Bar	35	2x150 (2x300kcmils)
	0366	550	530	Bar	35	2x210 (2x400kcmils)
	0399	630	660	Bar	35	2x240 (2x500kcmils)
	0457	720	750	Bar	35	
	0524	800	840	Bar	35	3x210 (3x400kcmils)
	0598	900	950	Bar	35	
	0748	1000	1070	Bar	35	3x240 (3x500kcmils)
	0831	1200	1190	Bar	35	4x185 (3x400kcmils)
S74	0964	1480	1500	Bar	35	4x240 (4x500kcmils)
	1130	1700	1730	Bar	35	6x210 (6x400kcmils)
	1296	1950	1980	Bar	35	6x240 (6x500kcmils)

CAUTION

Always use the correct cable cross-sections and activate the protecting devices installed on the DC power supply line. Failure to do so will cause the non-compliance to standard regulations of the system where the inverter is installed.

3.4.6.6. UL-APPROVED FUSES (5T AND 6T)

<table>
<tr><th rowspan="4">SIZE</th><th rowspan="4">SINUS PENTA SIZE</th><th colspan="8">UL-APPROVED FUSES MANUFACTURED BY</th></tr>
<tr><th colspan="4">SIBA Sicherungen-Bau GmbH
(200 kA_{RMS} Symmetrical A.I.C.)</th><th colspan="4">Bussmann Div Cooper (UK) Ltd
(100/200 kA_{RMS} Symmetrical A.I.C.)</th></tr>
<tr><th rowspan="2">Mod. No.</th><th colspan="3">FEATURES</th><th rowspan="2">Mod. No.</th><th colspan="3">FEATURES</th></tr>
<tr><th>VOLTAGE A_{RMS}</th><th>I^2t (690V) kA^2sec</th><th>Vac</th><th>VOLTAGE A_{RMS}</th><th>I^2t (690V) KA^2sec</th><th>Vac</th></tr>
<tr><td rowspan="8">S65</td><td>0250</td><td>20 622 32</td><td>500</td><td>150</td><td rowspan="12">700</td><td>FWP-500A</td><td>500</td><td>170</td><td rowspan="12">700</td></tr>
<tr><td>0312</td><td>20 622 32</td><td>630</td><td>300</td><td>FWP-600A</td><td>600</td><td>250</td></tr>
<tr><td>0366</td><td rowspan="2">20 622 32</td><td rowspan="2">800</td><td rowspan="2">580</td><td rowspan="2">FWP-800A</td><td rowspan="2">800</td><td rowspan="2">450</td></tr>
<tr><td>0399</td></tr>
<tr><td>0457</td><td rowspan="2">20 622 32</td><td rowspan="2">1000</td><td rowspan="2">1260</td><td rowspan="2">FWP-1000A</td><td rowspan="2">1000</td><td rowspan="2">600</td></tr>
<tr><td>0524</td></tr>
<tr><td>0598</td><td rowspan="2">20 632 32</td><td rowspan="2">1250</td><td rowspan="2">1750</td><td rowspan="2">FWP-1200A</td><td rowspan="2">1200</td><td rowspan="2">1100</td></tr>
<tr><td>0748</td></tr>
<tr><td>S70</td><td>0831</td><td>20 622 32</td><td>2x800</td><td>580</td><td>2xFWP-800A</td><td>2x800</td><td>450</td></tr>
<tr><td>S75</td><td>0964</td><td>20 622 32</td><td>2x1000</td><td>1260</td><td>2xFWP-1000A</td><td>2x1000</td><td>600</td></tr>
<tr><td rowspan="2">S80</td><td>1130</td><td>20 622 32</td><td>3x800</td><td>580</td><td>3xFWP-800A</td><td>3x800</td><td>450</td></tr>
<tr><td>1296</td><td>20 622 32</td><td>3x1000</td><td>1260</td><td>3xFWP-1000A</td><td>3x1000</td><td>600</td></tr>
</table>

NOTE

In modular sizes S65–S70, each supply arm shall be protected by a separate fuse (see table above).

3.4.7. INVERTER AND MOTOR GROUND CONNECTION

A bolted screw for the inverter enclosure grounding is located close to the power wiring terminals. The screw can be located by the symbol below:

Always ground the inverter to a state-of-the-art mains. To reduce disturbance and radiated interference to a minimum, connect the motor grounding conductor directly to the inverter following a parallel path to the motor supply cables, then connect it to the mains.

DANGER

Always connect the inverter grounding terminal to the grid grounding using a conductor having a cross-section equal to or larger than the cross-section of the supply conductors. The grounding conductor must comply with the safety regulations in force. Always connect the motor casing to the inverter grounding to avoid dangerous voltage peaks and electrical shock hazard. Always provide a proper grounding of the inverter frame and the motor casing.

NOTE

To fulfil UL conformity requirements of the system where the inverter is installed, use a “UL R/C” or “UL Listed” lug to connect the inverter to the grounding system. Use a loop lug fitting the ground screw and having the same cross-section as the ground cable being used.

3.5. CONTROL TERMINALS

Screwable terminal board in six extractable sections suitable for cross-sections 0.08 ÷ 1.5mm^2 (AWG 28-16)

No.	Name	Description	I/O Features	Dip Switch
1	CMA	0V for main reference (connected to control 0V)	Control board zero volt	
2	REF	Input for single-ended main reference to be configured either as a voltage input or as a current input.	Vfs = ± 10 V, Rin: 50k Ω; Resolution: 12 bits	SW1-1: Off (default)
			0 (4) ÷ 20 mA, Rin = 250 Ω; Resolution: 11 bit	SW1-1: On
3	-10VR	Negative reference supply output for external potentiometer.	-10V Imax: 10mA	
4	+10VR	Positive reference supply output for external potentiometer.	+10V Imax: 10mA	
5	AIN1+	Differential auxiliary analog input 1 to be configured either as a voltage input or as a current input.	Vfs = ± 10 V, Rin: 50k Ω; Resolution: 12 bits	SW1-2: Off
6	AIN1-		0 (4) ÷ 20 mA, Rin = 250 Ω; Resolution: 11 bits	SW1-2: On (default)
7	AIN2+/PTC1	Differential auxiliary analog input to be configured either as a voltage input or as a current input, or to be configured as a PTC acquisition input for motor protection.	Vfs = ± 10 V, Rin: 50k Ω; Resolution: 12 bits	SW1-3: Off SW1-4,5: Off
8	AIN2-/ PTC2		0 (4) ÷ 20 mA, Rin = 250 Ω; Resolution: 11 bits	SW1-3: On SW1-4,5: Off (default)
			Motor protection PTC reading according to DIN44081/DIN44082	SW1-3: Off SW1-4,5: On
9	CMA	0V for auxiliary inputs (connected to control 0V)		
10	AO1	Analog output 1 to be configured either as a voltage output or as a current output.	Vout = ± 10 V; Ioutmax = 5 mA; Resolution: 11 bits	SW2-1: On; SW2-2: Off (default)
			0 (4) ÷ 20 mA; Voutmax = 10V Resolution: 10 bits	SW2-1: Off; SW2-2: On
11	AO2	Analog output 2 to be configured either as a voltage output or as a current output.	Vout = ±10V; Ioutmax = 5mA Resolution: 11 bits	SW2-3: On; SW2-4: Off (default)
			0 (4) ÷ 20 mA; Voutmax = 10V Resolution: 10 bits	SW2-3: Off; SW2-4: On
12	AO3	Analog output 3 to be configured either as a voltage output or as a current output.	Vout = ±10V; Ioutmax = 5mA Resolution: 11 bits	SW2-5: On; SW2-6: Off (default)
			0 (4) ÷ 20 mA; Voutmax = 10V Resolution: 10 bits	SW2-5: Off; SW2-6: On
13	CMA	0V for main reference (connected to control 0V)		
14	START (MDI1)	Active input: inverter running. Inactive input: main ref. is reset and the motor stops with a deceleration ramp.	Optoisolated digital inputs 24 VDC; positive logic (PNP): active with greater signal with respect to CMD (terminal 22). In compliance with EN 61131-2 as type-1 digital inputs with rated voltage equal to 24 VDC. Max. response time to processor: 500 µs	
15	ENABLE (MDI2)	Active input: inverter running enabled. Inactive input: motor idling regardless of control mode; inverter not commutating.		
16	RESET (MDI3)	Alarm reset function. Multifunction digital input 3.		
17	MDI4	Multifunction digital input 4.		
18	MDI5	Multifunction digital input 5.		
19	MDI6 / ECHA / FINA	Multifunction digital input 6; Encoder dedicated input, push-pull 24 V single-ended phase A, frequency input A	Optoisolated digital inputs 24 VDC; positive logic (PNP): active with greater signal with respect to CMD (terminal 22). In compliance with EN 61131-2 as type-1 digital inputs with rated voltage equal to 24 VDC. Max. response time to processor: 600 µs	
20	MDI7 / ECHB	Multifunction digital input 7; Encoder dedicated input, push-pull 24 V single-ended, phase B.		
21	MDI8 / FINB	Multifunction digital input 8; Frequency dedicated input B		
22	CMD	0V digital input isolated to control 0V	Optoisolated digital input zero volt	
23	+24V	Auxiliary supply output for optoisolated multifunction digital inputs	+24V±15% ; Imax: 200mA Protect with resetting fuse	
24	+VMDO1	Supply input for MDO1 output.	20 ÷ 48 VDC; IDC = 10 mA + output current (max 60 mA)	

(continued)

(continued)

25	MDO1 /FOUT	Multifunction digital output 1; frequency output	Optoisolated digital output (push-pull); Iout = 50 mA max; fout max 100 kHz.	
26	CMDO1	0V Multifunction digital output 1	Common for supply and MDO1 output	
27	MDO2	Multifunction digital output 2	Isolated digital output (open collector); Vomax = 48 V; Iomax = 50mA	
28	CMDO2	Common for multifunction digital output 2	Common for multifunction output 2	

Screwable terminal board in two extractable sections suitable for cross-sections 0.2 ÷ 2.5 mm^2 (AWG 24-12)

N.	Name	Description	I/O Features	Dip Switch
29	MDO3-NC	Multifunction, relay digital output 3 (NC contact).	Reverse contact: with low logic level, common terminal is closed with NC terminal; with high logic level, common terminal is open with NO; Vomax = 250 VAC, Iomax = 3A Vomax = 30 VDC, Iomax = 3A	
30	MDO3-C	Multifunction, relay digital output 3 (NC contact).		
31	MDO3-NO	Multifunction, relay digital output 3 (common).		
32	MDO4-NC	Multifunction, relay digital output 3 (NO contact).		
33	MDO4-C	Multifunction, relay digital output 4 (NC contact).		
34	MDO4-NO	Multifunction, relay digital output 4 (common).		

NOTE

Analog outputs are inactive under the following circumstances (digital outputs inactive and 0V / 0mA for analog outputs):
- inverter off
- inverter initialization after startup
- inverter in emergency mode (see Programming Manual)
- updating of the application software

Always consider those conditions when operating the inverter.

NOTE

The software considers encoder inputs MDI6/ECHA, MDI7/ECHB as ENCODER A in the terminal board.
Inserting an optional board in slot C inactivates digital inputs and only MDI6 and MDI7 functions are active, while the ENCODER A acquisition function is assigned to the optional board. For more details, see the section relating to the Options and the Programming Manual.

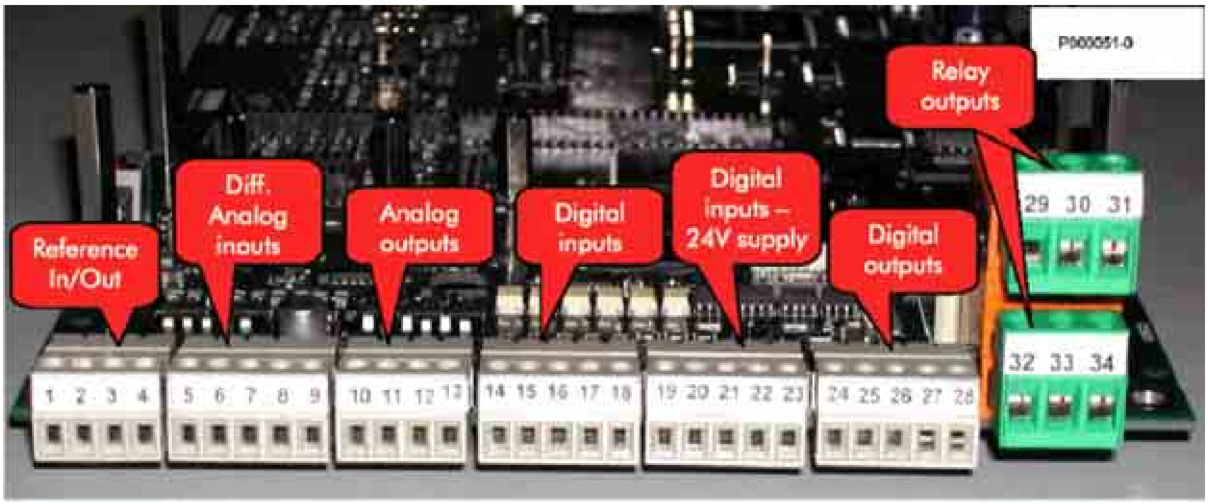


Figure 40: Control terminals

3.5.1.1. GAINING ACCESS TO CONTROL TERMINALS AND POWER TERMINALS FOR MODELS IP20 AND IP00

To access the inverter control terminals, loosen the two fastening screws shown in the figure below and remove the cover.

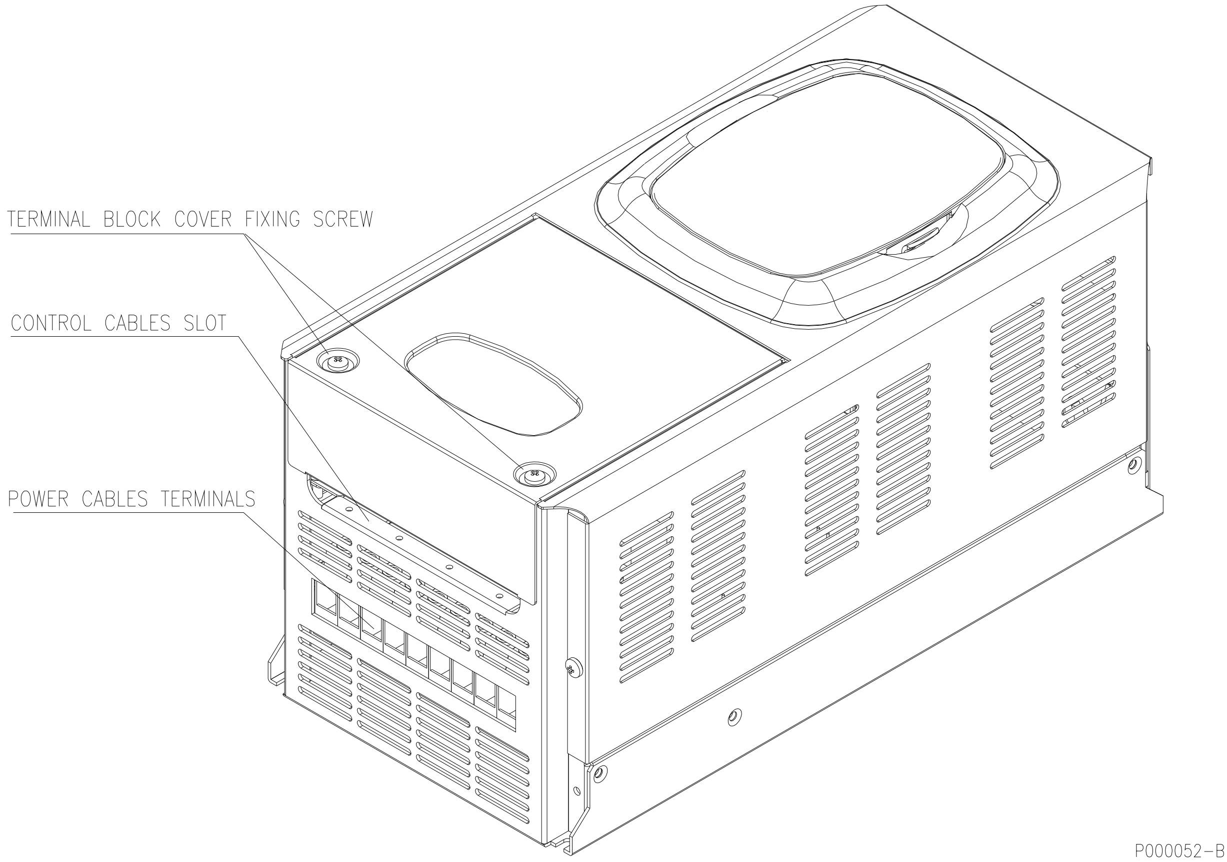


Figure 41: Gaining access to the control terminals

Size S05 ÷ S15: remove the cover to reach power terminals as well. Upper sizes: removing the cover allows to reach control signals only.

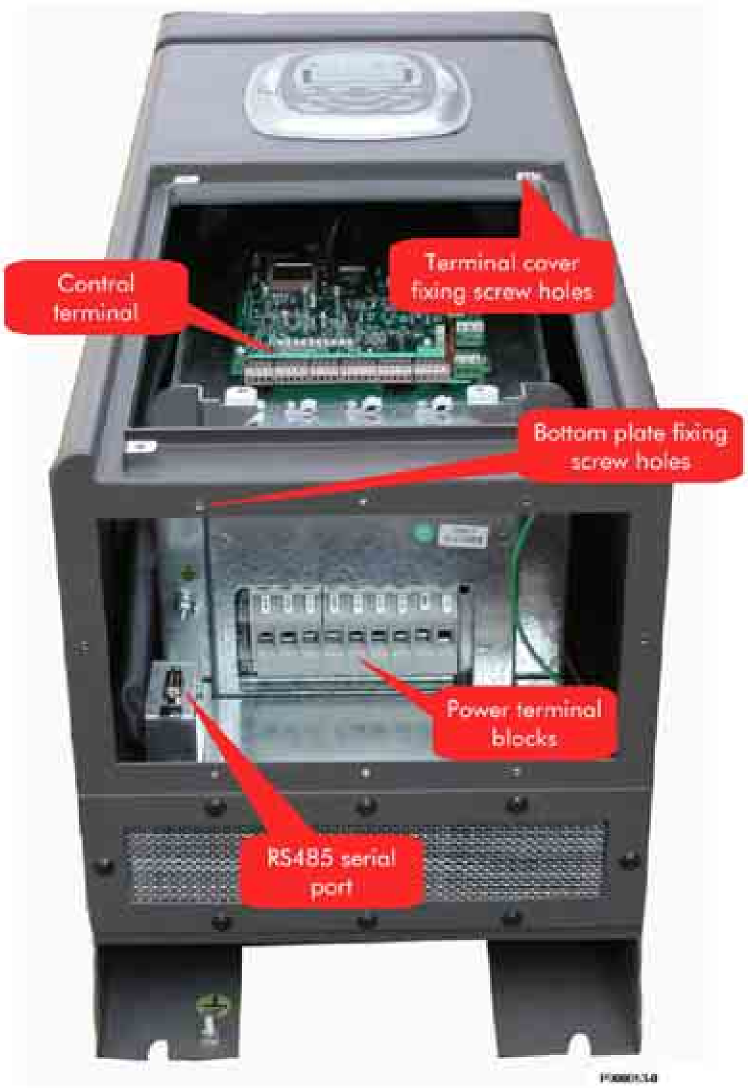
	DANGER	Before gaining access to the components inside the inverter, remove voltage from the inverter and wait at least 5 minutes. Wait for a complete discharge of the internal components to avoid any electrical shock hazard.
	CAUTION	Do not connect or disconnect signal terminals or power terminals when the inverter is on to avoid electrical shock hazard and to avoid damaging the inverter.
	NOTE	All fastening screws for removable parts (terminal cover, serial interface connector, cable path plates, etc.) are black, rounded-head, cross-headed screws. Only these screws may be removed when connecting the equipment. If other screws or bolts are removed, the product guarantee will be no longer valid.

3.5.1.2. GAINING ACCESS TO CONTROL TERMINALS AND POWER TERMINALS (INVERTER IP54)

To reach the control terminals and power terminals, remove the front panel by removing its fastening screws. The following can be accessed:

- control terminals,
- power terminals,
- serial interface connector.

For ingoing/outgoing cables, pierce some holes in the inverter front plate. To remove the inverter front plate, remove its fastening screws.



CAUTION — For ingoing/outgoing cables through the inverter bottom plate, the following safety measures are required to maintain degree of protection IP54: cable-glands or similar with degree of protection not lower than IP54.

CAUTION — Always remove the inverter front plate before piercing holes for ingoing/outgoing cables, thus preventing metals chips from entering the equipment.

3.5.1.3. Grounding Screened Cable Braiding

The inverters of the SINUS PENTA series include special conductor terminals connected to the inverter grounding (conductor terminals are located near the control terminals). Their function is dual: they allow cables to be mechanically fastened and they allow braiding of signal screened cables to be grounded. The figure shows how to wire a screened cable.

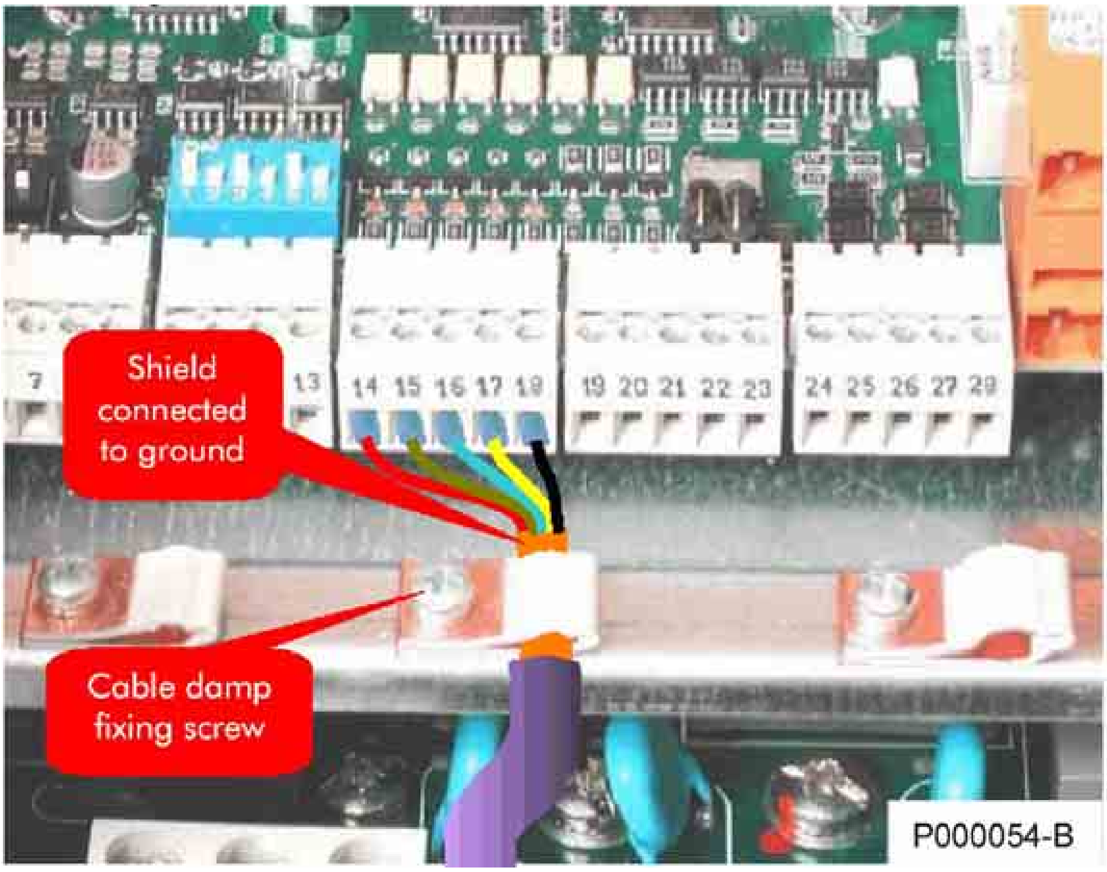


Figure 42: Clamping a signal screened cable

CAUTION

If no state-of-the-art wiring is provided, the inverter will be more easily affected by disturbance. Do not forget that disturbance may also accidentally trigger the motor startup.

3.5.2. CONTROL BOARD SIGNALS AND PROGRAMMING

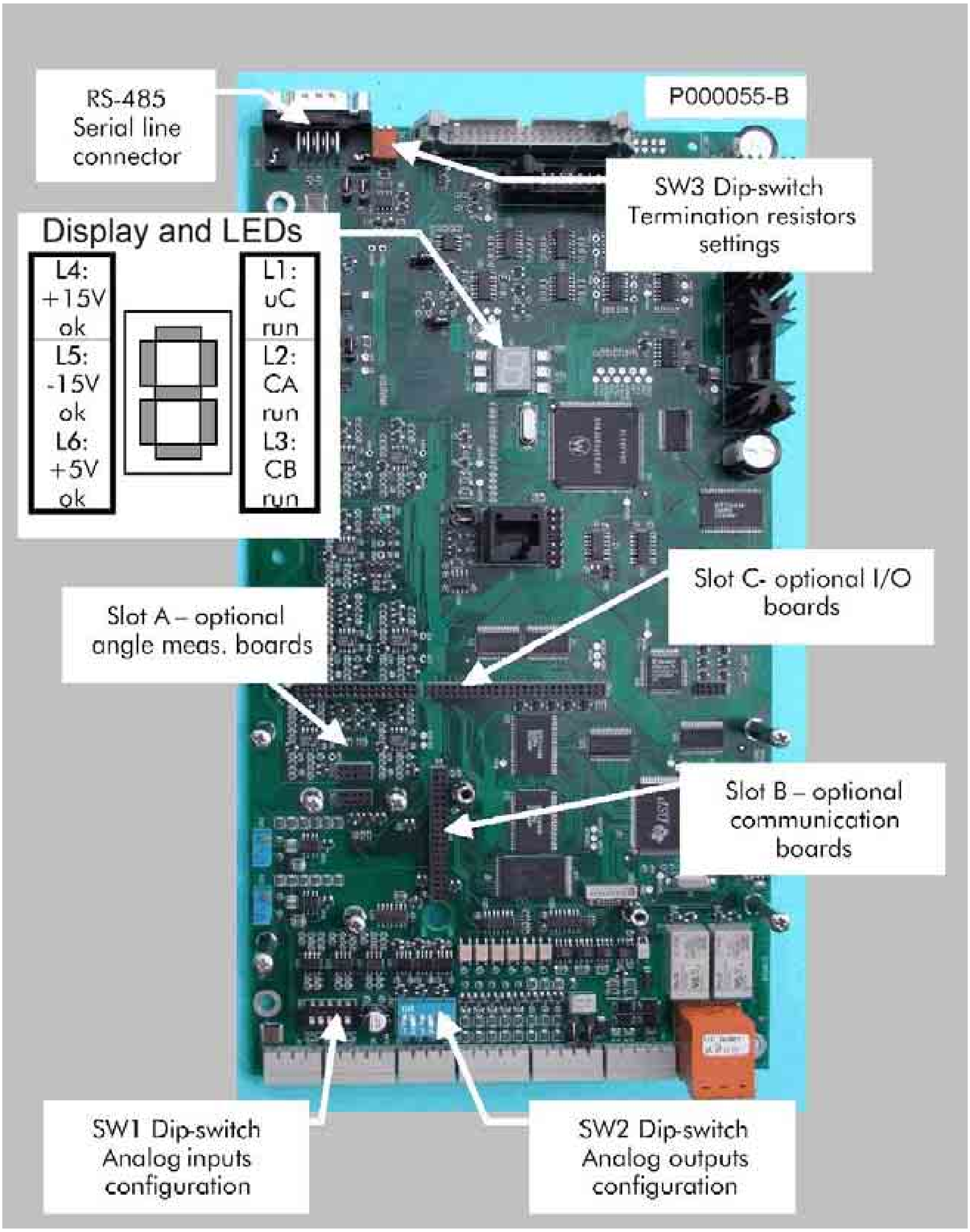


Figure 43: Control board: signals and programming

3.5.2.1. DISPLAY AND INDICATOR LEDS

The board display and indicator LEDs allow to view the inverter operating condition even if no user interface (display/keypad) is provided. The keypad housing allows to display the indicator lights.
The indicator LEDs are the following:

- Green LED L1 (uC run): If on, it indicates that processors are active. If it does not turn on when the inverter is normally operating, this means that the feeder or control board are faulty.
- Yellow LED L2 (CA run): If on, it indicates that the power convertor is commutating and is powering the connected load (terminals U, V, W). If off, all commutation devices of the power converter are inactive and the connected load is not powered.

CAUTION

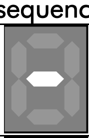
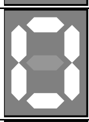
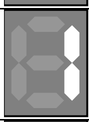
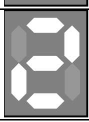
Electrical shock hazard exists even if the power converter is not operating and the inverter is disabled. Possible dangerous voltage peaks on terminals U, V, W may occur. Wait at least 5 minutes after switching off the inverter before operating on the electrical connection of the motor or the inverter.

- Yellow LED L3 (CB run): In Sinus Penta Drives it never turn on
- Green LED L4 (+15V ok): It comes on when it detects positive analog power supply (+15V). If it does not turn on when the inverter is normally operating, this means that the feeder or control board are faulty.
- Green LED L5 (-15V ok): It comes on when it detects negative power supply (-15V). If it does not turn on when the inverter is normally operating, this means that the feeder or control board are faulty.
- Green LED L6 (+5V ok): It comes on when it detects I/O power supply (+5V). It turns off to indicate the following conditions:
    - o Short-circuit over the power supply delivered to connector RS-485 output.
    - o Short-circuit over the power supply delivered to the connector output of the remotable keypad.
    - o Parameter quick storage and autoreset procedure due to “VDC undervoltage”.

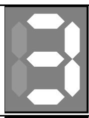
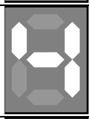
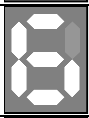
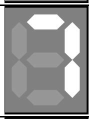
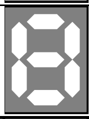
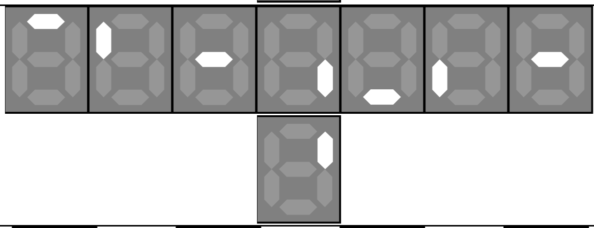
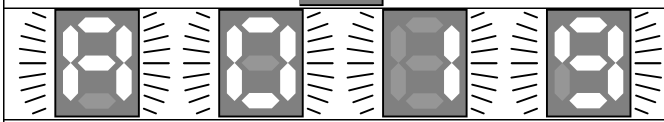
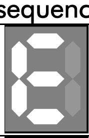
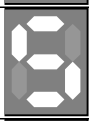
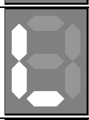
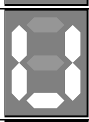
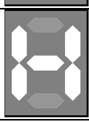
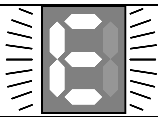
Messages appearing on the 7-segment display are the following:

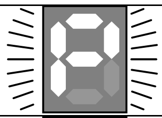
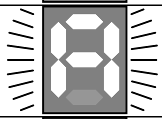
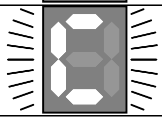
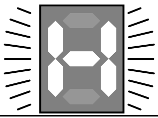
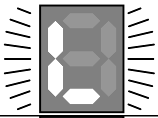
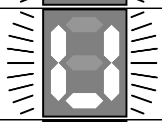
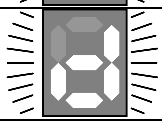
NOTE

The display can be seen only after removing the keypad. For more details, see section 1.6 in this installation manual.

Ordinary operation and alarms	
Symbol or sequence displayed	Inverter condition
	Inverter initialization stage
	Inverter ready waiting for the enable command: symbol 0 NOT flashing
	Inverter ready waiting for the ENABLE command 0->1: number 1 fixed; see Programming Manual, parameter C181
	Inverter ready waiting for the START command 0->1: number 2 fixed; see Programming manual, parameters Power Down and DC Braking.

0 1 2 3 4 5 6 7 8

	Motor not running because the PID value is disabled: number 3 fixed; see Programming Manual, parameters P254 and 255
	Motor not running because the PID value is disabled: number 4 fixed; see Programming Manual, parameters P065 and P066
	IFD enabled but waiting for the START signal: number 6 fixed
	IFD enabled and START signal on but waiting for reference: number 7 fixed, the actual value of the reference is below the minimum value.
	Waiting for pre-load: number '8' fixed; inverter is waiting for V_{DC} current inside the capacitor to exceed the minimum running value.
	Inverter enabled (power devices activated): a segment rotates to form an 8-shaped figure
	Emergency condition: a 3-digit alarm code cyclically flashes on the display (the example shows alarm A019)
Hardware and/or software failure	
Symbol or sequence displayed	**Inverter condition**
	Hardware/Software Failure The self-diagnostics function integrated to the control board detected a hardware/software failure. Please contact ELETTRONICA SANTERNO's Customer Service
	
	
	
	
Updating of the operating software (flash memory)	
Symbol or sequence displayed	**Inverter condition**
	Flash memory deletion: letter 'E' flashing

	Flash memory programming: letter ‘P’ flashing
	An alarm tripped while deleting or programming the software flash memory. Repeat programming: letter ‘A’ flashing
	Autoreset: letter ‘C’ flashing
Current limit and voltage limit while running	
Symbol or sequence displayed	Inverter condition
	Voltage limit while accelerating or voltage limit due to overload conditions; letter ‘H’ flashing if the output current is limited to the values set in the operating parameters.
	Output voltage limit; letter ‘L’ flashing if no voltage is delivered to the motor due to a V_{DC} too weak value.
	Voltage limit when decelerating; letter U_flashing if V_{DC} in the equipment exceeds the rated value by 20% during dynamic braking.
	Braking function active; letter D flashing when the inverter is stopping the motor forcing DC current. See Programming Manual, DC Braking function.

3.5.2.2. DIP-SWITCHES

The inverter control board includes three banks of dip-switches (SW1, SW2, and SW3) for the following functions:

- Dip-switch SW1: analog input configuration
- Dip-switch SW2: analog output configuration
- Dip-switch SW3: line termination over line RS-485

To gain access to dip-switches SW1 and SW2, remove the front cover of the control terminals by loosening the relevant fastening screws.

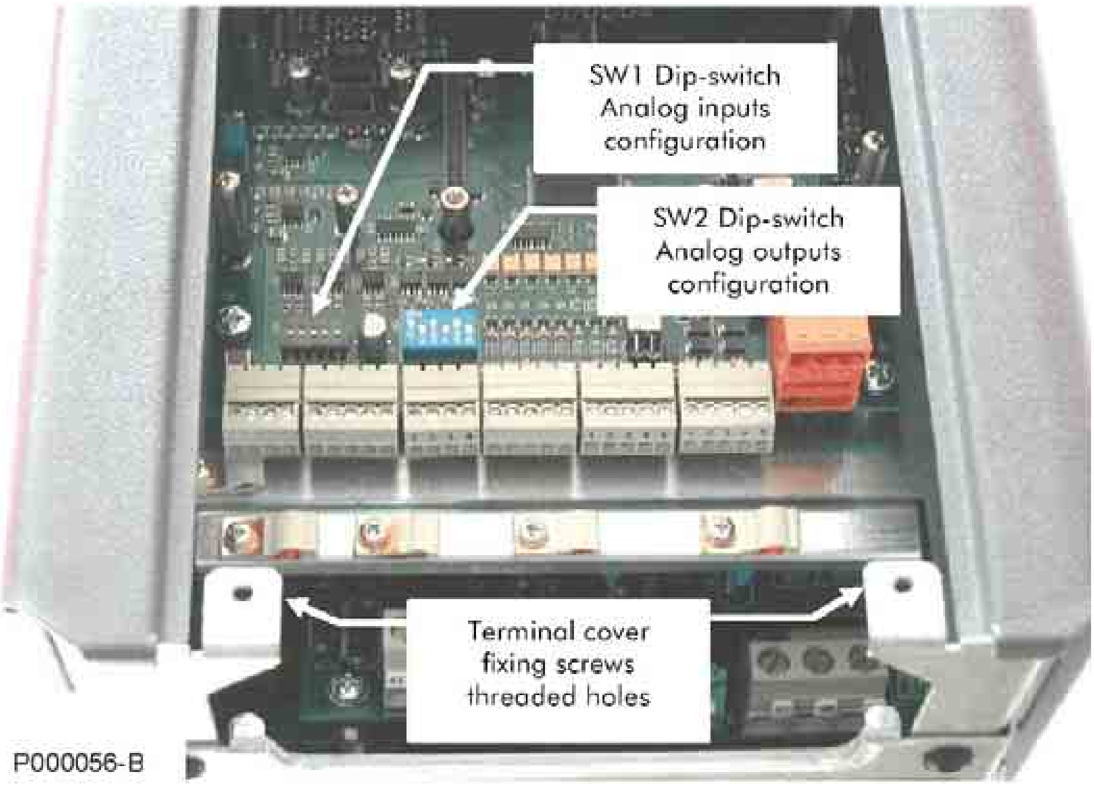


Figure 44: Gaining access to dip-switches SW1 and SW2

To gain access to dip-switch SW3, remove the protecting cover for connector RS-485.
SINUS PENTA S05 to S20: dip-switch SW3 is located on the control board next to interface connector RS-485; remove the inverter upper cover to gain access to dip-switch SW3.

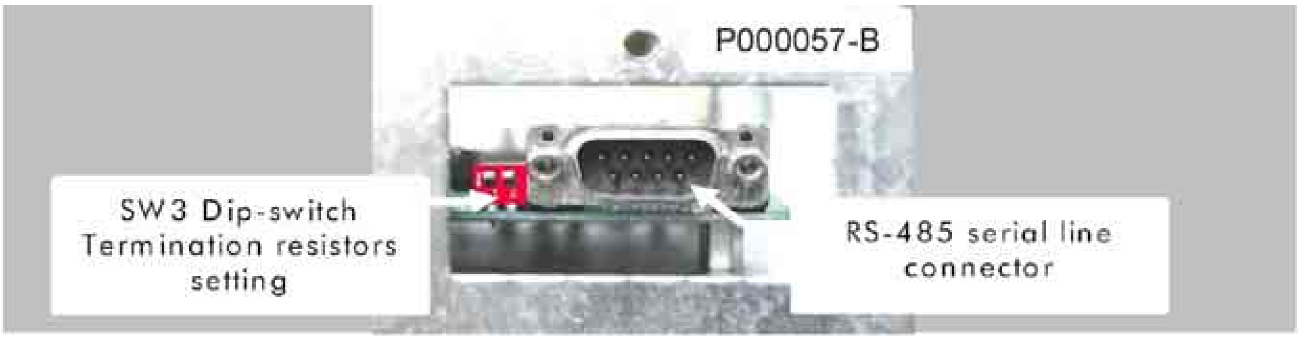


Figure 45: Gaining access to dip-switch SW3 and connector RS-485 (SINUS PENTA S05 to S20)

SINUS PENTA S30 to S60: interface connector RS-485 and dip-switch SW3 are located next to the control terminal board cover.
SINUS PENTA S65 and S70: to gain access to dip-switch SW3, remove the cover located on the rear part of the control board.

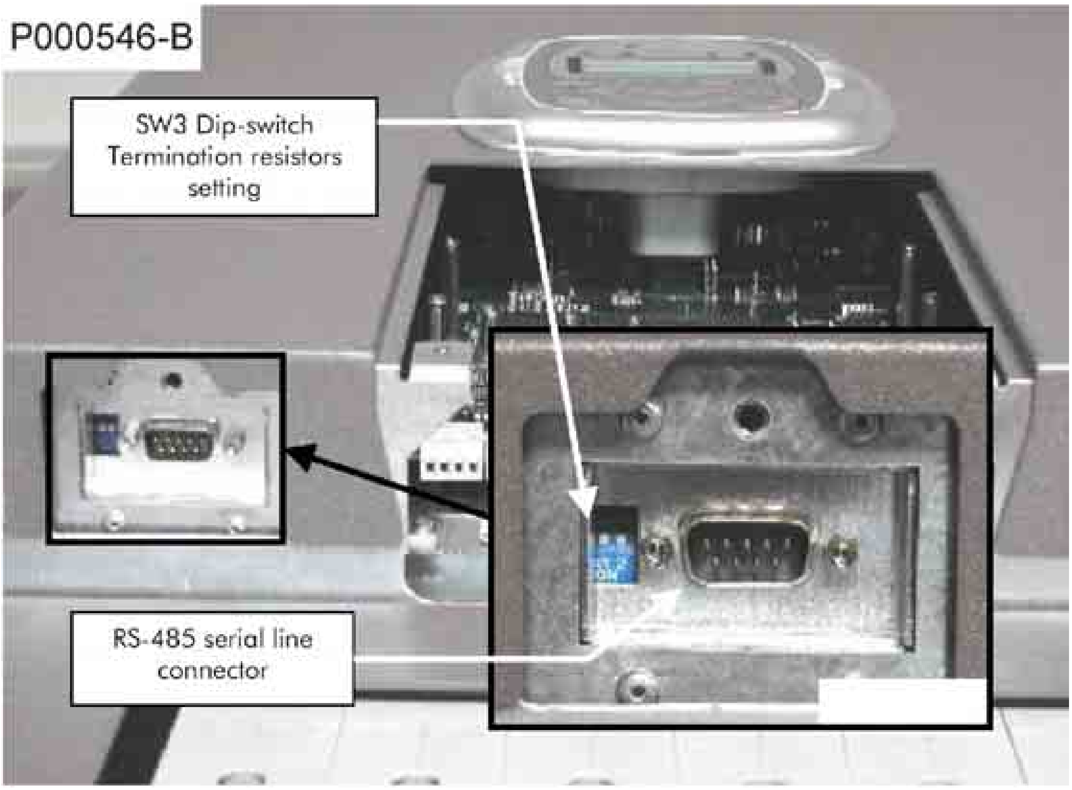


Figure 46: Position of dip-switch SW3 and connector RS-485 (SINUS PENTA S30 to S60)

For IP54 inverters, you can gain access to serial port connector RS-485 and to dipswitch SW3 from the inside of the front door covering wires and cables.

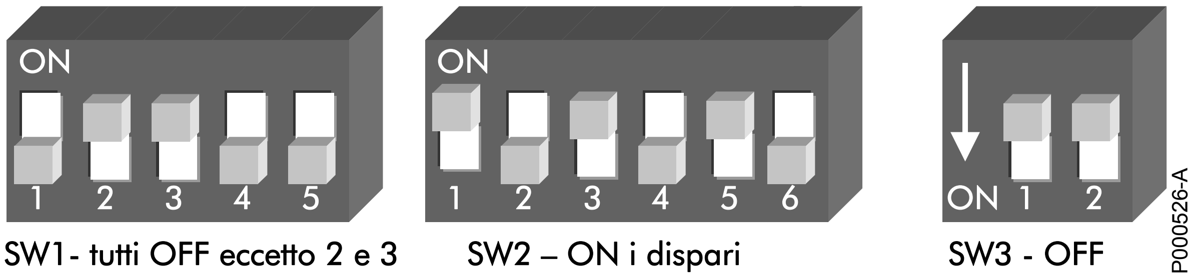
Dip-switch functionality is detailed in the tables below

Dip-switch SW1: analog input configuration		
Switch (es)	Functionality	
SW1-1	OFF: REF voltage input (DEFAULT)	ON: REF analog input (current input)
SW1-2	OFF: AIN1 voltage input	ON: AIN1 analog input (current input) (DEFAULT)
SW1-3	OFF: AIN2 voltage input or motor protection PTC acquisition	ON: AIN2 analog input (current input) (DEFAULT)
SW1-4, SW1-5	Both OFF: AIN2 current input or voltage input based on SW1-3(DEFAULT)	Both ON: AIN2 input for motor protection PTC acquisition

Dip-switch SW2: analog output configuration		
Switches	Functionality	
SW2-1, SW2-2	1=ON, 2=OFF: AO1 voltage output (DEFAULT)	1=OFF, 2=ON: AO1 current output
SW2-3, SW2-4	3=ON, 4=OFF: AO2 voltage output (DEFAULT)	3=OFF, 4=ON: AO2 current output
SW2-5, SW2-6	5=ON, 6=OFF: AO3 voltage output (DEFAULT)	5=OFF, 6=ON: AO3 current output

Dip-switch SW3: interface RS-485 terminator		
Switches	Functions	
SW3-1, SW3-2	Both OFF: RS-485 terminator disabled (DEFAULT)	Both ON: RS-485 terminator enabled

Dip-switch factory setting is as follows:



Factory setting provides the following operating modes:

- REF Analog input (voltage input) and two current analog inputs (AIN1, AIN2)
- Voltage analog outputs
- Terminator RS-485 off

3.5.3. DIGITAL INPUTS (TERMINALS 14 TO 21)

All digital inputs are galvanically isolated with respect to zero volt of the inverter control board. Consider isolated power supply on terminals 23 and 22 or 24V auxiliary supply before activating the inverter digital inputs.
The figure below shows the different control modes based on the inverter supply or the output of a control system (e.g. PLC). Internal supply (+24 VDC)—terminal 23—is protected by a 200mA self-resetting fuse.

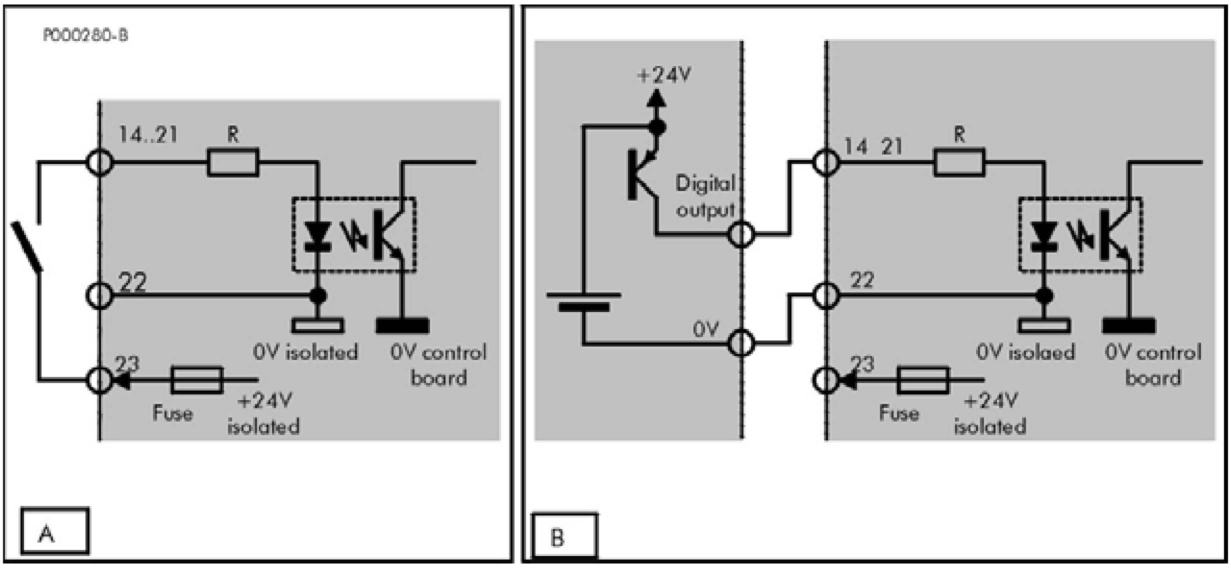


Figure 47: A) PNP command (active to + 24 V) through a voltage-free contact

B) PNP command (active to + 24 V), outcoming from a different device (PLC, digital output board, etc.)

NOTE Terminal 23 (digital input zero volt) is galvanically isolated from terminals 1, 9, 13 (control board zero volt) and from terminals 26 and 28 (common terminals of the digital outputs).

The digital input condition is displayed on the inverter display/keypad in the Measure menu as measure M033. Logic levels are displayed as □ for the inactive input and as ■ for the active input.
The inverter software acknowledges all inputs as multifunction inputs. Dedicated functions assigned to terminals START (14), ENABLE (15), RESET (16), MDI6 / ECHA / FINA(19), MDI7 / ECHB (20), and MDI8 / FIN B(21) are also available.

3.5.3.1. START (TERMINAL 14)

To enable the Start input, set the control modes via terminal board (factory setting). When the START input is active, the main reference is enabled; otherwise, the main reference is set to zero. The output frequency or the speed motor drops to zero with respect to the preset deceleration ramp.

0 1 2 3 4 5 6 7 8

3.5.3.2. ENABLE (TERMINAL 15)

The ENABLE input is always to be activated to enable the inverter operation regardless of the control mode.
If the ENABLE input is disabled, the inverter output voltage is always set to zero, so the motor performs a coast to stop.
The internal circuit managing the ENABLE signal is redundant and is more efficient in avoiding sending any commutation signal to the three-phase converter. Certain applications allow to get rid of the contactor installed between the inverter and the motor. Always consider any specific standard for your inverter application and comply with the safety regulations in force.

3.5.3.3. RESET (TERMINAL 16)

If an alarm trips, the inverter stops, the motor performs a coast to stop and the display shows an alarm message. Open the reset input for a while (factory setting: MDI3 on terminal 16, or press the RESET key on the keypad) to reset the alarm. This happens only if the cause responsible for the alarm has disappeared. If factory setting is used, enable and disable the ENABLE command to restart the inverter.

NOTE	Factory setting does not reset alarms at power off. Alarms are stored and displayed at next power on and the inverter is locked. A manual reset is then required to unlock the inverter.
CAUTION	If an alarm trips, see the Diagnostics section in the Programming Manual and reset the equipment after detecting the cause responsible for the alarm.
DANGER	Electrical shock hazard persists even when the inverter is locked on output terminals (U, V, W) and on the terminals used for the connection of resistive braking devices (+, -, B).
CAUTION	The motor performs a coast to stop when the inverter is locked due to an alarm trip or when the ENABLE input is inactive. In case a mechanical load with persistent resisting torque (e.g. lifting applications) is used, a motor coast to stop may cause the load to drop. In that case, always provide a mechanical locking device (brake) for the connected load.

3.5.3.4. CONNECTING THE ENCODER AND FREQUENCY INPUT (TERMINALS 19 TO 21)

Functionality of the programmable digital inputs is given in the Programming Manual. Digital inputs MDI5, MDI6, MDI7 may acquire fast digital signals and be used for the connection of an incremental encoder (push-pull encoder, single-ended encoder) and/or for the acquisition of a frequency input. An incremental encoder must be connected to "fast" inputs MDI6/ECHA/FINA(19) and MDI7/ECHB (20) as shown in the figure below.

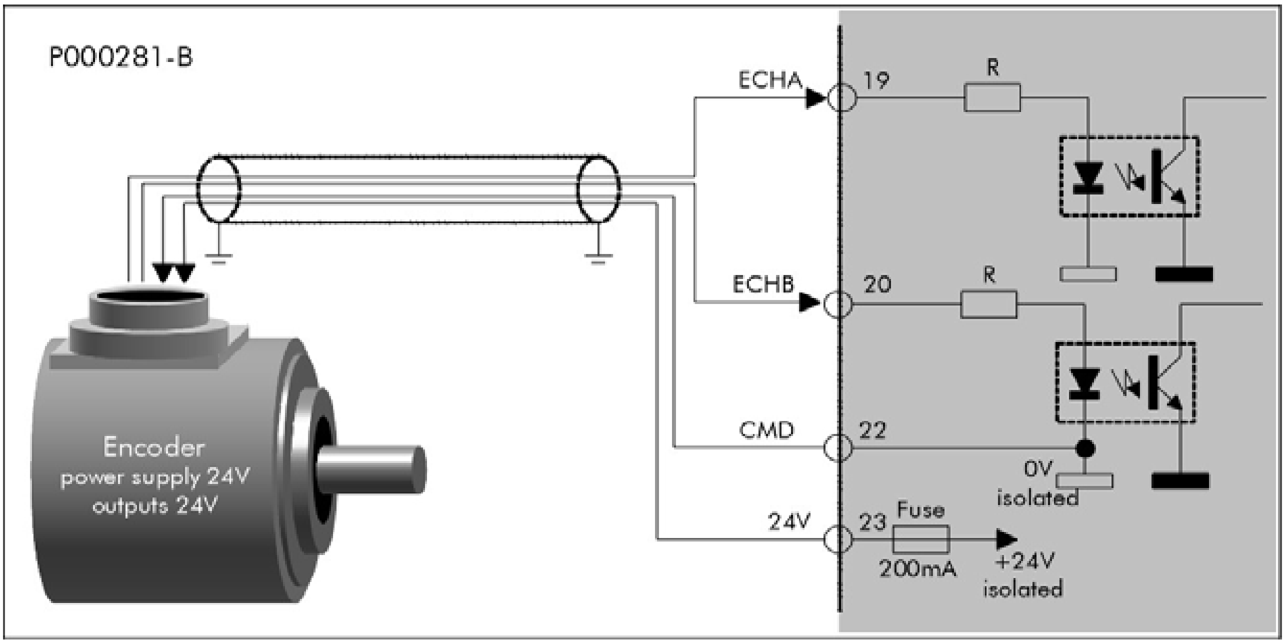


Figure 48: Connecting an incremental encoder

An incremental encoder must have PUSH-PULL outputs and must be powered at 24V directly to the inverter isolated power supply delivered to terminals +24V (23) and CMD (22). Max. allowable feeding current is 200mA and is protected by a self-resetting fuse.
Only encoders of that type may be connected to SINUS PENTA's terminal board. Max. signal frequency is 155kHz for 1024 pls/rev at 9000 rpm. To acquire different encoder types or to acquire an encoder without engaging any multifunction input, fit optional board for encoder acquisition in SLOT A.
The encoder acquired via terminal board is indicated as ENCODER A by the inverter software, whereas the encoder acquired via optional board is indicated as ENCODER B. Therefore, two encoders may be connected to the same inverter. (See Programming instructions.)
Input MDI8/FINB allows to acquire a square-wave frequency signal from 10kHz up to 100kHz. Then, the frequency signal will be converted into an analog value to be used as a frequency reference. Frequency values corresponding to the minimum reference and the maximum reference may be set as operating parameters
Signals must be sent from a Push-pull, 24V output with a common reference to terminal CMD (22) (see figure below).

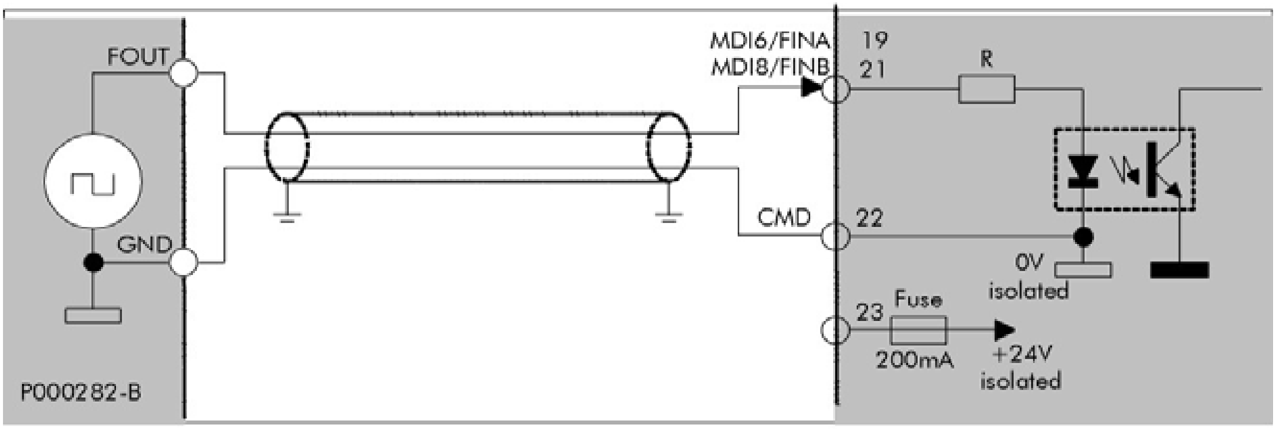


Figure 49: Signal sent from a Push-pull, 24 V output

3.5.3.5. TECHNICAL SHEET FOR DIGITAL INPUTS

Specification	Min.	Type	Max.	Unit of m.
MDI input voltage related to CMD	-30		30	V
Voltage for logic level 1 between MDI and CMD	15	24	30	V
Voltage for logic level 0 between MDI and CMD	-30	0	5	V
Current absorbed by MDI at logic level 1	5	9	12	mA
Input frequency for “fast” inputs MDI6, MDI7, MDI8			155	kHz
Duty-cycle allowed for frequency input	30	50	70	%
Min. time period at high level for “fast” inputs MDI6, MDI7, MDI8	4.5			µs
Voltage of isolation test between CMD (22) with respect to CMA (1,9)	500Vac, 50Hz, 1min.			

CAUTION — Avoid exceeding min. and max. input voltage values not to cause irreparable damages to the equipment.

NOTE — Isolated supply output is protected by a self-resetting fuse capable of preventing the inverter internal feeder from damaging due to a short-circuit. Nevertheless, if a short-circuit occurs, the inverter could lock and stop the motor.

3.5.4. ANALOG INPUTS (TERMINALS 1 TO 9)

The inverters of the SINUS PENTA series are provided with three analog inputs, one single-ended input and two differential inputs. Analog inputs may be configured either as voltage inputs or as current inputs. AIN2 input may be used to acquire a PTC thermistor in compliance with DIN44081/DIN44082 for the motor thermal protection. In that case, up to 6 PTCs can be series-connected; functionality of the overtemperature alarm is not altered. Two reference outputs with rated values + 10 V and – 10 V are also available for the direct connection of a reference potentiometer.
Configuration as voltage input, current input or motor PTC input is done through dip-switches (see section 3.5.2.2.).
Five acquisition modes are available (see the Programming Manual) for three hardware settings as shown in the table:

Type of preset data acquisition	HW configuration for SW1	Full-scale values and notes
Unipolar 0 ÷ 10 V	Voltage input	0 ÷ 10 V
Bipolar ± 10 V	Voltage input	- 10 V ÷ + 10 V
Unipolar 0 ÷ 20 mA	Current input	0 mA ÷ 20 mA
Unipolar 4 ÷ 20 mA	Current input	4 mA ÷ 20 mA; wire disconnection alarm with current values under 2 mA
PTC acquisition	PTC input	Motor overtemperature alarm if PTC resistance exceeds threshold defined in DIN44081/DIN44082

NOTE

Software parameter setting must be consistent with dip-switch setting. Otherwise, no predictable result is given for acquired values.

NOTE

Any voltage or current value exceeding full-scale values or dropping below min. values will generate an acquired value limited to the max. measure or the min. measure respectively.

CAUTION

Voltage inputs have high input impedance and must always be closed when active. Isolating a conductor connected to an analog input set as a voltage input will not ensure that its channel reading will be equal to zero. Zero is detected only if the input is short-circuited or wired to a low-impedance signal source. Relay contact should not series-connected to the inputs to reset the detected value.

You can adjust the relationship between the analog input set as a voltage input or a current input and the detected value by altering those parameters that regulate upper values (full-scale values) and lower values, thus adjusting the analog channel gain and offset. You can also adjust the signal filtering time constant. For any detail concerning functionality and programming of analog input parameters, see SINUS PENTA'S Programming Instruction manual.

3.5.4.1. REF SINGLE-ENDED REFERENCE INPUT (TERMINAL 2)

Reference input REF (2) is assigned to the inverter speed reference (factory setting) and is a single-ended input related to terminal CMA (1).
The figure below shows wiring to a unipolar potentiometer, a bipolar potentiometer and a sensor with 4÷20mA current output. The REF input is factory-set as a +/-10V voltage input.

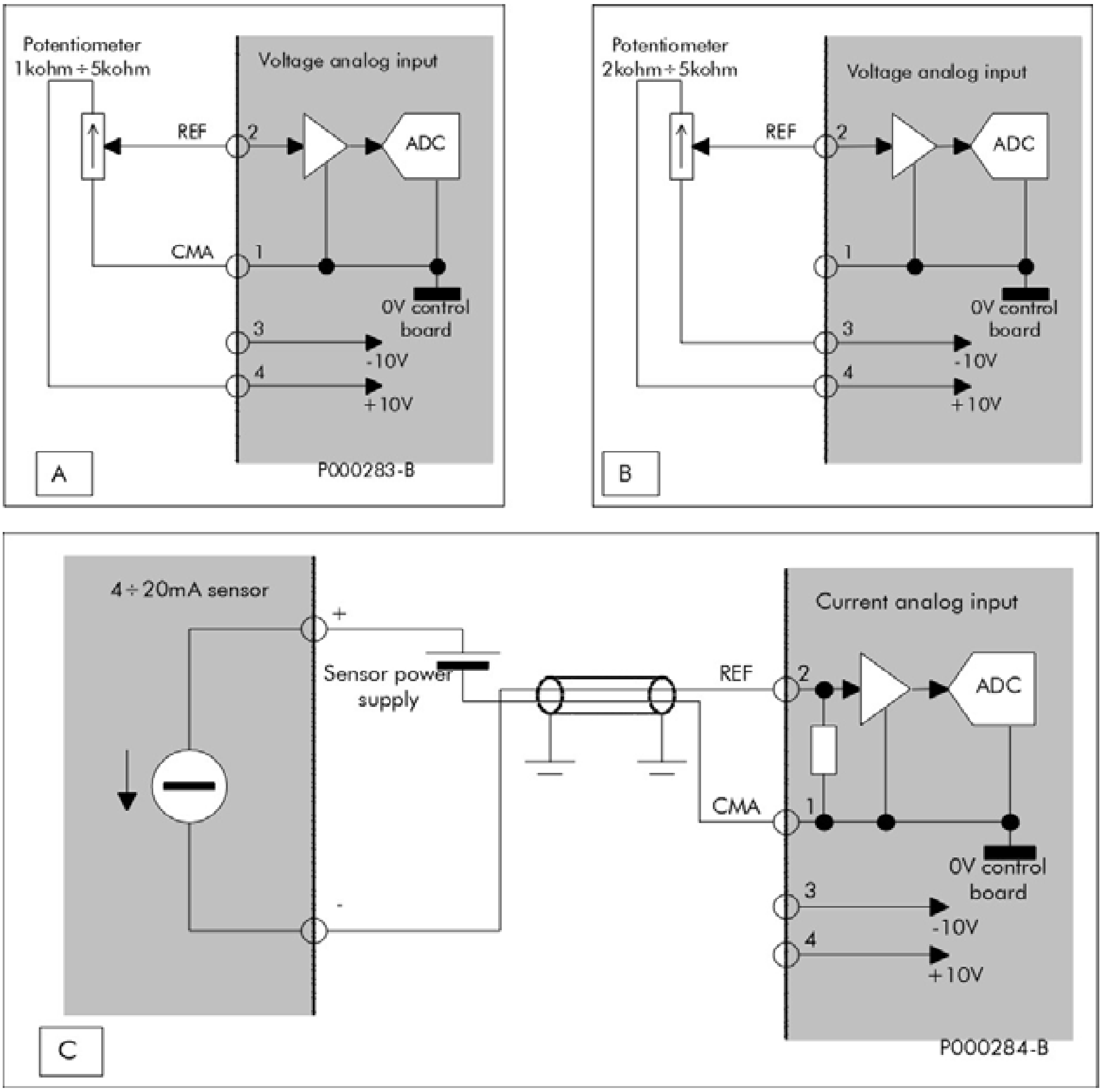


Figure 50: A) Potentiometer wiring for unipolar command 0 ÷REFMAX
B) Potentiometer wiring for bipolar command -REFmax÷+REFmax
C) 4 ÷ 20 mA Sensor wiring

NOTE

Do not apply + 24V voltage available on terminal 23 of the control board to supply 4 - 20 mA analog sensors, because it is used for the common terminal of the digital inputs (CMD – terminal 22), not for the common terminal of CMA analog inputs.
Galvanic isolation exists between the two terminals and must not be suppressed.

3.5.4.2. DIFFERENTIAL AUXILIARY INPUTS (TERMINALS 5–8)

Auxiliary inputs allow auxiliary voltage and current values for signals exceeding ground signals up to a preset maximum voltage value in common mode.
A differential input weakens disturbance due to "ground potentials" occurring when the signal is sent from a source that is located far from the inverter. Disturbance is weakened only if wiring is correct.
Each input is provided with a positive terminal and a negative terminal of the differential amplifier. Both terminals must be connected to the signal source and the signal grounding respectively. Make sure that the common mode voltage between the signal source grounding and the grounding of auxiliary inputs CMA (terminal 9) does not exceed the max. allowable voltage value in common mode.
When an input is used as a current input, the differential amplifier detects the voltage value produced by the lugs of a drop resistance (low ohm value). The max. potential for the negative terminal of the differential input must not exceed the voltage value in common mode. AIN1 and AIN2 inputs are factory-set as 4(0)…20mA current inputs.
Do the following to obtain noise rejection benefits:

- provide a common path of the differential torque
- make sure that the signal source grounding does not exceed input voltage in common mode.

The typical wiring is shown below:

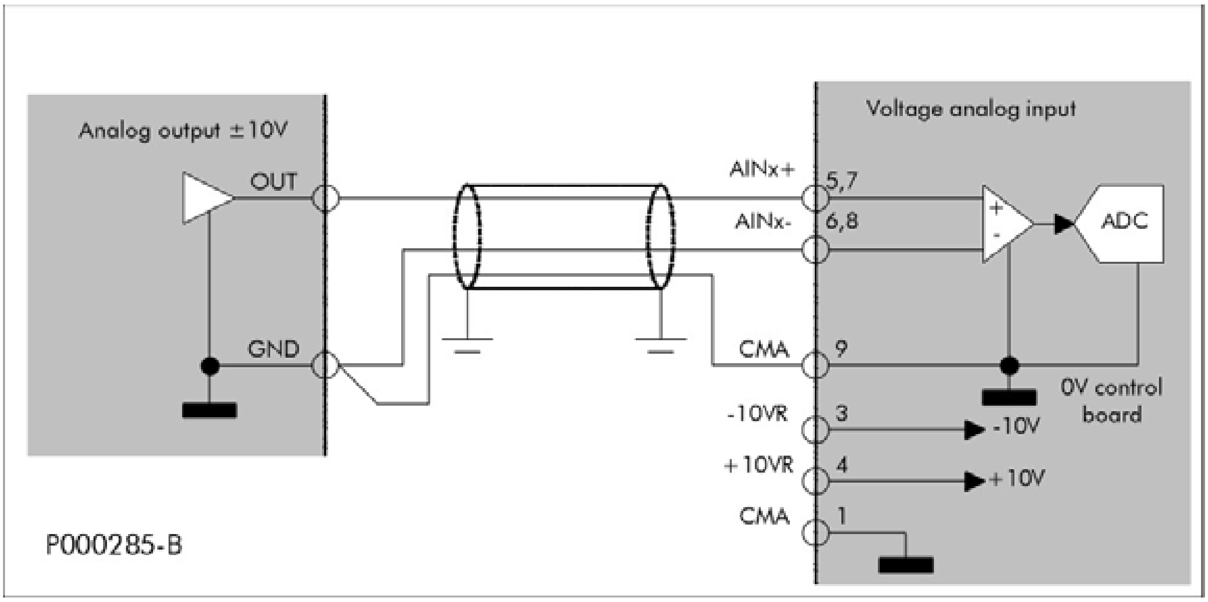


Figure 51: Wiring of a PLC analog output, axis control board, etc.

NOTE

Wiring between terminal CMA and the signal source grounding is required for proper data acquisition. Wiring may also be performed outside the screened cable.

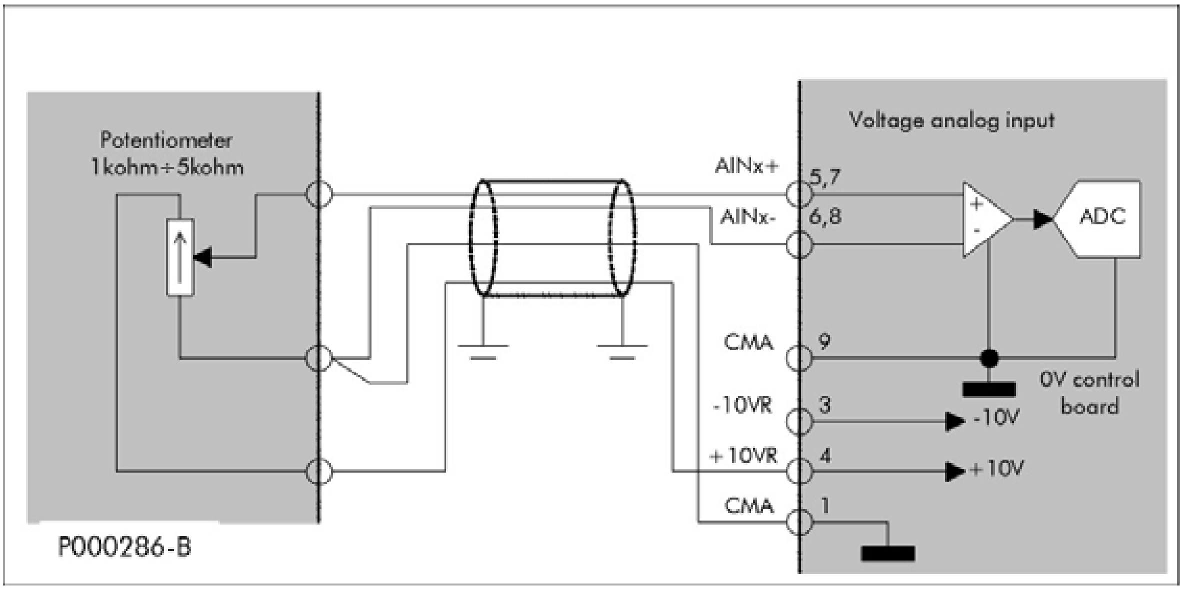


Figure 52: Wiring of unipolar remote potentiometer 0 ÷ REF max

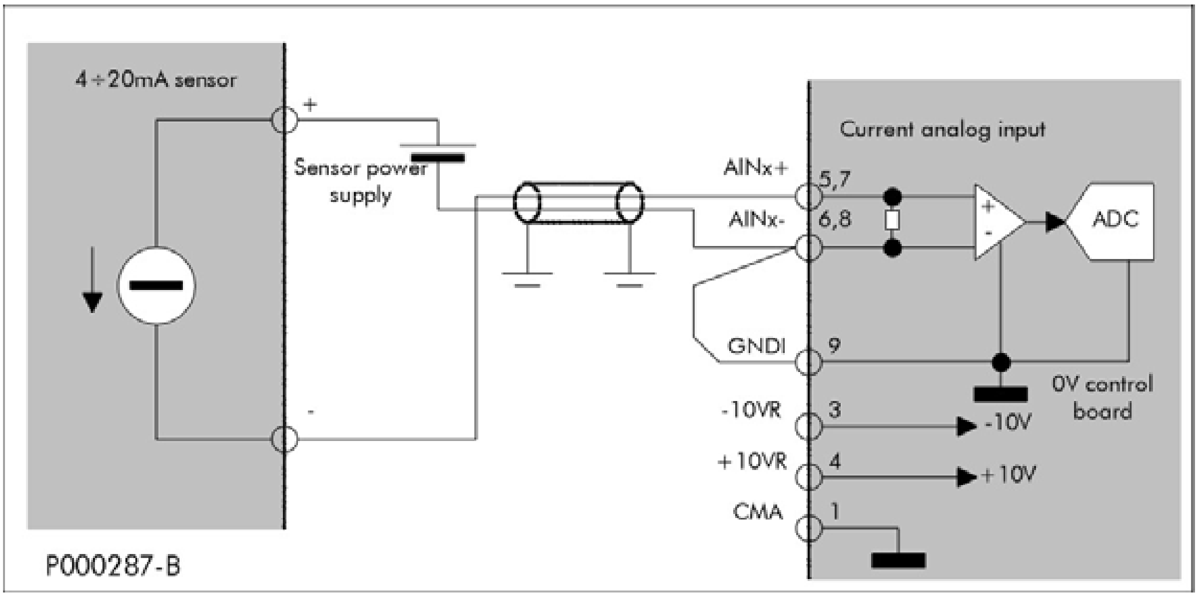


Figure 53: 4 ÷ 20 mA Sensor wiring

3.5.4.3. MOTOR THERMAL PROTECTION INPUT (PTC, TERMINALS 7-8)

The inverter manages the signal sent from or ore more thermistors (up to 6 thermistors) incorporated in the motor windings to obtain a hardware thermal protection of the motor. The thermistor ratings must comply with IEC 34-11-2 (BS4999 Pt.111 - DIN44081/DIN44082) or to thermistors named "Mark A" in standard IEC60947-8:

Resistor corresponding to Tnf temperature value:	1000 ohm (typical rating)
Resistor at Tnf –5 °C:	< 550 ohm
Resistor at Tnf + 5 °C:	> 1330 ohm

The typical resistor pattern with respect to temperature is shown in the figure below.

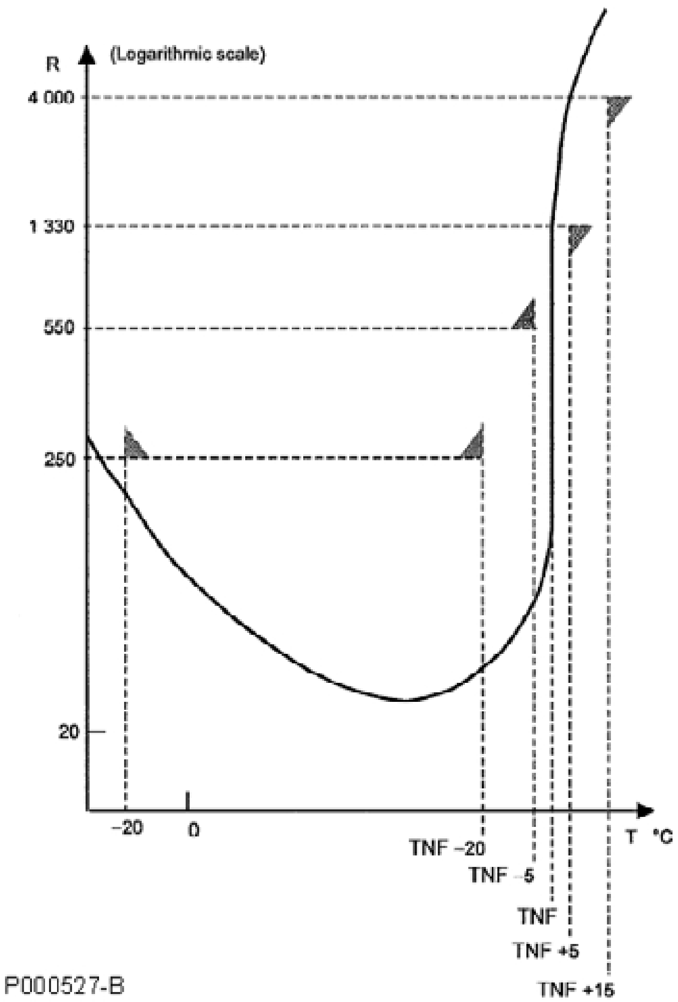


Figure 54: Standard pattern of the thermistor resistor for the motor thermal protection

Tnf temperature is the thermistor rated transient temperature to be adjusted based on the max. allowable temperature of the motor windings. The inverter sends a motor overheating alarm when it detects the thermistor resistance transient temperature of at least one of the series-connected thermistors, but does not display the real temperature of the motor windings. An alarm trips even if a short-circuit condition is detected in the thermistor circuit wiring. This alarm trips when the measured resistance is nominally lower than 20Ω.

NOTE

Maximum six (6) series-connected PTCs can be acquired. Motors usually have three or six series-connected PTCs, one or two per phase. If multiple sensors are series-connected, a false alarm trip may occur even when the motor is cold.

Do the following to use the thermistor:

1) Configure analog input AIN2/PTC by setting SW1-3: Off, SW1-4: 0n, SW1-5: On;
2) Connect the motor thermal protection terminals between terminals 7 and 8 in the control board;
3) In the "Thermal protection" menu, set the motor protection method with PTC (refer to SINUS PENTA's Programming Manual).

⚠	CAUTION	PTCs are located inside the motor winding coils. Although the safety standard imposes to perform an isolation test between the motor windings and the sensor applying 2.5kV voltage, if failures occur on the motor side, dangerous voltage peaks may be produced in PTC wiring, so electrical shock exists in case of accidental contacts in the inverter low-voltage circuits.

3.5.4.4. TECHNICAL SHEET FOR ANALOG INPUTS

Specification	Min.	Type	Max.	Unit of m.
Input impedance in voltage configuration (REF input)	10K			Ω
Input impedance in voltage configuration (differential inputs AIN1, AIN2)		80K		Ω
Input impedance in current configuration		250		Ω
Offset cumulative error and gain with respect to full-scale value			0.25	%
Temperature coefficient of gain error and offset			200	ppm/°C
Digital resolution in voltage mode			12	bit
Digital resolution in current mode			11	bit
Value of voltage LSB		4.88		mV
Value of current LSB		9.8		μA
Max. voltage of differential input common mode	-7		+7	V
Rejection ratio for differential input common mode at 50Hz	50			dB
Persistent overload with no damaging in voltage mode	-50		50	V
Persistent overload with no damaging in current mode	-23		23	mA
Input filter cut frequency (first prevailing order) over REF		230		Hz
Input filter cut frequency (first prevailing order) over AIN1, AIN2		500		Hz
Sampling time ([1])	0.6		1.2	ms
Max. current of resistance measure in PTC acquisition mode			2.2	mA
Resistive trip threshold for PTC protection	3300	3600	3930	Ω
Resistive trip threshold for PTC protection deactivation	1390	1500	1620	Ω
Resistive trip threshold for PTC short-circuit		20		Ω
Tolerance of reference output voltage + 10 VR, - 10 VR			0.8	%
Current absorbed by reference outputs			10	mA

Note: (1) depending on the commutation time period set for the connected motor

CAUTION — Avoid exceeding min. and max. input voltage values not to cause irreparable damages to the equipment.

NOTE — Reference outputs are electronically protected against temporary short-circuits. After wiring the inverter, make sure that the output voltage is correct, as a persistent short-circuit may damage the equipment.

3.5.5. DIGITAL OUTPUTS (TERMINALS 24 TO 34)

SINUS PENTA is provided with four digital outputs: one push-pull output, one open-collector output and two relay outputs. All outputs are optoisolated; push-pull output and open-collector output are isolated by an optoisolator; relay outputs are isolated by their relays. Each output has a common terminal segregated from the others, thus allowing to connect it to different devices without creating any ground loop.

3.5.5.1. PUSH-PULL OUTPUT MDO1 AND WIRING DIAGRAMS (TERMINALS 24 - 26)

Push-Pull MDO1 output (terminal 25) may also be used as a frequency output thanks to its powerful passband. Below you will find the wiring diagrams relating to the control of PNP/NPN loads and the cascade-connection of multiple inverters through frequency output and input.
Because supply line and common terminal of output MDO1 are isolated, you can use both 24V supply and auxiliary supply (24V or 48V—see dashed lines in the figures).
Output MDO1 is active (positive voltage related to CMDO1) when it is controlled by the load control (symbol ▮ displayed next to output MDO1, parameter M056). As a result, a load connected as a PNP output and powered between output MDO1 and common CMDO1 will activate, whereas a load connected as a NPN output between supply line +VMDO1 and output MDO1 will deactivate.
Cascade connection frequency output -> frequency input from a master inverter to a slave inverter allows a high-resolution transfer (up to 16 bits) of a reference between the two inverters. This also provides disturbance immunity because data are digitally transferred and the control board grounding is galvanically isolated.
A single master inverter may also control several slave inverters. To do so, use a screened cable to perform a star connection (a wire for each slave inverter will come from the output frequency).

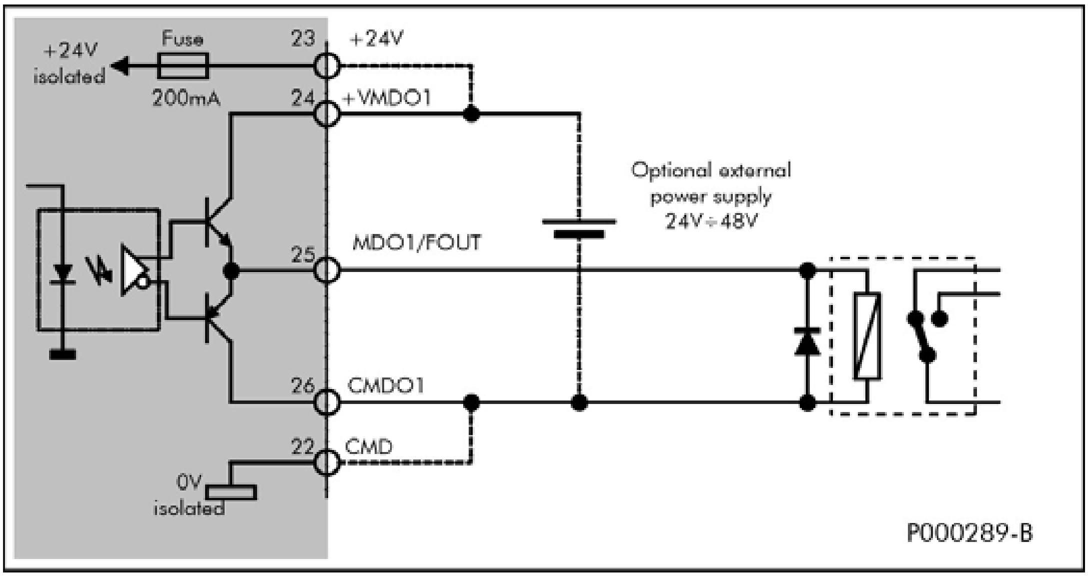


Figure 55: PNP output wiring for relay control

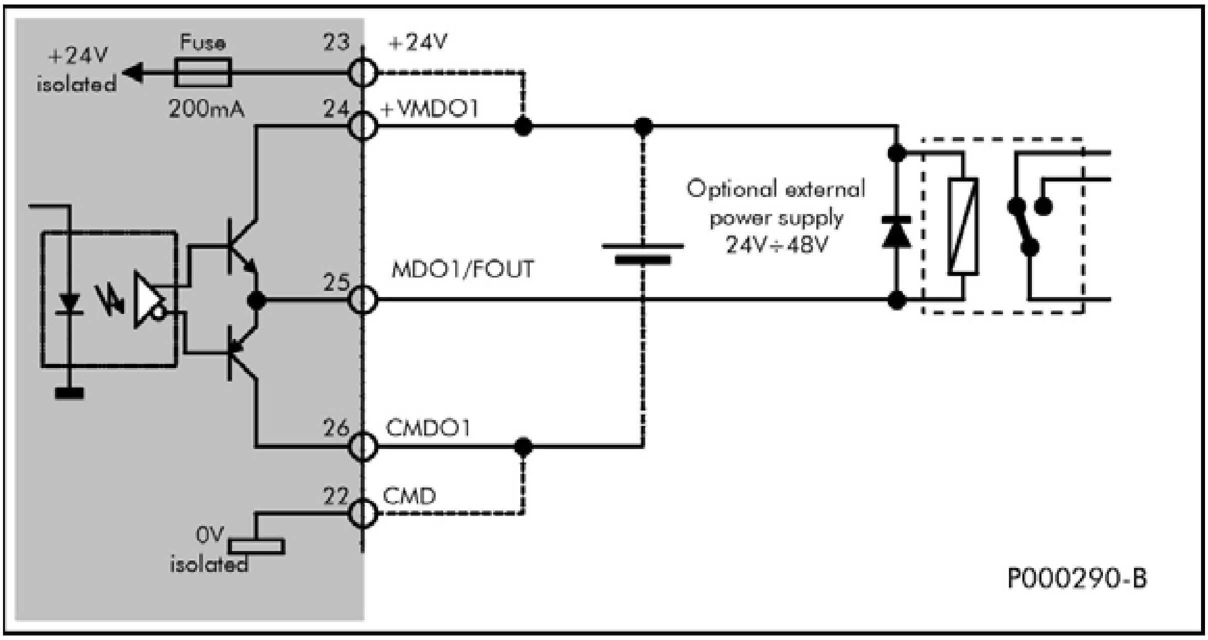


Figure 56: NPN output wiring for relay control

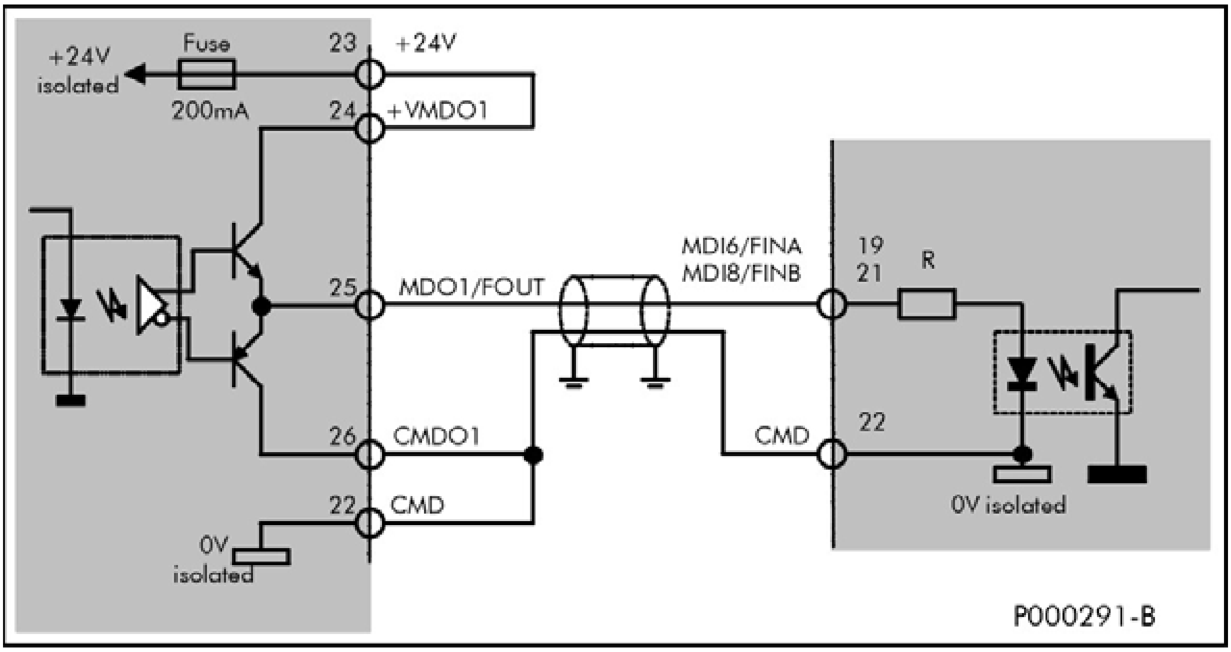


Figure 57: Cascade connection: frequency output -> frequency input.

	CAUTION	Always use a freewheeling diode for inductive loads (e.g. relay coils). Diode wiring is shown in the figure.
	NOTE	Connect *either* isolated inverter supply *or* auxiliary supply to power the output (dashed lines in the figure).

0 1 2 3 4 5 6 7 8

3.5.5.2. Open-collector MDO2 Output and Wiring Diagrams (Terminals 27 -28)

Multifunction output MDO2 (terminal 27) is provided with common terminal CMDO2 (terminal 28), which is galvanically isolated from the other outputs. Output MDO2 may be used for PNP and NPN connected loads (see wiring diagrams below).
Similarly to a closed contact, electrical conductibility is to be found on open-collector output between terminal MDO2 and terminal CMDO2 when OC output is active, i.e. when symbol ▮ is displayed for output MDO2 (parameter M056). Both PNP and NPN connected loads are activated.
Power supply may result from the inverter isolated supply or from an auxiliary source (24V or 48V; see dashed lines in the figure).

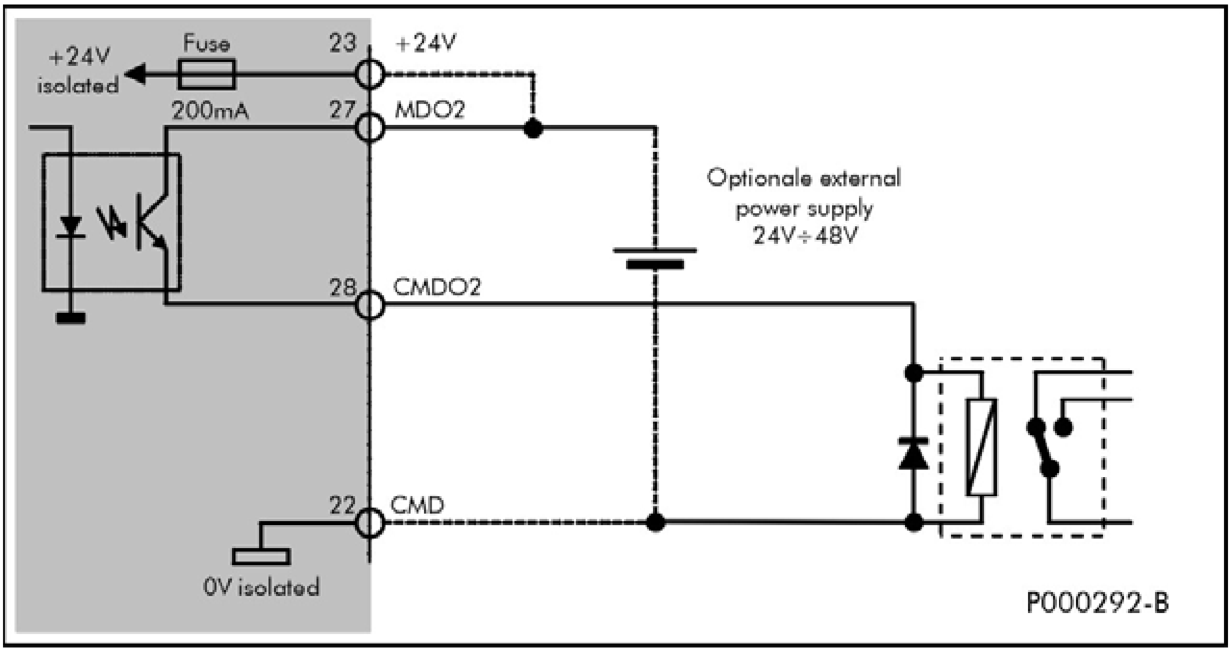


Figure 58: PNP output wiring for relay control

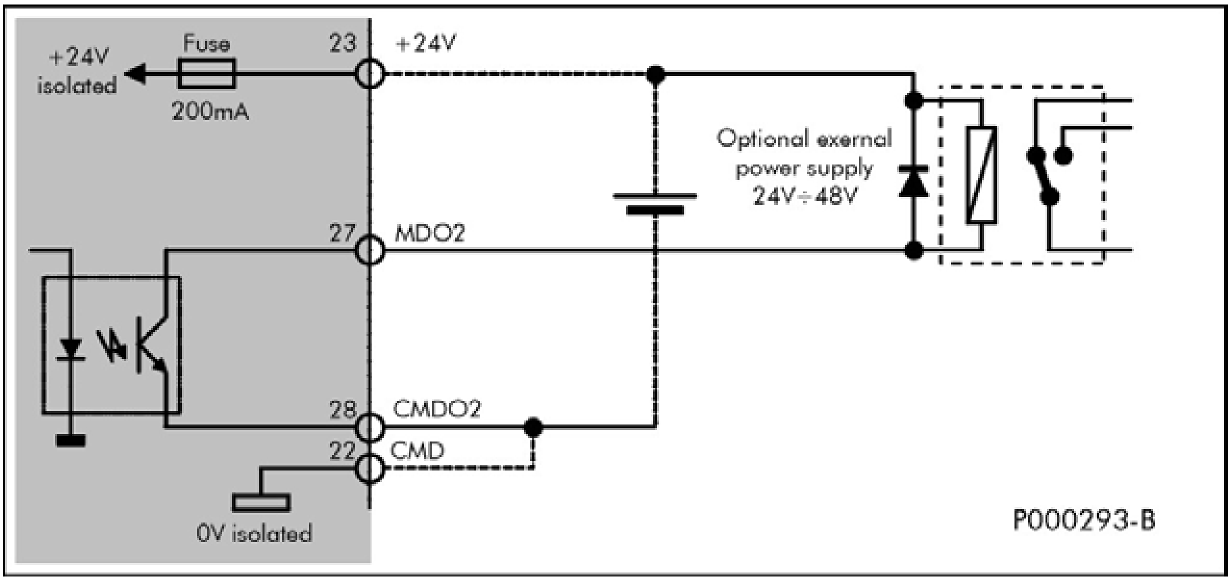


Figure 59: NPN output wiring for relay control

CAUTION	Always use a freewheeling diode for inductive loads (e.g. relay coils). Diode wiring is shown in the figure.
NOTE	Connect *either* isolated inverter supply *or* auxiliary supply to feed the output (dashed lines in the figure).

3.5.5.3. RELAY OUTPUTS (TERMINALS 29-34)

Two relay outputs are available with potential-free reverse contacts. Each output is equipped with three terminals: a normally closed (NC) terminal, a common terminal (C), and a normally open terminal (NO).
Relays may be configured as MDO3 and MDO4 outputs. When outputs MDO3 and MDO4 are active (symbol ▮ displayed for MDO1, measure parameter M056), close the normally open contact and the common contact and open the normally closed contact.

CAUTION	Contacts may shut off up to 250VAC. Do not touch the terminal board or the control board circuits to avoid electrical shock hazard when voltage exceeds 50VAC or 120VDC.
CAUTION	Never exceed max. voltage and max. current values allowed by relay contacts (see relay specifications).
CAUTION	Use freewheeling diode for DC inductive loads. Use antidisturbance filters for AC inductive loads.
NOTE	Like any multifunction output, relay outputs may be configured based on a comparison to an analog value (see Programming Manual). In that case, particularly if enabling delay time is set to zero, relays will cyclically energize/de-energize and this will strongly affect their durability. We suggest that output MDO1 or MDO2 be used, which is not affected by repeated energizing/de-energizing.

3.5.5.4. TECHNICAL SHEET FOR DIGITAL OUTPUTS

Specification	Min.	Type	Max.	Unit of m.
Voltage range for MDO1 and MDO2 outputs	20	24	50	V
Max. current to be commutated for outputs MDO1 and MDO2			50	mA
Voltage drop for output MDO1 (based on deactivated CMDO1 or based on activated +VMDO1)			3	V
Voltage drop for activated MDO2 output			2	V
Current leakage for deactivated MDO2 output			4	μA
Duty-cycle for MDO1 output used as a frequency output at 100kHz	40	50	60	%
Isolation test voltage between CMDO1 (26) and CMDO2 (27) based on GNDR (1) and GNDI (9)	500Vac, 50Hz, 1min.			
Voltage and current limit for relay contacts MDO3, MDO4	3A, 250Vac 3A, 30Vdc			
Residual resistance with closed contact for outputs MDO3 and MDO4			30	mΩ
Durability of relay contacts MDO3 and MDO4 from a mechanical and electrical point of view		$5x10^7$ / 10^5		oper.
Max. allowable frequency for relay outputs MDO3 and MDO4			30	oper./s

CAUTION — Avoid exceeding min. and max. input voltage values not to cause irreparable damages to the equipment.

NOTE — Digital outputs MDO1 and MDO2 are protected against transient short-circuits by a self-resetting fuse. After wiring the inverter, make sure that the output voltage is correct, as a persistent short-circuit may damage the equipment.

NOTE — Isolated supply output is protected by a self-resetting fuse capable of preventing the inverter internal feeder from damaging due to a short-circuit. Nevertheless, if a short-circuit occurs, the inverter could lock and stop the motor.

3.5.6. Analog Outputs (Terminals 10 to 13)

common terminal CMA (terminal 13). They can be set as voltage outputs or current outputs.
Each analog output is controlled by a DAC (digital to analog converter), that can be configured in order to output—as analog signals—three measured values chosen among the available values for each application (see Programming Manual).
The operating mode, gain, offset and filtering time constant (if any) may be defined by the user. The inverter software allows four operating modes that must match with the setup of the configuration dip-switches.

Type of acquisition set for the inverter parameters	Hardware configuration for SW2	Full-scale value and notes
±10 V	Voltage output	-10V ÷ +10V
0 ÷ 10 V	Voltage output	0÷10V
0 ÷ 20 mA	Current output	0mA ÷ 20mA
4 ÷ 20 mA	Current output	4mA ÷ 20mA

CAUTION — Never deliver input voltage to analog outputs. Do not exceed max. allowable current.

NOTE — Digital outputs MDO1 and MDO2 are protected against transient short-circuits by a self-resetting fuse. After wiring the inverter, make sure that the output voltage is correct, as a persistent short-circuit may damage the equipment.

3.5.6.1. Technical Sheet for Analog Outputs

Specification	Min.	Type	Max.	Unit of m.
Load impedance with voltage outputs	2000			Ω
Load impedance with current outputs			500	Ω
Max. allowable load to be connected to voltage outputs			10	nF
Offset cumulative error and typical gain related to full-scale value			1.5	%
Temperature coefficient of gain error and offset			300	ppm/°C
Digital resolution in voltage configuration			11	bit
Digital resolution in current configuration			10	bit
Value of voltage LSB		11.1		mV
Value of current LSB		22.2		μA
Stabilization time within 2% of the final value		1.11		ms
Time period of output activation		500		μs

NOTE — Analog outputs configured as voltage outputs are controlled by operational amplifiers that are subject to fluctuations. Do not install filter capacitors on analog output supply mains. If noise is detected at the system input connected to the analog outputs, switch to current output mode.

3.6. OPERATING AND REMOTING THE KEYPAD

For the parameter programming and view a display/keypad is located on the front part of the SINUS PENTA drives. The display/keypad is fitted on the drive front part; press the side tabs to remove the display/keypad. For more details, see the Remoting the Display/Keypad section below.

3.6.1. INDICATOR LEDS ON THE DISPLAY/KEYPAD

Eleven LEDs are located on the keypad, along with a 4-line, 16-character LCD display, a buzzer and 12 function keys. The display shows parameter values, diagnostic messages and the quantities processed by the inverter.
For any detail concerning menus and submenus, parameter programming, measure selection and messages displayed, please refer to the Sinus Penta's Programming Instructions Manual.
The figure below shows the location of the indicator Leds and their functionality.

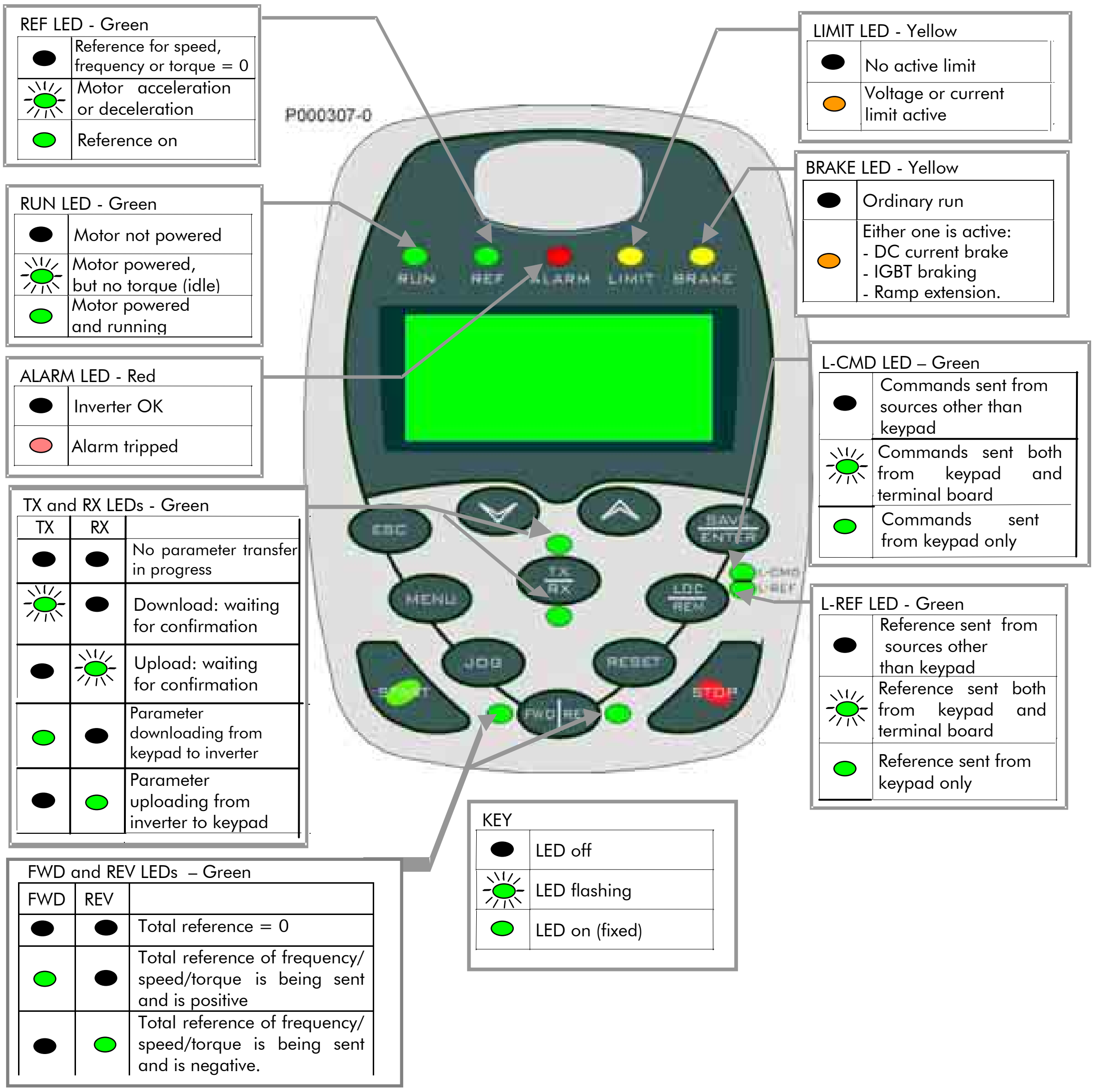
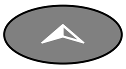
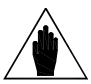


Figure 60: Display/keypad

3.6.2. FUNCTION KEYS

The table below details the display/keypad function keys:

Key	Functions
ESC	Allows to quit menus and sub-menus and to confirm a new parameter value (when the editing mode is activated, the cursor starts flashing), which is not saved to non-volatile memory (the value is lost when the inverter is turned off). If the Operator mode is set up and the keypad is locked on the Keypad page, press ESC for at least 5 s to restart navigation.
	Down arrow; scrolls through the menus and submenus, the pages in a submenu or the parameters in descending order. While programming, it decrements the parameter value. Hold it down along with the increment key ∧ to access the next menu.
	Up arrow; scrolls through the menus and submenus, the pages in a submenu or the parameters in ascending order. While programming, it increments the parameter value.
SAVE / ENTER	Allows to access menus and submenus. In programming mode (cursor flashing) this key saves to non-volatile memory (EEPROM) the value of the parameter being altered. This prevents any parameter modification from being cleared in case of mains loss. If pressed when the Keypad page is displayed, the SAVE/ENTER key allows to display the "Keypad Help" page, where the variables viewed in the previous page are detailed.
MENU	If pressed more than once, it allows to scroll through the menus: start page → access page for parameter alteration → ID SW page → keypad → start page, and so on.
TX / RX	Allows to enter the pages for the parameter DOWNLOAD from the keypad to the inverter (TX) or the parameter UPLOAD from the inverter to the keypad (RX); if pressed more than once, the TX|RX key allows to select either operating mode. The active selection is highlighted by the page displayed; the relevant TX or RX LED starts flashing. To confirm Upload/Download, press the Save/Enter key when the wanted selection is active.
LOC / REM	If pressed once, reference and commands are forced via keypad; press it again to return to the prior configuration or to change the active reference in the Keypad page depending on the preset type of Keypad page (see the Display menu in the SINUS PENTA's Programming Instruction manual).
RESET	It allows to reset the alarm tripped once the cause responsible for the alarm has disappeared. Press it for 8 seconds to reset the control board, thus allowing the microprocessors to be reinitialized and to activate R parameters with no need to shut off the inverter.
START	If enabled, it starts the motor (at least one of the command sources is represented by the keypad).
STOP	If enabled, it stops the motor (at least one of the command sources is represented by the keypad).
JOG	The Jog key is active only when at least one of the command sources is represented by the keypad; if depressed, it enters the Jog reference set in the relevant parameter.
FWD | REV	If enabled (at least one of the command sources is represented by the keypad), it reverses the sign of the overall reference. Press this key again to change the reference sign.



NOTE

Parameter increment or decrement (flashing cursor) is immediately effective or is enabled after quitting the programming mode (fixed cursor) depending on the parameter type. Numeric parameters activate as soon as they are altered; alphanumeric parameters activate after quitting the programming mode. Please refer to the Sinus Penta's Programming Instructions Manual for any detail.

3.6.3. SETTING THE OPERATING MODE

The display/keypad allows to select two different configuration modes. To do so, press the SAVE key for a few seconds, or press TX | RX + SAVE for a few seconds.
If the SAVE key is pressed, only the LCD contrast may be adjusted; press TX | RX + SAVE to set the display language, adjust the display contrast, enable or disable the buzzer and turn on/off the display backlight.

3.6.3.1. ADJUSTING THE DISPLAY CONTRAST

Press the SAVE key for more than 5 seconds; *** TUNING *** is displayed; the indicator Leds come on and configure as a 5-dot bar extending proportionally to the contrast value set. Press ∨ or ∧ to adjust the display contrast. Press SAVE for at least 2 seconds to store the new contrast setting.

3.6.3.2. ADJUSTING THE DISPLAY CONTRAST, LANGUAGE, BACK-LIGHT AND BUZZER

Press TX | RX + SAVE for more than 5 seconds. Press ∨ or ∧ to scroll through seven parameters relating to the display/keypad. Press the PROG key to enable parameter alteration and press ∨ or ∧ to decrement or increment the parameter value. Press SAVE to store the new parameter value to non-volatile memory.
The different parameters and their description are detailed in the table below.

Parameter	Possible values	Description
Vers. SW	-	Software version of the display/keypad (cannot be altered by the user)
Language		Inactive parameter (please refer to the Programming Instructions Manual to set a new dialog language)
Contrast	LOC	Contrast is set on the display
	REM	Contrast is set by the inverter and is forced to the display ([1])
Contrast value	nnn	Numeric value of the contrast register ranging from 0 (low) to 255 (high)
Buzzer	KEY	Buzzer beeps whenever a key is pressed
	REM	Buzzer controlled by the inverter ([1])
	OFF	Buzzer always off
Back-light	ON	LCD back-light always on
	REM	LCD back-light controlled by the inverter ([1])
	OFF	LCD back-light always off
Address	0	Imposes scanning the addresses of multidrop inverters connected to the display/keypad ([2])
	1÷247	MODBUS address of the inverter: allows to select an inverter among multidrop inverters connected to one display/keypad([2])

Once new parameter values are set, press the SAVE key for more than two seconds to return to the inverter ordinary operation.

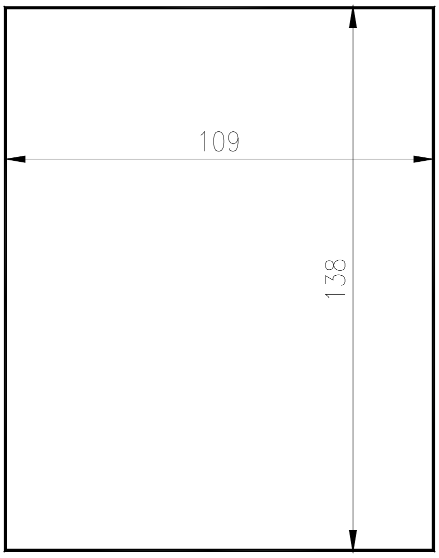
3.6.4. REMOTING THE DISPLAY/KEYPAD

The REMOTING KIT is required to remote the keypad. The remoting kit includes:

- Plastic shell
- Keypad mounting plate
- Fastening brackets
- Remoting wire (length: 5 m)

NOTE The cable length can be 3m or 5m (state cable length when ordering the equipment).

Do the following:
Pierce the holes as shown in the figure (template 138 x109 mm).



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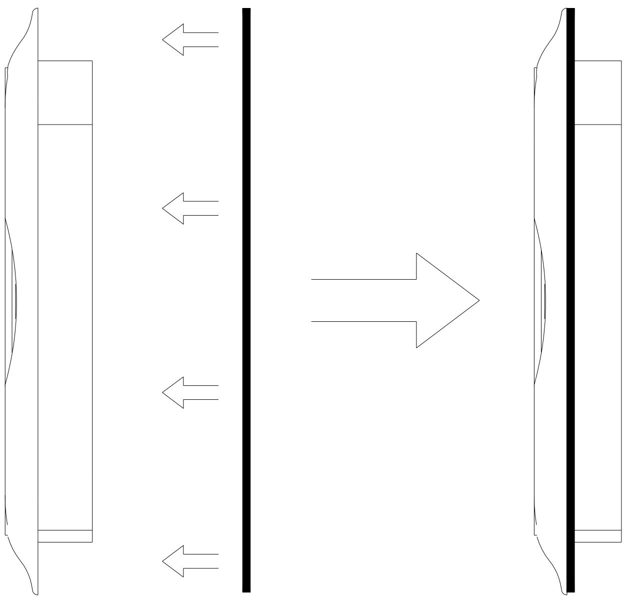
2 – Apply the self-adhesive mounting plate on the rear part of the plastic shell between the shell and the cabinet; make sure that holes coincide.



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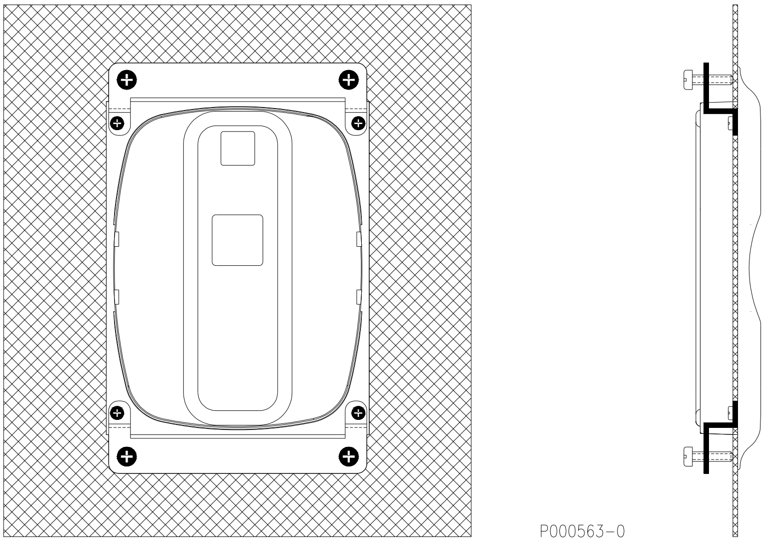
3 – Fit the plastic shell in the relevant slot.

4 - Fasten the plastic shell using the brackets supplied and tighten the fastening screws. Four self-threaded screws are supplied to fasten the brackets to the mounting plate; four fastening screws are also supplied to fix the shell to the panel.



5 – Remove the display/keypad from the inverter (Figure 61). A short wire with 8-pole telephone connectors is used to connect the display/keypad to the inverter. Press the cable tab to disconnect it.

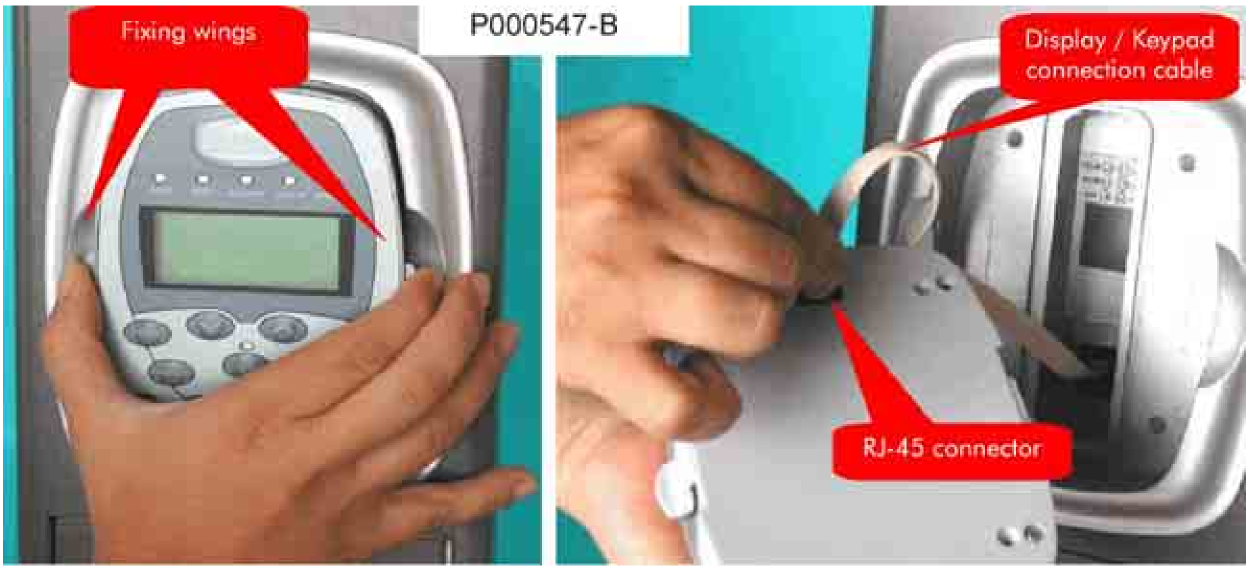


Figure 61: Removing the display/keypad module

6 - Connect the keypad to the inverter using the wire supplied. On the keypad side, the wire is provided with a telephone connector and a loop lug connected to the wire screening braiding. Fasten the loop to the panel grounding using one of the mounting jig fastening screws. Tighten the screw in an uncoated area of the panel, to ensure it is electrically connected to the ground. Panel grounding must comply with the safety regulations in force.

7 – Fit the display/keypad to its housing (side tabs snap); make sure that the telephone connector is connected both to the keypad and to the inverter. Avoid stretching the keypad wire.

The remoting kit ensures degree of protection IP54 for the front panel.

Figure 62: Front/rear view of the display/keypad and its shell.

CAUTION	Never connect and disconnect the keypad when the inverter is on. Temporary overload may lock the inverter due to alarm trip.
CAUTION	Only use wires supplied by Elettronica Santerno for the keypad wiring. Wires with a different contactor arrangement will cause irreparable damages to the inverter and the display/keypad. A remoting wire with different specifications may cause disturbance and affect communications between the inverter and the display/keypad.
CAUTION	Properly connect the remoting wire by grounding its braiding as explained above. The remoting wire must not be parallel-connected to the power wires connecting the motor or feeding the inverter. This will reduce disturbance between the inverter and the display/keypad connection to a minimum.

3.6.5. Using the Display/keypad for Parameter Transfer

The display/keypad can be used for parameter transfer between two inverters. Do the following to transfer parameters from an inverter to the display/keypad: connect the display keypad to inverter #2 and download parameters from the display/keypad to the inverter. Follow the instructions given in section 3.6.4 to fit/remove the display/keypad from the inverter. More details are given in the SINUS PENTA's Programming Instructions manual.

CAUTION	Never connect and disconnect the keypad when the inverter is on. Temporary overload may lock the inverter due to alarm trip.
CAUTION	Only use wires supplied by Elettronica Santerno for the keypad wiring. Wires with a different contactor arrangement will cause irreparable damages to the inverter and the display/keypad. A remoting wire with different specifications may cause disturbance and affect communications between the inverter and the display/keypad.

3.7. SERIAL COMMUNICATIONS

3.7.1. General Features

The inverters of the SINUS PENTA series may be connected to peripheral devices through a serial link; this enables both reading and writing of all parameters normally accessed through the display/keypad. Two-wire RS485 is used, which ensures a better immunity to disturbance even on long cable paths, thus limiting communication errors.
The inverter will typically behave as a slave device (i.e. it only answers to queries sent by another device); a master device (typically a computer) is then needed to start serial communication. The inverter may be connected directly to a computer or a multidrop network of inverters controlled by a master computer (see Figure 63 below).

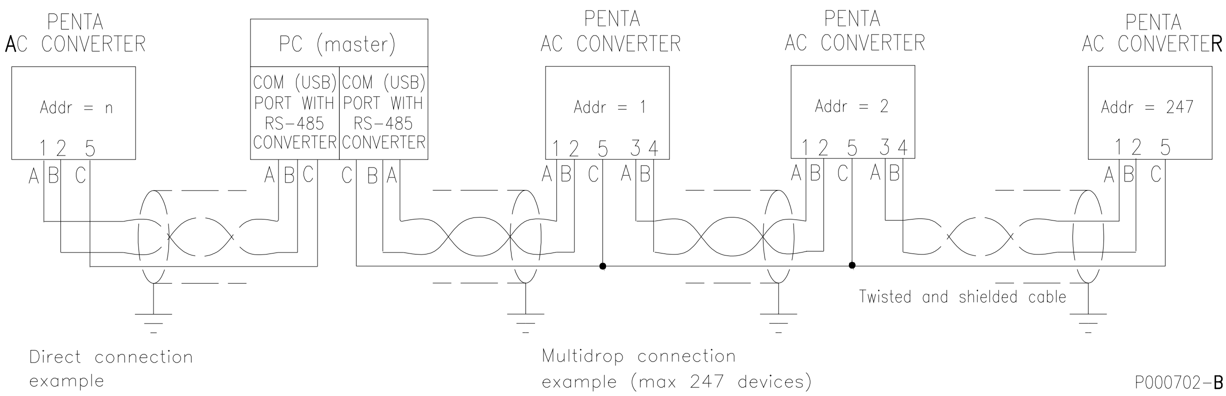


Figure 63: Example of multidrop and direct connection

The Sinus Penta is supplied with a connector which is equipped with 2 pins for each signal of the RS485 pair, thus allowing easier multidrop links with no need to connect two conductors to the same pin, and thus avoiding creating a star network, which is not recommended for this type of bus.

Any information sent to/from the inverter through the display/keypad unit may be obtained also via serial link using the RemoteDrive software offered by Elettronica Santerno. RemoteDrive allows the following functions: image acquisition, keypad simulation, oscilloscope functions and multifunction tester, table compiler including operation data log, parameter setup and data reception-transmission-storage from and to a computer, scan function for the automatic detection of the connected inverters (up to 247 inverters may be connected). Please refer to the RemoteDrive Instruction Manual for the inverters of the Sinus PENTA series manufactured by Elettronica Santerno.

The inverter is provided with two serial communication ports. The basic port (Serial Link 0, see Programming Instructions manual) is provided with a male D-connector described in the wiring section above; the second port (Serial Link 1, see Programming Instructions manual), which is provided with RJ-45 connector, is used for the connection of the display/keypad. When the display/keypad is not used, a master MODBUS device (such as a computer where RemoteDrive is installed) can be connected to Serial Link 1 port through a DB9-RJ45 adaptor.

3.7.2. DIRECT CONNECTION

Electrical standard RS485 may be connected directly to the computer if this is provided with a special port of this type. In case your computer is provided with a serial port RS232-C or a USB port, a RS232-C/ RS485 converter or a USB/RS485 converter is required.
Elettronica Santerno may supply both converters as optional components.
Logic "1" (normally called a MARK) means that terminal TX/RX A is positive with respect to terminal TX/RX B (viceversa for logic "0", normally called a SPACE).

3.7.3. MULTIDROP NETWORK CONNECTION

SINUS PENTA inverters may be connected to a network through electrical standard RS485, allowing a bus-type control of each device; up to 247 inverters may be interconnected depending on the link length and baud rate.
Each inverter has its own identification number, which can be set in the "Serial network" submenu as a unique code in the network connected to the PC.

3.7.3.1. CONNECTION

For the connection to serial link 0 use the 9-pole, male D connector located on the control board (sizes S05..S15) or on the inverter bottom besides the terminal board (sizes ≥ S20).
The D connector pins are the following.

PIN	FUNCTION
1 – 3	(TX/RX A) Differential input/output A (bidirectional) according to standard RS485. Positive polarity with respect to pins 2 – 4 for one MARK. Signal D1 according to MODBUS-IDA association.
2 – 4	(TX/RX B) Differential input/output B (bidirectional) according to standard RS485. Negative polarity with respect to pins 1 – 3 for one MARK. Signal D1 according to MODBUS-IDA association.
5	(GND) control board zero volt. Common according to MODBUS-IDA association.
6	(VTEST) Test supply input – (see section below)
7 – 8	not connected
9	+ 5 V, max 100 mA for power supply of optional converter RS-485/RS-232

The D-connector metal frame is connected to the grounding. Wire duplex cable braiding to the metal frame of the female connector to be connected to the inverter. To avoid obtaining a too high common voltage for driver RS-485 of the master or the multidrop-connected devices, connect together terminals GND (if any) for all devices. This ensures equipotentiality for all signal circuits, thus providing the best operating conditions for drivers RS-485; however, if devices are connected to each others with analog interfaces, this can create ground loops. If disturbance occurs when communication interfaces and analog interface operate at a time, use optional, galvanically isolated communications interface RS-485.

Otherwise, serial link 1 can be connected through RJ-45 connector. Pins of RJ-45 connector are the following:

PIN	FUNCTION
1-2-4	+ 5 V, max. 100mA for the power supply of external optional RS-485/RS232 converter.
3	(TX/RX B) Differential input/output B (bidirectional) according to standard RS485. Negative polarity with respect to pins 1 – 3 for one MARK. Signal D1 according to MODBUS-IDA association.
5	(TX/RX A) Differential input/output A (bidirectional) according to standard RS485. Positive polarity with respect to pins 2 – 4 for one MARK. Signal D1 according to MODBUS-IDA association.
6-7-8	(GND) control board zero volt. Common according to MODBUS-IDA association.

The pin lay-out of RJ-45 connector is shown in the figure below:

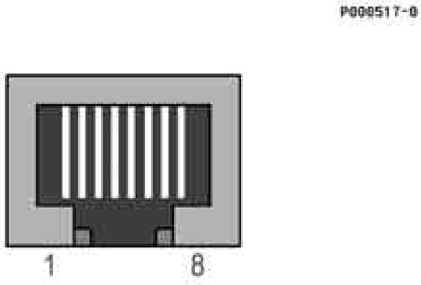


Figure 64: Pin lay-out of serial link 1 connector

MODBUS-IDA association (http://www.modbus.org) defines the type of wiring for MODBUS communications via serial link RS485 as a “2-wire cable”. The following specifications are recommended:

Type of cable	Screened cable composed of balanced D1/D0 pair + common conductor (“Common”)
Min. cross-section of conductors	AWG24 corresponding to 0.25 sq mm. For long cable length, larger cross-sections up to 0.75 sq mm are recommended.
Max. length	1000 metres based on the max. distance between two stations
Characteristic impedance	Better if exceeding 100Ω (120Ω is typically recommended)
Standard colours	Yellow/brown for D1/D0 pair, grey for “Common” signal

The figure below shows the reference wiring diagram recommended from MODBUS-IDA association for the connection of “2-wire” devices:

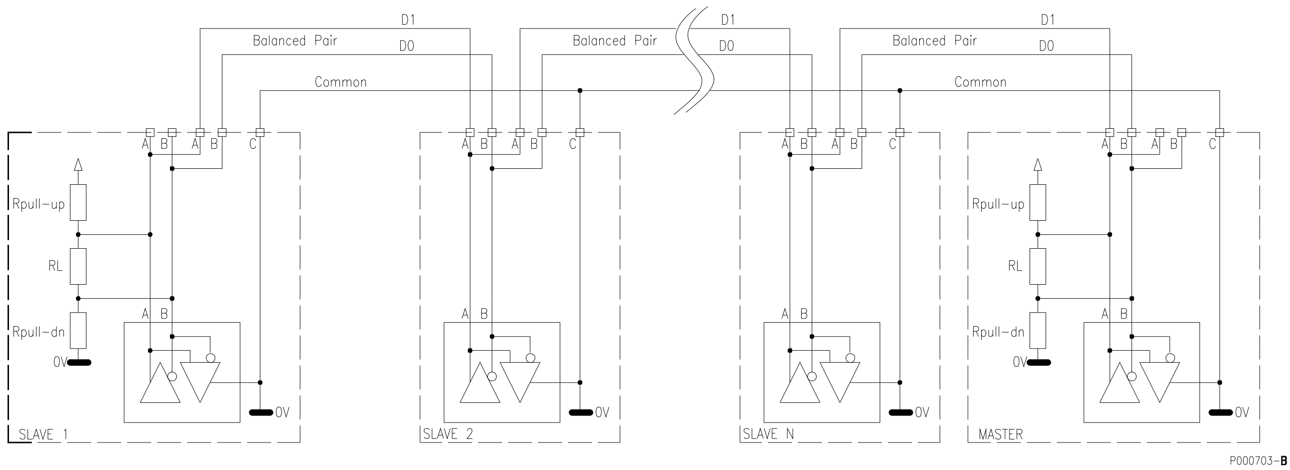


Figure 65: Recommended wiring diagram for “2-wire” MODBUS connection

Note that the networks composed of the termination resistor and the polarization resistors are integrated into the inverter and can be activated via appropriate dip-switches. Figure 65 shows the termination network in the devices at both ends of the chain. The terminator must be inserted in those devices only.

0 1 2 3 4 5 6 7 8

NOTE

Four-pair data transfer cables of Category 5 are normally used for serial links. Although their usage is not recommended, cables of Category 5 can be used for short cable paths. Note that the colours of such cables are different from the colours defined by MODBUS-IDA association. One pair is used for D1/D0 signals, one pair is used as a "Common" conductor, while the remaining two pairs must not be connected to any other device, or must be connected to the "Common".

NOTE

All devices connected to the communication multidrop network should be grounded to the same conductor to minimize any difference of ground potentials between devices that can affect communication.

NOTE

The common terminal for the supply of the inverter control board is isolated from grounding. If one or multiple inverters are connected to a communication device with a grounded common (typically a computer), a low-impedance path between control boards and grounding occurs. High-frequency disturbance could come from the inverter power components and interfere with the communication device operation.
If this happens, provide the communication device with a galvanically isolated interface, type RS-485/RS-232.

3.7.3.2. TEST SUPPLY INPUT

VTEST input supply pin is located on the connector of serial port 0. If 9DC voltage (with respect to GND) is delivered to the VTEST input, the inverter control board activates in Test mode, allowing to change the inverter parameters with no need to apply AC 3-phase supply. The test mode disables the alarms relating to the power section and the motor cannot be started up. The test supply input features are the following:

Features	Min.	Type	Max.	Unit of m.
Test supply voltage	7.5	9	12	VDC
Absorbed current		1.1	1.8	A
"Inrush" current at power on			3	A

NOTE

Do not apply 3-phase AC supply and test supply at a time. The motor cannot startup and alarms relating to the power section are inhibited.

CAUTION

The feeder voltage and current delivery capacity must meet the requirements of the test supply. Lower ratings than the supply test can cause the control board failure and the irreparable loss of the user-defined parameters. On the other hand, higher ratings can cause irreparable damage to the inverter control board. Switching feeders installed in the control board are characterized by strong "inrush" current at power on. Make sure that the feeder being used is capable of delivering such current ratings.

3.7.3.3. LINE TERMINATORS

Provide a linear wiring (not a star wiring) for multidrop line RS-485. To do so, two pins for each line signal are provided on the inverter connector. The incoming line may be connected to pins 1 and 2, whereas the outgoing line may be connected to pins 3 and 4.
The first device in the multidrop connection will have only one outgoing line, while the last device will have only one incoming line. The line terminator is to be installed on the first device and the last device. In serial link 0, the terminator is selected through dip-switch SW3 in the control board (see Dip-switches section) for SINUS PENTA inverters.
The line master (computer) is typically placed at the beginning or at the end of a multidrop connection; in that case, the line terminator of the farthest inverter from the master computer (or the only inverter in case of direct connection to the master computer) shall be enabled: dip-switch SW3, selector switches 1 and 2 in position ON.
The line terminator of the other inverters in intermediate positions shall be disabled: dip-switch SW3, selector switches 1 and 2 in position OFF.

NOTE

Communication does not take place or is adversely affected if multidrop terminators are not properly set, especially in case of a high baud rate. If more than two terminators are fitted, some drivers can enter the protection mode due to thermal overload, thus stopping dialoguing with some of the connected devices.

CAUTION

The line terminator in serial link 1, which is available on the keypad connector, is always ON and cannot be disabled. This avoids any multidrop connection of multiple inverters. A multidrop network can be used for point-to-point communications with the master computer or for the first/last inverter in a multidrop chain. If a multidrop network is connected to serial link 1 port, communications will not take place and the network-connected devices will be damaged by the large resistive load of the parallel-connected terminator resistors.

3.7.4. HOW TO USE ISOLATED SERIAL BOARD ES822 (OPTIONAL)

Optional board ES822 allows the connection to a serial link RS485 or RS232. Board ES822, to be installed inside the inverter, allows the inverter to be connected both to a computer through RS232—with no need to use additional devices—and to serial link RS485. Board ES822 also provides galvanic isolation between the serial link and the control board grounding of the inverter, thus avoiding ground loops and enhancing immunity to disturbance of the serial link. For more details, see section "Isolated serial board ES822" in "Accessories".
The activation of ES822 results in the automatic commutation of serial link 0, which is electrically suppressed from the standard serial connector of the inverter.

3.7.5. THE SOFTWARE

The serial communication protocol is MODBUS RTU standard.
Parameters are queried as they are read using the keys and the display. Parameter alteration is also managed along with the keypad and the display. Note that the inverter will always consider the latest value set either via serial link or by the inverter.
The terminal board inputs may be controlled by the field or the serial link, depending on the condition of the relevant parameters (see Programming Manual).
However, the ENABLE command is always to be sent via terminal board regardless of the inverter programming mode.

3.7.6. SERIAL COMMUNICATION RATINGS

Baud rate:	configurable between 1200 and 38,400 bps (default value: 38,400 bps)
Data format:	8 bits
Start bit:	1
Parity: (1)	NO, EVEN, ODD
Stop bit:	2,1
Protocol:	MODBUS RTU
Supported functions:	03 h (Read Holding Registers) 10 h (Preset Multiple Registers)
Device address:	configurable between 1 and 247 (default value: 1)
Electric standard:	RS485
Inverter response delay:	configurable between 0 and 1000 ms (default value: 5 ms)
End of message timeout:	configurable between 0 and 10,000 ms (default value: 0 ms)
Communications Watch Dog: (2)	configurable between 0 and 65,000 s (default value: disabled)

1) Ignored when receiving
2) If set up, an alarm trips if no legal message is sent within the timeout period.

NOTE For the parameters relating to the configuration of the serial communications, see the SINUS PENTA's Programming Manual.

4. STARTUP

This section covers the basic startup procedures for IFD, VTC, FOC motor control configurations.
For any detail concerning startup procedures of devices configured as “RGN” (regenerative inverter), see “SINUS PENTA REGENERATIVE APPLICATION”
For more details on the equipment functionality, please consult SINUS PENTA’s Programming Instruction Manual.

	DANGER	Before changing the equipment connections, shut off the inverter and wait at least 5 minutes to allow for the discharge of the heatsinks in the DC-link.
	DANGER	At startup, if the connected motor rotates in the wrong direction, send a low frequency reference in IFD mode and check to see if the direction of rotation is correct. With respect to its shaft, the motor normally rotates clockwise if the connection sequence is U, V, W and if a positive reference is set (FWD). Contact the motor manufacturer to check the preset direction of rotation of the motor.
	CAUTION	When an alarm message is displayed, find the cause responsible for the alarm trip before restarting the equipment.

4.1. "IFD" Motor Control

SINUS PENTA drives are factory set with the IFD (**C010**) control algorithm, allowing the first startup of the equipment. The default functions of the drive terminals are given in the table below. For more details, please refer to the Sinus Penta's Programming Instructions Manual.

1) Wiring:	Follow the instructions stated in the "Caution Statements" and "Installation" sections.
2) Power on:	Power on the drive and do not close the link to the **START** input to prevent the motor from running.
3) Parameter alteration	Access parameter **P000** (Key parameter) and set its code (default value: 00001). Use the ESC, ▲,▼ and SAVE/ENTER keys to access the programming parameters. Also refer to the Menu Tree in the SINUS PENTA'S Programming instruction Menù.
4) Supply voltage	Set the real supply voltage for the drive. You can set either mains voltage range or the DC supply stabilized by a Regenerative Penta drive. To set the type of power supply for the drive, access the MOTOR CONTROL MENU and set configuration parameter **C008** to the value corresponding to the installation concerned.
5) Motor parameters:	Set **C010** (Control Algorithm) as IFD Voltage/Frequency; set the motor ratings as follows: - **C015** (fmot1) rated frequency - **C016** (rpmnom1) rated rpm - **C017** (Pmot1) rated power - **C018** (Imot1) rated current - **C019** (Vmot1) rated voltage - **C029** (Speedmax1) max. allowable speed. For loads with square torque with respect to the rpm (centrifugal pumps, fans, etc.), set **C034** (preboost1) to 0%. Press SAVE/ENTER each time a new parameter value is set.
6) Autotune:	**For the IFD control algorithm, the Autotune function is not necessary but is always recommended.** First remove the **ENABLE** command, then access the AUTOTUNE MENU and set **I073** [1: Motor Tune] and **I074** = [0: All Ctrl no rotation]. Use the **ESC** key to accept changes. Close the **ENABLE** command and wait until tune is complete (Warning "**W32** Open Enable" is displayed). The drive has computed and saved the values for **C022** (stator resistance) and **C023** (leakage inductance). If alarm "**A097** Motor Wires KO" trips, check the motor wiring. If alarm "**A065** Autotune KO" trips, this means that the **ENABLE** command has opened before autotune was complete. In this case, reset the drive sending a command from terminal MDI3, or press the **RESET** key in the display/keypad and perform the autotune procedure again.
7) Overload:	Set parameters in the LIMITS MENU depending on the max. desired current.

8) Startup: Activate the **ENABLE** input (terminal 15) and the **START** input (terminal 14) and send a speed reference: the RUN LED and REF LED will come on and the motor will start. Make sure that the motor is rotating in the correct direction. If not, select the Engineering Level (P001) and set parameter **C014** (Phase Rotation) to [1:Yes], or open the ENABLE and START inputs, remove voltage from the drive and, after waiting at least 5 minutes, reverse two of the motor phases.

9) Possible failures: If no failure occurred, go to step 10. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference.

Also check if alarm messages are displayed. In the MEASURES MENU, check the reference speed (**M001**), the supply voltage to the control section (**M030**), the DC link voltage (**M029**), and the condition of control terminals (**M033**). Check to see if these readouts match with the measured values.

10) Additional parameter alterations: When parameter **P003** = Standby Only (condition required for altering C parameters), you can alter **Cxxx** parameters in the CONFIGURATION menu only when the drive is DISABLED or STOPPED, whereas if **P003** = Standby + Fluxing, you can alter Cxxx parameters when the motor is stopped but the drive is enabled.

Before altering any parameters, remember that the correct code for parameter **P000** must be previously set up.

You can write down any custom parameters in the table provided on the last pages of the Programming Instruction Manual.

11) Reset: If an alarm trips, find the cause responsible for the alarm and reset the drive. Enable input MDI3 (terminal 16) for some time, or press the **RESET** key on the display/keypad.

NOTE When the IFD control algorithm is used, only speed references can be set up.

0 1 2 3 4 5 6 7 8

4.2. "VTC" Motor Control

1) Wiring:	Follow the instructions stated in the "Caution Statements" and "Installation" sections.
2) Power on:	Power on the drive and do not close the link to the **START** input to prevent the motor from running.
3) Parameter alteration:	Access parameter **P000** (Key parameter) and set its code (default value: 00001). Select the Engineering access level seting P001 = Eng. Use the ESC, ▲,▼ and SAVE/ENTER keys to access the programming parameters. Also refer to the Menu Tree in the SINUS PENTA'S Programming Instruction Manual.
4) Supply voltage:	Set the real supply voltage for the drive. You can set either mains voltage range or the DC supply stabilized by a Regenerative Penta drive. To set the type of power supply for the drive, access the MOTOR CONTROL MENU and set configuration parameter **C008** to the value corresponding to the installation concerned.
5) Motor parameters:	Set **C010** (Control Algorithm) as VTC Vector Torque Control. Set the motor ratings as follows: - **C015** (fmot1) rated frequency - **C016** (rpmnom1) rated rpm - **C017** (Pmot1) rated power - **C018** (Imot1) rated current - **C019** (Vmot1) rated voltage - **C029** (Speedmax1) max. speed desired. Also set **C022** (resistance of one stator phase for a star connection or one third of one phase resistance for a delta connection) and **C023** (stator leakage inductance of one phase for a star connection or one third of the leakage of one phase for a delta connection). The value for **C022** corresponds to half the resistance value measured with an ohm-meter between two phases of the motor. If values to be set for **C022** and **C023** are not known, motor autotune is required (see step 6), otherwise, go to step 7. Press SAVE/ENTER each time a new parameter is set.
6) Autotune:	First remove the **ENABLE** command, then access the AUTOTUNE MENU and set **I073** [1: Motor Tune] and **I074** = [0: All Ctrl no rotation]. Use the **ESC** key to accept changes. Close the **ENABLE** command and wait until tune is complete (Warning "**W32** Open Enable" is displayed). The drive has computed and saved the values for **C022** (stator resistance) and **C023** (leakage inductance). If alarm "**A097** Motor Wires KO" trips, check the motor wiring. If alarm "**A065** Autotune KO" trips, this means that the **ENABLE** command has opened before autotune was complete. In this case, reset the drive sending a command from terminal MDI3, or press the **RESET** key in the display/keypad and perform the autotune procedure again.
7) Overload:	Set parameter **C048** in the LIMITS MENU based on the maximum torque that can be generated expressed as a percentage of the motor rated torque.

8) Startup:	Activate the **ENABLE** input (terminal 15) and the **START** input (terminal 14) and send a speed reference. The RUN LED and REF LED will come on and the motor will start. Make sure that the motor is rotating in the correct direction. If not, set parameter **C014** (Phase Rotation) to [1:Yes], or open the ENABLE and START inputs, remove voltage from the drive and, after waiting at least 5 minutes, reverse two of the motor phases.
9) Speed regulator adjustment:	If overshoot occurs when the speed setpoint is attained or if a system instability is detected (uneven motor operation), adjust the parameters relating to the speed loop (SPEED LOOP AND CURRENT BALANCING MENU). Set the two parameters relating to integral time (**P125, P126**) as [Disabled] and set low values for the parameters relating to proportional gain (**P127, P128**). Set equal values for **P127** and **P128** and increase them until overshoot takes place when the setpoint is attained. Decrease **P127** and **P128** by approx. 30%, then decrease the high values set for integral time in **P125** and **P126** (keep both values equal) until an acceptable setpoint response is obtained. Check to see if the motor runs smoothly at constant speed.
10) Possible failures:	If no failure occurred, go to step 11. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the MEASURES MENU, check the speed reference (**M000**), the reference speed processed by the ramps (**M002**), the supply voltage of the control section (**M030**), the DC-link voltage (**M029**), the condition of the control terminals (**M033**). Check to see if these readouts match with the measured values.
11) Additional parameter alterations:	When parameter **P003** = Standby Only (condition required for altering C parameters), you can alter **Cxxx** parameters in the CONFIGURATION menu only when the drive is DISABLED or STOPPED, whereas if **P003** = Standby + Fluxing, you can alter Cxxx parameters when the motor is stopped but the drive is enabled. Before altering any parameters, remember that the correct code for parameter **P000** must be previously set up. You can write down any custom parameters in the table provided on the last pages of the Programming Instruction Manual.
12) Reset:	If an alarm trips, find the cause responsible for the alarm and reset the drive. Enable input MDI3 (terminal 16) for some time, or press the **RESET** key on the display/keypad.

0 1 2 3 4 5 6 7 8

4.3. "FOC" Motor Control

1) Wiring: Follow the instructions stated in the "Caution Statements" and "Installation" sections.

2) Power on: Power on the drive and do not close the link to the **START** input to prevent the motor from running.

3) Parameter alteration: Access parameter **P000** (Key parameter) and set its code (default value: 00001). Select the Engineering access level seting P001 = Eng. Use the ESC, ▲,▼ and SAVE/ENTER keys to access the programming parameters. Also refer to the Menu Tree in the SINUS PENTA'S Programming Instruction Manual.

4) Supply voltage: Set the real supply voltage for the drive. You can set either mains voltage range or the DC supply stabilized by a Regenerative Penta drive. To set the type of power supply for the drive, access the MOTOR CONTROL MENU and set configuration parameter **C008** to the value corresponding to the installation concerned.

5) Motor parameters: Set **C010** (Control Algorithm) as FOC Field Oriented Control. Set the motor ratings as follows:

- **C015** (fmot1) rated frequency
- **C016** (rpmnom1) rated rpm
- **C017** (Pmot1) rated power
- **C018** (Imot1) rated current
- **C019** (Vmot1) rated voltage
- **C029** (Speedmax1) max. speed desired.

If the no-load current of the motor is known, in **C021** (**Io**) set the value of **Io** expressed as a percentage of the motor rated current.
If the no-load current of the motor is not known, but the motor can run with no connected load, start the motor at its rated speed, read the current value detected by the drive (parameter **M026**) in the Motor Measures Menu and use it as the first attempt value for **Io**.

NOTE: If the connected motor must run at a higher speed than its rated speed (flux weakening), measure the no-load current value at its max. speed of rotation to ensure better performances.

If the no-load current of the motor is not known and the motor cannot run in no-load conditions, use a first attempt value for **Io** that is automatically computed by the drive, as described in step 7.

NOTE: When parameter **C021** (Io)=0, whenever the motor autotune (step 7) is performed, the drive will automatically set a value depending on the motor ratings.

Once a no-load current value is entered in **C021**, the value of the parameter relating to mutual inductance (**C024**) will be automatically computed when parameters **I073**= [1: Motor Tune] and **I074**= [1: FOC Auto no rotation] are set up as for current autotune (**C024** is computed even if no autotune procedure occurs).

Also set **C022** (resistance of one stator phase for a star connection or one third of one phase resistance for a delta connection) and **C023** (stator leakage inductance of one phase for a star connection or one third of the leakage of one phase for a delta connection). The value for **C022** corresponds to half the resistance value measured with an ohm-meter between two phases of the motor. If values to be set for **C022** and **C023** are not known, motor autotune is required (see step 6), otherwise, go to step 7. Press SAVE/ENTER each time a new parameter is set.

6) Encoder TEST: **The motor must run when testing the encoder.**
Access the ENCODER/FREQUENCY INPUTS MENU, set the source of the encoder signal used as a speed feedback (Encoder A in terminal board, Encoder B from ES836 optional board), enter the number of pulse/rev and the number of the encoder channels (more details are given in the section relating to the Encoder/Frequency Input menu in the present Programming Manual).
In the MOTOR CONTROL MENU, set the parameter relating to the speed feedback from encoder: **C012** = Yes.
Access the AUTOTUNE MENU and set parameter **I073** (Select Autotune Type) as "Encoder Tune". Use the **ESC** key to confirm changes. Close the **ENABLE** command and wait until encoder tune is complete ("W32 Open Enable" is displayed).
Once encoder tune is complete, the display will show one of the following messages:
"**W31** Encoder Ok"; the speed feedback is correct. If the speed detected by the encoder is opposite to the desired speed, the drive will automatically reverse the feedback sign (parameter **C199**).
"**A59** Encoder Fault"; the speed detected from the encoder is not consistent with the control speed. Possible causes:
- Wrong number of pls/rev of the encoder
- Wrong power supply of the Encoder (e.g. +5V instead of +24V): check the encoder ratings and the position of jumpers and dip-switches for the encoder supply in the optional encoder board
- Wrong configuration of the dip-switches for the encoder selection (push-pull or line-driver encoder) in the optional encoder board
- No connection to the encoder channel (check wiring)
- At least one Encoder channel is faulty (replace the encoder).

7) Autotune of the stator resistance and leakage inductance: First remove the **ENABLE** command, then access the MOTOR CONTROL MENU and set **I073** [1: Motor Tune] and **I074** = [0: All Ctrl no rotation]. Use the **ESC** key to accept changes. Close the **ENABLE** command and wait until autotune is complete (warning "**W32** Open Enable" is displayed). The drive has computed and saved the values for **C022** and **C023**. If alarm "**A097** Motor wires KO" trips, check the motor wiring. If alarm "A065 Autotune KO" trips, this means that the **ENABLE** command has opened before autotune was completed. In this case, reset the drive sending a command from terminal MDI3, or press the **RESET** key in the display/keypad and perform the autotune procedure again.

8) Autotune of the current loop: First remove the **ENABLE** command, , then access the AUTOTUNE MENU and set **I073** [1: Motor Tune] and **I074** = [1: FOC Auto no rot.]. Use the **ESC** key to accept changes. Close the **ENABLE** command and wait until autotune is complete (warning "**W32** Open Enable" is displayed). The drive has computed and saved the values for **P155** and **P156**. If alarm "**A065** Autotune KO" trips, this means that the **ENABLE** command has opened before autotune was completed or that the autotune algorithm failed. In this case, reset the drive sending a command from terminal MDI3, or press the **RESET** key in the display/keypad and perform the autotune procedure again.

NOTE: if the **ENABLE** command was not opened before autotune was over, decrease by 5% the no-load current value set in **C021** and perform the autotune procedure again.

9) Tuning the rotor time constant: The rotor time constant (**C025**) is estimated with a special autotune procedure allowing the motor to run even in no-load conditions. First remove the **ENABLE** command, then access the AUTOTUNE MENU and set **I073** [1: Motor Tune] and **I074** = [2: FOC Auto + rot]. Use the **ESC** key to accept changes. Close the **ENABLE** command and wait until autotune is over (warning "**W32** Open Enable" is displayed). When autotune is complete, the value obtained for the rotor time constant is automatically saved in parameter **C025**.

If the motor cannot run in no-load conditions, use a first attempt value for **Io** that is automatically computed by the drive, as described in step 7.

10) Startup: Now that all the parameters have been set for the FOC motor control algorithm, activate the **ENABLE** input (terminal 15) and the **START** input (terminal 14) and send a speed reference: the RUN LED and REF LED will come on and the motor will start. Make sure that the motor is rotating in the correct direction. If not, set parameter **C014** (Phase Rotation) to [1:Yes], or open the ENABLE and START inputs, remove voltage from the drive and, after waiting at least 5 minutes, reverse two of the motor phases.

11) Speed regulator adjustment: If overshoot occurs when the speed setpoint is attained or if a system instability is detected (uneven motor operation), adjust the parameters relating to the speed loop (SPEED LOOP AND CURRENT BALANCING MENU). Set the two parameters relating to integral time (**P125, P126**) as [Disabled] and set low values for the parameters relating to proportional gain (**P127, P128**). Set equal values for **P127** and **P128** and increase them until overshoot takes place when the setpoint is attained. Decrease **P127** and **P128** by approx. 30%, then decrease the high values set for integral time in **P125** and **P126** (keep both values equal) until an acceptable setpoint response is obtained. Check to see if the motor runs smoothly at constant speed.

12) Possible failures: If alarm "**A060** Fault No Curr." trips, this means that the current loop is not properly tuned. Follow the instructions given in step 8 and decrease the value of I_0 (parameter **C021** in the MOTOR CONTROL MENU).
If the motor is noisy when starting, this means that the rotor time constant is not correct. Follow the instructions given in step 9 again, or manually change the value of the rotor time constant (parameter **C025**) for a smooth motor startup.
If no failure occurred, go to step 13. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the Motor Measure Menù, check the speed reference (**M000**), the reference speed processed by the ramps (**M002**), the supply voltage of the control section (**M030**), the DC link voltage (**M029**), the condition of the control terminals (**M033**). Check to see if these readouts match with the measured values.

13) Additional parameter alterations:

For the optimization of the motor performance, manually adjust parameters **C021** (no-load current), **C024** (mutual inductance), **C025** (rotor time constant). Consider the following:

- **C021** Too high values → Lower torque, especially at rated speed, because most part of the voltage imposed by the drive is used to magnetize the motor instead of generating a proper motor torque;

- **C021** Too low values → Because of the motor flux weakening, higher current ratings are needed;

- **C024** Mutual inductance → This is computed each time the no-load current level is altered. This is not binding for the motor control, but strongly affects the correct estimation of the output torque; in case of overestimation, decrease **C025**, and vice versa;

- **C025** Optimum value → To obtain the optimum value of the rotor time constant, the best way consists in performing several attempts with a constant load but with different values of **C025**. The optimum value is the one ensuring to obtain the output torque with the lower current (see **M026** in the Motor Measures Menu).

When parameter **P003** = Standby Only (condition required for altering C parameters), you can alter **Cxxx** parameters in the CONFIGURATION menu only when the drive is DISABLED or STOPPED, whereas if **P003** = Standby + Fluxing, you can alter Cxxx parameters when the motor is stopped but the drive is enabled.
Before altering any parameters, remember that the correct code for parameter **P000** must be previously set up.
You can write down any custom parameters in the table provided on the last pages of this Programming Manual.

14) Reset:

If an alarm trips, find the cause responsible for the alarm and reset the drive. Enable input MDI3 (terminal 16) for some time, or press the **RESET** on the display/keypad.

5. TECHNICAL SPECIFICATIONS

Power Range
• kW connected motor/voltage range
0.55~630kW 200÷240Vac, 3phase
1~1170kW 380÷415Vac, 3phase
1~1340kW 440÷460Vac, 3phase
1~1460kW 480÷500Vac, 3phase
83~1670kW 575Vac, 3phase
100~2010kW 660÷690Vac, 3phase
• Degree of protection/size
STAND ALONE: IP20 from Size S05 to Size S40, IP00 Size S50, S60, S70, IP54 from Size S05 to Size S30
BOX: IP54
CABINET: IP24 and IP54.

Mains
• VAC supply voltage/tolerance
2T → 200÷240 Vac, 3phase, -15% +10%
4T → 380÷500 Vac, 3phase, -15% +10%
5T → 500÷575 Vac, 3phase, -15% +10%
6T → 575÷690 Vac, 3phase, -15% +10%
Maximum voltage imbalance: +/-3% of the rated supply voltage
• VDC supply voltage/tolerance
2T → 280÷360 Vdc, -15% +10%
4T → 530÷705 Vdc, -15% +10%
5T → 705÷810 Vdc, -15% +10%
6T → 810÷970 Vdc, -15% +10%
• Supply frequency (Hz)/tolerance
50÷60Hz, +/-20%

Specifications for motor wiring
• Motor voltage range/precision
0÷Vmains, +/-2%
• Current/torque to motor/time
105÷200% for 2 min. every 20 min. up to S30.
105÷200% for 1 min. every 10 min. from S40.
• Starting torque/max. time
240% for a short time
• Output frequency/resolution *
0÷1000 Hz, resolution 0.01 Hz
• Braking torque
DC braking 30%*Cn
Braking while decelerating up to 20%*Cn (with no braking resistor)
Braking while decelerating up to 150%*Cn (with braking resistors)
• Adjustable carrier frequency with silent random modulation.

S05÷S15 = 0.8÷16 kHz
S20 = 0.8÷12.8 kHz
S30 = 0.8÷10 kHz (5 kHz for 0150 and 0162)
≥S40 = 0.8÷4 kHz

Environmental Requirements
• Ambient temperature
0÷50 °C with no derating
(see table section 5.3)
• Storage temperature
- 25 ÷ + 70 °C
• Humidity
5 ÷ 95% (non condensing)
• Altitude
Up to 1,000m above sea level.
For higher altitudes, derate the output current of 1% every 100 m beyond 1,000 m (max. 4,000 m)
• Vibrations
Lower than 5.9 m/sec^2 (= 0.6 G)
• Installation environment
Do not install in direct sunlight and in places exposed to conductive dust, corrosive gases, vibrations, water sprinkling or dripping; do not install in salty environments.
• Operating atmospheric pressure
86 ÷ 106 kPa
• Cooling system
Forced air-cooling

*NOTE: The maximum output frequency is limited with respect to the preset carrier frequency.

NOTE For DC supply applied to Sinus Penta S60, S65, S70, please contact Elettronica Santerno SpA.

MOTOR CONTROL	Motor control methods		IFD = Voltage/Frequency with symmetrical PWM modulation VTC = Vector Torque Control (Sensorless vector direct torque control) FOC = Field adjustment with field regulation and torque for synchronous motors SYN = Field adjustment with torque control for synchronous motors
	Frequency / speed setting resolution		Digital reference: 0.1 Hz (IFD SW); 1 rpm (VTC SW); 0.01 rpm (FOC and SYN SW) 12-bit Analog reference: 4096 with respect to speed range
	Speed precision		Open loop: ±0.5% of max. speed Closed loop (with an encoder): < 0.01% of max. speed
	Overload capacity		Up to 2 times rated current for 120 sec.
	Starting torque		Up to 200% Cn for 120 sec and 240% Cn for a short duration
	Torque boost		Programmable for a rated torque increase
OPERATION	Input signals	Operation method	Operation via terminal board, keypad, MODBUS RTU serial interface, field bus interface
		Reference analog inputs / auxiliary inputs	3 analog inputs to be configured as voltage/current inputs: - 1 single-ended input, max. resolution 12 bits - 2 differential inputs, max resolution 12 bits Analog quantities from keypad, serial interface, field bus
		Digital inputs	8 digital inputs; 3 preset inputs (ENABLE, START, RESET) and 5 configurable inputs
		Multispeed	15 sets of programmable speed values +/-32,000 rpm; first 3 sets with resolution 0.01 rpm (FOC and SYN Methods)
		Ramps	4 + 4 accel./decel. ramps, 0 to 6,500 sec; possibility to set user-defined patterns.
	Output signals	Digital outputs	4 configurable digital outputs with possibility to set internal timers for activation/deactivation delay: 1 push-pull output, 20÷48 Vdc, 50 mA max. 1 open collector, NPN/PNP output, 5÷48 Vdc, 50 mA max 2 relay outputs with reverse contacts, 250 VAC, 30 VDC, 3A
		Auxiliary voltage	24 Vdc +/-5%, 200 mA
		Reference voltage for potentiometer	+ 10 Vdc ± 0.8%, 10 mA -10 Vdc ± 0.8%, 10 mA
		Analog outputs	3 configurable analog outputs, – 10 ÷ 10 Vdc, 0 ÷ 10 Vdc, 0(4) ÷ 20 mA, resolution 9/11 bits
PROTECTIONS	Alarms		Inverter thermal protection, motor thermal protection, mains failure, overvoltage, undervoltage, overcurrent at constant speed or ground failure, overcurrent while accelerating, overcurrent while decelerating, overcurrent during speed search (IFD SW only), auxiliary trip from digital input, serial communication failure, control board failure, precharge circuit failure, inverter overload conditions for long duration, unconnected motor, encoder (if any) failure, overspeed.
	Warning		INVERTER OK, INVERTER ALARM, acceleration – constant rpm – deceleration, current/torque limiting, POWER DOWN, SPEED SEARCHING, DC braking, autotune.
COMMUNICATION DISPLAY	Operating data		Frequency/torque/speed reference, output frequency, motor speed, torque demand, generated torque, current to motor, voltage to motor, DC bus voltage, motor-absorbed power, digital input condition, digital output condition, trip log (last 5 alarms), operating time, auxiliary analog input value, PID reference, PID feedback, PID error value, PID regulator output, PID feedback with programmable multiplying factor.
	Serial link		Standard incorporated RS485 multidrop 247 drops MODBUS RTU communication protocol
	Field bus		Profibus DP; CANopen; Device Net; Ethernet; with optional internal board
SAFETY REQUIREMENTS			EN 61800-5-1, EN50178, EN60204-1, IEC 22G/109/NP
Marking			

5.1. CHOOSING THE PRODUCT

The inverter of the SINUS PENTA series are dimensioned based on allowable current and overload.

The SINUS PENTA series is characterized by 2 current values:

- Inom is the continuous current that can be delivered.
- Imax is the max. current that can be delivered in overload conditions for a time period of 120 sec every 20 min up to S30, and for a time period of 60 sec every 10 min from S40 to S70.

Each inverter model may be connected to different motor power sizes depending on load performance. Four types of torque/current overloads are available:

LIGHT	overload up to 120%; may be connected to light loads with constant/quadratic torque (pumps, fans, etc.);
STANDARD	overload up to 140%; may be connected to standard loads with constant torque (conveyors, mixers, extruders, etc.);
HEAVY	overload up to 175%; may be connected to heavy loads with constant torque (lifts, injection presses, mechanical presses, translation and lifting of cranes, bridge cranes, mills, etc.);
STRONG	overload up to 200%; may be applied to very heavy loads with constant torque (mandrels, axis control, etc.).

The table below indicates the overload class typically required for each application.
Dimensioning is not binding; the torque model required by the duty cycle of the connected machine should be known.

Application	OVERLOAD			
	LIGHT	STANDARD	HEAVY	STRONG
Atomizer, bottle washer, screw compressor (no-load), damped axial fan, undamped axial fan, centrifugal damped fan, undamped centrifugal fan, high-pressure fan, bore pumps, centrifugal pumps, positive displacement pumps, dust collector, grinder, etc.	*			
Slurry pump, ..	*	*		
Agitator, centrifuge, piston compressor (no-load), screw compressor (loaded), roller conveyor, cone crusher, rotary crusher, vertical impact crusher, debarker, edger, hydraulic power pack, mixer, rotary table, sanding machine, bandsaw, disk saw, separator, shredder, chopper, twister/spinner, industrial washer, palletizer, extruder, etc.		*		
Conveyor belt, drier, slicer, tumbler, mechanical press, forming machine, shears, winding/unwinding machine, drawplate, calender, screw injection moulding machine, etc.		*	*	
Piston compressor (loaded), conveyor screw, crusher jaw, mill, ball mill, hammer mill, roller mill, planer, pulper, vibrating screen, hoist and crane displacement, loom, etc.			*	
Mandrel, axis control, lifting application, hydraulic power pack injection press, etc.			*	*

The tables contained in the following pages state the power of the motors to be connected to SINUS PENTA inverters based on their overload classes.

IMPORTANT Data contained in the tables below relate to standard 4-pole motors.

MAKE SURE THAT:

- The rated current of the connected motor is lower than Inom (tolerance: +5%).
- If multiple motors are connected, the sum of their rated current values must not exceed Inom.
- The ratio between the inverter maximum current and the motor rated current is included in the overload class required.

EXAMPLE:

Application: bridge crane
Motor used: 37kW
Rated current: 68A
Rated voltage: 400V
Required overload: 160%

Heavy application

Inverter ratings:

Inom: at least 68A*0.95=65A
Imax: at least 68*1.6=102

According to the table, SINUS PENTA 0060 providing Inom=88A and Imax=112A is to be used for this type of application.

CAUTION

When multiple motors are connected, it can happen that the inverter does not detect whether a motor enters a stall condition or exceeds power ratings. In that case, motors can be seriously damaged and fire hazard exists.
Always provide a failure detection system for each motor, independent of the inverter, in order to lock all motors when failures occur.

5.1.1. LIGHT APPLICATION: OVERLOAD UP TO 120%

5.1.1.1. TECHNICAL SHEET FOR 2T AND 4T VOLTAGE CLASSES

Size	Sinus Penta Model	Applicable Motor Power												Inom	Imax	Ipeak (3 s.)
		200-240Vac			380-415Vac			440-460Vac			480-500Vac					
		kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A	A	A	A
S05	SINUS 0005	-	-	-	4.5	6	9.0	5.5	7.5	9.7	6.5	9	10.2	10.5	11.5	14
	SINUS 0007	3	4	11.2	5.5	7.5	11.2	7.5	10	12.5	7.5	10	11.8	12.5	13.5	16
	SINUS 0008	3.7	5	13.2	-	-	-	-	-	-	-	-	-	15	16	19.5
	SINUS 0009	-	-	-	7.5	10	14.5	9.2	12.5	16	9.2	12.5	14.3	16.5	17.5	21
	SINUS 0010	4	5.5	14.6	-	-	-	-	-	-	-	-	-	17	19	23
	SINUS 0011	-	-	-	7.5	10	14.8	9.2	12.5	16	11	15	16.5	16.5	21	25
	SINUS 0013	4.5	6	15.7	-	-	-	-	-	-	-	-	-	19	21	25
	SINUS 0014	-	-	-	7.5	10	14.8	9.2	12.5	16	11	15	16.5	16.5	25	30
	SINUS 0015	5.5	7.5	19.5	-	-	-	-	-	-	-	-	-	23	25	30
	SINUS 0016	7.5	10	25.7	-	-	-	-	-	-	-	-	-	27	30	36
	SINUS 0020	9.2	12.5	30	-	-	-	-	-	-	-	-	-	30	36	43
S10	SINUS 0016	7.5	10	26	11	15	21	15	20	25	15	20	23.2	26	30	36
	SINUS 0017	9.2	13	30	15	20	29	18.5	25	30	18.5	25	28	30	32	38
	SINUS 0020	9.2	13	30	15	20	29	18.5	25	30	18.5	25	28	30	36	43
	SINUS 0025	12.5	17	41	22	30	41	22	30	36	22	30	33	41	48	58
	SINUS 0030	12.5	17	41	22	30	41	22	30	36	25	35	37	41	56	67
	SINUS 0035	12.5	17	41	22	30	41	22	30	36	28	38	41	41	72	86
S12	SINUS 0016	-	-	-	11	15	21	15	20	25	15	20	23.2	27	30	36
	SINUS 0017	-	-	-	15	20	29	18.5	25	30	18.5	25	28	30	32	38
	SINUS 0020	-	-	-	15	20	29	18.5	25	30	18.5	25	28	30	36	43
	SINUS 0023	11	15	36	-	-	-	-	-	-	-	-	-	38	42	51
	SINUS 0025	-	-	-	22	30	41	22	30	36	22	30	33	41	48	58
	SINUS 0030	-	-	-	22	30	41	22	30	36	25	35	37	41	56	67
	SINUS 0033	16	20	50	-	-	-	-	-	-	-	-	-	51	56	68
	SINUS 0034	-	-	-	30	40	55	30	40	48	37	50	53	57	63	76
	SINUS 0036	-	-	-	30	40	55	37	50	58	37	50	53	60	72	86
	SINUS 0037	18.5	25	61	-	-	-	-	-	-	-	-	-	65	72	86
S15	SINUS 0038	18.5	25	61	30	40	55	37	40	58	45	60	64	65	75	90
	SINUS 0040	22	30	71	37	50	67	45	60	70	50	70	70	72	80	90
	SINUS 0049	25	35	80	45	60	80	50	65	75	55	75	78	80	96	115
S20	SINUS 0060	28	38	88	50	70	87	55	75	85	65	90	88	88	112	134
	SINUS 0067	30	40	96	55	75	98	65	90	100	75	100	103	103	118	142
	SINUS 0074	37	50	117	65	90	114	75	100	116	85	115	120	120	144	173
	SINUS 0086	45	60	135	75	100	133	90	125	135	90	125	127	135	155	186
S30	SINUS 0113	55	75	170	100	135	180	110	150	166	132	180	180	180	200	240
	SINUS 0129	65	90	195	110	150	191	125	170	192	140	190	195	195	215	258
	SINUS 0150	70	95	213	120	165	212	132	180	198	150	200	211	215	270	324
	SINUS 0162	75	100	231	132	180	228	150	200	230	175	238	240	240	290	348
S40	SINUS 0179	90	125	277	160	220	273	200	270	297	220	300	300	300	340	408
	SINUS 0200	110	150	332	200	270	341	220	300	326	250	340	337	345	365	438
	SINUS 0216	120	165	375	220	300	375	250	340	366	260	350	359	375	430	516
	SINUS 0250	132	180	390	230	315	390	260	350	390	280	380	390	390	480	576

(continued)

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S50 1)	SINUS	0312	160	220	475	280	380	480	315	430	459	355	480	471	480	600	720
	SINUS	0366	185	250	550	315	430	528	375	510	540	400	550	544	550	660	792
	SINUS	0399	200	270	593	375	510	621	400	550	591	450	610	612	630	720	864
S60 1)	SINUS	0457	250	340	732	400	550	680	450	610	665	500	680	673	720	880	1056
	SINUS	0524	260	350	780	450	610	765	500	680	731	560	760	751	800	960	1152
S65 1)	SINUS	0598	300	400	898	500	680	841	560	760	817	630	860	864	900	1100	1320
	SINUS	0748	330	450	985	560	760	939	630	860	939	710	970	960	1000	1300	1560
	SINUS	0831	400	550	1183	710	970	1200	800	1090	1160	900	1230	1184	1200	1440	1728
S75 1)	SINUS	0964	500	680	1463	900	1230	1480	1000	1360	1431	1100	1500	1480	1480	1780	2136
	SINUS	1130	560	770	1633	1000	1360	1646	1170	1600	1700	1270	1730	1700	1700	2040	2448
	SINUS	1296	630	860	1878	1170	1600	1950	1340	1830	1950	1460	1990	1650	1950	2340	2808
Penta's Supply Voltage			200-240Vac; 280-360Vdc.			380-500Vac; 530-705Vdc.											

The rated current of the applicable motor must not exceed 5% of Inom.
1)Input and output choke is required for these models.

5.1.1.2. Technical Sheet for 5T and 6T Voltage Classes

Size	Inverter Model	Applicable Motor Power						Inom	Imax	Ipeak (3sec)
		575Vac			660-690Vac					
		kW	HP	A	kW	HP	A	A	A	A
S65 1)	SINUS 0250	330	450	390	400	550	390	390	480	576
	SINUS 0312	400	550	473	500	680	480	480	600	720
	SINUS 0366	450	610	532	560	770	544	550	660	792
	SINUS 0399	560	770	630	630	860	626	630	720	864
	SINUS 0457	630	860	720	710	970	696	720	880	1056
	SINUS 0524	710	970	800	800	1090	773	800	960	1152
	SINUS 0598	800	1090	900	900	1230	858	900	1100	1320
	SINUS 0748	900	1230	1000	1000	1360	954	1000	1300	1560
S70 1)	SINUS 0831	1000	1360	1145	1240	1690	1200	1200	1440	1728
S75 1)	SINUS 0964	1270	1730	1480	1530	2090	1480	1480	1780	2136
S80 1)	SINUS 1130	1460	1990	1700	1750	2380	1700	1700	2040	2448
	SINUS 1296	1670	2280	1950	2010	2740	1950	1950	2340	2808
Inverter power supply		500-575Vac; 705-810Vdc			575-690Vac; 810-970Vdc					

The rated current of the applicable motor must not exceed 5% of Inom.
1)Input and output choke is required for these models.

Legend:
Inom = continuous rated current of the inverter
Imax = max. current produced by the inverter for 120 sec every 20 min up to S30, and for 60 sec every 10 min for S40 and greater
Ipeak = deliverable current for max. 3 sec

5.1.2. STANDARD APPLICATIONS: OVERLOAD UP TO 140%

5.1.2.1. TECHNICAL SHEET FOR 2T AND 4T VOLTAGE CLASSES

Size	Sinus Penta Model	Applicable Motor Power												Inom	Imax	Ipeak (3 s.)
		200-240Vac			380-415Vac			440-460Vac			480-500Vac					
		kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A			
S05	SINUS 0005	-	-	-	4	5.5	8.4	4.5	6	7.8	5.5	7.5	9.0	10.5	11.5	14
	SINUS 0007	2.2	3	8.5	4.5	6	9.0	5.5	7.5	9.7	6.5	9	10.2	12.5	13.5	16
	SINUS 0008	3	4	11.2	-	-	-	-	-	-	-	-	-	15	16	19.5
	SINUS 0009	-	-	-	5.5	7.5	11.2	7.5	10	12.5	7.5	10	11.8	16.5	17.5	21
	SINUS 0010	3.7	5	13.2	-	-	-	-	-	-	-	-	-	17	19	23
	SINUS 0011	-	-	-	7.5	10	14.8	9.2	12.5	15.6	9.2	12.5	14.3	16.5	21	25
	SINUS 0013	4	5.5	14.6	-	-	-	-	-	-	-	-	-	19	21	25
	SINUS 0014	-	-	-	7.5	10	14.8	9.2	12.5	15.6	11	15	16.5	16.5	25	30
	SINUS 0015	4.5	6	15.7	-	-	-	-	-	-	-	-	-	23	25	30
	SINUS 0016	5.5	7.5	19.5	-	-	-	-	-	-	-	-	-	27	30	36
	SINUS 0020	7.5	10	25.7	-	-	-	-	-	-	-	-	-	30	36	43
S10	SINUS 0016	5.5	7.5	19.5	9.2	12.5	17.9	11	15	18.3	15	20	23.2	26	30	36
	SINUS 0017	7.5	10	25.7	11	15	21	11	15	18.3	15	20	23.2	30	32	38
	SINUS 0020	9.2	13	30	15	20	29	15	20	25	18.5	25	28	30	36	43
	SINUS 0025	11	15	36	18.5	25	35	18.5	25	30	22	30	33	41	48	58
	SINUS 0030	12.5	17	41	22	30	41	22	30	36	25	35	37	41	56	67
	SINUS 0035	12.5	17	41	22	30	41	25	35	40	28	38	41	41	72	86
S12	SINUS 0016	-	-	-	9.2	12.5	17.9	11	15	18.3	15	20	23.2	27	30	36
	SINUS 0017	-	-	-	11	15	21	11	15	18.3	15	20	23.2	30	32	38
	SINUS 0020	-	-	-	15	20	29	15	20	25	18.5	25	28	30	36	43
	SINUS 0023	9.2	12.5	30	-	-	-	-	-	-	-	-	-	38	42	51
	SINUS 0025	-	-	-	18.5	25	35	18.5	25	30	22	30	33	41	48	58
	SINUS 0030	-	-	-	22	30	41	22	30	36	25	35	37	41	56	67
	SINUS 0033	11	15	36	-	-	-	-	-	-	-	-	-	51	56	68
	SINUS 0034	-	-	-	25	35	46	30	40	48	30	40	44	57	63	76
	SINUS 0036	-	-	-	30	40	55	30	40	48	37	50	53	60	72	86
	SINUS 0037	15	20	50	-	-	-	-	-	-	-	-	-	65	72	86
S15	SINUS 0038	15	20	50	25	35	46	30	40	48	37	50	53	65	75	90
	SINUS 0040	18.5	25	61	30	40	55	37	50	58	40	55	58	72	80	90
	SINUS 0049	22	30	71	37	50	67	45	60	70	45	60	64	80	96	115
S20	SINUS 0060	25	35	80	45	60	80	55	75	85	55	75	78	88	112	134
	SINUS 0067	30	40	96	55	75	98	60	80	91	65	90	88	103	118	142
	SINUS 0074	37	50	117	65	90	114	70	95	107	75	100	103	120	144	173
	SINUS 0086	40	55	127	75	100	133	75	100	116	85	115	120	135	155	186
S30	SINUS 0113	45	60	135	90	125	159	90	125	135	90	125	127	180	200	240
	SINUS 0129	55	75	170	100	135	180	110	150	166	110	150	153	195	215	258
	SINUS 0150	65	90	195	110	150	191	132	180	198	150	200	211	215	270	324
	SINUS 0162	75	100	231	132	180	228	150	200	230	160	220	218	240	290	348

(continued)

0 1 2 3 4 5 6 7 8

(continued)

S40	SINUS 0179	80	*110*	250	150	*200*	264	160	*220*	237	185	*250*	257	300	340	408
	SINUS 0200	90	*125*	277	160	*220*	273	185	*250*	279	200	*270*	273	345	365	438
	SINUS 0216	110	*150*	332	200	*270*	341	220	*300*	326	250	*340*	337	375	430	516
	SINUS 0250	132	*180*	390	220	*300*	375	260	*350*	390	260	*350*	359	390	480	576
S50 1)	SINUS 0312	150	*200*	458	250	*340*	421	315	*430*	459	330	*450*	453	480	600	720
	SINUS 0366	160	*220*	475	280	*380*	480	355	*480*	512	375	*510*	497	550	660	792
	SINUS 0399	185	*250*	550	315	*430*	528	375	*510*	540	400	*550*	544	630	720	864
S60 1)	SINUS 0457	220	*300*	661	400	*550*	680	450	*610*	665	500	*680*	673	720	880	1056
	SINUS 0524	260	*350*	780	450	*610*	765	500	*680*	731	560	*770*	751	800	960	1152
S65 1)	SINUS 0598	300	*400*	898	500	*680*	841	560	*760*	817	630	*860*	864	900	1100	1320
	SINUS 0748	330	*450*	985	560	*760*	939	630	*860*	939	710	*970*	960	1000	1300	1560
	SINUS 0831	400	*550*	1183	630	*860*	1080	800	*1090*	1160	800	*1090*	1067	1200	1440	1728
S75 1)	SINUS 0964	450	*610*	1330	800	*1090*	1334	900	*1230*	1287	1000	*1360*	1317	1480	1780	2136
	SINUS 1130	560	*770*	1633	900	*1230*	1480	1100	*1500*	1630	1170	*1600*	1570	1700	2040	2448
	SINUS 1296	630	860	1878	1100	1500	1874	1240	*1690*	1800	1340	*1830*	1800	1950	2340	2808
Penta's Supply Voltage		200-240Vac; 280-360Vdc.			380-500Vac; 530-705Vdc.											

The rated current of the applicable motor must not exceed 5% of Inom.
1)Input and output choke is required for these models.

5.1.2.2. TECHNICAL SHEET FOR 5T AND 6T VOLTAGE CLASSES

Size	Inverter Model	Applicable Motor Power						Inom	Imax	Ipeak (3 sec)
		575Vac			660-690Vac					
		kW	HP	A	kW	HP	A			
S65 1)	SINUS 0250	315	*430*	367	375	510	360	390	480	576
	SINUS 0312	375	*510*	432	450	610	443	480	600	720
	SINUS 0366	400	*550*	473	500	680	480	550	660	792
	SINUS 0399	450	*610*	532	560	770	544	630	720	864
	SINUS 0457	560	*770*	630	630	860	626	720	880	1056
	SINUS 0524	630	*860*	720	710	970	696	800	960	1152
	SINUS 0598	710	*970*	800	900	1230	858	900	1100	1320
	SINUS 0748	900	*1230*	1000	1000	1360	954	1000	1300	1560
S70 1)	SINUS 0831	1000	*1360*	1145	1100	1500	1086	1200	1440	1728
S75 1)	SINUS 0964	1180	*1610*	1369	1410	1920	1369	1480	1780	2136
S80 1)	SINUS 1130	1350	*1840*	1569	1620	2210	1569	1700	2040	2448
	SINUS 1296	1540	*2100*	1800	1850	2520	1800	1950	2340	2808
Penta's Supply Voltage		500-575Vac; 705-810Vdc			575-690Vac; 810-970Vdc					

The rated current of the applicable motor must not exceed 5% of Inom.
1)Input and output choke is required for these models.

Legend:
Inom = continuous rated current of the inverter
Imax = max. current produced by the inverter for 120 sec every 20 min up to S30, and for 60 sec every 10 min for S40 and greater
Ipeak = deliverable current for max. 3 sec

5.1.3. HEAVY APPLICATIONS: OVERLOAD UP TO 175%

5.1.3.1. TECHNICAL SHEET FOR 2T AND 4T VOLTAGE CLASSES

Size	Sinus Penta Model	Applicable Motor Power												Inom	Imax	Ipeak (3 s.)
		200-240Vac			380-415Vac			440-460Vac			480-500Vac					
		kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A			
S05	SINUS 0005	-	-	-	3	4	6.4	3.7	5	6.6	4.5	6	7.2	10.5	11.5	14
	SINUS 0007	1.8	2.5	7.3	4	5.5	8.4	4.5	6	7.8	5.5	7.5	9.0	12.5	13.5	16
	SINUS 0008	2.2	3	8.5	-	-	-	-	-	-	-	-	-	15	16	19.5
	SINUS 0009	-	-	-	4.5	6	9.0	5.5	7.5	9.7	7.5	10	11.8	16.5	17.5	21
	SINUS 0010	3	4	11.2	-	-	-	-	-	-	-	-	-	17	19	23
	SINUS 0011	-	-	-	5.5	7.5	11.2	7.5	10	12.5	9.2	12.5	14.3	16.5	21	25
	SINUS 0013	3.7	5	13.2	-	-	-	-	-	-	-	-	-	19	21	25
	SINUS 0014	-	-	-	7.5	10	14.8	9.2	12.5	15.6	11	15	16.5	16.5	25	30
	SINUS 0015	4	5.5	16.6	-	-	-	-	-	-	-	-	-	23	25	30
	SINUS 0016	4.5	6	15.7	-	-	-	-	-	-	-	-	-	27	30	36
	SINUS 0020	5.5	7.5	19.5	-	-	-	-	-	-	-	-	-	30	36	43
S10	SINUS 0016	5.5	7.5	19.5	9.2	12.5	17.9	11	15	18.3	12.5	17	18.9	26	30	36
	SINUS 0017	5.5	7.5	19.5	9.2	12.5	17.9	11	15	18.3	12.5	17	18.9	30	32	38
	SINUS 0020	7.5	10	25.7	11	15	21	15	20	25	15	20	23.2	30	36	43
	SINUS 0025	9.2	12.5	30	15	20	29	18.5	25	30	18.5	25	28	41	48	58
	SINUS 0030	11	15	36	18.5	25	35	22	30	36	22	30	33	41	56	67
	SINUS 0035	12.5	17	41	22	30	41	25	35	40	28	38	41	41	72	86
S12	SINUS 0016	-	-	-	9.2	12.5	17.9	11	15	18.3	12.5	17	18.9	27	30	36
	SINUS 0017	-	-	-	9.2	12.5	17.9	11	15	18.3	12.5	17	18.9	30	32	38
	SINUS 0020	-	-	-	11	15	21	15	20	25	15	20	23.2	30	36	43
	SINUS 0023	7.5	10	25.7	-	-	-	-	-	-	-	-	-	38	42	51
	SINUS 0025	-	-	-	15	20	29	18.5	25	30	18.5	25	28	41	48	58
	SINUS 0030	-	-	-	18.5	25	35	22	30	36	22	30	33	41	56	67
	SINUS 0033	11	15	36	-	-	-	-	-	-	-	-	-	51	56	68
	SINUS 0034	-	-	-	22	30	41	25	35	40	28	38	41	57	63	76
	SINUS 0036	-	-	-	25	35	46	30	40	48	30	40	44	60	72	86
	SINUS 0037	15	20	50	-	-	-	-	-	-	-	-	-	65	72	86
S15	SINUS 0038	15	20	50	25	35	46	30	40	48	30	40	44	65	75	90
	SINUS 0040	15	20	50	25	35	46	30	40	48	37	50	53	72	80	90
	SINUS 0049	18.5	25	61	30	40	55	37	50	58	45	60	64	80	96	115
S20	SINUS 0060	22	30	71	37	50	67	45	60	70	50	70	70	88	112	134
	SINUS 0067	25	35	80	45	60	80	50	70	75	55	75	78	103	118	142
	SINUS 0074	30	40	96	50	70	87	55	75	85	65	90	88	120	144	173
	SINUS 0086	32	45	103	55	75	98	65	90	100	75	100	103	135	155	186
S30	SINUS 0113	45	60	135	75	100	133	75	100	116	90	125	127	180	200	240
	SINUS 0129	50	70	150	80	110	144	90	125	135	110	150	153	195	215	258
	SINUS 0150	55	75	170	90	125	159	110	150	166	132	180	180	215	270	324
	SINUS 0162	65	90	195	110	150	191	132	180	198	140	190	191	240	290	348

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S40	SINUS 0179	75	*100*	231	120	165	212	150	200	230	160	220	218	300	340	408
	SINUS 0200	80	*110*	250	132	180	228	160	220	237	185	250	257	345	365	438
	SINUS 0216	90	*125*	277	160	220	273	185	250	279	200	270	273	375	430	516
	SINUS 0250	110	*150*	332	185	250	321	220	300	326	220	300	300	390	480	576
S50 1)	SINUS 0312	132	*180*	390	220	300	375	260	350	390	300	400	413	480	600	720
	SINUS 0366	150	*200*	458	250	340	421	300	400	449	330	450	453	550	660	792
	SINUS 0399	160	*220*	475	280	380	480	330	450	493	355	480	471	630	720	864
S60 1)	SINUS 0457	200	*270*	593	315	430	528	375	510	540	450	610	612	720	880	1056
	SINUS 0524	220	*300*	661	355	480	589	450	610	665	500	680	673	800	960	1152
S65 1)	SINUS 0598	250	*340*	732	400	550	680	500	680	731	560	760	751	900	1100	1320
	SINUS 0748	280	*380*	840	500	680	841	560	760	817	630	860	864	1000	1300	1560
	SINUS 0831	330	*450*	985	560	760	939	630	860	939	710	970	960	1200	1440	1728
S75 1)	SINUS 0964	400	*550*	1183	710	970	1200	800	1090	1160	900	1230	1184	1480	1780	2136
	SINUS 1130	450	*620*	1330	800	1090	1334	900	1230	1287	1000	1360	1317	1700	2040	2448
	SINUS 1296	560	*770*	1633	900	1230	1480	1100	1500	1630	1170	1600	1560	1950	2340	2808
Penta's Supply Voltage		200-240Vac; 280-360Vdc			380-500Vac; 530-705Vdc											

The rated current of the applicable motor must not exceed 5% of Inom.
1)Input and output choke is required for these models.

5.1.3.2. TECHNICAL SHEET FOR 5T AND 6T VOLTAGE CLASSES

Size	Inverter Model	Applicable Motor Power						Inom.	Imax	Ipeak (3 sec)
		575Vac			660-690Vac					
		kW	HP	A	kW	HP	A			
S65 1)	SINUS 0250	280	*380*	334	330	*450*	328	390	480	576
	SINUS 0312	355	*480*	410	400	*550*	390	480	600	720
	SINUS 0366	375	*510*	432	450	*610*	443	550	660	792
	SINUS 0399	400	*550*	473	500	*680*	480	630	720	864
	SINUS 0457	500	*680*	585	560	*770*	544	720	880	1056
	SINUS 0524	560	*770*	630	630	*860*	626	800	960	1152
	SINUS 0598	630	*860*	720	710	*970*	696	900	1100	1320
	SINUS 0748	710	*970*	800	900	*1230*	858	1000	1300	1560
S70 1)	SINUS 0831	800	*1090*	900	1000	*1360*	954	1200	1440	1728
S75 1)	SINUS 0964	1000	*1360*	1145	1220	*1660*	1187	1480	1780	2136
S80 1)	SINUS 1130	1170	*1600*	1360	1400	*1910*	1360	1700	2040	2448
	SINUS 1296	1340	*1830*	1560	1610	*2190*	1560	1950	2340	2808
Inverter power supply		500-575Vac; 705-810Vdc			575-690Vac; 810-970Vdc					

The rated current of the applicable motor must not exceed 5% of Inom.
1)Input and output choke is required for these models.

Legend:
Inom = continuous rated current of the inverter
Imax = max. current produced by the inverter for 120 sec every 20 min up to S30, and for 60 sec every 10 min for S40 and greater
Ipeak = deliverable current for max. 3 sec

5.1.4. STRONG Applications: Overload up to 200%

5.1.4.1. Technical Sheet for 2T and 4T voltage Classes

Size	Sinus Penta Model	Applicable Motor Power												Inom	Imax	Ipeak (3s)
		200-240Vac			380-415Vac			440-460Vac			480-500Vac					
		kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A			
S05	SINUS 0005	-	-	-	2.2	3	4.9	3	4	5.6	3.7	5	6.1	10.5	11.5	14
	SINUS 0007	1.5	2	6.1	3	4	6.4	3.7	5	6.6	4.5	6	7.2	12.5	13.5	16
	SINUS 0008	1.8	2.5	7.3	-	-	-	-	-	-	-	-	-	15	16	19.5
	SINUS 0009	-	-	-	4	5.5	8.4	4.5	6	7.8	5.5	7.5	9.0	16.5	17.5	21
	SINUS 0010	2.2	3	8.5	-	-	-	-	-	-	-	-	-	17	19	23
	SINUS 0011	-	-	-	4.5	6	9.0	5.5	7.5	9.7	7.5	10	11.8	16.5	21	25
	SINUS 0013	3	4	11.2	-	-	-	-	-	-	-	-	-	19	21	25
	SINUS 0014	-	-	-	5.5	7.5	11.2	7.5	10	12.5	9.2	12.5	14.3	16.5	25	30
	SINUS 0015	3.7	5	13.2	-	-	-	-	-	-	-	-	-	23	25	30
	SINUS 0016	4	5.5	14.6	-	-	-	-	-	-	-	-	-	27	30	36
	SINUS 0020	4.5	6	15.7	-	-	-	-	-	-	-	-	-	30	36	43
S10	SINUS 0016	4	5.5	14.6	7.5	10	14.8	9.2	12.5	15.6	11	15	16.5	26	30	36
	SINUS 0017	4.5	6	15.7	7.5	10	14.8	9.2	12.5	15.6	12.5	17	18.9	30	32	38
	SINUS 0020	5.5	7.5	19.5	9.2	12.5	17.9	11	15	18.3	12.5	17	18.9	30	36	43
	SINUS 0025	7.5	10	25.7	11	15	21	15	20	25	15	20	23.2	41	48	58
	SINUS 0030	9.2	12.5	30	15	20	29	18.5	25	30	18.5	25	28	41	56	67
	SINUS 0035	11	15	36	18.5	25	35	22	30	36	22	30	33	41	72	86
S12	SINUS 0016	-	-	-	7.5	10	14.8	9.2	12.5	15.6	11	15	16.5	27	30	36
	SINUS 0017	-	-	--	7.5	10	14.8	9.2	12.5	15.6	12.5	17	18.9	30	32	38
	SINUS 0020	-	-	-	9.2	12.5	17.9	11	15	18.3	12.5	17	18.9	30	36	43
	SINUS 0023	5.5	7.5	19.5	-	-	-	-	-	-	-	-	-	38	42	51
	SINUS 0025	-	-	-	11	15	21	15	20	25	15	20	23.2	41	48	58
	SINUS 0030	-	-	-	15	20	29	18.5	25	30	18.5	25	28	41	56	67
	SINUS 0033	7.5	10	25.7	-	-	-	-	-	-	-	-	-	51	56	68
	SINUS 0034	-	-	-	18.5	25	35	22	30	36	22	30	33	57	63	76
	SINUS 0036	-	-	-	22	30	41	25	35	40	28	38	41	60	72	86
	SINUS 0037	11	15	36	-	-	-	-	-	-	-	-	-	65	72	86
S15	SINUS 0038	12.5	17	41	22	30	41	25	35	40	28	38	41	65	75	90
	SINUS 0040	12.5	17	41	22	30	41	25	35	40	30	40	44	72	80	90
	SINUS 0049	15	20	50	25	35	46	30	40	48	37	50	53	80	96	115
S20	SINUS 0060	18.5	25	61	30	40	55	37	50	58	45	60	64	88	112	134
	SINUS 0067	20	27	66	32	45	59	40	55	63	50	70	70	103	118	142
	SINUS 0074	22	30	71	37	50	67	45	60	70	55	75	78	120	144	173
	SINUS 0086	25	35	80	45	60	80	55	75	85	65	90	88	135	155	186
S30	SINUS 0113	30	40	96	55	75	98	65	88	100	75	100	103	180	200	240
	SINUS 0129	37	50	117	65	90	114	75	100	116	85	115	120	195	215	258
	SINUS 0150	45	60	135	75	100	133	90	125	135	90	125	127	215	270	324
	SINUS 0162	55	75	170	90	125	159	110	150	166	110	150	153	240	290	348

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S40	SINUS 0179	60	85	185	100	135	180	120	165	184	132	180	180	300	340	408
	SINUS 0200	65	90	195	110	150	191	132	180	198	150	200	211	345	365	438
	SINUS 0216	75	100	231	120	165	212	150	200	230	160	220	218	375	430	516
	SINUS 0250	90	125	277	132	180	228	185	250	279	200	270	273	390	480	576
S50 1)	SINUS 0312	110	150	332	185	250	321	220	300	326	250	340	337	480	600	720
	SINUS 0366	120	165	375	200	270	341	250	340	366	260	350	359	550	660	792
	SINUS 0399	132	180	390	220	300	375	260	350	390	300	400	413	630	720	864
S60 1)	SINUS 0457	160	220	475	280	380	480	330	450	493	375	510	497	720	880	1056
	SINUS 0524	185	250	550	315	430	528	375	510	540	400	550	544	800	960	1152
S65 1)	SINUS 0598	200	270	593	355	480	589	400	550	591	450	610	612	900	1100	1320
	SINUS 0748	250	340	732	400	550	680	500	680	731	560	760	751	1000	1300	1560
	SINUS 0831	280	380	840	450	610	765	560	760	817	630	860	864	1200	1440	1728
S75 1)	SINUS 0964	355	480	1024	560	770	939	710	970	1043	800	1090	1067	1480	1780	2136
	SINUS 1130	400	550	1183	710	970	1200	800	1090	1160	900	1230	1184	1700	2040	2448
	SINUS 1296	450	610	1330	800	1090	1334	900	1230	1287	1000	1360	1317	1950	2340	2808
Penta's Supply Voltage		200-240Vac; 280-360Vdc.			380-500Vac; 530-705Vdc.											

The rated current of the applicable motor must not exceed 5% of Inom.
1)Input and output choke is required for these models.

5.1.4.2. TECHNICAL SHEET FOR 5T AND 6T VOLTAGE CLASSES

Size	Inverter Model	Applicable Motor Power						Inom	Imax	Ipeak (3 sec)
		575Vac			660-690Vac					
		kW	HP	A	kW	HP	A			
S65 1)	SINUS 0250	220	*300*	261	280	*380*	278	390	480	576
	SINUS 0312	280	*380*	334	355	*480*	341	480	600	720
	SINUS 0366	315	*430*	367	375	*510*	360	550	660	792
	SINUS 0399	355	*480*	410	400	*550*	390	630	720	864
	SINUS 0457	400	*550*	473	500	*680*	480	720	880	1056
	SINUS 0524	450	*610*	532	560	*770*	544	800	960	1152
	SINUS 0598	560	*770*	630	630	*860*	626	900	1100	1320
	SINUS 0748	630	*860*	720	800	*1090*	773	1000	1300	1560
S70 1)	SINUS 0831	710	*970*	800	900	*1230*	858	1200	1440	1728
S75 1)	SINUS 0964	900	*1230*	1000	1000	*1360*	954	1480	1780	2136
S80 1)	SINUS 1130	1000	*1360*	1145	1100	*1500*	1086	1700	2040	2448
	SINUS 1296	1150	*1570*	1337	1380	*1880*	1337	1950	2340	2808
Inverter power supply		500-575Vac; 705-810Vdc			575-690Vac; 810-970Vdc					

The rated current of the applicable motor must not exceed 5% of Inom.
1)Input and output choke is required for these models.

Legend:
Inom = continuous rated current of the inverter
Imax = max. current produced by the inverter for 120 sec every 20 min up to S30, and for 60 sec every 10 min for S40 and greater
Ipeak = deliverable current for max. 3 sec

5.2. CARRIER FREQUENCY SETTING

The continuous current generated by the inverter in continuous operation type S1 at 40°C depends on carrier frequency. The higher the carrier frequency, the more silent is the motor; the control performance is enhanced, but this causes a greater heating of the inverter, thus affecting energy saving.
Do not exceed the carrier values stated in the table below and set through parameters C001 and C002 in the Carrier Frequency submenu. If those carrier values are exceeded, alarm A094 (Heatsink Overheated) will trip. Depending on the inverter model, peak current values represent transient maximum allowable current before overcurrent protections trip.
Based on the inverter model, peak current values represent the maximum current allowed in transient operation before overcurrent protections trip.

Size	SINUS PENTA Model	Recommended Maximum Allowable Carrier Frequency (Parameters C001 and C002) 2T and 4T Classes					Peak Currents	
		LIGHT	STANDARD	HEAVY	STRONG	Max. Carrier	for 3s	Instant
		(kHz)	(kHz)	(kHz)	(kHz)	(kHz)	(A_{RMS})	(A_{peak})
S05	0005	8	10	16	16	16	14	28
	0007	8	10	16	16	16	16	33
	0008	8	10	16	16	16	19.5	
	0009	8	10	16	16	16	21	47
	0010	8	10	16	16	16	23	
	0011	8	10	16	16	16	25	56
	0013	8	10	16	16	16	25	
	0014	8	10	12.8	16	16	30	67
	0015	8	10	16	16	16	30	
	0016	8	10	16	16	16	36	
	0020	8	10	16	16	16	43	87
S10	0016	3	5	12.8	16	16	36	72
	0017	3	5	12.8	16	16	38	77
	0020	3	5	12.8	16	16	43	87
	0025	3	5	12.8	16	16	58	114
	0030	3	5	10	12.8	16	67	133
	0035	3	5	5	12.8	16	86	167
S12	0016	3	5	12.8	16	16	36	72
	0017	3	5	12.8	16	16	38	77
	0020	3	5	12.8	16	16	43	87
	0023	3	5	10	12.8	16	51	100
	0025	3	5	12.8	16	16	58	114
	0030	3	5	10	12.8	16	67	133
	0033	3	5	8	10	16	68	137
	0034	3	5	8	10	16	76	153
	0036	3	5	6	8	16	86	173
	0037	3	5	6	8	16	86	173
S15	0038	3	5	12.8	16	16	90	170
	0040	3	5	12.8	16	16	90	173
	0049	3	5	12.8	12.8	12.8	115	228

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S20	0060	3	5	12.8	12.8	12.8	134	266
	0067	3	5	12.8	12.8	12.8	142	280
	0074	3	5	12.8	12.8	12.8	173	347
	0086	3	5	10	12.8	12.8	186	373
S30	0113	3	5	10	10	10	240	484
	0129	3	5	10	10	10	258	520
	0150	3	4	5	5	5	324	596
	0162	3	4	5	5	5	348	640
S40	0179	3	4	4	4	4	408	807
	0200	3	4	4	4	4	438	867
	0216	2	3	4	4	4	516	1033
	0250	2	3	4	4	4	576	1153
S50	0312	2	3	4	4	4	720	1444
	0366	2	3	4	4	4	792	1589
	0399	2	3	4	4	4	864	1733
S60	0457	2	2	3	4	4	1056	2078
	0524	2	2	3	4	4	1152	2333
S65	0598	2	2	3	4	4	1320	2597
	0748	2	2	3	4	4	1560	3069
	0831	2	2	3	4	4	1728	3400
S75	0964	2	2	3	4	4	2136	4192
	1130	2	2	3	4	4	2448	4815
	1296	2	2	3	4	4	2808	5525

Size	SINUS PENTA Model	Recommended Maximum Allowable Carrier Frequency (parameters C001 and C002) 5T and 6T Classes					Peak Currents	
		LIGHT	STANDARD	HEAVY	STRONG	Max. Carrier	for 3sec	Instant
		(kHz)	(kHz)	(kHz)	(kHz)	(kHz)	(A_{RMS})	(A_{peak})
S65	0250	2	3	4	4	4	576	1153
	0312	2	3	4	4	4	720	1444
	0366	2	3	4	4	4	792	1589
	0399	2	3	4	4	4	864	1733
	0457	2	2	3	4	4	1056	2078
	0524	2	2	3	4	4	1152	2333
	0598	2	2	3	4	4	1320	2597
	0748	2	2	3	4	4	1560	3069
S70	0831	2	2	3	4	4	1728	3400
S75	0964	2	2	3	4	4	2136	4192
S80	1130	2	2	3	4	4	2448	4815
	1296	2	2	3	4	4	2808	5525

5.3. OPERATING TEMPERATURES BASED ON APPLICATION CLASSES

The operating temperature of the inverters of the SINUS PENTA series is maximum 40 °C at rated current and can reach max. 50 °C if the operating current is reduced. The operating temperature of some SINUS PENTA models can even exceed 40 °C at rated current. The maximum operating temperatures based on the inverter size and application class are detailed in the tables below.

NOTE The tables below relate to operating current values equal to or lower than the current rating stated in the relevant application sheet.

Size	SINUS PENTA Model	APPLICATION - 2T-4T CLASSES			
		LIGHT	STANDARD	HEAVY	STRONG
		Maximum allowable operating temperature (°C)			
S05	0005	50	50	50	50
	0007	50	50	50	50
	0009	40	45	50	50
	0011	40	40	45	50
	0014	40	40	40	50
	0015	50	50	50	50
	0016	45	50	50	50
	0020	40	45	50	50
S10	0016	45	45	50	50
	0017	40	45	50	50
	0020	40	40	50	50
	0025	40	40	50	50
	0030	40	40	45	50
	0035	40	40	40	50
S12	0016	45	45	50	50
	0017	40	45	50	50
	0020	40	40	50	50
	0023	50	50	50	50
	0025	40	40	50	50
	0030	40	40	45	50
	0033	45	50	50	50
	0034	40	45	50	50
	0036	40	40	45	50
	0037	45	40	45	50
S15	0038	45	45	50	50
	0040	40	45	50	50
	0049	40	40	50	50
S20	0060	45	45	50	50
	0067	40	40	50	50
	0074	45	45	50	50
	0086	40	40	50	50
S30	0113	45	45	50	50
	0129	40	45	50	50
	0150	45	45	50	50
	0162	40	40	50	50
S40	0179	45	50	50	50
	0200	40	45	50	50
	0216	40	45	50	50
	0250	40	40	50	50

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S50	0312	50	50	50	50
	0366	45	45	50	50
	0399	40	40	50	50
S60	0457	45	45	50	50
	0524	40	40	50	50
S65	0598	50	50	50	50
	0748	45	45	50	50
	0831	40	40	50	50
S75	0964	50	50	50	50
	1130	45	45	50	50
	1296	40	40	50	50

Size	SINUS PENTA Model	APPLICATION - 5T-6T CLASSES			
		LIGHT	STANDARD	HEAVY	STRONG
		Maximum allowable operating temperature (°C)			
S65	0250	50	50	50	50
S65	0312	50	50	50	50
S65	0366	50	50	50	50
S65	0399	50	50	50	50
S65	0457	50	50	50	50
S65	0524	50	50	50	50
S65	0598	50	50	50	50
S65	0748	45	45	50	50
S70	0831	40	40	50	50
S75	0964	50	50	50	50
S80	1130	45	45	50	50
S80	1296	40	40	50	50

6. ACCESSORIES

6.1. BRAKING RESISTORS

6.1.1. APPLICATION TABLES

From size S05 to size S30, SINUS PENTA inverters are supplied with a built-in braking module. The braking resistor is to be connected outside the inverter to terminal B and terminal + (see Section Lay-out of the Power Terminals); properly set the parameters relating to the inverter braking (see the Programming Instruction Manual). An external braking unit is used for higher sizes. When choosing the braking resistor, consider the inverter supply voltage (voltage class), the braking resistor Ohm value and rated power. The voltage class and the Ohm value determine the instant power dissipated in the braking resistor and are relating to the motor power; the rated power determines the mean power to be dissipated in the braking resistor and is relating to the duty cycle of the equipment, i.e. to the resistor activation time with respect to the duty cycle full time (the duty cycle of the resistor is equal to the motor braking time divided by the equipment duty cycle).

It is not possible to connect resistors with a Ohm value lower than the min. value acknowledged by the inverter.

The following pages contain application tables stating the resistors to be used depending on the inverter size, the application requirements and the supply voltage. The braking resistor power is stated as an approximate value; a correct dimensioning of the braking resistor is based on the equipment duty cycle and the power regenerated during the braking stage.

For more details on the connection and features of the external braking module, refer to the braking module instruction manual.

0 1 2 3 4 5 6 7 8

6.1.1.1. BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF 10% AND 380 - 500 VAC SUPPLY VOLTAGE

Size	SINUS PENTA Model 4T Class	Braking unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 10% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S05	0005	internal	50	75Ω-550W	IP33	RE3063750
	0007	internal	50	75Ω-550W	IP33	RE3063750
	0009	internal	50	50Ω-1100W	IP55	RE3083500
	0011	internal	50	50Ω-1100W	IP55	RE3083500
	0014	internal	50	50Ω-1100W	IP55	RE3083500
S10	0016	internal	50	50Ω-1500W	IP54	RE3093500
	0017	internal	50	50Ω-1500W	IP54	RE3093500
	0020	internal	50	50Ω-1500W	IP54	RE3093500
	0025	internal	20	25Ω-1800W	IP54	RE3103250
	0030	internal	20	25Ω-1800W	IP54	RE3103250
	0035	internal	20	25Ω-1800W	IP54	RE3103250
S12	0016	internal	40	50Ω-1500W	IP54	RE3093500
	0017	internal	40	50Ω-1500W	IP54	RE3093500
	0020	internal	40	50Ω-1500W	IP54	RE3093500
	0025	internal	20	25Ω-1800W	IP54	RE3103250
	0030	internal	20	25Ω-1800W	IP54	RE3103250
	0034	internal	20	20Ω-4000W	IP20	RE3483200
	0036	internal	20	20Ω-4000W	IP20	RE3483200
S15	0038	internal	15	15Ω-4000W	IP20	RE3483150
	0040	internal	15	15Ω-4000W	IP20	RE3483150
	0049	internal	10	15Ω-4000W	IP20	RE3483150
S20	0060	internal	10	10Ω-8000W	IP20	RE3763100
	0067	internal	10	10Ω-8000W	IP20	RE3763100
	0074	internal	8.5	10Ω-8000W	IP20	RE3763100
	0086	internal	8.5	10Ω-8000W	IP20	RE3763100
S30	0113	internal	6	6.6Ω-12000W	IP20	RE4022660
	0129	internal	6	6.6Ω-12000W	IP20	RE4022660
	0150	internal	5	6.6Ω-12000W	IP20	RE4022660
	0162	internal	5	6.6Ω-12000W	IP20	RE4022660
S40	0179	2*BU200	5	2*10Ω-8000W (*)	IP20	2*RE3763100
	0200	2*BU200	5	2*6.6Ω-12000W (*)	IP20	2*RE4022660
	0216	2*BU200	5	2*6.6Ω-12000W (*)	IP20	2*RE4022660
	0250	2*BU200	5	2*6.6Ω-12000W (*)	IP20	2*RE4022660
S50	0312	3*BU200	5	3*6.6Ω-12000W (*)	IP20	3*RE4022660
	0366	3*BU200	5	3*6.6Ω-12000W (*)	IP20	3*RE4022660
	0399	3*BU200	5	3*6.6Ω-12000W (*)	IP20	3*RE4022660
S60	0457	3*BU200	5	3*6.6Ω-12000W (*)	IP20	3*RE4022660
	0524	4*BU200	5	4*6.6Ω-12000W (*)	IP20	4*RE4022660

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S65	0598	BU1440 2T-4T	0.48	1.2Ohm/64000W(*)	IP23	RE4562120
	0748	BU1440 2T-4T	0.48	1.2Ohm/64000W(*)	IP23	RE4562120
	0831	BU1440 2T-4T	0.48	2*1.6Ohm/48000W(*)	IP23	2*RE4462160
S75	0964	BU1440 2T-4T	0.48	2*1.6Ohm/48000W(*)	IP23	2*RE4462160
	1130	BU1440 2T-4T	0.48	2*1.2Ohm/48000W(*)	IP23	2*RE4462120
	1296	BU1440 2T-4T	0.48	2*1.2Ohm/64000W(*)	IP23	2*RE4562120

(*) : For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

DANGER Braking resistors may reach temperatures higher than 200°C.

CAUTION Braking resistors may dissipate approx. 10% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.1.2. Braking Resistors for Applications with a Braking DUTY CYCLE of 20% and 380 - 500 Vac Supply Voltage

Size	SINUS PENTA Model 4T Class	Braking unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 20% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S05	0005	internal	50	50Ω-1100W	IP55	RE3083500
	0007	internal	50	50Ω-1100W	IP55	RE3083500
	0009	internal	50	50Ω-1100W	IP55	RE3083500
	0011	internal	50	50Ω-1500W	IP54	RE3093500
	0014	internal	50	50Ω-1500W	IP54	RE3093500
S10	0016	internal	50	50Ω-2200W	IP54	RE3113500
	0017	internal	50	50Ω-2200W	IP54	RE3113500
	0020	internal	50	50Ω-4000W	IP20	RE3483500
	0025	internal	20	25Ω-4000W	IP20	RE3483250
	0030	internal	20	25Ω-4000W	IP20	RE3483250
	0035	internal	20	25Ω-4000W	IP20	RE3483250
S12	0016	internal	40	50Ω-2200W	IP54	RE3113500
	0017	internal	40	50Ω-2200W	IP54	RE3113500
	0020	internal	40	50Ω-4000W	IP20	RE3483500
	0025	internal	20	25Ω-4000W	IP20	RE3483250
	0030	internal	20	25Ω-4000W	IP20	RE3483250
	0034	internal	20	20Ω-4000W	IP20	RE3483200
	0036	internal	20	20Ω-4000W	IP20	RE3483200
S15	0038	internal	15	15Ω-4000W	IP20	RE3483150
	0040	internal	15	15Ω-4000W	IP20	RE3483150
	0049	internal	10	10Ω-8000W	IP20	RE3763100
S20	0060	internal	10	10Ω-8000W	IP20	RE3763100
	0067	internal	10	10Ω-12000W	IP20	RE4023100
	0074	internal	8.5	10Ω-12000W	IP20	RE4023100
	0086	internal	8.5	10Ω-12000W	IP20	RE4023100
S30	0113	internal	6	2*3.3Ω-8000W (*)	IP20	2*RE3762330
	0129	internal	6	2*3.3Ω-8000W (*)	IP20	2*RE3762330
	0150	internal	5	2*10Ω-12000W (**)	IP20	2*RE4023100
	0162	internal	5	2*10Ω-12000W (**)	IP20	2*RE4023100
S40	0179	2* BU200	6.6	2*6.6Ω-12000W (***)	IP20	2*RE4022660
	0200	2* BU200	6.6	2*6.6Ω-12000W (***)	IP20	2*RE4022660
	0216	3* BU200	6.6	3*6.6Ω-12000W (***)	IP20	3*RE4022660
	0250	3* BU200	6.6	3*6.6Ω-12000W (***)	IP20	3*RE4022660
S50	0312	4* BU200	6.6	4*6.6Ω-12000W (***)	IP20	4*RE4022660
	0366	4* BU200	6.6	4*6.6Ω-12000W (***)	IP20	4*RE4022660
	0399	4* BU200	6.6	4*6.6Ω-12000W (***)	IP20	4*RE4022660
S60	0457	5*BU200	6.6	5*10Ω-12000W (***)	IP20	5*RE4023100
	0524	5*BU200	6.6	5*10Ω-12000W (***)	IP20	5*RE4023100

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S65	0598	BU1440 2T-4T	0.48	2*2.4Ω-64000W (***)	IP23	2*RE4562240
	0748	BU1440 2T-4T	0.48	2*2.4Ω-64000W (***)	IP23	2*RE4562240
	0831	BU1440 2T-4T	0.48	2*1.6Ω-64000W (***)	IP23	2*RE4562160
S75	0964	BU1440 2T-4T	0.48	3*2.4Ω-64000W (***)	IP23	3*RE4562240
	1130	BU1440 2T-4T	0.48	4*2.4Ω-48000W (***)	IP23	4*RE4462240
	1296	BU1440 2T-4T	0.48	4*2.4Ω-64000W (***)	IP23	4*RE4562240

(note *): Two series-connected resistors, 3.3 Ohm/8000 W
(note **): 2 parallel-connected resistors, 10 Ohm/12000 W
(note *)**: For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

DANGER — Braking resistors may reach temperatures higher than 200°C.

CAUTION — Braking resistors may dissipate approx. 20% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION — Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.1.3. Braking Resistors for Applications with a Braking DUTY CYCLE of 50% and 380 - 500 Vac Supply Voltage

Size	SINUS PENTA Model 4T Class	Braking unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 50% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S05	0005	internal	50	50Ω-4000W	IP23	RE3503500
	0007	internal	50	50Ω-4000W	IP23	RE3503500
	0009	internal	50	50Ω-4000W	IP23	RE3503500
	0011	internal	50	50Ω-4000W	IP23	RE3503500
	0014	internal	50	50Ω-4000W	IP23	RE3503500
S10	0016	internal	50	50Ω-8000W	IP23	RE3783500
	0017	internal	50	50Ω-8000W	IP23	RE3783500
	0020	internal	50	50Ω-8000W	IP23	RE3783500
	0025	internal	20	20Ω-12000W	IP23	RE4053200
	0030	internal	20	20Ω-12000W	IP23	RE4053200
	0035	internal	20	20Ω-12000W	IP23	RE4053200
S12	0016	internal	40	50Ω-8000W	IP23	RE3783500
	0017	internal	40	50Ω-8000W	IP23	RE3783500
	0020	internal	40	50Ω-8000W	IP23	RE3783500
	0025	internal	20	20Ω-12000W	IP23	RE4053200
	0030	internal	20	20Ω-12000W	IP23	RE4053200
	0034	internal	20	20Ω-12000W	IP23	RE4053200
	0036	internal	20	20Ω-12000W	IP23	RE4053200
S15	0038	internal	15	15Ω-16000W	IP23	RE4163150
	0040	internal	15	15Ω-16000W	IP23	RE4163150
	0049	internal	10	15Ω-16000W	IP23	RE4163150
S20	0060	internal	10	10Ω-24000W	IP23	RE4293100
	0067	internal	10	10Ω-24000W	IP23	RE4293100
	0074	internal	8.5	10Ω-24000W	IP23	RE4293100
	0086	internal	8.5	10Ω-24000W	IP23	RE4293100
S30	0113	internal	6	6Ω-48000W	IP23	RE4462600
	0129	internal	6	6Ω-48000W	IP23	RE4462600
	0150	internal	5	5Ω-64000W	IP23	RE4552500
	0162	internal	5	5Ω-64000W	IP23	RE4552500
S40	0179	3 * BU200	10	3*10Ω-24000W (*)	IP23	3*RE4293100
	0200	3 * BU200	10	3*10Ω-24000W (*)	IP23	3*RE4293100
	0216	3 * BU200	10	3*10Ω-24000W (*)	IP23	3*RE4293100
	0250	4 * BU200	10	4*10Ω-24000W (*)	IP23	4*RE4293100
S50	0312	4 * BU200	10	4*10Ω-24000W (*)	IP23	4*RE4293100
	0366	6 * BU200	10	6*10Ω-24000W (*)	IP23	6*RE4293100
	0399	6 * BU200	10	6*10Ω-24000W (*)	IP23	6*RE4293100
S60	0457	8 * BU200	10	8*10Ω-24000W (*)	IP23	8*RE4293100
	0524	10 * BU200	10	10*10Ω-24000W (*)	IP23	10*RE4293100

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S65	0598	BU1440 2T-4T	0.48	4*1.2Ω-64000W (*)	IP23	4*RE4562120
	0748	BU1440 2T-4T	0.48	4*1.2Ω-64000W (*)	IP23	4*RE4562120
	0831	BU1440 2T-4T	0.48	4*0.8Ω-64000W (*)	IP23	4*RE4561800
S75	0964	BU1440 2T-4T	0.48	8*1.6Ω-48000W (*)	IP23	8*RE4462160
	1130	BU1440 2T-4T	0.48	8*1.2Ω-48000W (*)	IP23	8*RE4462120
	1296	BU1440 2T-4T	0.48	8*1.2Ω-64000W (*)	IP23	8*RE4562120

(*): For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

DANGER Braking resistors may reach temperatures higher than 200°C.

CAUTION Braking resistors may dissipate approx. 50% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.1.4. BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF 10% AND 200 - 240 VAC SUPPLY VOLTAGE

Size	SINUS PENTA Model 2T Class	Braking Unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 10% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S05	0007	internal	25.0	56Ω-350W	IP55	RE2643560
	0008	internal	25.0	2*56Ω-350W (*)	IP55	2*RE2643560
	0010	internal	25.0	2*56Ω-350W (*)	IP55	2*RE2643560
	0013	internal	20.0	2*56Ω-350W (*)	IP55	2*RE2643560
	0015	internal	20.0	2*56Ω-350W (*)	IP55	2*RE2643560
	0016	internal	20.0	2*56Ω-350W (*)	IP55	2*RE2643560
	0020	internal	20.0	2*56Ω-350W (*)	IP55	2*RE2643560
S10	0016	internal	25.0	2*56Ω-350W (*)	IP55	2*RE2643560
	0017	internal	25.0	2*56Ω-350W (*)	IP55	2*RE2643560
	0020	internal	25.0	2*56Ω-350W (*)	IP55	2*RE2643560
	0025	internal	10.0	15Ω-1100W	IP55	RE3083150
	0030	internal	10.0	15Ω-1100W	IP55	RE3083150
	0035	internal	10.0	15Ω-1100W	IP55	RE3083150
S12	0023	internal	15.0	15Ω-1100W	IP55	RE3083150
	0033	internal	10.0	10Ω-1500W	IP55	RE3093100
	0037	internal	10.0	10Ω-1500W	IP55	RE3093100
S15	0038	internal	7.5	2*15Ω-1100W (*)	IP55	2*RE3083150
	0040	internal	7.5	2*15Ω-1100W (*)	IP55	2*RE3083150
	0049	internal	5.0	5Ω-4000W	IP20	RE3482500
S20	0060	internal	5.0	5Ω-4000W	IP20	RE3482500
	0067	internal	5.0	5Ω-4000W	IP20	RE3482500
	0074	internal	4.2	5Ω-4000W	IP20	RE3482500
	0086	internal	4.2	5Ω-4000W	IP20	RE3482500
S30	0113	internal	3.0	3.3Ω-8000W	IP20	RE3762330
	0129	internal	3.0	3.3Ω-8000W	IP20	RE3762330
	0150	internal	2.5	3.3Ω-8000W	IP20	RE3762330
	0162	internal	2.5	3.3Ω-8000W	IP20	RE3762330
S40	0179	2 * BU200	2.5	2*3.3Ω-8000W (**)	IP20	2*RE3762330
	0200	2 * BU200	2.5	2*3.3Ω-8000W (**)	IP20	2*RE3762330
	0216	2 * BU200	2.5	2*3.3Ω-8000W (**)	IP20	2*RE3762330
	0250	2 * BU200	2.5	2*3.3Ω-8000W (**)	IP20	2*RE3762330
S50	0312	3 * BU200	2.5	3*3.3Ω-8000W (**)	IP20	3*RE3762330
	0366	3 * BU200	2.5	3*3.3Ω-8000W (**)	IP20	3*RE3762330
	0399	3 * BU200	2.5	3*3.3Ω-8000W (**)	IP20	3*RE3762330
S60	0457	3 * BU200	2.5	3*3.3Ω-8000W (**)	IP20	3*RE3762330
	0524	4 * BU200	2.5	4*3.3Ω-8000W (**)	IP20	4*RE3762330
S65	0598	BU1440 2T-4T	0.24	0.45Ω-48000W (**)	IP23	RE4461450
	0748	BU1440 2T-4T	0.24	0.45Ω-48000W (**)	IP23	RE4461450
	0831	BU1440 2T-4T	0.24	0.3Ω-64000W (**)	IP23	RE4561300

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S75	0964	BU1440 2T-4T	0.24	0.3Ω-64000W (**)	IP23	RE4561300
	1130	BU1440 2T-4T	0.24	0.3Ω-64000W (**)	IP23	RE4561300
	1296	BU1440 2T-4T	0.24	0.3Ω-64000W (**)	IP23	RE4561300

(*): Parallel-connection is required
(**): For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

DANGER Braking resistors may reach temperatures higher than 200°C.

CAUTION Braking resistors may dissipate approx. 10% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.1.5. BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF 20% AND 200 - 240 VAC SUPPLY VOLTAGE

Size	SINUS PENTA Model 2T Class	Braking Unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 20% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S05	0007	internal	25.0	2*100Ω-350W (*)	IP55	2*RE2644100
	0008	internal	25.0	2*56Ω-350W(*)	IP55	2*RE2635560
	0010	internal	25.0	2*56Ω-350W(*)	IP55	2*RE2635560
	0013	internal	20.0	4*100Ω-350W (*)	IP55	4*RE2644100
	0015	internal	20.0	4*100Ω-350W (*)	IP55	4*RE2644100
	0016	internal	20.0	4*100Ω-350W(*)	IP55	4*RE2644100
	0020	internal	20.0	25Ω-1800	IP54	RE3103250
S10	0016	internal	25.0	4*100Ω-350W (*)	IP55	4*RE2644100
	0017	internal	25.0	4*100Ω-350W(*)	IP55	4*RE2644100
	0020	internal	25.0	25Ω-1800	IP54	RE3103250
	0025	internal	10.0	6*75Ω-550W (*)	IP33	6*RE3063750
	0030	internal	10.0	6*75Ω-550W (*)	IP33	6*RE3063750
	0035	internal	10.0	6*75Ω-550W (*)	IP33	6*RE3063750
S12	0023	internal	15.0	5*75Ω-550W (*)	IP33	5*RE3063750
	0033	internal	10.0	2*25Ω-1800W (*)	IP54	2*RE3103250
	0037	internal	10.0	2*25Ω-1800W (*)	IP54	2*RE3103250
S15	0038	internal	8.0	2*25Ω-1800W (*)	IP54	2*RE3103250
	0040	internal	8.	2*25Ω-1800W (*)	IP54	2*RE3103250
	0049	internal	5	5Ω-4000W	IP20	RE3482500
S20	0060	internal	5.0	5Ω-8000W	IP20	RE3762500
	0067	internal	5.0	5Ω-8000W	IP20	RE3762500
	0074	internal	4.2	5Ω-8000W	IP20	RE3762500
	0086	internal	4.2	5Ω-8000W	IP20	RE3762500
S30	0113	internal	3.0	3.3Ω-12000W	IP20	RE4022330
	0129	internal	3.0	3.3Ω-12000W	IP20	RE4022330
	0150	internal	2.5	3.3Ω-12000W	IP20	RE4022330
	0162	internal	2.5	3.3Ω-12000W	IP20	RE4022330
S40	0179	2 * BU200	3.3	2*3.3Ω-8000W (**)	IP20	2*RE3762330
	0200	2 * BU200	3.3	2*3.3Ω-8000W (**)	IP20	2*RE3762330
	0216	2 * BU200	3.3	2*3.3Ω-12000W (**)	IP20	2*RE4022330
	0250	2 * BU200	3.3	2*3.3Ω-12000W (**)	IP20	2*RE4022330
S50	0312	3 * BU200	3.3	3*3.3Ω-12000W (**)	IP20	3*RE4022330
	0366	3 * BU200	3.3	3*3.3Ω-12000W (**)	IP20	3*RE4022330
	0399	3 * BU200	3.3	3*3.3Ω-12000W (**)	IP20	3*RE4022330
S60	0457	3 * BU200	3.3	3*3.3Ω-12000W (**)	IP20	3*RE4022330
	0524	4 * BU200	3.3	4*3.3Ω-12000W (**)	IP20	4*RE4022330
S65	0598	BU1440 2T-4T	0.24	0.45-64000W (**)	IP23	RE4561450
	0748	BU1440 2T-4T	0.24	0.45-64000W (**)	IP23	RE4561450
	0831	BU1440 2T-4T	0.24	2*0.6-48000W (**)	IP23	2*RE4461600

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S75	0964	BU1440 2T-4T	0.24	2*0.6-48000W (**)	IP23	2*RE4461600
	1130	BU1440 2T-4T	0.24	2*0.6-64000W (**)	IP23	2*RE4561600
	1296	BU1440 2T-4T	0.24	2*0.6-64000W (**)	IP23	2*RE4561600

(*): Parallel-connection is required
(**): For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

DANGER — Braking resistors may reach temperatures higher than 200°C

CAUTION — Braking resistors may dissipate approx. 20% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION — Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

0 1 2 3 4 5 6 7 8

6.1.1.6. BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF 50% AND 200 - 240 VAC SUPPLY VOLTAGE

Size	SINUS PENTA Model 2T Class	Braking Unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 50% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S05	0007	internal	25.0	50Ω-1100W	IP55	RE3083500
	0008	internal	25.0	25Ω-1800W	IP54	RE3103250
	0010	internal	25.0	25Ω-1800W	IP54	RE3103250
	0013	internal	20.0	25Ω-4000W	IP20	RE3483250
	0015	internal	20.0	25Ω-4000W	IP20	RE3483250
	0016	internal	20.0	25Ω-4000W	IP20	RE3483250
	0020	internal	20.0	20Ω-4000W	IP20	RE3483200
S10	0016	internal	25.0	25Ω-4000W	IP20	RE3483250
	0017	internal	25.0	25Ω-4000W	IP20	RE3483250
	0020	internal	25.0	25Ω-4000W	IP20	RE3483250
	0025	internal	10.0	10Ω-8000W	IP20	RE3763100
	0030	internal	10.0	10Ω-8000W	IP20	RE3763100
	0035	internal	10.0	10Ω-8000W	IP20	RE3763100
S12	0023	internal	15.0	20Ω-4000W	IP20	RE3483200
	0033	internal	10.0	10Ω-8000W	IP20	RE3763100
	0037	internal	10.0	10Ω-8000W	IP20	RE3763100
S15	0038	internal	7.5	10Ω-8000W	IP20	RE3763100
	0040	internal	7.5	10Ω-8000W	IP20	RE3763100
	0049	internal	5.0	6.6Ω-12000W	IP20	RE4022660
S20	0060	internal	5.0	6.6Ω-12000W	IP20	RE4022660
	0067	internal	5.0	2*10Ω-8000W (*)	IP20	2*RE3762500
	0074	internal	4.2	2*10Ω-8000W (*)	IP20	2*RE3763100
	0086	internal	4.2	2*10Ω-8000W (*)	IP20	2*RE3763100
S30	0113	internal	3.0	2*6.6Ω-12000W (*)	IP20	2*RE4022660
	0129	internal	3.0	2*6.6Ω-12000W (*)	IP20	2*RE4022660
	0150	internal	2.5	3*10Ω-12000W (*)	IP20	RE4023100
	0162	internal	2.5	3*10Ω-12000W (*)	IP20	RE4023100
S40	0179	3*BU200	5.0	3*6.6Ω-12000W (**)	IP20	3*RE4022660
	0200	4*BU200	5.0	4*6.6Ω-12000W (**)	IP20	4*RE4022660
	0216	4*BU200	5.0	4*6.6Ω-12000W (**)	IP20	4*RE4022660
	0250	5*BU200	5.0	5*6.6Ω-12000W (**)	IP20	5*RE4022660
S50	0312	6*BU200	5.0	6*6.6Ω-12000W (**)	IP20	6*RE4022660
	0366	6*BU200	5.0	6*6.6Ω-12000W (**)	IP20	6*RE4022660
	0399	7*BU200	5.0	7*6.6Ω-12000W (**)	IP20	7*RE4022660
S60	0457	8*BU200	5.0	8*6.6Ω-12000W (**)	IP20	8*RE4022660
	0524	10*BU200	5.0	10*6.6Ω-12000W (**)	IP20	10*RE4022660
S65	0598	BU1440 2T-4T	0.24	4*0.45/48000W (**)	IP23	4*RE4461450
	0748	BU1440 2T-4T	0.24	4*0.45/48000W (**)	IP23	4*RE4461450
	0831	BU1440 2T-4T	0.24	4*0.3/64000W (**)	IP23	4*RE4561300

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S75	0964	BU1440 2T-4T	0.24	4*0.3/64000W (**)	IP23	4*RE4561300
	1130	BU1440 2T-4T	0.24	4*0.3/64000W (**)	IP23	4*RE4561300
	1296	BU1440 2T-4T	0.24	4*0.3/64000W (**)	IP23	4*RE4561300

(*): Parallel-connection is required
(**): For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

DANGER — Braking resistors may reach temperatures higher than 200°C.

CAUTION — Braking resistors may dissipate approx. 50% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION — Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.1.7. BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF 10% AND 500 - 575 VAC SUPPLY VOLTAGE

Size	SINUS PENTA Model 5T Class	Braking Unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 10% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S65	0250	BU720 5T-6T	1.15	2.4Ω-48000W	IP23	RE4462240
	0312	BU720 5T-6T	1.15	2.4Ω-48000W	IP23	RE4462240
	0366	BU720 5T-6T	1.15	2.4Ω-48000W	IP23	RE4462240
	0399	BU720 5T-6T	1.15	1.6Ω-64000W	IP23	RE4562160
	0457	BU720 5T-6T	1.15	1.6Ω-64000W	IP23	RE4562160
	0524	BU720 5T-6T	1.15	1.2Ω-64000W	IP23	RE4562120
	0598	BU720 5T-6T	1.15	1.2Ω-64000W	IP23	RE4562120
	0748	BU1440 5T-6T	0.58	2*1.6Ω-48000W	IP23	2*RE4462160
S70	0831	BU1440 5T-6T	0.58	2*1.6Ω-48000W	IP23	2*RE4462160
S75	0964	BU1440 5T-6T	0.58	2*1.2Ω-64000W	IP23	2*RE4562120
S80	1130	BU1440 5T-6T	0.58	2*1.2Ω-64000W	IP23	2*RE4562120
	1296	BU1440 5T-6T	0.58	2*1.2Ω-64000W	IP23	2*RE4562120

NOTE For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

CAUTION Braking resistors may dissipate approx. 10% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.1.8. BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF 20% AND 500 - 575 VAC SUPPLY VOLTAGE

Size	SINUS PENTA Model 5T Class	Braking Unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 20% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S65	0250	BU720 5T-6T	1.15	2.4Ω-64000W	IP23	RE4562240
	0312	BU720 5T-6T	1.15	2.4Ω-64000W	IP23	RE4562240
	0366	BU720 5T-6T	1.15	2.4Ω-64000W	IP23	RE4562240
	0399	BU720 5T-6T	1.15	2*0.8Ω-48000W	IP23	2*RE4461800
	0457	BU720 5T-6T	1.15	2*0.8Ω-48000W	IP23	2*RE4461800
	0524	BU720 5T-6T	1.15	2*2.4Ω-64000W	IP23	2*RE4562240
	0598	BU720 5T-6T	1.15	2*2.4Ω-64000W	IP23	2*RE4562240
	0748	BU1440 5T-6T	0.58	3*2.4Ω-64000W	IP23	3*RE4562240
S70	0831	BU1440 5T-6T	0.58	3*2.4Ω-64000W	IP23	3*RE4562240
S75	0964	BU1440 5T-6T	0.58	4*2.4Ω-64000W	IP23	4*RE4562240
S80	1130	BU1440 5T-6T	0.58	4*2.4Ω-64000W	IP23	4*RE4562240
	1296	BU1440 5T-6T	0.58	4*2.4Ω-64000W	IP23	4*RE4562240

NOTE — For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

CAUTION — Braking resistors may dissipate approx. 20% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION — Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.1.9. Braking Resistors for Applications with a Braking DUTY CYCLE of 50% and 500 - 575 Vac Supply Voltage

Size	SINUS PENTA Model 5T Class	Braking Unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 50% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S65	0250	BU720 5T-6T	1.15	4*2.4Ω-48000W	IP23	4*RE4462240
	0312	BU720 5T-6T	1.15	4*2.4Ω-48000W	IP23	4*RE4462240
	0366	BU720 5T-6T	1.15	4*2.4Ω-48000W	IP23	4*RE4462240
	0399	BU720 5T-6T	1.15	4*1.6Ω-64000W	IP23	4*RE4562160
	0457	BU720 5T-6T	1.15	4*1.6Ω-64000W	IP23	4*RE4562160
	0524	BU720 5T-6T	1.15	4*5Ω-64000W	IP23	4*RE4552500
	0598	BU720 5T-6T	1.15	5*6Ω-64000W	IP23	5*RE4562600
	0748	BU1440 5T-6T	0.58	6*5Ω-64000W	IP23	6*RE4552500
S70	0831	BU1440 5T-6T	0.58	6*5Ω-64000W	IP23	6*RE4552500
S75	0964	BU1440 5T-6T	0.58	8*5Ω-64000W	IP23	8*RE4552500
S80	1130	BU1440 5T-6T	0.58	10*6Ω-64000W	IP23	10*RE4562600
	1296	BU1440 5T-6T	0.58	10*6Ω-64000W	IP23	10*RE4562600

NOTE For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

CAUTION Braking resistors may dissipate approx. 50% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.1.10. BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF 10% AND 660 - 690 VAC SUPPLY VOLTAGE

Size	SINUS PENTA Model 6T Class	Braking Unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 10% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S65	0250	BU720 5T-6T	1.38	2.4Ω-48000W	IP23	RE4462240
	0312	BU720 5T-6T	1.38	2.4Ω-48000W	IP23	RE4462240
	0366	BU720 5T-6T	1.38	2.4Ω-48000W	IP23	RE4462240
	0399	BU720 5T-6T	1.38	2.4Ω-64000W	IP23	RE4562240
	0457	BU720 5T-6T	1.38	1.6Ω-64000W	IP23	RE4562160
	0524	BU720 5T-6T	1.38	1.6Ω-64000W	IP23	RE4562160
	0598	BU960 5T-6T	1.10	2*2.4Ω-48000W	IP23	2*RE4462240
	0748	BU960 5T-6T	1.10	2*2.4Ω-48000W	IP23	2*RE4462240
S70	0831	BU960 5T-6T	1.10	2*2.4Ω-48000W	IP23	2*RE4462240
S75	0964	BU1440 5T-6T	0.69	2*1.6Ω-64000W	IP23	2*RE4562160
S80	1130	BU1440 5T-6T	0.69	2*1.6Ω-64000W	IP23	2*RE4562160
	1296	BU1440 5T-6T	0.69	3*2.4Ω-64000W	IP23	3* RE4562240

NOTE: For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

CAUTION: Braking resistors may dissipate approx. 10% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION: Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

0 1 2 3 4 5 6 7 8

6.1.1.11. BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF 20% AND 660 - 690 VAC SUPPLY VOLTAGE

Size	SINUS PENTA Model 6T Class	Braking Unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 20% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S65	0250	BU720 5T-6T	1.38	2.4Ω-64000W	IP23	RE4562240
	0312	BU720 5T-6T	1.38	2*1.2Ω-64000W	IP23	2*RE4562120
	0366	BU720 5T-6T	1.38	2*1.2Ω-64000W	IP23	2*RE4562120
	0399	BU720 5T-6T	1.38	2*1.2Ω-64000W	IP23	2*RE4562120
	0457	BU720 5T-6T	1.38	2*0.8Ω-64000W	IP23	2*RE4561800
	0524	BU720 5T-6T	1.38	2*0.8Ω-64000W	IP23	2*RE4561300
	0598	BU960 5T-6T	1.10	4*5Ω-48000W	IP23	4*RE4462500
	0748	BU960 5T-6T	1.10	4*5Ω-48000W	IP23	4*RE4462500
S70	0831	BU960 5T-6T	1.10	4*5Ω-48000W	IP23	4*RE4462500
S75	0964	BU1440 5T-6T	0.69	4*0.8Ω-64000W	IP23	4*RE4561800
S80	1130	BU1440 5T-6T	0.69	6*5Ω-64000W	IP23	6*RE4552500
	1296	BU1440 5T-6T	0.69	6*5Ω-64000W	IP23	6*RE4552500

NOTE — For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

CAUTION — Braking resistors may dissipate approx. 20% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION — Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.1.12. Braking Resistors for Applications with a Braking DUTY CYCLE of 50% and 660 - 690 Vac Supply Voltage

Size	SINUS PENTA Model 6T Class	Braking Unit	Min. Resistance to be Applied to the BU	BRAKING RESISTANCE WITH 50% DUTY CYCLE		
			Ω	Type	IP Rating	ID
S65	0250	BU720 5T-6T	1.38	4*2.4Ω-48000W	IP23	4*RE4462240
	0312	BU720 5T-6T	1.38	4*2.4Ω-64000W	IP23	4*RE4562240
	0366	BU720 5T-6T	1.38	4*2.4Ω-64000W	IP23	4*RE4562240
	0399	BU720 5T-6T	1.38	4*2.4Ω-64000W	IP23	4*RE4562240
	0457	BU720 5T-6T	1.38	4*1.6Ω-64000W	IP23	4*RE4562160
	0524	BU720 5T-6T	1.38	6*2.4Ω-64000W	IP23	6*RE4562240
	0598	BU960 5T-6T	1.10	8*2.4Ω-64000W	IP23	8*RE4562240
	0748	BU960 5T-6T	1.10	8*2.4Ω-64000W	IP23	8*RE4562240
S70	0831	BU960 5T-6T	1.10	8*2.4Ω-64000W	IP23	8*RE4562240
S75	0964	BU1440 5T-6T	0.69	8*1.6Ω-64000W	IP23	8*RE4562160
S80	1130	BU1440 5T-6T	0.69	12*2.4Ω-64000W	IP23	12*RE4562240
	1296	BU1440 5T-6T	0.69	12*2.4Ω-64000W	IP23	12*RE4562240

NOTE — For the connection of external braking units and braking resistors, please refer to the relevant instruction manuals.

CAUTION — Braking resistors may dissipate approx. 50% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

CAUTION — Do not connect any braking resistor with an Ohm value lower than the value stated in the tables.

6.1.2. AVAILABLE MODELS

The specifications given for each resistor model also include the mean power to be dissipated and the max. operating time, depending on the inverter voltage class.
Based on these values, parameters C211 and C212 (concerning braking features) in the Resistor Braking menu can be set up. (See relevant section in the Programming Manual).
The max. operating time set in C212 is factory-set in order not to exceed the allowable time for each resistor model (see section below).
Parameter C211represents the max. duty-cycle of the resistor and is to be set to a value lower than or equal to the value stated in the dimensioning table (see sections above).

	DANGER	Braking resistors may reach temperatures higher than 200°C.
	CAUTION	For parameters C211 and C212, do not set values exceeding the max. allowable values stated in the tables above. Failure to do so will cause irreparable damage to the braking resistors; also, fire hazard exists.
	CAUTION	Braking resistors may dissipate up to 50% of the rated power of the connected motor; use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

6.1.2.1. MODEL 56-100 OHM/350 W

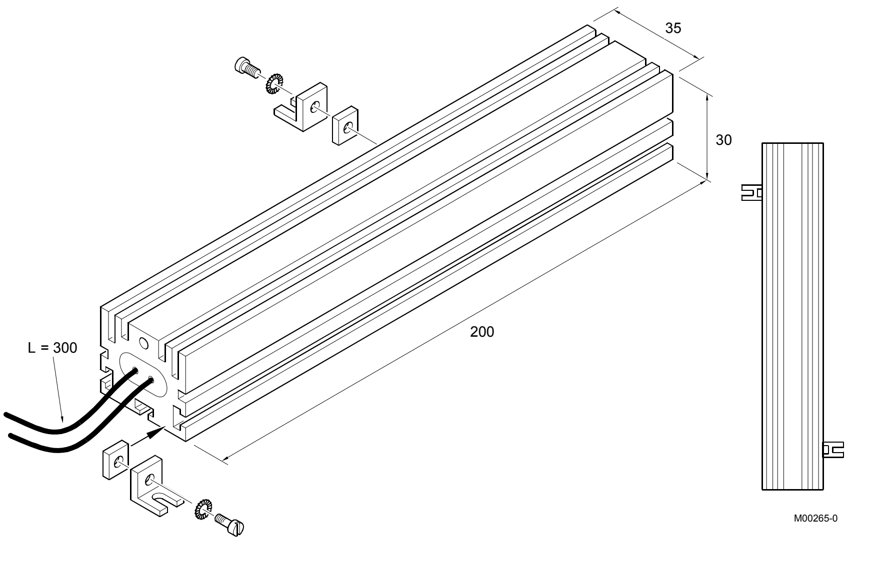


Figure 66: Overall dimensions, resistor 56-100Ω/350W

Type	Weight (g)	Degree of Protection	Mean Power to be Dissipated (W)	Max. Duration of Continuous Operation for 200 - 240 VAC (s)*
56Ohm/350W RE2643560	400	IP55	350	3.5
100Ohm/350W RE2644100	400	IP55	350	3.5

(*) max. value to be set for parameter C212. When setting the braking duty cycle in C211, make sure that the maximum power dissipated from the braking resistor being used is not exceeded.

6.1.2.2. Model 75 Ohm/1300 W

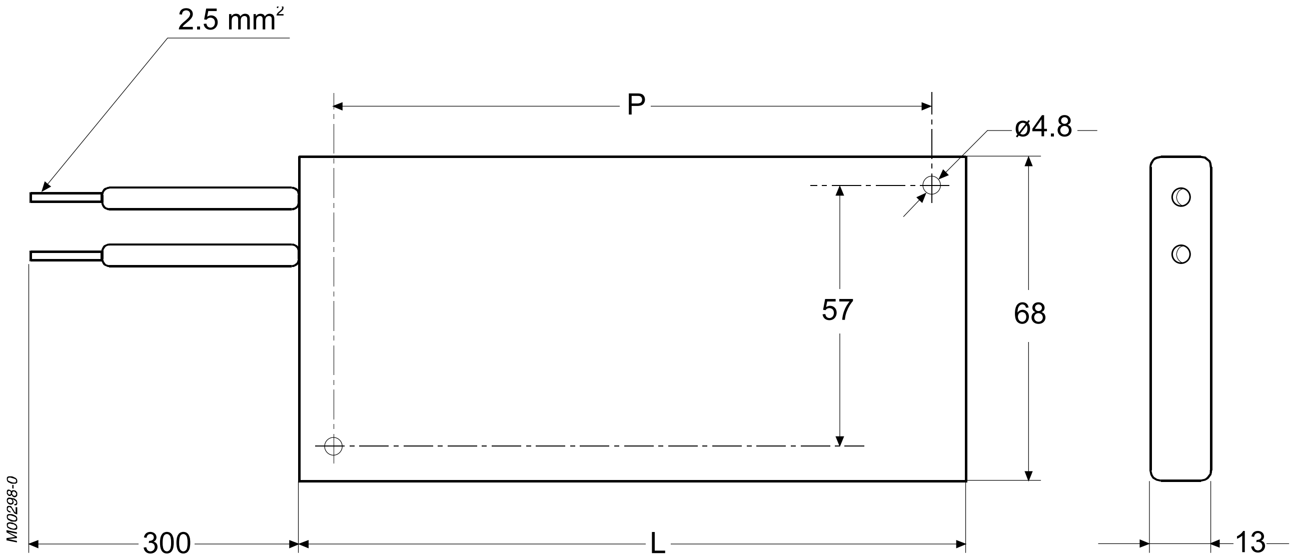


Figure 67: Overall dimensions and ratings for braking resistor 75 Ω/1300W

Type	L (mm)	D (mm)	Wgt (g)	Degree of protection	Mean power to be dissipated (W)	Max. duration of continuous operation for 380 - 5000 VCA (s)*
75Ohm/1300W RE3063750	195	174	500	IP33	550	2.25

(*) max. value to be set for parameter C212. When setting the braking duty cycle in C211, make sure that the maximum power dissipated from the braking resistor being used is not exceeded.

6.1.2.3. Models IP55-54 from 1100 W to 2200 W

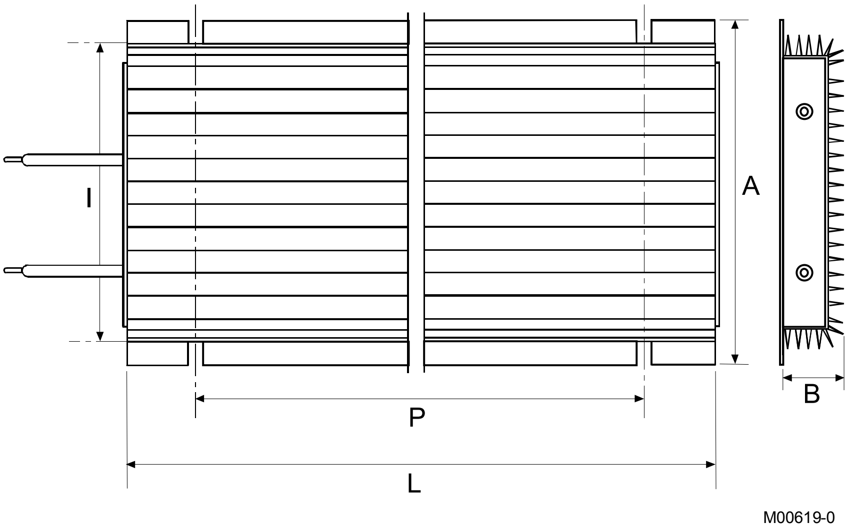


Figure 68: Overall dimensions and mechanical features for braking resistors from 1100 W to 2200 W

Type	A (mm)	B (mm)	L (mm)	I (mm)	D (mm)	Weight (g)	Degree of Protection	Mean Power to be Dissipated (W)	Max. Duration of Continuous Operation	
									380 - 500 Vac (s)*	200 - 240 Vac (s)*
15Ohm/1100W RE3083150	95	30	320	80-84	240	1250	IP55	950	not applicable	6
20Ohm/1100W RE3083200									not applicable	8
50Ohm/1100W RE3083500									5	20
10Ohm/1500W RE3093100	120	40	320	107-112	240	2750	IP54	1100	not applicable	4.5
39Ohm/1500W RE3093390									4.5	18
50Ohm/1500W RE3093500										
25Ohm/1800W RE310250	120	40	380	107-112	300	3000	IP54	1300	3	12
50Ohm/2200W RE3113500	190	67	380	177-182	300	7000	IP54	2000	8	not limited
75Ohm/2200W RE3113750									11	
wire standard length: 300mm										

(*) max. value to be set for parameter C212. When setting the braking duty cycle in C211, make sure that the maximum power dissipated from the braking resistor being used is not exceeded.

6.1.2.4. IP20 MODELS 4KW-8KW-12KW

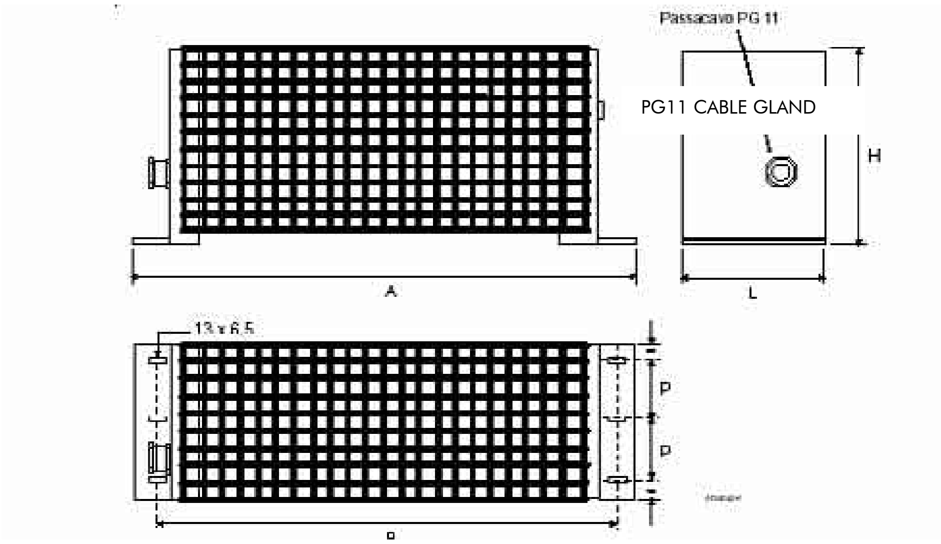


Figure 69: Overall dimensions for braking resistors 4 kW, 8 kW and 12 kW

RESISTOR	A (mm)	B (mm)	L (mm)	H (mm)	D (mm)	Wgt (Kg)	Degree of Protection	Average Power to be Dissipated (W)	Max. Duration of Continuous Operation		Wire Cross-section (sqmm) **
									Operation at 380-500VAC (s)*	Operation at 200-240VAC (s)*	
5Ω4KW RE3482500	620	600	100	250	40	5.5	IP20	4000	not applicable	10	10
15Ω4KW RE3483150									5	100	6
20Ω4kW RE3483200									10	150	6
25Ω4kW RE3483250									20	not limited	6
39Ω4kW RE3483390									60		6
50Ω4kW RE3483500									90		4
3.3Ω/8kW RE3762330	620	600	160	250	60	10.6	IP20	8000	not applicable	5	16
5Ω/8kW RE3762500									not applicable	40	10
10Ω/8kW RE3763100									2	100	10
3.3 Ω/12kW RE4022330	620	600	200	250	80	13.7	IP20	12000	not applicable	70	25
6.6Ω/12kW RE4022660									5	200	16
10Ω/12kW RE4023100									12	not limited	10

(*) Max. value to be set for parameter C212. When setting the braking duty cycle in C211, make sure that the maximum power dissipated from the braking resistor being used is not exceeded.
(**) Wire cross-sections relate to the applications covered in this manual.

CAUTION

Because the metal frame of the braking resistor can reach high temperatures, appropriate cables capable of withstanding high temperatures must be used.

6.1.2.5. Box Resistor Models IP23 4kW - 64kW

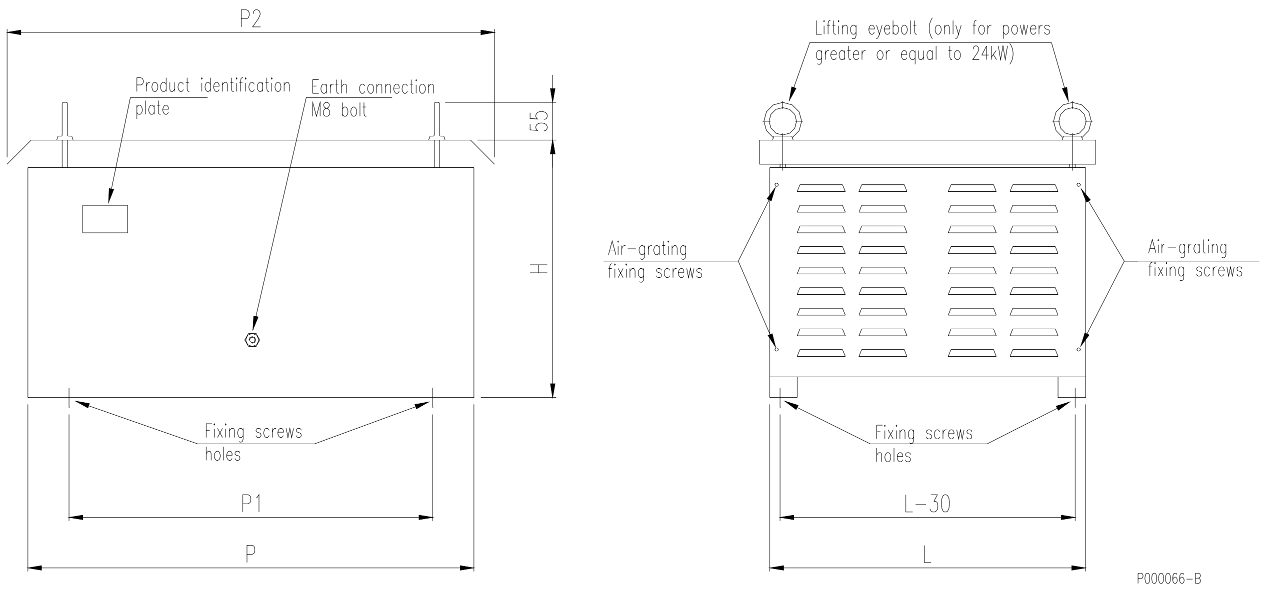


Figure 70: Overall dimensions of IP23 Box resistors

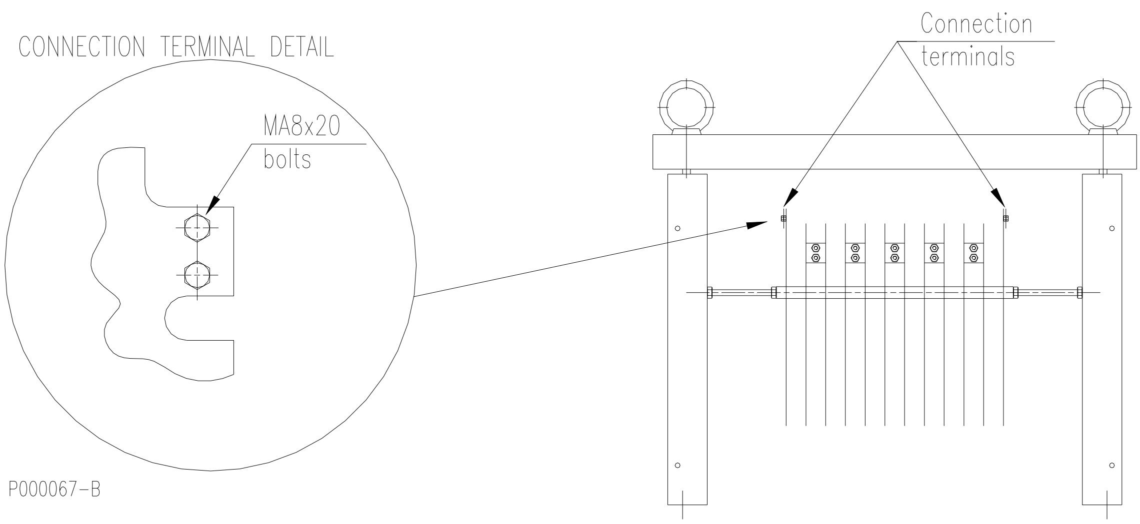


Figure 71: Position of electrical connections in box resistors

Remove the grids to gain access to wiring terminals (loosen fastening screws).

NOTE — The figure shows 20Ohm/12kW resistor. In certain models, remove both panels to gain access to the wiring terminals.

CAUTION — Because the metal frame of the braking resistor can reach high temperatures, appropriate cables capable of withstanding high temperatures must be used.

RESISTOR	D (mm)	D1 (mm)	D2 (mm)	L (mm)	H (mm)	Wgt (Kg)	Degree of Protection	Average Power to be Dissipated (W)	Max. Duration of Continuous Operation (s)(*)				Wire Cross-sections (mm²)**
									Operation at 200-240Vac	Operation at 380-500Vac	Operation at 500-575Vac	Operation at 660-690Vac	
50Ω/4KW RE3503500	650	530	710	320	375	20	IP23	4000	not limited	30	not applicable	not applicable	4
50Ω/8KW RE3783500	650	530	710	380	375	23	IP23	8000	not limited	50	not applicable	not applicable	4
20Ω/12KW RE4053200	650	530	710	460	375	34	IP23	12000	not limited	50	not applicable	not applicable	6
15Ω/16KW RE4163150	650	530	710	550	375	40	IP23	16000	not limited	58	not applicable	not applicable	10
10Ω /24kW RE4293100	650	530	710	750	375	54	IP23	24000	not limited	62	not applicable	not applicable	16
6.6Ω/32kW RE4362660	650	530	710	990	375	68	IP23	32000	not limited	62	not applicable	not applicable	25
6Ω/48kW RE4462600	650	530	710	750	730	101	IP23	48000	not limited	90	65	44	35
6Ω/64kW RE4562600	650	530	710	990	730	128	IP23	64000	not limited	120	90	60	50
5Ω/48kW RE4462500	650	530	710	750	730	101	IP23	48000	not limited	75	55	35	35
5Ω/64kW RE4552500	650	530	710	990	730	128	IP23	64000	not limited	106	75	50	50
2.4Ω/48kW RE4462240	650	530	710	750	730	101	IP23	48000	150	37	35	24	70
2.4Ω/64kW RE4562240	650	530	710	990	730	128	IP23	64000	not limited	50	25	18	90
1.6Ω/48kW RE4462160	650	530	710	750	730	101	IP23	48000	100	25	17	12	90
1.6Ω/64kW RE4562160	650	530	710	990	730	128	IP23	64000	130	35	24	16	120
1.2Ω/48kW RE4462120	650	530	710	750	730	101	IP23	48000	75	18	12	9	120
1.2 Ω /64kW RE4562120	650	530	710	990	730	128	IP23	64000	100	25	18	12	120
0.8Ω/48kW RE4461800	650	530	710	750	730	101	IP23	48000	50	12	8	6	120
0.8Ω/64kW RE4561800	650	530	710	990	730	128	IP23	64000	70	18	12	8	185
0.6Ω/48kW RE4461600	650	530	710	750	730	101	IP23	48000	36	9	6	not applicable	120
0.6Ω/64kW RE4561600	650	530	710	990	730	128	IP23	64000	50	12	9	not applicable	185
0.45Ω/48kW RE4461450	650	530	710	750	730	101	IP23	48000	48	not applicable	not applicable	not applicable	120
0.45Ω/64kW RE4561450	650	530	710	990	730	128	IP23	64000	38	not applicable	not applicable	not applicable	210
0.3Ω/64kW RE4561300	650	530	710	990	730	128	IP23	64000	25	not applicable	not applicable	not applicable	240

(*) Max. value to be set for parameter C212. When setting the braking duty cycle in C211, make sure that the maximum power dissipated from the braking resistor being used is not exceeded.
(**) Wire cross-sections relate to the applications covered in this manual.

6.2. BRAKING UNIT BU200

An external braking unit is available to be connected to terminals + and – (see section "Power Wiring" in the standard Installation Instructions manual) of the inverter for sizes S40 to S65. This type of braking unit can be used when a high braking torque is needed, particularly when a prompt braking is needed for high inertial loads (e.g. fans).
The braking power required to brake a rotating object is proportional to the total moment of inertia of the rotating object, to speed variations, and to absolute speed, while it inversely proportional to the deceleration time required.
This braking power is dissipated to a resistor (external to the braking unit) with an Ohm value depending on the inverter size and the average power to be dissipated.

6.2.1. INSPECTIONS UPON RECEIPT OF THE GOODS

Make sure that the equipment is not damaged and it complies with the equipment you ordered by referring to its front nameplate (see figure below). If the equipment is damaged, contact the supplier or the insurance company concerned. If the equipment does not comply with the one you ordered, please contact the supplier as soon as possible.
If the equipment is stored before being started, make sure that temperatures range from -20 °C to +60 °C and that relative humidity is <95% (non-condensing).
The equipment guarantee covers any manufacturing defect. The manufacturer has no responsibility for possible damages due to the equipment transportation or unpacking. The manufacturer is not responsible for possible damages or faults caused by improper and irrational uses; wrong installation; improper conditions of temperature, humidity, or the use of corrosive substances. The manufacturer is not responsible for possible faults due to the equipment operation at values exceeding the equipment ratings and is not responsible for consequential and accidental damages.
The braking unit BU200 is covered by a one-year guarantee starting from the date of delivery.

6.2.1.1. NAMEPLATE OF BU200

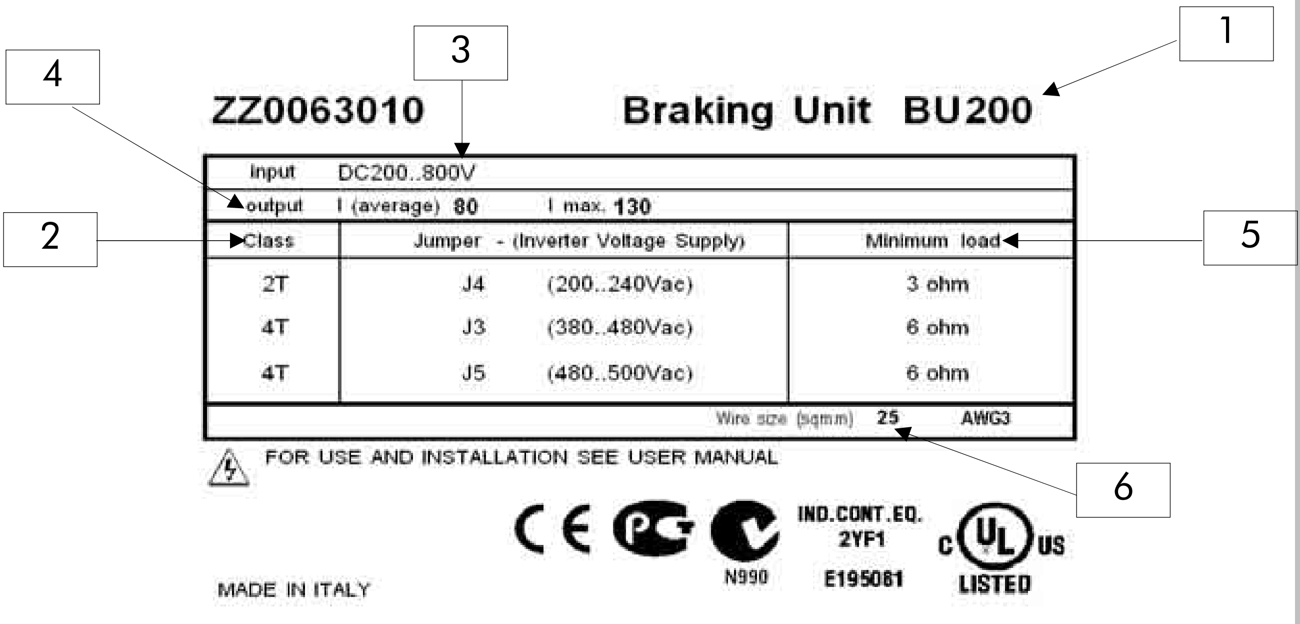


Figure 72: Nameplate of BU200

Numbered items in the figure above:

1.	Model:	BU200 - braking unit
2.	Voltage class:	List of applicable voltage classes
3.	Supply ratings:	200÷800 Vdc (DC supply voltage produced by the inverter terminals);
4.	Output current:	80A (average) – average current in output cables, 130A (Peak) – peak current in output cables
5.	Min. load:	Minimum value of the resistor to be connected to the output terminals (see application tables)
6.	Cable cross-section:	Dimensioning of the power cables

6.2.2. Operation

The basic size of the braking unit can be used with a braking resistor avoiding exceeding a max. instant current of 130 A, corresponding to a peak braking power of approx. 97.5 kW (class 4T) and to an average power of 60 kW (class 4T). For applications requiring higher braking power values, multiple braking units can be parallel-connected in order to obtain a greater braking power based on the number of braking units.
To ensure that the overall braking power is evenly distributed to all braking units, configure one braking unit in MASTER mode and the remaining braking units in SLAVE mode, and connect the output signal of the MASTER unit (terminal 8 in connector M1) to the forcing input for all SLAVE braking units (terminal 4 in connector M1).

6.2.2.1. Configuration Jumpers

Jumpers located on board ES839 are used for the configuration of the braking unit.
Their positions and functions are as follows:

Jumper	Function
J1	If on, it configures the SLAVE operating mode
J2	If on, it configures the MASTER operating mode

NOTE Either one of the two jumpers must always be "on". Avoid enabling both jumpers at a time.

Jumper	Function
J3	To be activated for class 4T inverters and mains voltage ranging from 380 Vac to 480 Vac
J4	To be activated for class 2T inverters and mains voltage ranging from 200 Vac to 240 Vac
J5	To be activated for class 4T inverters and mains voltage ranging from 481 Vac to 500 Vac
J6	To be activated for special adjustment requirements

NOTE One of the four jumpers must always be "on". Avoid enabling two or more jumpers at a time.

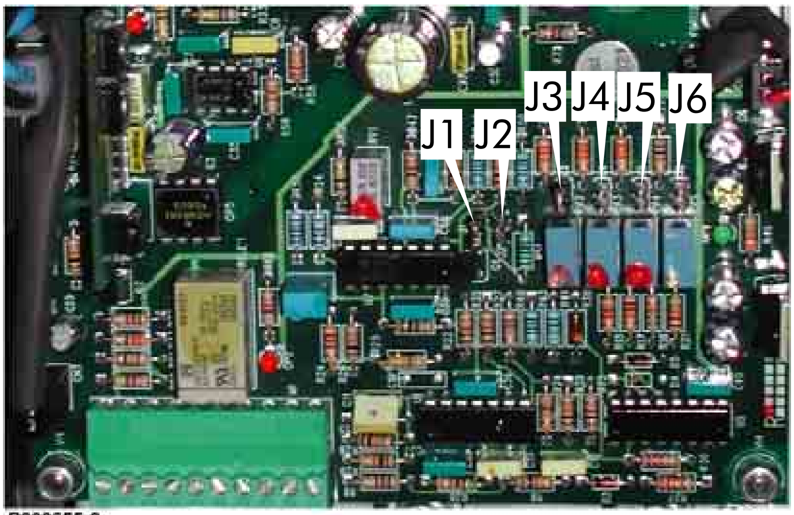


Figure 73: Positions of BU200 configuration jumpers

DANGER — Before changing jumper positions, remove voltage from the equipment and wait at least 5 minutes.

CAUTION — **Never** set jumpers to a voltage value lower than the inverter supply voltage. This will avoid continuous activation of the braking unit.

6.2.2.2. ADJUSTING TRIMMERS

Four trimmers are installed on the inverter control board. Depending on the jumper configuration, each trimmer allows the fine-tuning of the braking unit voltage threshold trip.
Jumper-trimmer matching is as follows:

Jumper	Function
J3	Fine-tuning of pick-up voltage through trimmer RV2
J4	Fine-tuning of pick-up voltage through trimmer RV3
J5	Fine-tuning of pick-up voltage through trimmer RV4
J6	Fine-tuning of pick-up voltage through trimmer RV5

The rated voltage for the braking unit activation and its range to be set with the 4 trimmers is stated in the table below:

Mains voltage [Vac]	Jumper	Trimmer	Minimum braking voltage [Vdc]	Rated braking voltage [Vdc]	Maximum braking voltage [Vdc]
200÷240 (2T)	J4	RV2	339	364	426
380÷480 (4T)	J3	RV3	700	764	826
481÷500 (4T)	J5	RV4	730	783	861
230-500	J6	RV5	464	650	810

CAUTION!! — Max. values in the table above are theoretical values for special applications only; their use must be authorized by Elettronica Santerno. For standard applications, never change the factory-set rated value.

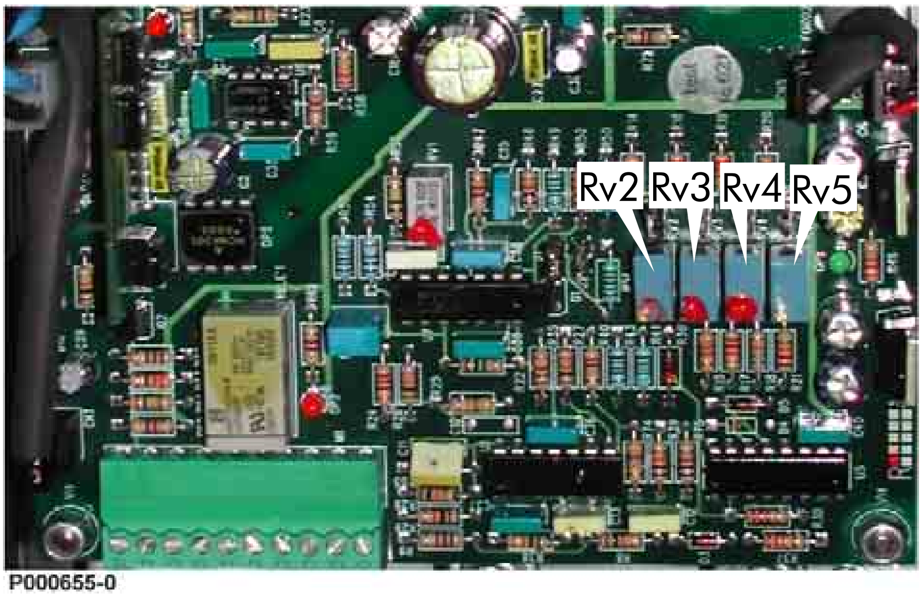


Figure 74: Positions of BU200 adjusting trimmers

6.2.2.3. INDICATOR LEDs

The indicator LEDs below are located on the front part of the braking units:

OK LED — Normally "on"; the equipment is running smoothly. This LED turns off due to overcurrent or power circuit failure.

B LED — Normally off"; this LED turns on when the braking unit activates.

TMAX LED — Normally "off"; this LED turns on when the thermoswitch located on the heatsink of the braking unit trips; if overtemperature protection trips, the equipment is locked until temperature drops below the alarm threshold.

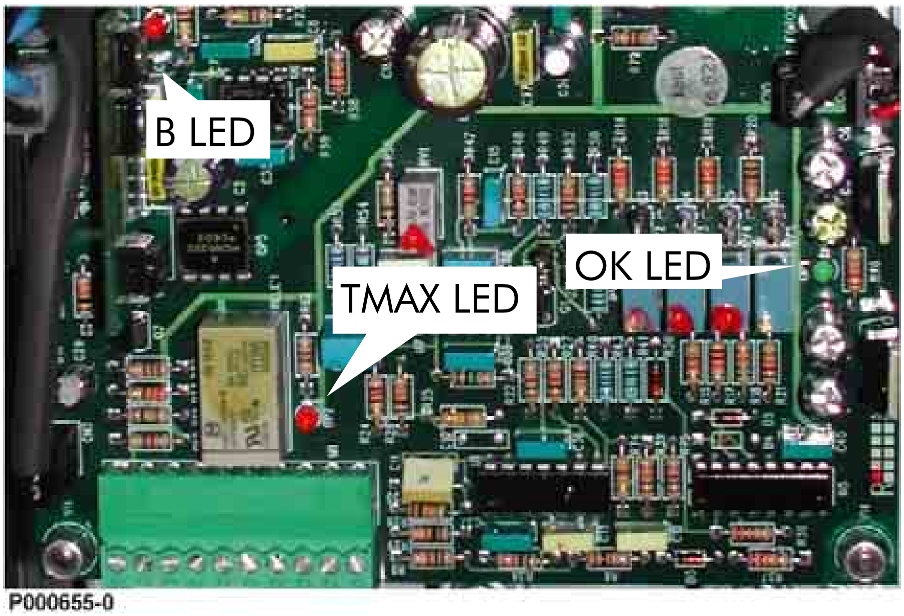


Figure 75: Position of Indicator Leds

6.2.3. RATINGS

SIZE	Max. Braking Current (A)	Average Braking Current (A)	INVERTER SUPPLY VOLTAGE and JUMPER POSITIONS		
			200-240Vac (class 2T)	380-480Vac (class 4T)	480-500Vac (class 4T)
			J4	J3	J5
			MIN. BRAKING RESISTOR (Ohm)	MIN. BRAKING RESISTOR (Ohm)	MIN. BRAKING RESISTOR (Ohm)
BU200	130	80	3	6	6

6.2.4. INSTALLING THE BRAKING UNIT

6.2.4.1. MOUNTING

- Install vertically;
- Make sure to allow a min. clearance of 5 cm on both sides and 10 cm on top and bottom;
- Use cable-glands to maintain degree of protection IP20.

ENVIRONMENTAL REQUIREMENTS FOR THE BRAKING UNIT INSTALLATION, STORAGE AND TRANSPORT

Operating ambient temperatures	0-40 °C with no derating from 40 °C to 50 °C with a 2% derating of the rated current for each degree beyond 40 °C.
Ambient temperatures for storage and transport	- 25 °C - +70 °C.
Installation environment	Pollution degree 2 or higher. Do not install in direct sunlight and in places exposed to conductive dust, corrosive gases, vibrations, water sprinkling or dripping (depending on IP ratings); do not install in salty environments.
Altitude	Up to 1000 m above sea level. For higher altitudes, derate the output current of 1% every 100m above 1000m (max. 4000m).
Operating ambient humidity	From 5% to 95%, from 1g/m3 to 25g/m3, non-condensing and non-freezing (class 3k3 according to EN50178).
Storage ambient humidity	From 5% to 95%, from 1g/m3 to 25g/m3, non condensing and non freezing (class 1k3 according to EN50178).
Ambient humidity during transport	Max. 95%; up to 60g/m3, condensation may appear when the equipment is not running (class 2k3 according to EN50178).
Storage and operating atmospheric pressure	From 86 to 106 kPa (classes 3k3 and 1k4 according to EN50178).
Atmospheric pressure during transport	From 70 to 106 kPa (class 2k3 according to EN50178).

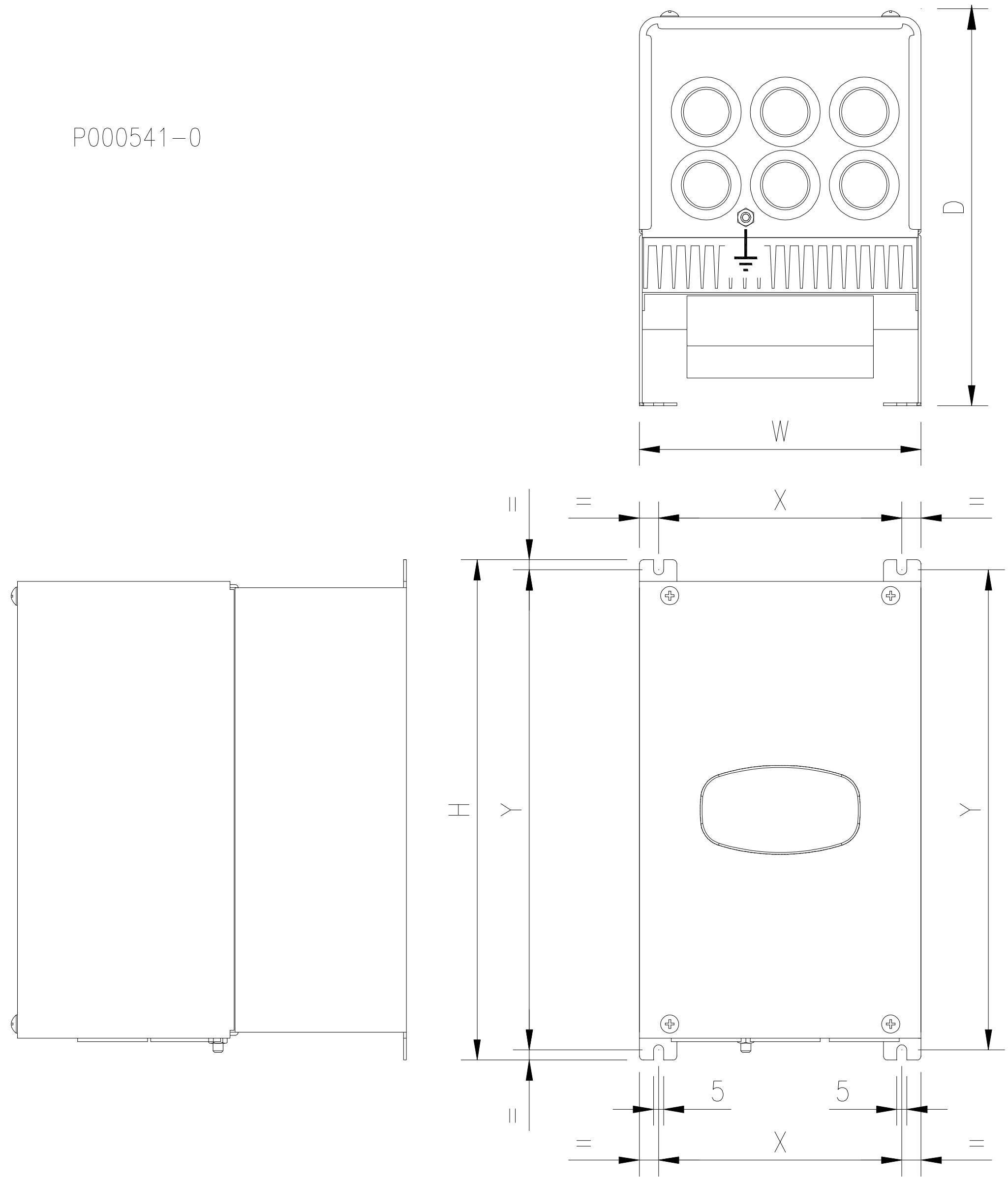
CAUTION!! Ambient conditions strongly affect the inverter life. Do not install the equipment in places that do not have the above-mentioned ambient conditions.

COOLING SYSTEM AND DISSIPATED POWER

The braking unit is provided with a heatsink reaching a max. temperature of 80 °C.
Make sure that the bearing surface for the braking unit is capable of withstanding high temperatures. Max. dissipated power is approx. 150 W and depends on the braking cycle required for the operating conditions of the load connected to the motor.
The max. temperature alarm for the braking unit shall be used as a digital signal to control the inverter stop.

STANDARD MOUNTING

The braking unit BU200 must be installed in an upright position inside a cabinet. Fix the BU200 with four M4 screws.



Dimensions (mm)			Distance between fixing points (mm)		Type of screws	Weight (Kg)
W	H	D	X	Y	M4	4
139	247	196	120	237		

Figure 76: Dimensions and fixing points of BU200

NOTE Elettronica Santerno reserves the right to make any technical changes to this manual and to the device without prior notice.

6.2.4.2. ELECTRIC INSTALLATION

WIRING DIAGRAM

The braking unit must be connected to the inverter and the braking resistor.
The braking unit is connected directly to the inverter terminals (or copper bars for sizes greater than S40) of the DC output, while the braking resistor must be connected to the inverter on one side and to the braking unit on the other side.
The wiring diagram is shown in the figure below:

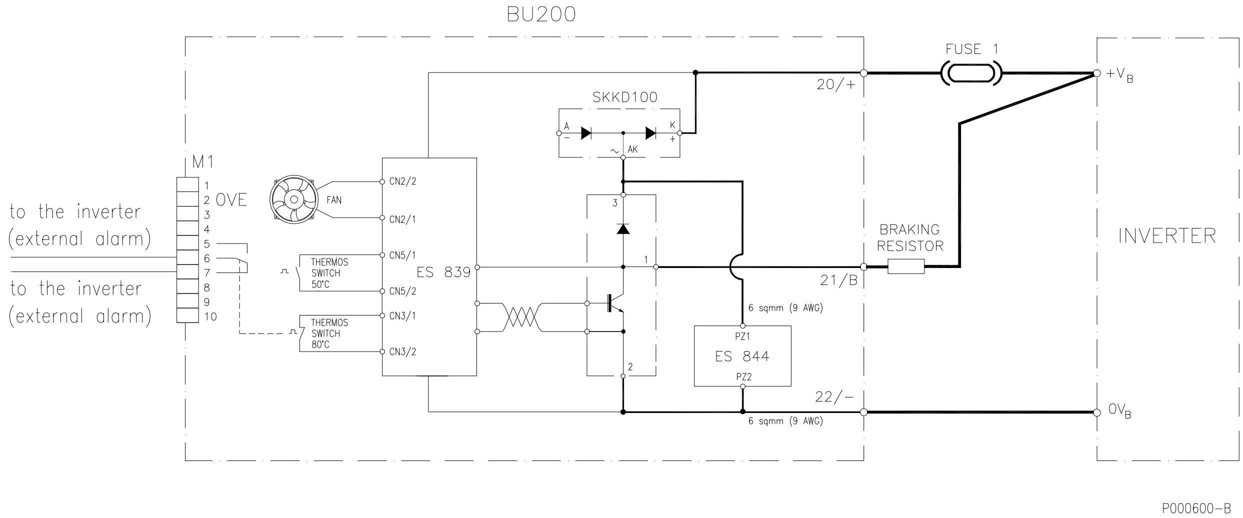


Figure 77: Connecting one BU200 to the inverter

	NOTE!!	The braking resistor must be connected between terminal **B** of BU200 and terminal + of the inverter. In that way, no sudden variation in braking current occurs in the supply line between the inverter and BU200. In order to minimize electromagnetic radiated emissions when BU200 is operating, the loop obtained from the wiring connecting terminal + of the inverter, the braking resistor, terminals **B** and **-** of BU200 and terminal **-** of the inverter should be as short as possible.
	NOTE	Install a 50A fuse with a DC current of at least 700 Vdc (type URDC SIBA series, NH1 fuse) provided with a safety contact.
	CAUTION	Link the safety contact of the fuse being used with the external alarm of BU200.

MASTER – SLAVE CONNECTION

The Master-Slave connection must be used when multiple braking units are connected to the same inverter. An additional connection must be done between the Master output signal (terminal 8 in M1) and the Slave input signal (terminal 4 in M1); zero volt of the signal connector in the Master module (terminal 2 in M1) must be connected to zero volt of the signal connector in the Slave module (terminal 2 in M1).
The connection of more than two modules must always be done by configuring one module like a master and the other modules like slaves. Use configuration jumpers accordingly.
The max. temperature alarm of the braking unit must be used as a digital signal to control the inverter stop. All contacts (voltage-free contacts) in all braking modules may be series-connected as shown in the diagram below:

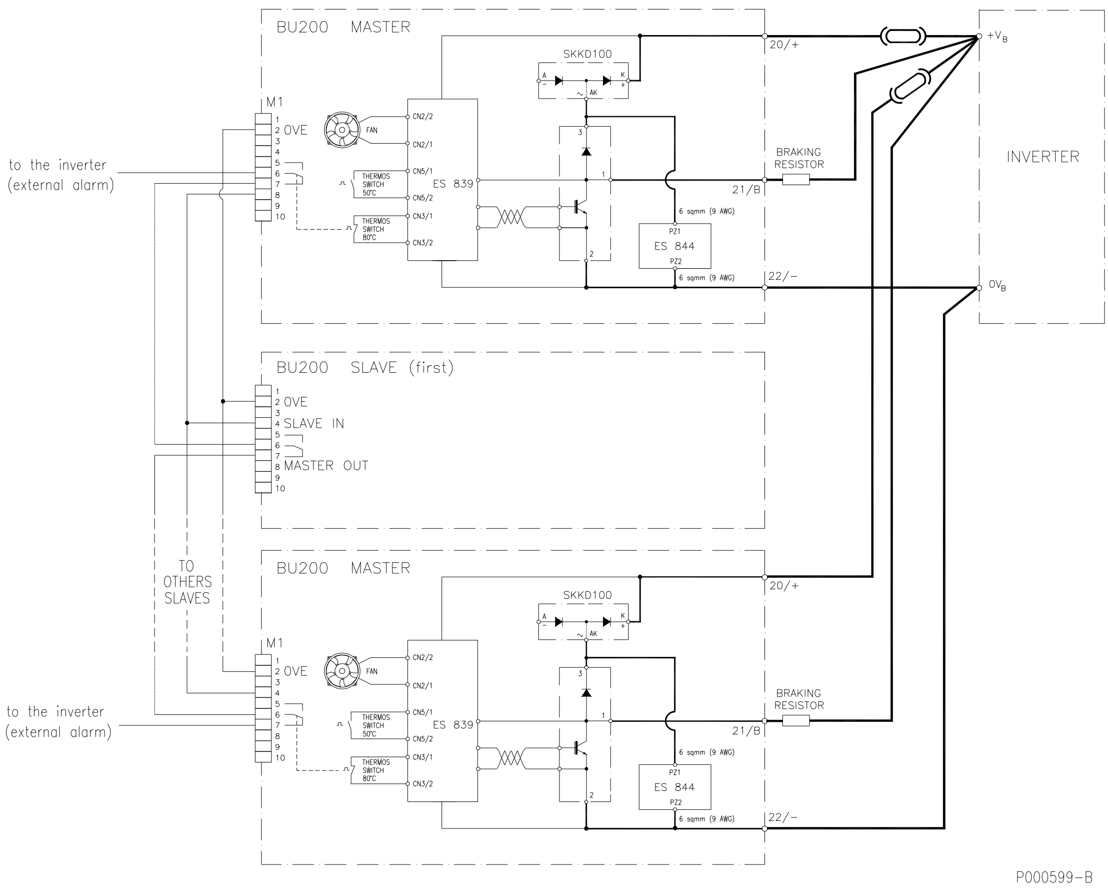


Figure 78: Master – Slave multiple connection

NOTE NEVER connect signal zero volt (terminal 2 in M1) to zero volt of the inverter power supply voltage (-).

NOTE Install a 50A fuse with a DC current of at least 700 Vdc (type URDC SIBA series, NH1 fuse) provided with a safety contact.

CAUTION Link the safety contact of the fuse being used with the external alarm of BU200.

LAY-OUT OF POWER TERMINALS AND SIGNAL TERMINALS

Remove the cover of the braking unit to gain access to its terminal blocks. Just loosen the four fixing screws of the cover located on the front side and on the bottom side of the braking unit.
Loosen the fastening screws to slide off the cover from above.
Power terminals consist of copper bars, that can be reached through the three front holes.

Terminal	N.	Type of terminal	Connection
+	20	Copper bar	Inverter DC side connected to terminal +
B	21	Copper bar	Connection to braking resistor
-	22	Copper bar	Inverter DC side connected to terminal -

Signal terminal block M1 can be accessed through its hole (see figure below).

Terminal block M1:

N°	Name	Description	Notes	Features
M1 : 1		Not used		
M1 : 2	0VE	Signal zero volt		Control board zero volt
M1 : 3	Vin	Modulation input (0÷10 V)	To be used for special applications	Rin=10kOhm
M1 : 4	Sin	Logic input for signal sent from Master	The SLAVE brakes if a signal > 6 V is sent	Max. 30V
M1 : 5	RL-NO	NO contact of "thermoswitch on" relay	The relay energizes when an overtemperature alarm trips for BU200	250Vac,3A 30Vdc,3A
M1 : 6	RL-C	Common of the contact of "thermoswitch on" relay		
M1 : 7	RL-NC	NC contact of "thermoswitch on" relay		
M1 : 8	Mout	Digital output for Slave command signal	High level output when the Master is braking	PNP output (0-15V)
M1 : 9		Not used		
M1 :10		Not used		

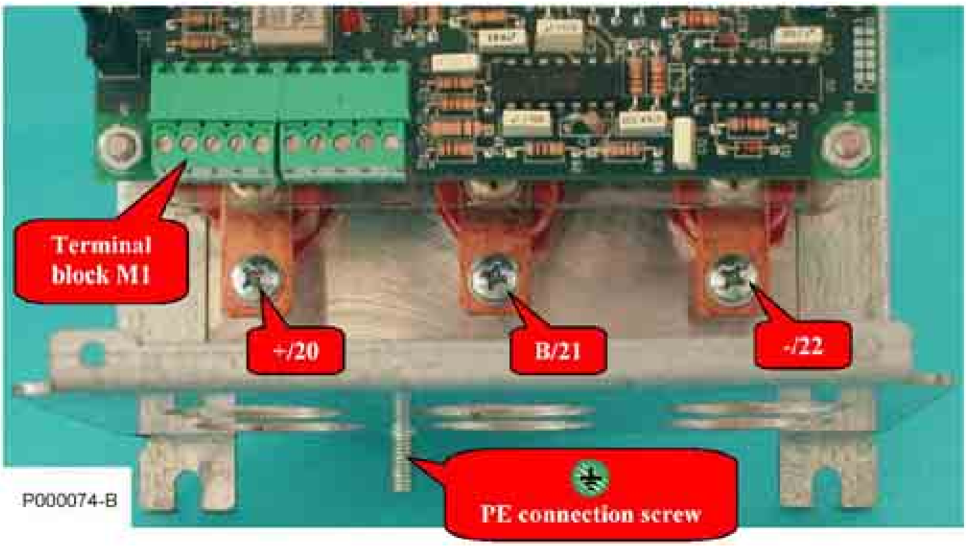


Figure 79: Terminals in BU200

0 1 2 3 4 5 6 7 8

WIRE CROSS-SECTIONS

Use 25 sqmm wires for power connection wirings and 0.5 or 1sqmm wires for signal wiring.
When connecting the conductor to the braking resistor, consider that the latter can reach a temperature of 200 °C.

RESISTORS THAT CAN BE CONNECTED TO THE BRAKING UNIT

The min. rating of the resistor to be connected to the braking unit depends on the inverter rated voltage (see Section Ratings). The max. braking time (Ton) is limited from the max. allowable temperature and from the allowable dissipated power. As a result, the Duty-cycle parameter is defined based on the braking resistor rating and time Ton (braking time) and is expressed as the ratio between time Ton and the entire duty-cycle (Ton+Toff). Duty-cycle represents a whole braking cycle.
Figure 80 shows the max. allowable duty-cycle (depending on Ton) for the connected braking resistor.

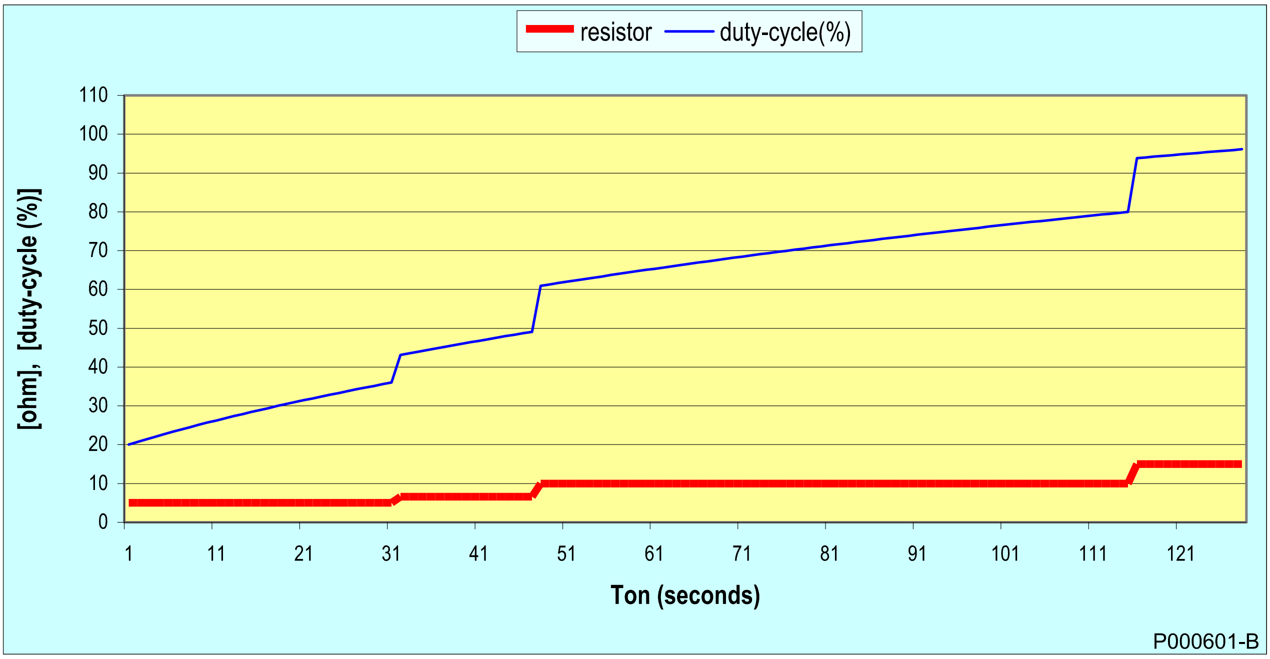


Figure 80: Max. allowable duty-cycle (depending on Ton) for the connected braking resistor

Figure 81 shows the value of the peak power and the average power dissipated to the braking resistor depending on the actual braking time.
The selection of the resistor power depends both on the average dissipated power and on the peak power the resistor shall be capable of withstanding.

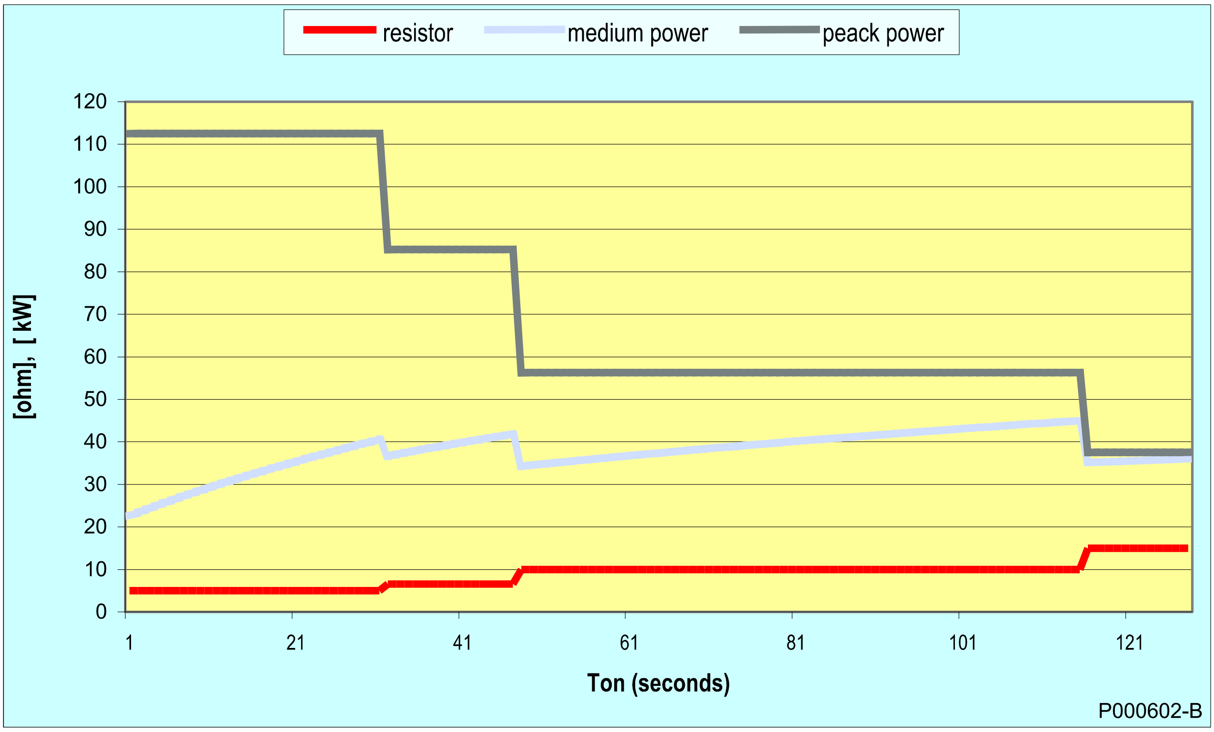


Figure 81: Peak power and average power (depending on Ton) dissipated to the braking resistor

CLASS 2T	DUTY-CYCLE			
RESISTORS (Ohm)	0-10%	10%-20%	20%-50%	50%-100%
2.8	240 s	240 s	240 s	Not applicable
3.3	400 s	400 s	400 s	Not applicable
4.5	Not limited	Not limited	Not limited	Not limited

Table 1: Max. braking time depending on the duty-cycle and the connected braking resistor

CLASS 4T	DUTY-CYCLE			
RESISTORS (Ohm)	0-10%	10%-20%	20%-50%	50%-100%
6	240 s	240 s	240 s	Not applicable
6.6	300 s	300 s	300 s	Not applicable
10	Not limited	Not limited	Not limited	Not limited

Table 2: Max. braking time depending on the duty-cycle and the connected braking resistor

6.3. BRAKING UNIT (BU 720-960-1440) FOR MODULAR INVERTERS

A braking unit to be applied to modular inverters only is available. The inverter size must be equal to or larger than S65.

6.3.1. INSPECTION UPON RECEIPT OF THE GOODS

Make sure that the equipment is not damaged and that it complies with the equipment you ordered by referring to the nameplate located on the inverter front part (see figure below). If the equipment is damaged, contact the supplier or the insurance company concerned. If the equipment does not comply with the one you ordered, please contact the supplier as soon as possible.
If the equipment is stored before being started, make sure that temperatures range from -20 °C to +60 °C and that relative humidity is <95% (non-condensing).
The equipment guarantee covers any manufacturing defect. The manufacturer has no responsibility for possible damages occurred while shipping or unpacking the equipment. The manufacturer is not responsible for possible damages or faults caused by improper and irrational uses; wrong installation; improper conditions of temperature, humidity, or the use of corrosive substances. The manufacturer is not responsible for possible faults due to the equipment operation at values exceeding the equipment ratings. The manufacturer is not responsible for consequential and accidental damages.
The braking unit is covered by a 12-month guarantee starting from the date of delivery.

6.3.1.1. NAMEPLATE FOR BU 720-960-1440

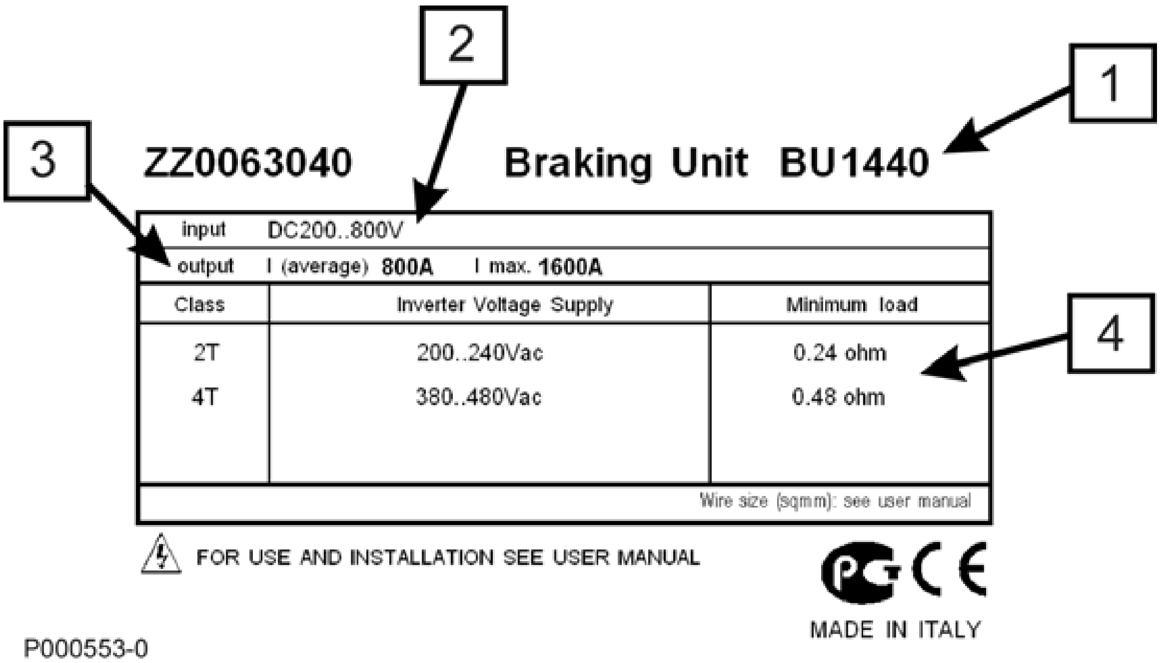


Figure 82: Nameplate for BU 720-960-1440

1. Model (BU1440 – braking unit)
2. Supply ratings: 200 to 800 VDC for BU 720-1440 2-4T (DC supply voltage produced by the inverter terminals)
3. Output current: 800A (average): mean current in output cables, 1600A (Peak): peak current in output cables;
4. Minimum value of the resistor to be connected to the output terminals (see application table).

6.3.2. Operation

Each size of the braking unit can be used with a braking resistor avoiding exceeding the max. instant current stated in its specifications.
The braking unit is controlled directly by the control unit. Braking units cannot be parallel-connected when applied to modular inverters.

6.3.3. Ratings

SIZE	Max. braking current (A)	Mean braking current (A)	Inverter supply voltage	Min. braking resistor (Ohm)	Dissipated power (at mean braking current) (W)
BU1440 2-4T	1600	800	200-240Vac/	0.24	1700
BU1440 2-4T	1600	800	380-500Vac/	0.48	1800
BU720 5-6T	800	400	500-575Vac/	1.15	950
BU720 5-6T	800	400	600-690Vac/	1.38	1000
BU960 5-6T	1000	500	500-575Vac/	0.92	1200
BU960 5-6T	1000	500	600-690Vac/	1.1	1300
BU1440 5-6T	1600	800	500-575Vac/	0.58	2100
BU1440 5-6T	1600	800	600-690Vac/	0.69	2200

6.3.4. INSTALLATION

6.3.4.1. MOUNTING

- Install vertically;
- Make sure to allow a min. clearance of 2 cm on both sides and 10 cm on top and bottom;
- Use Lexan cable-glands to maintain degree of protection IP20.

ENVIRONMENTAL REQUIREMENTS FOR THE BRAKING UNIT INSTALLATION, STORAGE AND TRANSPORT

Operating ambient temperatures	0-40 °C with no derating from 40 °C to 50 °C with a 2% derating of the rated current for each degree beyond 40 °C
Ambient temperatures for storage and transport	- 25 °C - +70 °C
Installation environment	Pollution degree 2 or higher. Do not install in direct sunlight and in places exposed to conductive dust, corrosive gases, vibrations, water sprinkling or dripping; do not install in salty environments.
Altitude	Up to 1000 m above sea level. For higher altitudes, derate the output current of 1% every 100m above 1000m (max. 4000m).
Operating ambient humidity	From 5% to 95%, from 1g/m^3 to 25g/m^3, non condensing and non freezing (class 3k3 according to EN50178)
Storage ambient humidity	From 5% to 95%, from 1g/m^3 to 25g/m^3, non condensing and non freezing (class 1k3 according to EN50178).
Ambient humidity during transport	Max. 95%, up to 60g/m^3; condensation may appear when the equipment is not running (class 2k3 according to EN50178)
Storage and operating atmospheric pressure	From 86 to 106 kPa (classes 3k3 and 1k4 according to EN50178)
Atmospheric pressure during transport	From 70 to 106 kPa (class 2k3 according to EN50178)

⚠ CAUTION!! Ambient conditions strongly affect the inverter life. Do not install the equipment in places that do not have the above-mentioned ambient conditions.

6.3.4.2. STANDARD MOUNTING

Install braking unit BU720-1440 for modular inverters in an upright position inside a cabinet, next to the other inverter modules. Its overall dimensions are the same as those of an inverter arm.

Dimensions (mm)			Fixing points (mm)				Screws	Weight (Kg)
W	H	D	X	Y	D1	D2	M10	110'
230	1400	480	120	237	11	25		

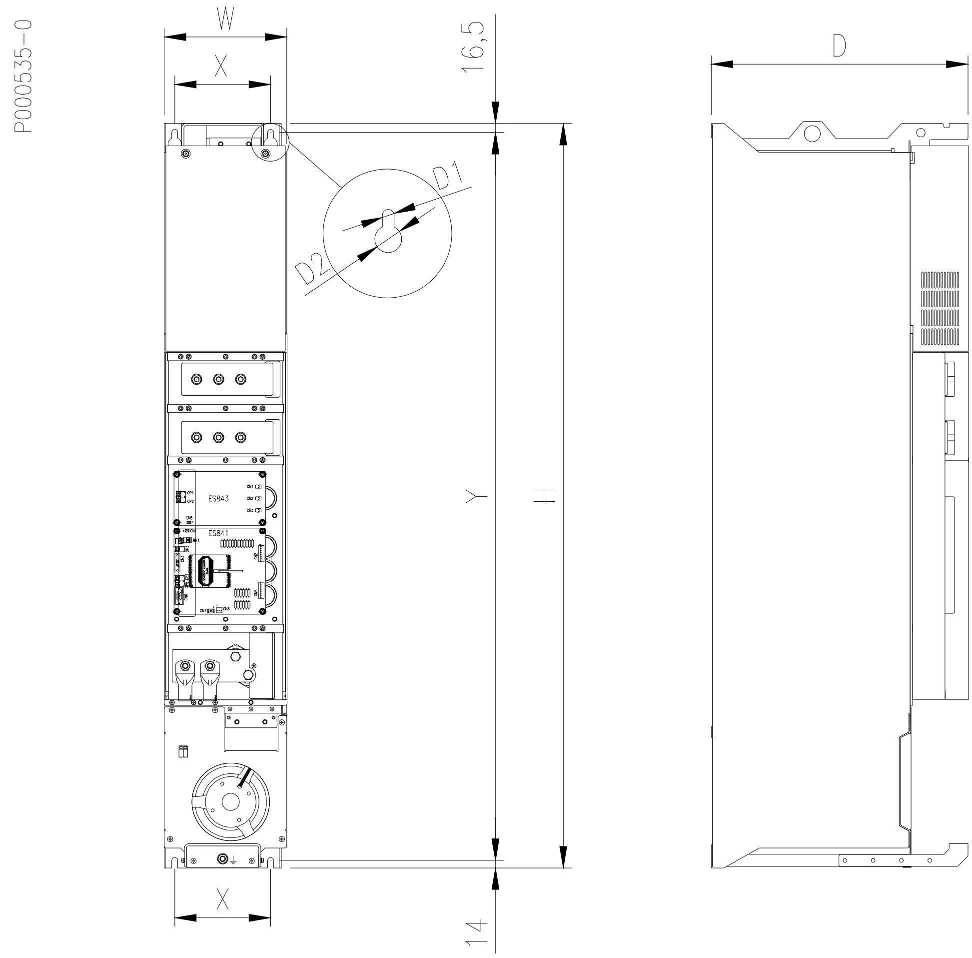


Figure 83: Dimensions and fixing points of BU720-1440

NOTE

Elettronica Santerno reserves the right to make any technical changes to this manual and to the device described herein without prior notice.

6.3.4.3. WIRING

WIRING DIAGRAM

a) Power unit

The braking unit must be connected to the inverter and the braking resistor.
The connection to the inverter is direct through 60*10mm copper plates connecting the different inverter modules. The braking resistor is connected to the + bar and to the braking unit.
Also connect the single-phase 220Vac supply of the cooling fan.

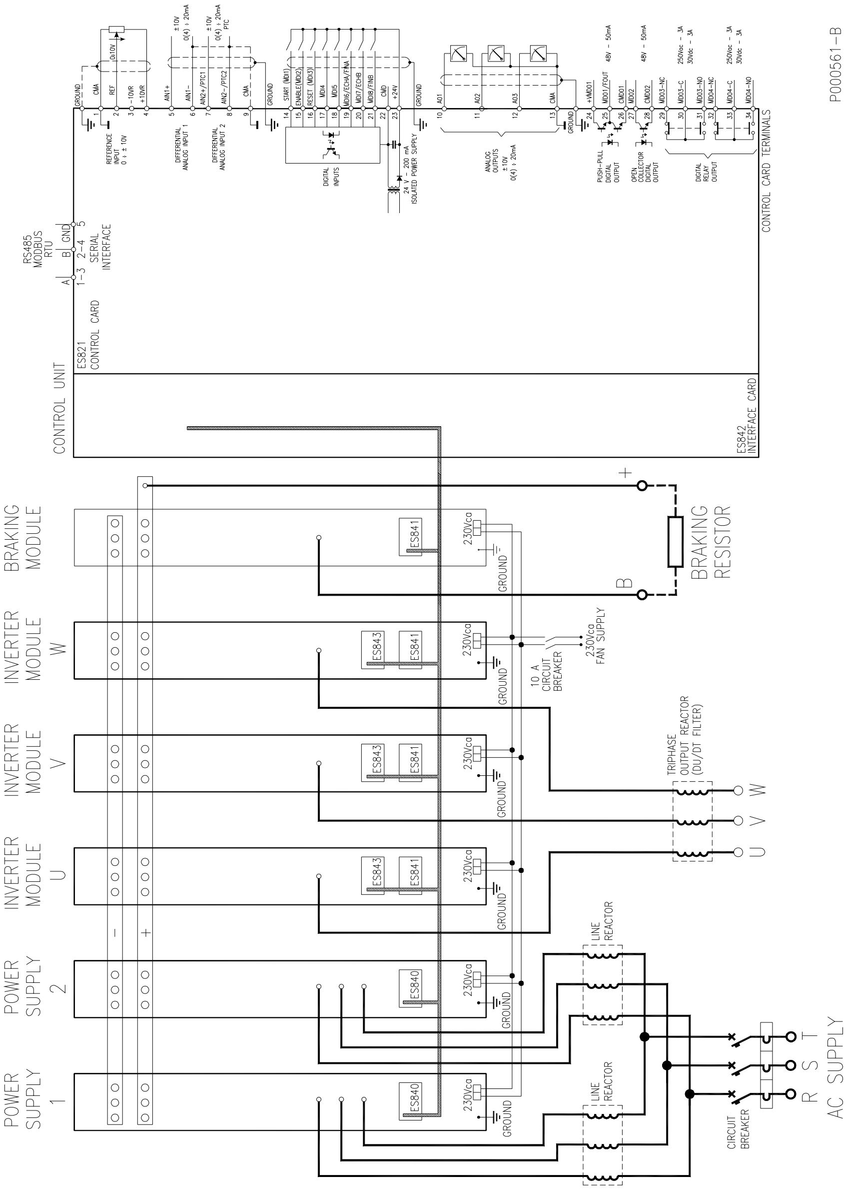


Figure 84: External power connections for modular inverters S65-S70 provided with braking unit BU770-1440

NOTE Feeder n.2 (power supply 2) is available for size S70.

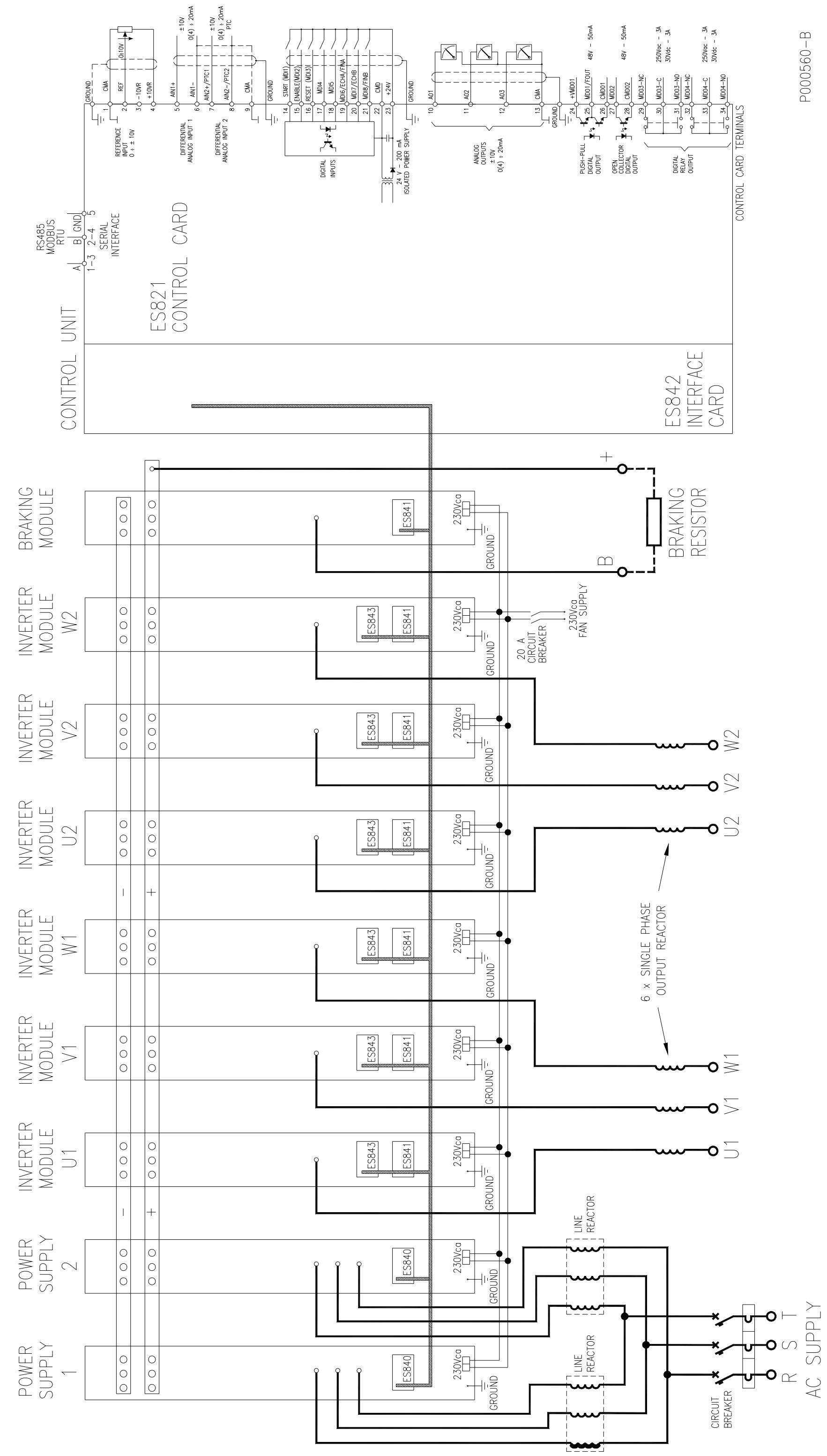


Figure 85: External power connections for modular inverters S75-S80 provided with braking unit BU770-1440

NOTE Feeder n. 3 is available for size S80.

Wire braking resistors as stated in the tables below.

Voltage class: 2T

Applications with a braking duty cycle of 10%

Inverter Size	Braking Unit	Braking Resistor			
		Quantity	Recommended Rating (Ohm)	Power (W)	Wire Cross-section mm² (kcmils)
0598	BU1440 2T-4T	1	0.45	48000	120 (250)
0748	BU1440 2T-4T	1	0.45	48000	120 (250)
0831	BU1440 2T-4T	1	0.3	64000	210(400)
0964	BU1440 2T-4T	1	0.3	64000	210(400)
1130	BU1440 2T-4T	1	0.3	64000	240(500)
1296	BU1440 2T-4T	1	0.3	64000	240(500)

Applications with a braking duty cycle of 20%

Inverter Size	Braking Unit	Braking Resistors					
		Applicable Resistors			Resistor Wiring	Resultant Rating (Ohm)	Wire Cross-section mm² (kcmils)
		Qt	Recommended Rating (Ohm)	Power (W)			
0598	BU1440 2T-4T	2	0.8	100000	parallel-connected	0.4	210(400)
0748	BU1440 2T-4T	2	0.8	100000	parallel-connected	0.4	210(400)
0831	BU1440 2T-4T	2	0.6	100000	parallel-connected	0.3	2*120 (250)
0964	BU1440 2T-4T	2	0.6	100000	parallel-connected	0.3	2*120 (250)
1130	BU1440 2T-4T	2	0.6	100000	parallel-connected	0.3	2*185(400)
1296	BU1440 2T-4T	2	0.6	100000	parallel-connected	0.3	2*185(400)

Applications with a braking duty cycle of 50%

Inverter Size	Braking Unit	Braking resistor					
		Applicable Resistors			Resistor Wiring	Resultant Rating (Ohm)	Wire Cross-section mm² (kcmils)
		Qt	Recommended Rating (Ohm)	Power (W)			
0598	BU1440 2T-4T	4	0.45	48000	series/parallel-connected	0.45	2*120 (250)
0748	BU1440 2T-4T	4	0.45	48000	series/parallel-connected	0.45	2*185(400)
0831	BU1440 2T-4T	4	0.3	64000	series/parallel-connected	0.3	2*240(400)
0964	BU1440 2T-4T	4	0.3	64000	series/parallel-connected	0.3	4*120(400)
1130	BU1440 2T-4T	4	0.3	64000	series/parallel-connected	0.3	4*120(400)
1296	BU1440 2T-4T	4	0.3	64000	series/parallel-connected	0.3	4*120(400)

Voltage class: 4T

Applications with a braking duty cycle of 10%

Inverter size	Braking Unit	Braking Resistors			
		Quantity	Recommended Rating (Ohm)	Power (W)	Wire Cross-section mm² (kcmils)
0598	BU1440 2T-4T	1	1.2Ohm	64000	120 (250)
0748	BU1440 2T-4T	1	1.2Ohm	64000	120 (250)
0831	BU1440 2T-4T	1	0.8Ohm	100000	120 (250)
0964	BU1440 2T-4T	1	0.8Ohm	100000	185(400)
1130	BU1440 2T-4T	1	0.6Ohm	100000	240(500)
1296	BU1440 2T-4T	1	0.6Ohm	100000	240(500)

Applications with a braking duty cycle of 20%

Inverter size	Braking unit	Braking resistors					
		Applicable resistors			Resistor wiring	Resultant rating (Ohm)	Wire cross-section mm² (kcmils)
		Qt	Recommended rating (Ohm)	Power (W)			
0598	BU1440 2T-4T	2	2.4	64000	parallel-connected	1.2	185(400)
0748	BU1440 2T-4T	2	2.4	64000	parallel-connected	1.2	185(400)
0831	BU1440 2T-4T	2	1.6	100000	parallel-connected	0.8	240(500)
0964	BU1440 2T-4T	2	1.6	100000	parallel-connected	0.8	2*120 (250
1130	BU1440 2T-4T	3	1.6	100000	parallel-connected	0.57	3*120(400)
1296	BU1440 2T-4T	3	1.6	100000	parallel-connected	0.57	3*120(400)

Applications with a braking duty cycle of 50%

Inverter Size	Braking Unit	Braking Resistors					
		Applicable Resistors			Resistor Wiring	Resultant Rating (Ohm)	Wire Cross-section mm² (kcmils)
		Quantity	Recommended Rating (Ohm)	Power (W)			
0598	BU1440 2T-4T	4	1.2	64000	series/parallel-connected	1.2	2*120 (250)
0748	BU1440 2T-4T	4	1.2	64000	series/parallel-connected	1.2	2*120 (250)
0831	BU1440 2T-4T	4	0.8	100000	series/parallel-connected	0.8	2*185(400)
0964	BU1440 2T-4T	4	0.8	100000	series/parallel-connected	0.8	2*210(400)
1130	BU1440 2T-4T	4	0.6	100000	series/parallel-connected	0.6	2*240(400)
1296	BU1440 2T-4T	4	0.6	100000	series/parallel-connected	0.6	4*120(400)

Voltage class: 5T

Applications with a braking duty cycle of 10%

Inverter Size	Braking Unit	Braking Resistors					
		Applicable Resistors			Resistor Wiring	Resultant Rating (Ohm)	Wire Cross-section mm² (AWG or kcmils)
		Quantity	Recommended rating (Ohm)	Power (W)			
0250	BU 720 5-6T	1	2.4	48000	-	2.40	50(1/0AWG)
0312	BU 720 5-6T	1	2.4	48000	-	2.40	50(1/0AWG
0366	BU 720 5-6T	1	2.4	48000	-	2.40	50(1/0AWG
0399	BU 720 5-6T	1	1.6	64000	-	1.60	95(4/0AWG)
0457	BU 720 5-6T	1	1.6	64000	-	1.60	95(4/0AWG)
0524	BU 720 5-6T	1	1.2	64000	-	1.20	120 (250 kcmils)
0598	BU 720 5-6T	1	1.2	64000	-	1.20	120 (250 kcmils)
0748	BU 1440 5-6T	1	0.8	100000	-	0.80	210(400)
0831	BU 1440 5-6T	1	0.8	100000	-	0.80	210(400)
0964	BU 1440 5-6T	2	1.2	64000	parallel-connected	0.60	2*150 (300kcmils)
1130	BU 1440 5-6T	2	1.2	64000	parallel-connected	0.60	2*150 (300kcmils)
1296	BU 1440 5-6T	2	1.2	100000	parallel-connected	0.60	2*150 (300kcmils)

Applications with a braking duty cycle of 20%

Inverter Size	Braking Unit	Braking Resistors					
		Applicable Resistors			Resistor Wiring	Resultant Rating (Ohm)	Wire Cross-section mm² (AWG or kcmils)
		Quantity	Recommended rating (Ohm)	Power (W)			
0250	BU 720 5-6T	1	2.4	64000	-	2.40	95(4/0AWG)
0312	BU 720 5-6T	1	2.4	64000	-	2.40	95(4/0AWG)
0366	BU 720 5-6T	1	2.4	64000	-	2.40	95(4/0AWG)
0399	BU 720 5-6T	1	1.6	100000	-	1.60	120 (250 kcmils)
0457	BU 720 5-6T	1	1.6	100000	-	1.60	120 (250 kcmils)
0524	BU 720 5-6T	2	2.4	64000	parallel-connected	1.20	185(400 kcmils)
0598	BU 720 5-6T	2	2.4	64000	parallel-connected	1.20	185(400 kcmils)
0748	BU 1440 5-6T	2	1.6	100000	parallel-connected	0.80	2*150 (300kcmils)
0831	BU 1440 5-6T	2	1.6	100000	parallel-connected	0.80	2*150 (300kcmils)
0964	BU 1440 5-6T	2	1.2	100000	parallel-connected	0.60	2*240(400kcmils)
1130	BU 1440 5-6T	4	2.4	64000	parallel-connected	0.60	2*240(400kcmils)
1296	BU 1440 5-6T	4	2.4	64000	parallel-connected	0.60	2*240(400kcmils)

Applications with a braking duty cycle of 50%

Inverter Size	Braking Unit	Braking Resistors					
		Applicable Resistors			Resistor Wiring	Resultant Rating (Ohm)	Wire Cross-section mm² (AWG or kcmils)
		Quantity	Recommended Rating (Ohm)	Power (W)			
0250	BU 720 5-6T	4	2.4	48000	series/parallel-conn.	2.40	120 (250 kcmils)
0312	BU 720 5-6T	4	2.4	48000	series/parallel-conn.	2.40	120 (250 kcmils)
0366	BU 720 5-6T	4	2.4	48000	series/parallel-conn.	2.40	185(400 kcmils)
0399	BU 720 5-6T	4	1.6	64000	series/parallel-conn.	1.60	210(500 kcmils)
0457	BU 720 5-6T	4	1.6	64000	series/parallel-conn.	1.60	2*120 (250 kcmils)
0524	BU 720 5-6T	4	1.2	64000	series/parallel-conn.	1.20	2*120 (250 kcmils)
0598	BU 720 5-6T	4	1.2	100000	series/parallel-conn.	1.20	2*185(400 kcmils)
0748	BU 1440 5-6T	4	0.8	100000	series/parallel-conn.	0.80	2*185(400 kcmils)
0831	BU 1440 5-6T	4	0.8	100000	series/parallel-conn.	0.80	2*185(400 kcmils)
0964	BU 1440 5-6T	8	1.2	64000	series/parallel-conn.	0.60	4*150 (300 kcmils)
1130	BU 1440 5-6T	8	1.2	100000	series/parallel-conn.	0.60	4*150 (300 kcmils)
1296	BU 1440 5-6T	8	1.2	100000	series/parallel-conn.	0.60	4*150 (300 kcmils)

Voltage class: 6T

Applications with a braking duty cycle of 10%

Inverter Size	Braking Unit	Braking Resistors					
		Applicable Resistors			Resistor Wiring	Resultant Rating (Ohm)	Wire Cross-section mm² (AWG or kcmils)
		Quantity	Recommended rating (Ohm)	Power (W)			
0250	BU 720 5-6T	1	2.4	48000	-	2.4	50(1/0AWG)
0312	BU 720 5-6T	1	2.4	48000	-	2.4	50(1/0AWG
0366	BU 720 5-6T	1	2.4	48000	-	2.4	50(1/0AWG
0399	BU 720 5-6T	1	2.4	64000	-	2.4	50(1/0AWG
0457	BU 720 5-6T	1	1.6	64000	-	1.6	120 (250 kcmils)
0524	BU 720 5-6T	1	1.6	64000	-	1.6	120 (250 kcmils)
0598	BU 960 5-6T	1	1.2	100000	-	1.2	120 (250 kcmils)
0748	BU 960 5-6T	1	1.2	100000	-	1.2	185(400 kcmils)
0831	BU 960 5-6T	1	1.2	100000	-	1.2	185(400 kcmils)
0964	BU 1440 5-6T	2	1.6	100000	parallel-connected	0.8	240(500 kcmils)
1130	BU 1440 5-6T	2	1.6	100000	parallel-connected	0.8	240(500 kcmils)
1296	BU 1440 5-6T	2	1.6	100000	parallel-connected	0.8	240(500 kcmils)

Applications with a braking duty cycle of 20%

Inverter Size	Braking Unit	Braking Resistors					
		Applicable Resistors			Resistor Wiring	Resultant Rating (Ohm)	Wire Cross-section mm² (AWG or kcmils)
		Quantity	Recommended rating (Ohm)	Power (W)			
0250	BU 720 5-6T	1	2.4Ohm	64000	-	2.4	95(4/0AWG)
0312	BU 720 5-6T	2	1.2Ohm	64000	series-connected	2.4	120 (250 kcmils)
0366	BU 720 5-6T	2	1.2Ohm	64000	series-connected	2.4	120 (250 kcmils)
0399	BU 720 5-6T	2	1.2Ohm	64000	series-connected	2.4	120 (250 kcmils)
0457	BU 720 5-6T	2	0.8Ohm	64000	series-connected	1.6	185(400 kcmils)
0524	BU 720 5-6T	2	0.8Ohm	64000	series-connected	1.6	185(400 kcmils)
0598	BU 960 5-6T	2	0.6Ohm	100000	series-connected	1.2	240(500 kcmils)
0748	BU 960 5-6T	2	0.6Ohm	100000	series-connected	1.2	240(500 kcmils)
0831	BU 960 5-6T	2	0.6Ohm	100000	series-connected	1.2	240(500 kcmils)
0964	BU 1440 5-6T	4	0.8Ohm	64000	series/parallel-conn.	0.8	3*120 (250 kcmils)
1130	BU 1440 5-6T	6	1.2Ohm	64000	series/parallel-conn.	0.8	3*120 (250 kcmils)
1296	BU 1440 5-6T	6	1.2Ohm	64000	series/parallel-conn.	0.8	3*120 (250 kcmils)

Applications with a braking duty cycle of 50%

Inverter Size	Braking Unit	Braking Resistors					
		Applicable Resistors			Resistor Wiring	Resultant Rating (Ohm)	Wire Cross-section mm² (AWG or kcmils)
		Quantity	Recommended Rating (Ohm)	Power (W)			
0250	BU 720 5-6T	4	2.4	64000	series/parallel conn.	2.4	120 (250 kcmils)
0312	BU 720 5-6T	4	2.4	64000	series/parallel conn.	2.4	185(400 kcmils)
0366	BU 720 5-6T	4	2.4	64000	series/parallel conn.	2.4	185(400 kcmils)
0399	BU 720 5-6T	4	2.4	64000	series/parallel conn.	2.4	240(500 kcmils))
0457	BU 720 5-6T	4	1.6	100000	series/parallel conn.	1.6	240(500 kcmils)
0524	BU 720 5-6T	4	1.6	100000	series/parallel conn.	1.6	2*150 (300 kcmils)
0598	BU 960 5-6T	8	2.4	64000	series/parallel conn.	1.2	2*150 (300 kcmils)
0748	BU 960 5-6T	8	2.4	64000	series/parallel conn.	1.2	2*240 (500 kcmils)
0831	BU 960 5-6T	8	2.4	64000	series/parallel conn.	1.2	2*240(500 kcmils)
0964	BU 1440 5-6T	8	1.6	100000	series/parallel-conn.	0.8	4*150 (300 kcmils)
1130	BU 1440 5-6T	8	1.6	100000	series/parallel conn.	0.8	4*150 (300 kcmils)
1296	BU 1440 5-6T	8	1.6	100000	series/parallel conn.	0.8	4*150 (300 kcmils)

b) Signal wiring

CAUTION!! Make sure that the control device is properly set-up when using the braking arm. When ordering the inverter, always state the inverter configuration you want to obtain.

Because the braking arm is controlled directly by the control device, the following wiring is required:

- connect +24V supply of gate unit ES841 of the braking unit through a pair of unipolar wires (AWG17-18 - 1 mm^2)
- connect braking IGBT to the fault IGBT signal through 2 optical fibres (diameter: 1mm) made of plastic (typical attenuation coefficient: 0.22dB/m) provided with Agilent HFBR-4503/4513 connectors.

The wiring diagram is as follows:

Signal	Type of wiring	Wire marking	Component	Board	Connector	Component	Board	Connector
+24VD Driver board ES841 power supply	Unipolar wire 1mm^2	24V-GB	Phase W	ES841	MR1-3	Braking unit	ES841	MR1-1
0VD Driver board ES841 power supply	Unipolar wire 1mm^2		Phase W	ES841	MR1-4	Braking unit	ES841	MR1-2
Brake IGBT command	Single optical fibre	G-B	Control unit	ES842	OP-4	Braking unit	ES841	OP5
Brake IGBT fault	Single optical fibre	FA-B	Control unit	ES842	OP-3	Braking unit	ES841	OP3

CAUTION!! Do not remove the cap of connector OP4 in control board ES841 for the braking module.

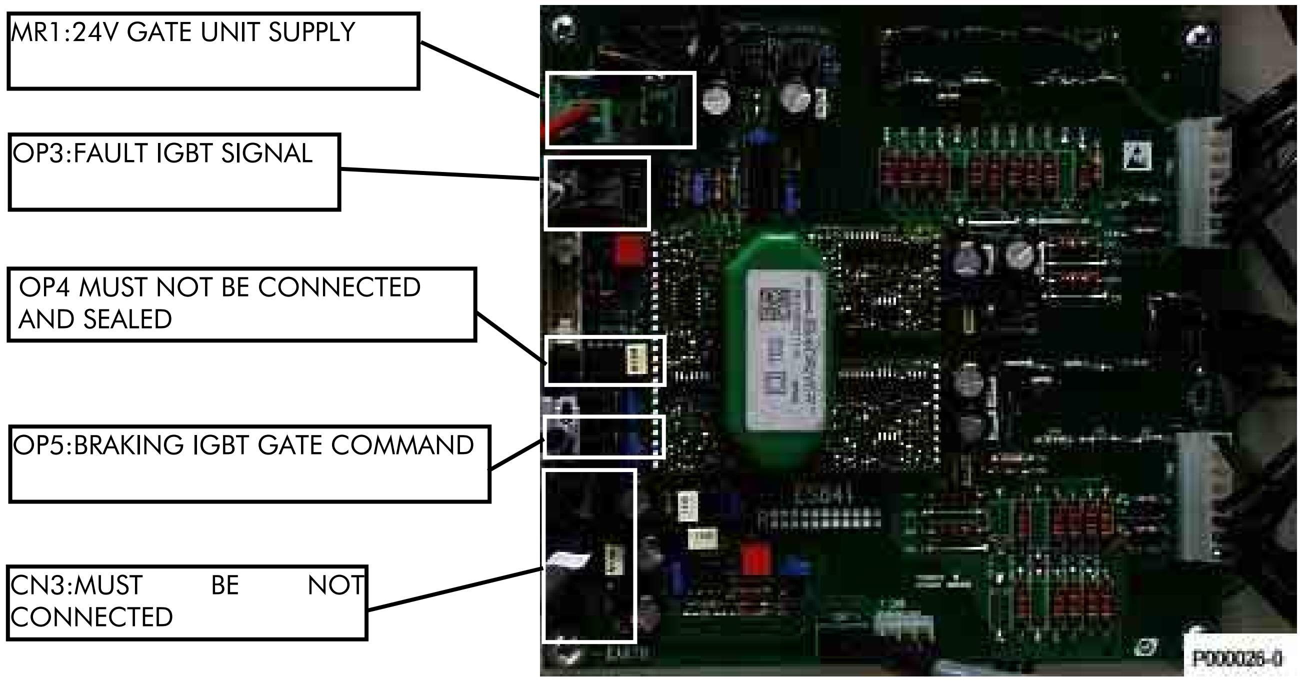


Figure 86: Gate unit board ES841 for the braking unit

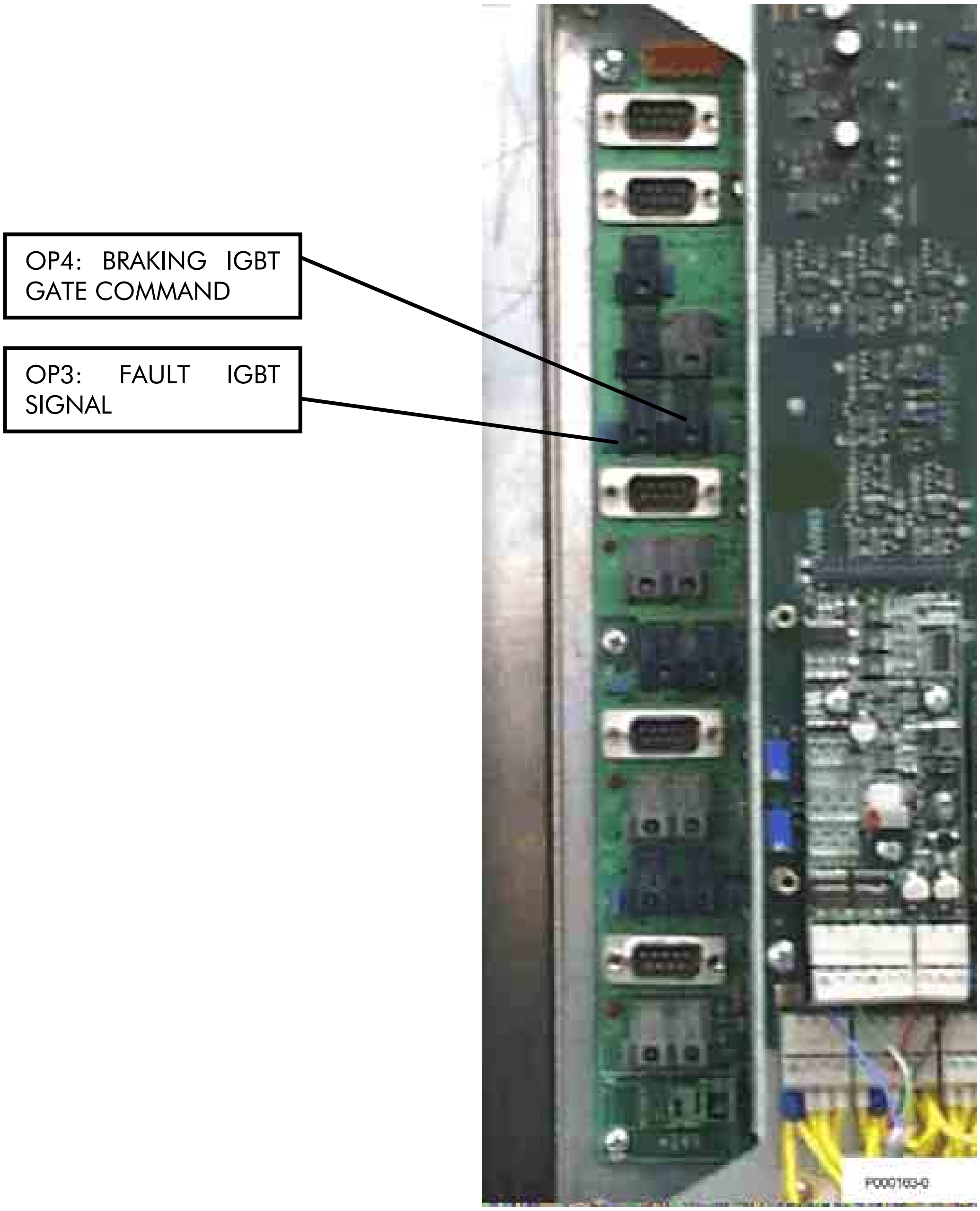


Figure 87: wiring points of the optical fibres in control board ES842

The figure below shows the internal wiring of inverters S65-S70 provided with a braking unit.

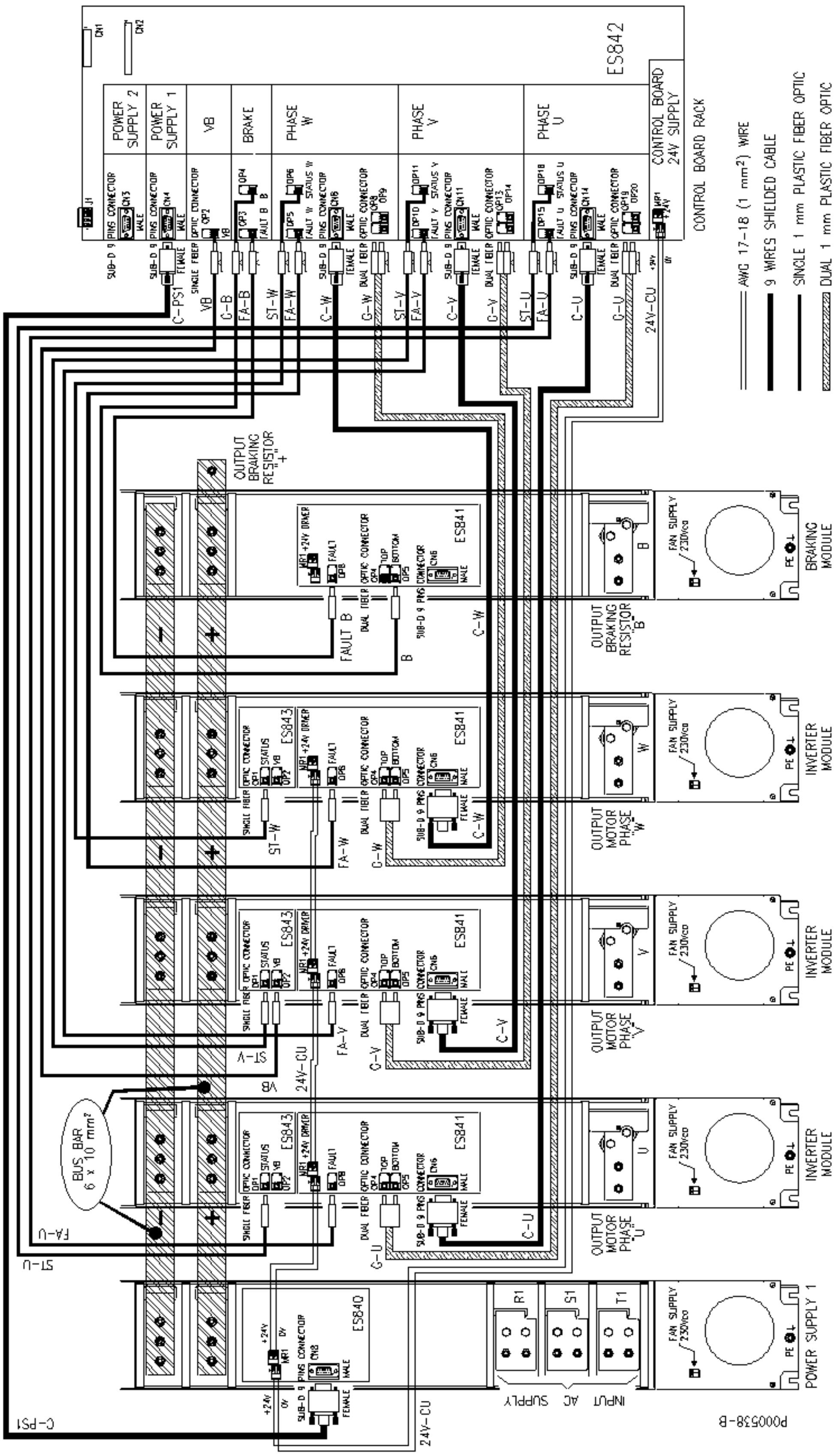


Figure 88: Internal wiring of inverters S65- provided with a braking unit.

6.4. KEYPAD REMOTING KITS

6.4.1. REMOTING THE KEYPAD ON THE CABINET

The inverter keypad may be remoted. A special kit is supplied, which includes the following:
- plastic frame allowing to install the keypad on the front wall of the cabinet,
- keypad jig allowing to install the keypad on the front door of the cabinet,
- seal between keypad frame and cabinet,
- remoting cable (length: 5 m).

If the kit supplied is properly assembled, degree of protection IP54 is obtained for the front panel in the cabinet.
For any details on how to remote the keypad, see section 1.5 "Operating and Remoting the Keypad".

6.4.2. REMOTING A KEYPAD CONTROLLING MULTIPLE INVERTERS

The keypad remoting kit is used to connect a standard SINUS PENTA keypad to one or multiple inverters manufactured by Elettronica Santerno via an RS485 link using protocol MODBUS RTU. The keypad can then communicate with one device at a time and will become the network master, thus avoiding communicating with any other master devices (e.g. PLCs).
The keypad automatically detects which device it is connected to. If multiple devices are connected, you can select the device to be used from a selection list.

NOTE — The devices connected to the same network must have different addresses. Otherwise, no communication is possible.

NOTE — The sections below state the applicability of the keypad remoting kit to the products manufactured by Elettronica Santerno.

6.4.2.1. KIT COMPONENT PARTS

The kit for the keypad used via serial link RS485 includes the following component parts:

N.1 Interface converter provided with 1 plug RJ45 on one side, and with a 9-pole, female sub-D connector on the other side.
N.1 220 VAC – 9 VAC supply, for separate supply from standard keypad.

DESCRIPTION	ID NUMBER
Adaptor kit for keypad connection via RS-485	ZZ0101850

6.4.2.2. OPERATING CONDITIONS

Operating temperature:	0 to +50 °C ambient temperature (contact Elettronica Santerno for higher ambient temperatures)
Relative humidity:	5 to 95% (non condensing)
Max. operating altitude:	4000 m (a.s.l.)
Max. consumption over 9 V power supply:	300 mA
Max. baud rate:	38.400 bps

6.4.2.3. APPLICABILITY

The keypad remoting kit can be applied to the following devices manufactured by Elettronica Santerno:

"Sinus PENTA" industrial inverters
"Sunway T/TG/TG-A/M-XR" solar inverters
"Sunway Bach" solar battery chargers
"ALADIN M/T" hybrid inverters

6.4.2.4. CONNECTING THE KEYPAD

Inverter-side connection: use a 9-pole, male D connector. To gain access to the D connector, just remove the cover on top of the inverter (size S05..S15), or remove the cover from the inverter bottom, located next to the control terminals (size ≥ S20). For more details on D connector, see the installation manual of the product. If multiple inverters are connected to the same network, use a connector having the same features as the connector installed on the inverter.
The connector pins are detailed in the table below.

PIN	FUNCTION
1 – 3	(TX/RX A) Differential input/output A (bidirectional) according to standard RS485. Positive polarity with respect to pins 2 – 4 for one MARK.
2 – 4	(TX/RX B) Differential input/output B (bidirectional) according to standard RS485. Negative polarity with respect to pins 1 – 3 for one MARK.
5	(GND) control board zero volt
6	(VTEST) Test supply input – <u>do not connect</u>
7 – 8	Not connected
9	+ 5 V, max. 100 mA power supply

NOTE — The metal frame of the connector is connected to the inverter grounding. Connect the braiding of the twisted pair data cable to the metal frame of the female connector to be connected to the inverter.

Connector RJ 45 must be connected to the keypad.
This connector has the following connections:

PIN	FUNCTION
4	(TX/RX A) Differential input/output A (bidirectional) according to standard RS485. Positive polarity with respect to pin 6 for one MARK.
6	(TX/RX B) Differential input/output B (bidirectional) according to standard RS485. Negative polarity with respect to pin 4 for one MARK.
1-2-3	(GND) keypad zero volt.
5-7-8	+ 5 V, max. 100 mA power supply

The figure below shows the wiring diagram:

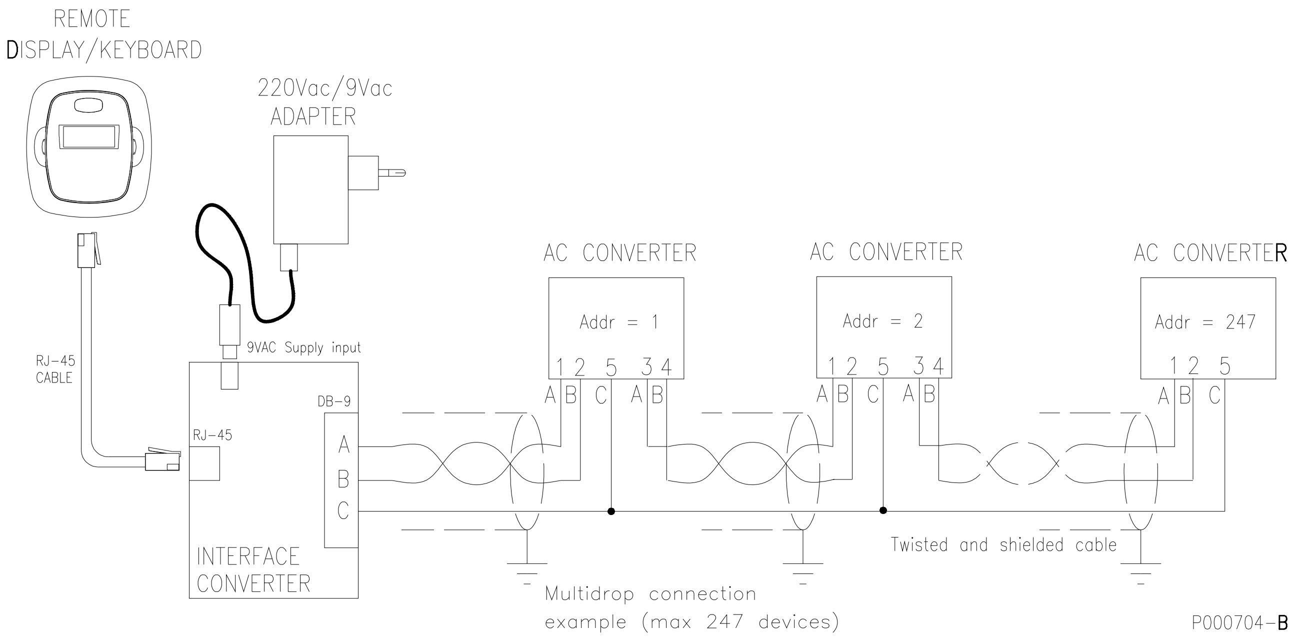


Figure 89: Wiring diagram of the keypad remoting kit controlling multiple inverters

6.4.2.5. COMMUNICATIONS PROTOCOL

Standard MODBUS RTU protocol is used for communications.
Set the following values for the inverter/keypad; please refer to the Programming Manual of the inverter being used for the setup of the relevant parameters:

Setting values to the inverter

Baud rate:	38.400 bps
Data format:	8 bits
Start bit:	1
Parity:	NO
Stop bit:	2
Protocol:	MODBUS RTU
Device address:	to be set between 1 and 247 to avoid conflicts (default address is 1)
Electric standard:	RS485
Inverter response delay:	5 ms
End of message timeout:	2 ms

Setting values to the keypad

Device address:	To be set between 0 and 247 (default address is 1)

In order to scan the connected inverters, set the device address to 0 for the keypad. The keypad can communicate with one device at a time, based on the address that has been set up.

CAUTION — If different parameter values are set, communication errors between the inverter and the keypad may occur.

6.4.2.6. CONNECTION

Remove voltage from the inverter(s). Then proceed as follows:

Disconnect the keypad installed on the inverter (if any)
Please refer to the Installation Manual of the inverter being used.

Connect the cable to the interface converter and the keypad
Connect connector DB9 to the inverter or to network RS485. The inverter side with telephone connector RJ45 must be already connected to the keypad.

Check that communication is correct
Turn on one of the inverters connected to the network. The keypad shows POWER ON. To scan the inverters connected to the network, set the device address on the keypad to 0 (please refer to the Programming Manual of the inverter being used). The list of the connected devices appears on the keypad display. Select the device to be used to start communicating with the keypad, using all functionalities offered by the connected device. Please refer to the Users Manual of the device being used for the operation of the keypad connected to the device.

Segregate the keypad power supply using the supply
Connect the supply output to the proper plug and set the toggle to ON.

6.5. REACTANCE

6.5.1. INPUT INDUCTANCE

We suggest that a three-phase inductance, or a DCBUS DC inductance be installed on the supply line to obtain the following benefits:
- limit input current peaks on the input circuit of the inverter and value di/dt due to the input rectifier and to the capacitive load of the capacitors set;
- reducing supply harmonic current;
- increasing power factor, thus reducing line current;
- increasing the duration of line capacitors inside the inverter.

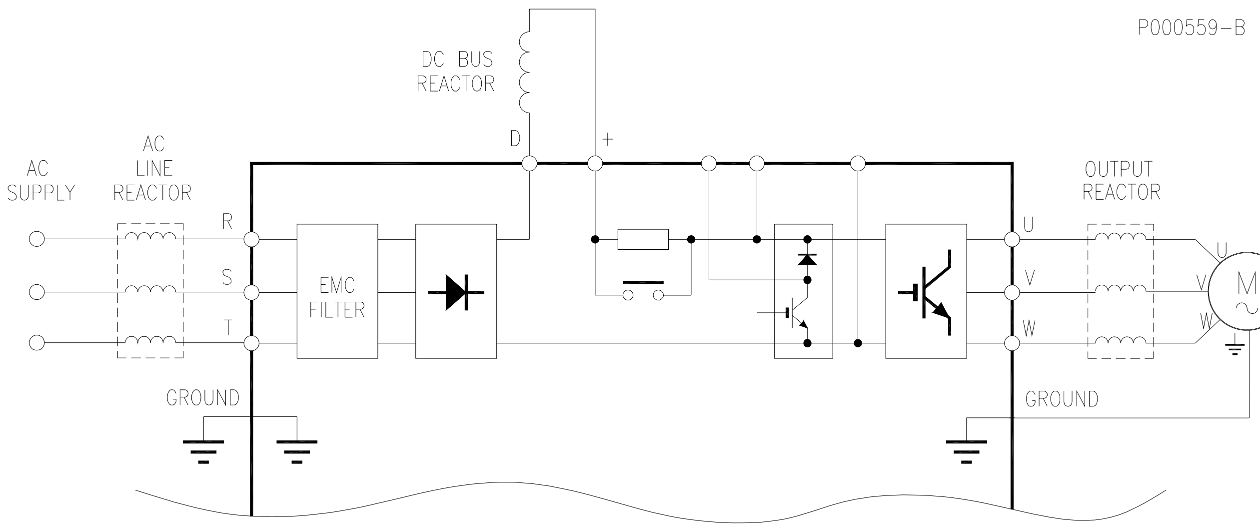


Figure 90: Wiring diagram for optional inductance

Harmonic currents

The shapes of the different waves (current or voltage) may be expressed as the sum of the basic frequency (50 or 60Hz) and its multiples. In balanced, three-phase systems, only odd harmonic current exists, as even current is neutralized by symmetrical considerations.
Harmonic current is generated by non linear loads absorbing non-sinusoidal current. Typical sources of this type are bridge rectifiers (power electronics), switching feeders and fluorescent lamps. Three-phase rectifiers absorb line current with a harmonic content n=6K±1 with K=1,2,3,... (e.g. 5th,7th,11th,13th,17th,19th, etc.). Harmonic current amplitude decreases when frequency increases. Harmonic current carries no active power; it is additional current carried by electrical cables. Typical effects are: conductor overload, power factor decrease and measurement systems instability. Voltage generated by current flowing in the transformer reactance may also damage other appliances or interfere with mains-synchronized switching equipment.

Solving the problem

Harmonic current amplitude decreases when frequency increases; as a result, reducing high-amplitude components determines the filtering of low-frequency components. The better way is to increase low-frequency impedance by installing an inductance. Power drive systems with no mains-side inductance generate larger harmonic currents than power drives which do have an inductance.
The inductance may be installed both on AC-side, as a 3-phase inductance on the supply line, and on DC-side, as a single-phase inductance installed between the rectifier bridge and the capacitor bank inside the inverter. Even greater benefits are obtained if inductance is installed both on AC-side and on DC-side.
Unlike DC inductance, AC inductance filters also high-frequency components with greater efficiency.

NOTE DC-side inductance can be connected only to inverters sizes from S15 on (to be stated when ordering the equipment).

NOTE When a DC-side inductance is used, it is sometimes possible that no braking resistor or external braking unit can be connected to the inverter.

Harmonic currents in the inverter power supply

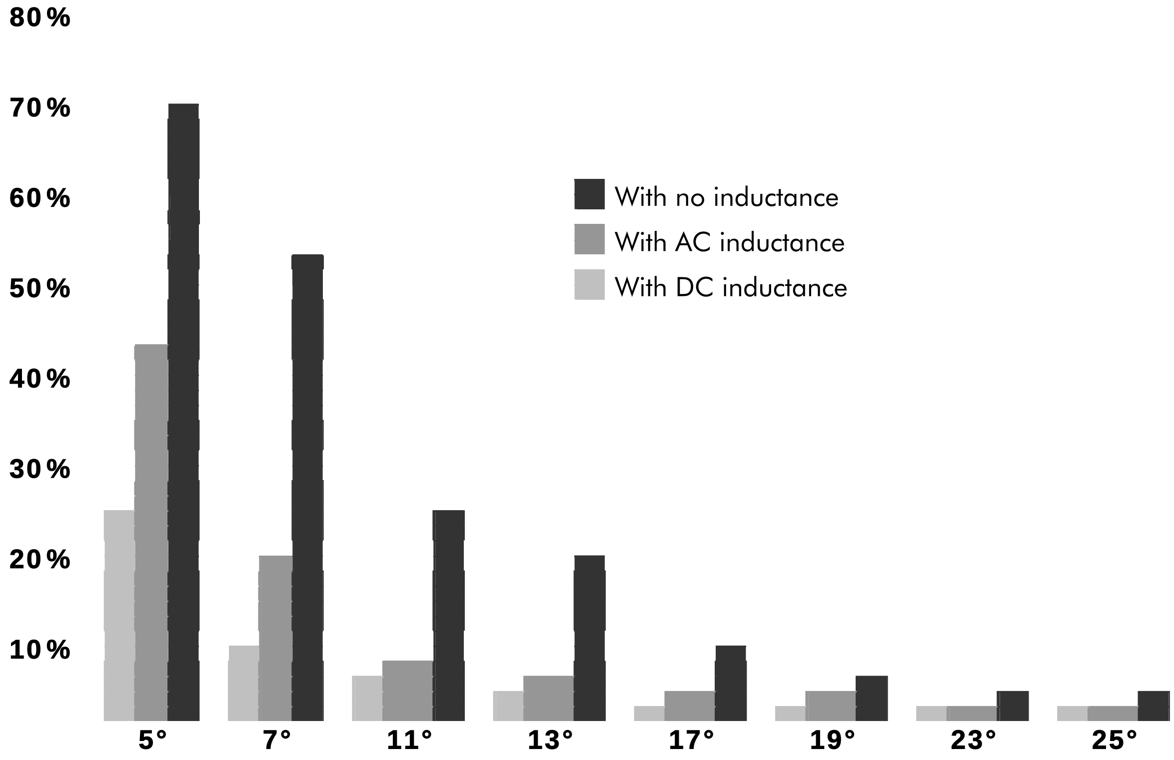


Figure 91: Amplitude of harmonic currents (approximate values)

CAUTION

For inverter sizes lower than S40 included, always use an input inductance under the following circumstances: mains instability; converters installed for DC motors; loads generating strong voltage variations at startup; power factor correction systems; mains rated power exceeding 500 KVA.
Always activate a line inductance for inverter sizes higher than S50, unless the inverter is powered via a dedicated transformer.

CAUTION

Always activate AC line inductance for modular inverters equipped with multiple supplies (size S70, S75, S80).

NOTE

The amplitude of harmonic currents and their distortion of the mains voltage is strongly affected by the features of the mains where the equipment is installed. The ratings stated in this manual fit most applications. For special applications, please contact Elettronica Santerno's After-sales service.

The ratings of optional inductance recommended based on the inverter size are detailed in section 6.5.4 below.

0 1 2 3 4 5 6 7 8

6.5.2. 12-PHASE CONNECTION

For >500kW drives, a *12-pulse* rectifier is normally used. This suppresses the lowest harmonic current in the supply line.
A 12-pulse inductance suppresses 5th and 7th harmonics; harmonics left are the 11th and the 13th, followed by the 23th, the 25th and so on, with their relevant low levels. The supply current shape is very similar to a sinusoid.
In that case, a dedicated transformer is needed, along with a specific interphase inductance for current balance and an additional diode bridge installed outside the inverter (two supply modules are needed for modular inverters).

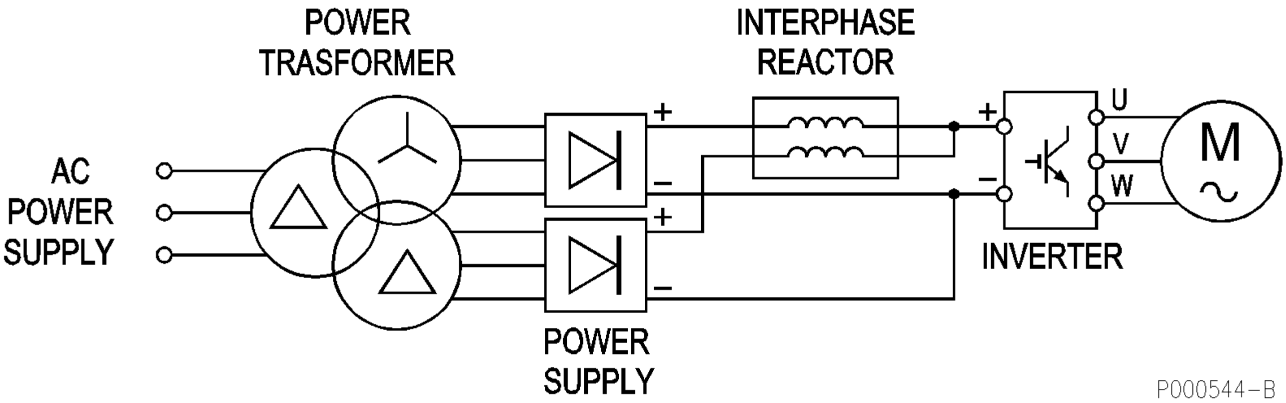


Figure 92: Layout of a 12-phase connection

6.5.3. OUTPUT INDUCTANCE

Installations requiring a longer distance between the inverter and the motor may cause overcurrent protections to frequently trip. This is due to the wire parasite capacity generating current pulses at the inverter output. This current peaks may be limited by an inductance installed on the inverter output. Screened cables even have a higher capacity and may have problems with a shorter length. The recommended output inductance is the same that can be installed at the inverter input (see previous section). The max. distance between the motor and the inverter is given as an example, as parasite capacity is also affected by the type of wiring path and wiring system. For instance, when several inverters and their connected motors are networked, segregating the inverter wires from the motor wires will avoid capacitive couplings between the wiring of each motor. In that case, a reactance should be installed at the output of each inverter.

Motor wiring with unscreened cables

2-4-6 pole MOTORS

Size							
Up to S10							
Up to S30							
Up to S40							
From S40							
Cable Length	30	60	90	120	150	> 150	**mt.**

8 - 10 pole MOTORS

Size						
Up to S10						
Up to S30						
Up to S40						
From S40						
Cable Length	30	60	90	120	>120	**mt.**

CAUTION — Inductance stated in the tables above may be used when the inverter output frequency does not exceed 60 Hz. For a higher output frequency a special inductance for the max. allowable operating frequency must be used; please contact Elettronica Santerno S.p.A.

NOTE — When using > 10 - pole motors an output inductance is always required.

NOTE — When using parallel-connected motors, always consider the total length of the cables being used (sum of the cable length of each motor).

Motor wiring with screened cables

2-4-6 pole MOTORS

Size					
Up to S10					
Up to S30					
Up to S40					
From S40					
Cable Length	20	40	80	>80	**mt.**

8 - 10 pole MOTORS

Size						
Up to S10						
Up to S30						
Up to S40						
From S40						
Cable Length	20	40	60	80	> 80	**mt.**

The output inductance is not required
The output inductance is required

CAUTION — Inductance stated in the tables above may be used when the inverter output frequency does not exceed 60 Hz. For a higher output frequency a special inductance for the max. allowable operating frequency must be used; please contact Elettronica Santerno S.p.A.

NOTE — When using > 10 - pole motors an output inductance is always required.

NOTE — When using parallel-connected motors, always consider the total length of the cables being used (sum of the cable length of each motor).

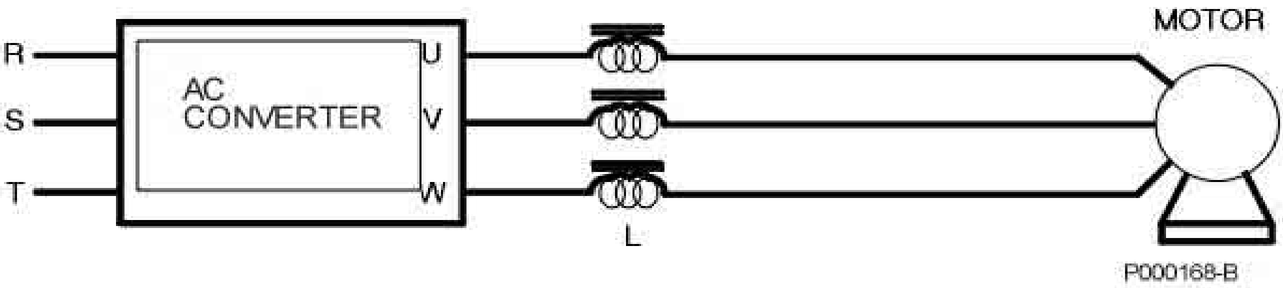


Figure 93: Output inductance wiring

6.5.4. Applying the Inductance to the Inverter

6.5.4.1. 2T Class – AC and DC Inductance

SIZE	SINUS PENTA MODEL	INPUT AC 3-PHASE INDUCTANCE	DC SINGLE-PHASE INDUCTANCE	OUTPUT INDUCTANCE
S05	0007	IM0126004 2.0mH–11Arms	IM0140054 8mH-10.5Arms/12.8Apeak	IM0126004 2.0mH–11Arms (AC 3-phase)
	0008	IM0126044 1.27mH–17Arms	IM0140104 5.1mH-17Arms/21Apeak	IM0126044 1.27mH–17Arms (AC 3-phase)
	0010			
	0015	IM0126084 0.7mH–32Arms	IM0140154 2.8mH–32.5Arms/40.5Apeak	IM0126084 0.7mH–32Arms (AC 3-phase)
	0016			
	0020			
S10	0016	IM0126084 0.7mH–32Arms	Not applicable	IM0126084 0.7mH–32Arms (AC 3-phase)
	0017			
	0020			
	0025	IM0126124 0.51mH – 43Arms	Not applicable	IM0126124 0.51mH–43Arms (AC 3-phase)
	0030			
	0035			
S12	0023	IM0126124 0.51mH – 43Arms	IM0140204 2.0mH–47Arms/58.5 Apeak	IM0126124 0.51mH–43Arms (AC 3-phase)
	0033	IM0126144 0.3mH–68Arms	IM0140254 1.2mH–69Arms/87Apeak	IM0126144 0.32mH–68Arms (AC 3-phase)
	0037			
S15	0038		Not applicable	
	0040	IM0126164 0.24mH–92Arms		IM0126164 0.24 mH–92Arms (AC 3-phase)
	0049			
S20	0060		IM0140304 0.64mH–160Arms/195Apeak	
	0067	IM0126204 0.16mH–142Arms		IM0126204 0.16mH–142Arms (AC 3-phase)
	0074			
	0086			
S30	0113	IM0126244 0.09mH–252Arms	IM0140404 0.36mH–275Arms/345 Apeak	IM0126244 0.09mH–252Arms (AC 3-phase)
	0129			
	0150			
	0162			
S40	0179	IM0126284 0.061mH–362Arms	IM0140504 0.24mH–420Arms/520Apeak	IM0126284 0.061mH–362Arms (AC 3-phase)
	0200			
	0216	IM0126324 0.054mH–410Arms	IM0140554 0.216mH–460Arms/580Apeak	IM0126324 0.054mH–410Arms (AC 3-phase)
	0250			
S50	0312	IM0126364 0.033mH–662Arms	IM0140654 0.132mH–740Arms/930Apeak	IM0126364 0.033mH–662Arms (AC 3-phase)
	0366			
	0399			
S60	0457	IM0126404 0.023mH–945Arms	IM0140754 0.092mH–1040Arms1300/Apeak	IM0126404 0.023mH–945Arms (AC 3-phase)
	0525			
S65	0598			
	0748	IM0126444 0.018mH–1260 Arms	IM0140854 0.072mH–1470Arms/1850Apeak	IM0126444 0.018mH–1260Arms (AC 3-phase)
	0831			

(continued)

(continued)

S75	0964	2 x IM0126404	2 x IM0140754	6 x IM0140674 0.024mH–950Arms (AC single-phase)
	1130	2 x IM0126404	2 x IM0140754	6 x IM0140774 0.018mH–1250Arms (AC single-phase)
	1296	2 x IM0126444	2 x IM0140854	

6.5.4.2. 5T – 6T CLASSES – AC AND DC INDUCTANCE

SIZE	SINUS PENTA MODEL	INPUT AC 3-PHASE INDUCTANCE	DC SINGLE-PHASE INDUCTANCE	OUTPUT INDUCTANCE
S05	0005	IM0126004 2.0mH–11Arms	Not applicable	IM0126004 2.0mH–11Arms (AC 3-phase)
	0007	IM0126044 1.27mH – 17Arms	Not applicable	IM0126044 1.27mH–17Arms (AC 3-phase)
	0009			
	0011			
	0014			
S10	0016	IM0126084 0.7mH–32Arms	Not applicable	IM0126084 0.7mH–32Arms (AC 3-phase)
	0017			
	0020			
	0025	IM0126124 0.51mH – 43Arms	Not applicable	IM0126124 0.51mH–43Arms (AC 3-phase)
	0030			
	0035			
S12	0016	IM0126084 0.7mH–32Arms	IM0140154 2.8mH–32.5Arms/40.5Apeak	IM0126084 0.7mH–32Arms (AC 3-phase)
	0017			
	0020			
	0025	IM0126124 0.51mH – 43Arms	IM0140204 2.0mH–47Arms/58.5 Apeak	IM0126124 0.51mH–43Arms (AC 3-phase)
	0030			
	0034	IM0126144 0.3mH–68Arms	IM0140254 1.2mH–69Arms/87Apeak	IM0126144 0.32mH–68Arms (AC 3-phase)
	0036			
S15	0038		Not applicable	
	0040	IM0126164 0.24mH–92Arms		IM0126164 0.24 mH–92Arms (AC 3-phase)
	0049			
S20	0060		IM0140304 0.64mH–160Arms/195Apeak	
	0067	IM0126204 0.16mH–142Arms		IM0126204 0.16mH–142Arms (AC 3-phase)
	0074			
	0086			
S30	0113	IM0126244 0.09mH–252Arms	IM0140404 0.36mH–275Arms/345 Apeak	IM0126244 0.09mH–252Arms (AC 3-phase)
	0129			
	0150			
	0162			
S40	0179	IM0126284 0.061mH–362Arms	IM0140504 0.24mH–420Arms/520Apeak	IM0126284 0.061mH–362Arms (AC 3-phase)
	0200			
	0216	IM0126324 0.054mH–410Arms	IM0140554 0.216mH–460Arms/580Apeak	IM0126324 0.054mH–410Arms (AC 3-phase)
	0250			
S50	0312	IM0126364 0.033mH–662Arms	IM0140654 0.132mH–740Arms/930Apeak	IM0126364 0.033mH–662Arms (AC 3-phase)
	0366			
	0399			
S60	0457	IM0126404 0.023mH–945Arms	IM0140754 0.092mH–1040Arms1300/Apeak	IM0126404 0.023mH–945Arms (AC 3-phase)
	0525			
S65	0598			
	0748	IM0126444 0.018mH–1260 Arms	IM0140854 0.072mH–1470Arms/1850Apeak	IM0126444 0.018mH–1260Arms (AC 3-phase)
	0831			

(continued)

continued)

S75	0964	2 x IM0126404	2 x IM0140754	6 x IM0140674 0.024 mH – 950 A (AC single-phase)
	1130	2 x IM0126404	2 x IM0140754	6 x IM0140774 0.018 mH – 1250 A (AC single-phase)
	1296	2 x IM0126444	2 x IM0140854	

6.5.4.3. 5T - 6T CLASSES – AC AND DC INDUCTANCE

SIZE	SINUS PENTA MODEL	INPUT AC 3-PHASE INDUCTANCE	DC SINGLE-PHASE INDUCTANCE	OUTPUT INDUCTANCE
S65	0250	IM0127324 0.093 mH – 410 A	IM0141604 0.372mH– 520Arms/680Apeak	IM0127324 0.093 mH – 410 A (AC 3-phase)
	0312 0366 0399	IM0127364 0.058 mH – 662 A	IM0141704 0.232mH– 830Arms/1080Apeak	IM0127364 0.058 mH – 662 A (AC 3-phase)
	0457 0525 0598	IM0127404 0.040 mH – 945 A	IM0141804 0.160mH– 1170Arms/1530Apeak	IM0127404 0.040 mH – 945 A (AC 3-phase)
	0748	IM0127444 0.030 mH – 1260 A	IM0141904 0.120mH– 1290Arms/1680Apeak	IM0127444 0.030 mH – 1260 A (AC 3-phase)
S70	0831	2 x IM0127364	2 x IM0141704	IM0127444 0.030 mH – 1260 A (AC 3-phase)
S75	0964	2 x IM0127404	2 x IM0141804	6 x IM0141724 0.04 mH – 950 A (AC single-phase)
S80	1130	3 x IM0127364	3 x IM0141704	6 x IM0141724 0.04 mH – 950 A (AC single-phase)
	1296	3 x IM0127404	3 x IM0141804	6 x IM0141784 0.03 mH – 1250 A (AC single-phase)

CAUTION

For inverter sizes lower than S40 included, always use an input inductance under the following circumstances: mains instability; converters installed for DC motors; loads generating strong voltage variations at startup; power factor correction systems; mains rated power exceeding 500 KVA.
Always activate a line inductance for inverter sizes higher than S50, unless the inverter is powered via a dedicated transformer.

NOTE

When modular inverters are used (size S65 to S80), the input inductance shall be connected to each supply arm.

6.5.4.4. 2T – 4T CLASSES – INTERPHASE INDUCTANCE

SIZE INVERTER	INVERTER MODEL	INTERPHASE INDUCTANCE MODEL	
S65	0598	1100A	IM0143504
	0748	1400A	IM0143604
	0831		
S75	0964	2000A	IM0143704
	1130	2650A	IM0143804
	1296		

NOTE

Inductance designed for 12-phase connection.
Carefully follow the application diagram.

6.5.4.5. 5T – 6T CLASSES – INTERPHASE INDUCTANCE

SIZE INVERTER	INVERTER MODEL	INTERPHASE INDUCTANCE MODEL	
S65	0399	850A	IM0144304
	0457 0542 0598	1200A	IM0144454
	0748	1450A	IM0144504
S70	0831		
S75/S80	0964	1850A	IM0144604
	1130	2450A	IM0144754
	1296		

NOTE

Inductance designed for 12-phase connection.
Carefully follow the application diagram.

6.5.5. INDUCTANCE RATINGS

6.5.5.1. CLASS 2T – 4T

INDUCTANCE MODEL	TYPE	INDUCTANCE RATINGS		DIMENSIONS							HOLE	WGT	LEAKAGE
		mH	A	TYPE	L	H	D	M	E	G	mm	Kg	W
IM0126004	AC 3-PHASE	2.0	11	A	120	125	75	25	67	55	5	2.9	29
IM0126044	AC 3-PHASE	1.27	17	A	120	125	75	25	67	55	5	3	48
IM0126084	AC 3-PHASE	0.70	32	B	150	130	115	50	125	75	7x14	5.5	70
IM0126124	AC 3-PHASE	0.51	43	B	150	130	115	50	125	75	7x14	6	96
IM0126144	AC 3-PHASE	0.3	68	B	180	160	150	60	150	82	7x14	9	150
IM0126204	AC 3-PHASE	0.16	142	B	240	210	175	80	200	107	7x14	17	272
IM0126244	AC 3-PHASE	0.09	252	B	240	210	220	80	200	122	7x14	25	342
IM0126284	AC 3-PHASE	0.061	362	C	300	260	185	100	250	116	9x24	36	407
IM0126324	AC 3-PHASE	0.054	410	C	300	260	205	100	250	116	9x24	39.5	423
IM0126364	AC 3-PHASE	0.033	662	C	300	290	235	100	250	143	9x24	53	500
IM0126404	AC 3-PHASE	0.023	945	C	300	320	240	100	250	143	9x24	67	752
IM0126444	AC 3-PHASE	0.018	1260	C	360	375	280	100	250	200	12	82	1070

6.5.5.2. 5T – 6T CLASSES

INDUCTANCE MODEL	TYPE	INDUCTANCE RATINGS		DIMENSIONS							HOLE	WGT	LEAKAGE
		mH	A	TYPE	L	H	P	M	E	G	mm	Kg	W
IM0127324	AC 3-PHASE	0.093	410	C	300	290	220	100	250	133	9x24	52	581
IM0127364	AC 3-PHASE	0.058	662	C	360	310	275	120	325	166	9x24	79	746
IM0127404	AC 3-PHASE	0.040	945	C	360	385	260	120	250	200	12	88	1193
IM0127444	AC 3-PHASE	0.030	1260	C	420	440	290	140	300	200	12	110	1438

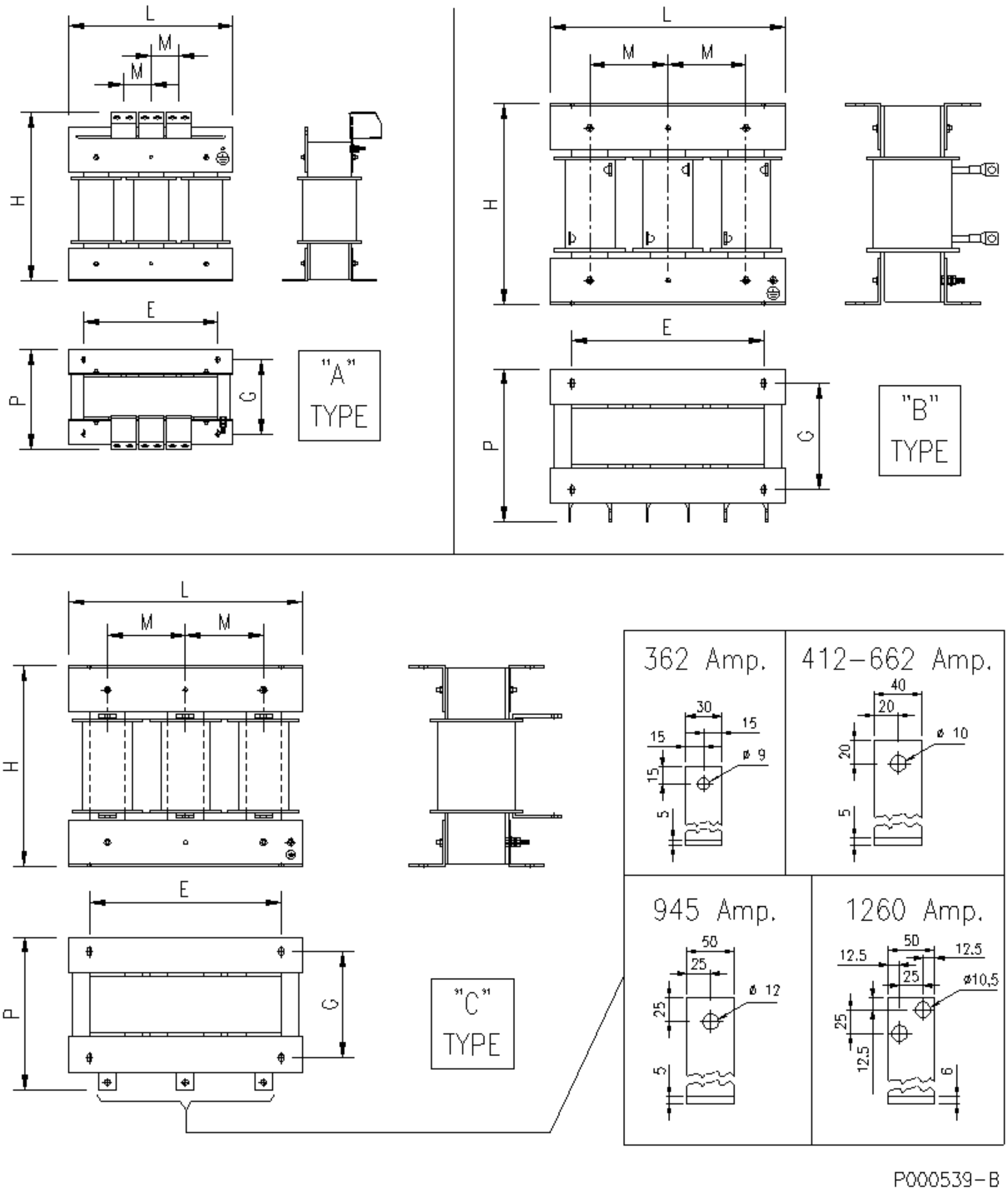


Figure 94: Mechanical features of a 3-phase inductance

6.5.6. 3-PHASE AC INDUCTANCE, 2T-4T CLASSES, IP54, CABINET

SIZE	SINUS PENTA MODEL	INDUCTANCE MODEL	TYPE	MECHANICAL DIMENSIONS (see figure below)	WEIGHT	LEAKAGE
				TYPE	Kg	W
S05	0005	ZZ0112010	AC 3-PHASE	A	6.5	29
S05	0007	ZZ0112020	AC 3-PHASE	A	7	48
S05	0009	ZZ0112020	AC 3-PHASE	A	7	48
S05	0011	ZZ0112020	AC 3-PHASE	A	7	48
S05	0014	ZZ0112020	AC 3-PHASE	A	7	48
S05-S10	0016	ZZ0112030	AC 3-PHASE	A	9.5	70
S05-S10	0017	ZZ0112030	AC 3-PHASE	A	9.5	70
S05-S10	0020	ZZ0112030	AC 3-PHASE	A	9.5	70
S10-S12	0023	ZZ0112040	AC 3-PHASE	A	10	96
S10-S12	0025	ZZ0112040	AC 3-PHASE	A	10	96
S10-S12	0030	ZZ0112040	AC 3-PHASE	A	10	96
S10-S12	0035	ZZ0112040	AC 3-PHASE	A	10	96
S12	0033	ZZ0112045	AC 3-PHASE	B	14	150
S12	0034	ZZ0112045	AC 3-PHASE	B	14	150
S12	0036	ZZ0112045	AC 3-PHASE	B	14	150
S12	0037	ZZ0112045	AC 3-PHASE	B	14	150
S15	0038	ZZ0112050	AC 3-PHASE	B	14.5	183
S15	0040	ZZ0112050	AC 3-PHASE	B	14.5	183
S15	0049	ZZ0112050	AC 3-PHASE	B	14.5	183
S20	0060	ZZ0112050	AC 3-PHASE	B	14.5	183
S20	0067	ZZ0112060	AC 3-PHASE	C	26	272
S20	0074	ZZ0112060	AC 3-PHASE	C	26	272
S20	0086	ZZ0112060	AC 3-PHASE	C	26	272
S30	0113	ZZ0112070	AC 3-PHASE	C	32.5	342
S30	0129	ZZ0112070	AC 3-PHASE	C	32.5	342
S30	0150	ZZ0112070	AC 3-PHASE	C	32.5	342
S30	0162	ZZ0112070	AC 3-PHASE	C	32.5	342

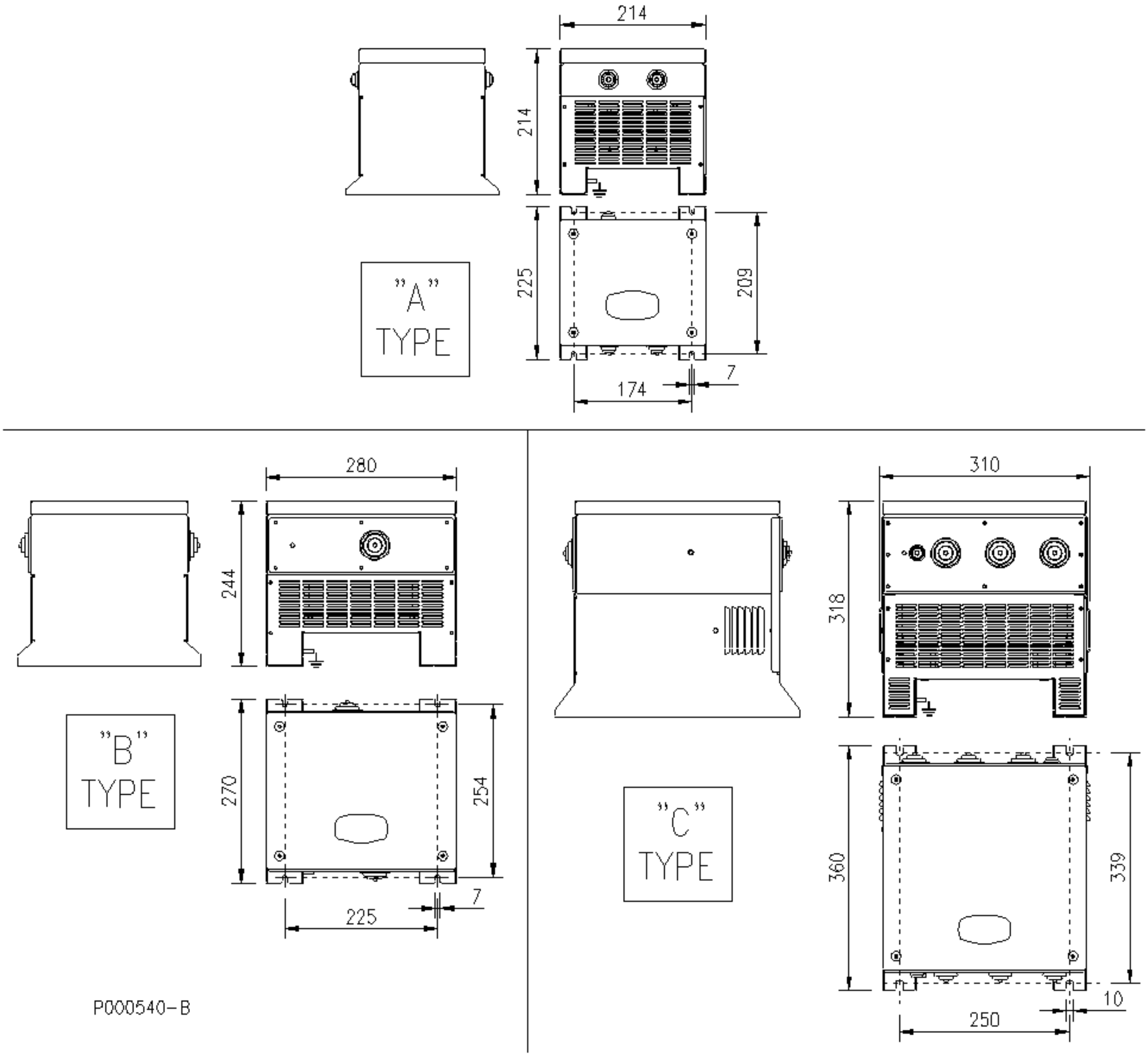


Figure 95: Mechanical features of AC 3-phase inductance, 2T-4T classes, in IP54 cabinet

6.6. ENCODER BOARD ES836/2 (SLOT A)

Board for incremental, bidirectional encoder to be used as a speed feedback for inverters of the SINUS series. It allows the acquisition of encoders with power supply ranging from 5 to 15VDC (adjustable output voltage) with complementary outputs (line driver, push-pull, TTL outputs). It can also be connected to 24DC encoders with both complementary and single-ended push-pull or PNP/NPN outputs.
The encoder board is to be installed into SLOT A. See section Installing Encoder Board ES836/2 (SLOT A) on the Inverter .

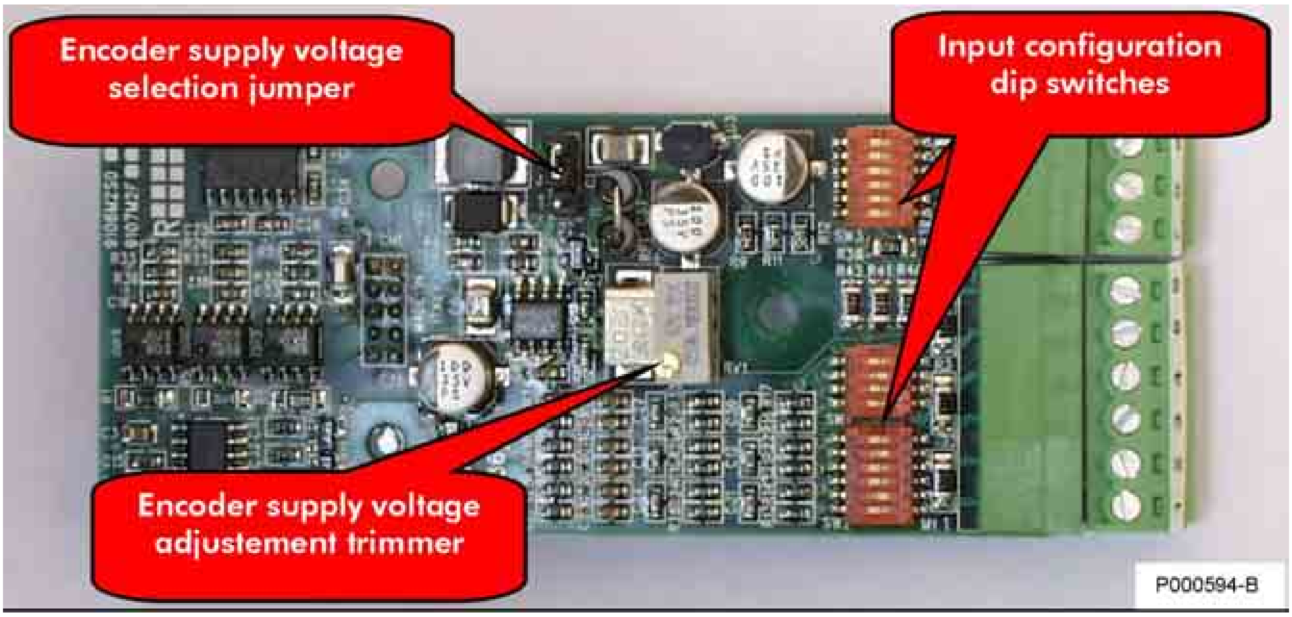


Figure 96: Picture of the encoder board ES836/2

DESCRIPTION	CODE	COMPATIBLE ENCODERS	
		POWER SUPPLY	OUTPUT
Encoder board ES836/2	ZZ0095834	5VDC to 15VDC, 24VDC	Complementary LINE DRIVER, NPN, PNP, PUSH-PULL outputs and single-ended NPN, PNP, PUSH-PULL outputs

6.6.1. ENVIRONMENTAL REQUIREMENTS

Operating temperature:	0 to +50 °C ambient temperature (contact Elettronica Santerno for higher ambient temperatures)
Relative humidity:	5 to 95% (non-condensing)
Max. operating altitude	4000 m (a.s.l.)

6.6.2. ELECTRIC SPECIFICATIONS

Electric Specifications	*Ratings*			
	Min.	*Type*	*Max.*	*Unit*
Encoder supply current, + 24 V, protected with resettable fuse			200	mA
Electronically protected encoder supply current, +12V			350	mA
Electronically protected encoder supply current, +5V			900	mA
Adjustment range for encoder supply voltage (5V mode)	4.4	5.0	7.3	V
Adjustment range for encoder supply voltage (12V mode)	10.3	12.0	17.3	V
Input channels	Three channels: A, B, and zero notch Z			
Type of input signals	Complementary or single-ended			
Voltage range for encoder input signals	4		24	V
Pulse max. frequency with noise filter "on"	77kHz (1024pls @ 4500rpm)			
Pulse max. frequency with noise filter "off"	155kHz (1024pls @ 9000rpm)			
Input impedance in NPN or PNP mode (external pull-up or pull-down resistors required)		15k		Ω
Input impedance in push-pull or PNP and NPN mode when internal load resistors (at max. frequency) are connected		3600		Ω
Input impedance in line-driver mode or complementary push-pull signals with internal load resistors activated via SW3 (at max. frequency)		780		Ω

ISOLATION:

The encoder supply line and inputs are galvanically isolated from the inverter control board grounding for a 500 VAC test voltage for 1 minute. Encoder supply grounding is in common with control board digital inputs available in the terminal board.

6.6.3. Installing Encoder Board ES836/2 (Slot A) on the Inverter

1) Remove voltage from the inverter and wait at least 5 minutes.
2) Remove the cover allowing to gain access to the inverter control terminals. The fixing spacers and the signal connector are located on the left.

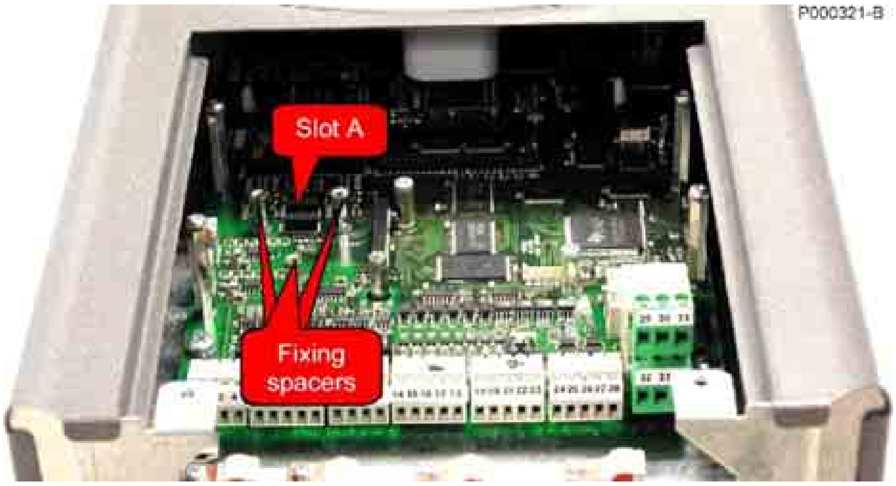


Figure 97: Position of slot A for the installation of the encoder board

3) Fit the encoder board and make sure that all contacts enter the relevant housing in the signal connector. Fasten the encoder board to the fixing spacers using the screws supplied.
4) Configure the Dip-switches and the jumper located on the encoder board based on the connected encoder. Check that the supply voltage delivered to the terminal output is correct.
5) Power on the inverter and set up parameters relating to the encoder feedback (see Sinus Penta's programming Manual).

Figure 98: Encoder board fastened to its slot

6.6.4. Terminals in Encoder Board

A 9-pole terminal board is located on the front side of the encoder board for the connection to the encoder.

Terminal board, pitch 3.81 mm in two separate extractable sections (6-pole and 3-pole sections)		
Terminal	Signal	Type and Features
1	CHA	Encoder input channel A true polarity
2	$\overline{\text{CHA}}$	Encoder input channel A inverse polarity
3	CHB	Encoder input channel B true polarity
4	$\overline{\text{CHB}}$	Encoder input channel B inverse polarity
5	CHZ	Encoder input channel Z (zero notch) true polarity
6	$\overline{\text{CHZ}}$	Encoder input channel Z (zero notch) inverse polarity
7	+VE	Encoder supply output 5V...15V or 24V
8	GNDE	Encoder supply ground
9	GNDE	Encoder supply ground

For the encoder connection to the encoder board, see wiring diagrams on the following pages.

6.6.5. Configuration Dip-switches

Encoder board ES836/2 is provided with two dip-switch banks to be set up depending on the type of connected encoder. Dip-switches are located in the front left corner of encoder board ES836/2 and are adjusted as shown in the figure below.

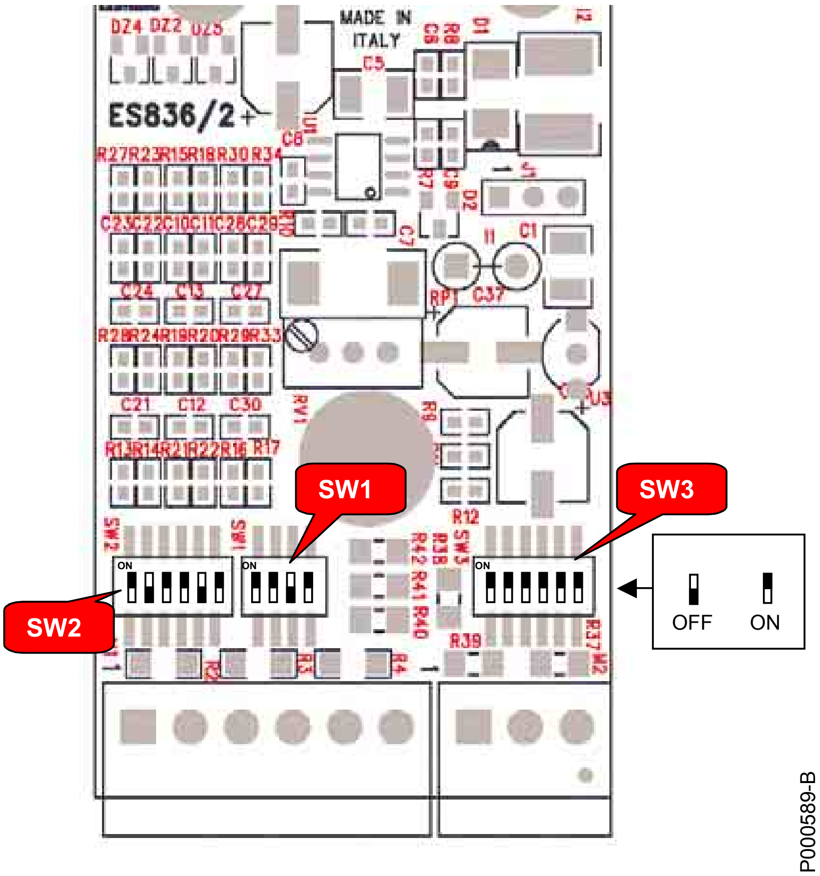


Figure 99: Positions of dip-switches and their factory-setting

Dip-switch functionality and factory-settings are detailed in the table below.

Switch (factory-setting)	*OFF - open*	*ON - closed*
SW2.1 (on)	Channel B, type NPN or PNP	Channel B, type Line driver or Push-Pull
SW2.2 (off)	Channel B with complementary signals	Channel B with only one single-ended signal
SW2.3 (on)	Channel B with no band limit	Channel B with band limit
SW2.4 (on)	Channel Z, type NPN or PNP	Channel Z, type Line driver or Push-Pull
SW2.5 (off)	Channel Z with complementary signals	Channel Z with only one single-ended signal
SW2.6 (on)	Channel Z with no band limit	Channel Z with band limit
SW1.1 (on)	12V Supply voltage (J1 in pos. 2-3)	5V Supply Voltage (J1 in pos. 2-3)
SW1.2 (on)	Channel A, type NPN or PNP	Channel A, type Line driver or Push-Pull
SW1.3 (off)	Channel A with complementary signals	Channel A with only one single-ended signal
SW1.4 (on)	Channel A with no band limit	Channel A with band limit
SW3.1 (on)	Load resistors disabled	Load resistors towards ground enabled for all encoder signals (required for 5V Line driver or Push-pull encoders, especially if long cables are used).
SW3.2 (on)		
SW3.3 (on)		
SW3.4 (on)		
SW3.5 (on)		
SW3.6 (on)		

CAUTION — Put SW3 contacts to ON only if a complementary Push-pull or Line-driver encoder is used (power supply: 5V or 12V). Otherwise, put contacts to OFF.

NOTE — Put ALL contacts in dip-switch SW3 to ON or OFF. Different configurations may cause the malfunctioning of the encoder board.

6.6.6. JUMPER SELECTING THE TYPE OF ENCODER SUPPLY

Two-position jumper J1 installed on encoder board ES836/2 allows to set the encoder supply voltage. It is factory-set to pos. 2-3. Set jumper J1 to position 1-2 to select non-tuned, 24V encoder supply voltage. Set jumper J1 to position 2-3 to select tuned, 5/12V encoder supply voltage. Supply values of 5V or 12V are to be set through dip-switch SW1.1 (see table above).

6.6.7. TUNING TRIMMER

Trimmer RV1 installed on board ES836/2 allows to adjust the encoder supply voltage. This can compensate voltage drops in case of long distance between the encoder and the encoder board, or allows to feed an encoder with intermediate voltage values if compared to factory-set values.

Tuning procedure:

1. Put a tester on the encoder supply connector (encoder side of the connecting cable); make sure that the encoder is powered.
2. Rotate the trimmer clockwise to increase supply voltage. Trimmer is factory set to deliver 5V and 12V (depending on the dip-switch selection) to the power supply termination lugs. For a power supply of 5V, supply may range from 4.4V to 7.3V; for a power supply of 12V, supply may range from 10.3V to 17.3V.

NOTE — Output voltage cannot be adjusted by trimmer RV1 (jumper J1 in pos. 1-2) for 24V power supply.

CAUTION — Power supply values exceeding the encoder ratings may damage the encoder. Always use a tester to check voltage delivered from board ES836 before wiring.

CAUTION — Do not use the encoder supply output to power other devices. Failure to do so would increase the hazard of control interference and short-circuits with possible uncontrolled motor operation due to the lack of feedback.

CAUTION — The encoder supply output is isolated from the common terminal of the analog signals incoming to the terminals of the control board (CMA). Do not link the two common terminals together.

6.6.8. ENCODER WIRING AND CONFIGURATION

The figures below show how to connect and configure the dip-switches for the most popular encoder types.

CAUTION — A wrong encoder-board connection may damage both the encoder and the board.

NOTE — In all the figures below, dip-switches SW1.4, SW2.3, SW2.6 are set to ON, i.e. 77 kHz band limit is on. If a connected encoder requires a higher output frequency, set dip-switches to OFF.

NOTE — The max. length of the encoder wire depends on the encoder outputs, not on encoder board ES836. See the encoder ratings.

NOTE — Dip-Switch SW1.1 is not shown in the figures below because its setting depends on the supply voltage required by the encoder. Refer to the dip-switch setting table to set SW1.1.

NOTE — Zero notch connection is optional and is required only for particular software applications. However, for those applications that do not require any zero notch, its connection does not affect the inverter operation. See SINUS PENTA's Programming Manual for details.

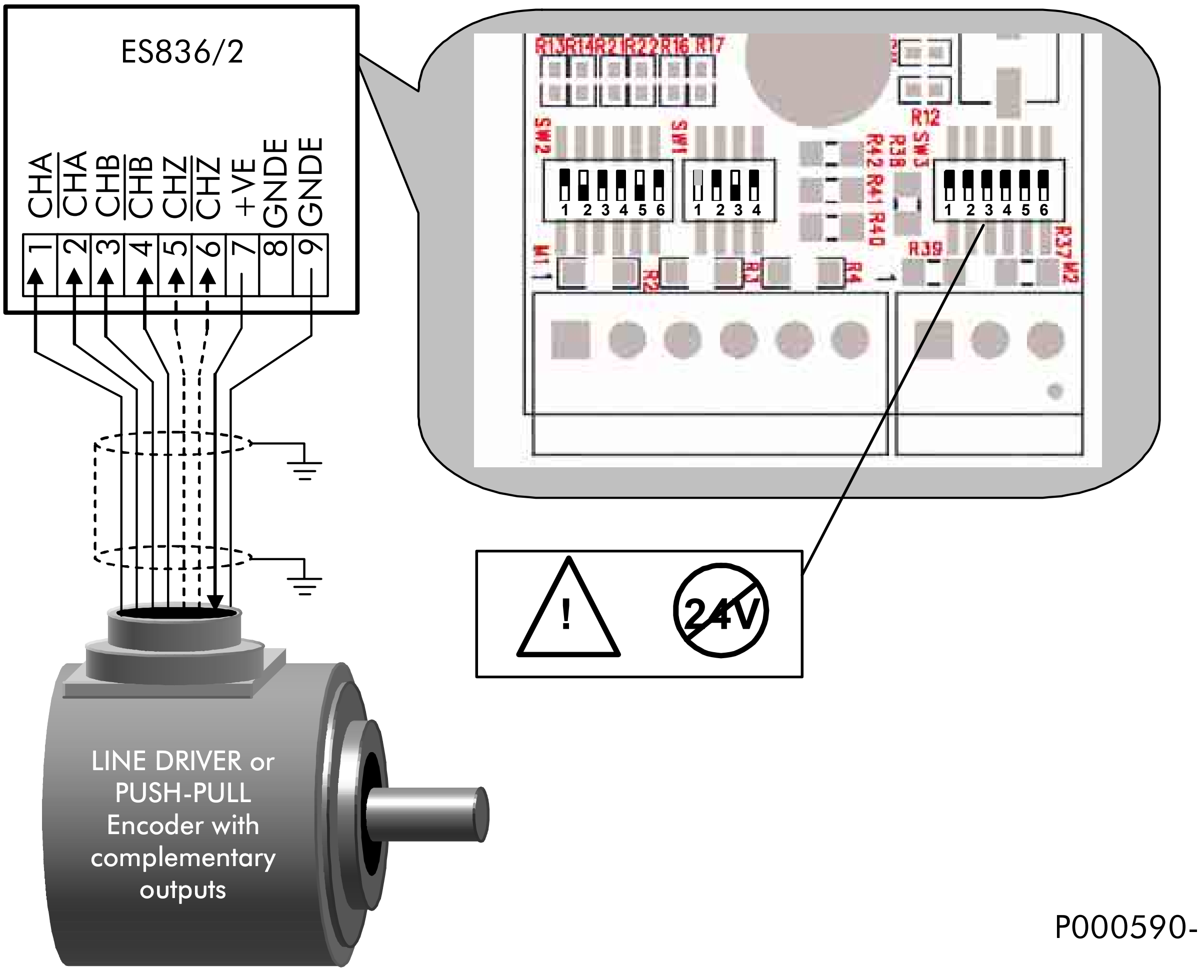


Figure 100: LINE DRIVER or PUSH-PULL encoder with complementary outputs

⚠ **CAUTION** Put SW3 contacts to ON only if a complementary Push-pull or Line driver encoder is used (power supply: 5V or 12V). If a 24V push-pull encoder is used, put contacts to OFF.

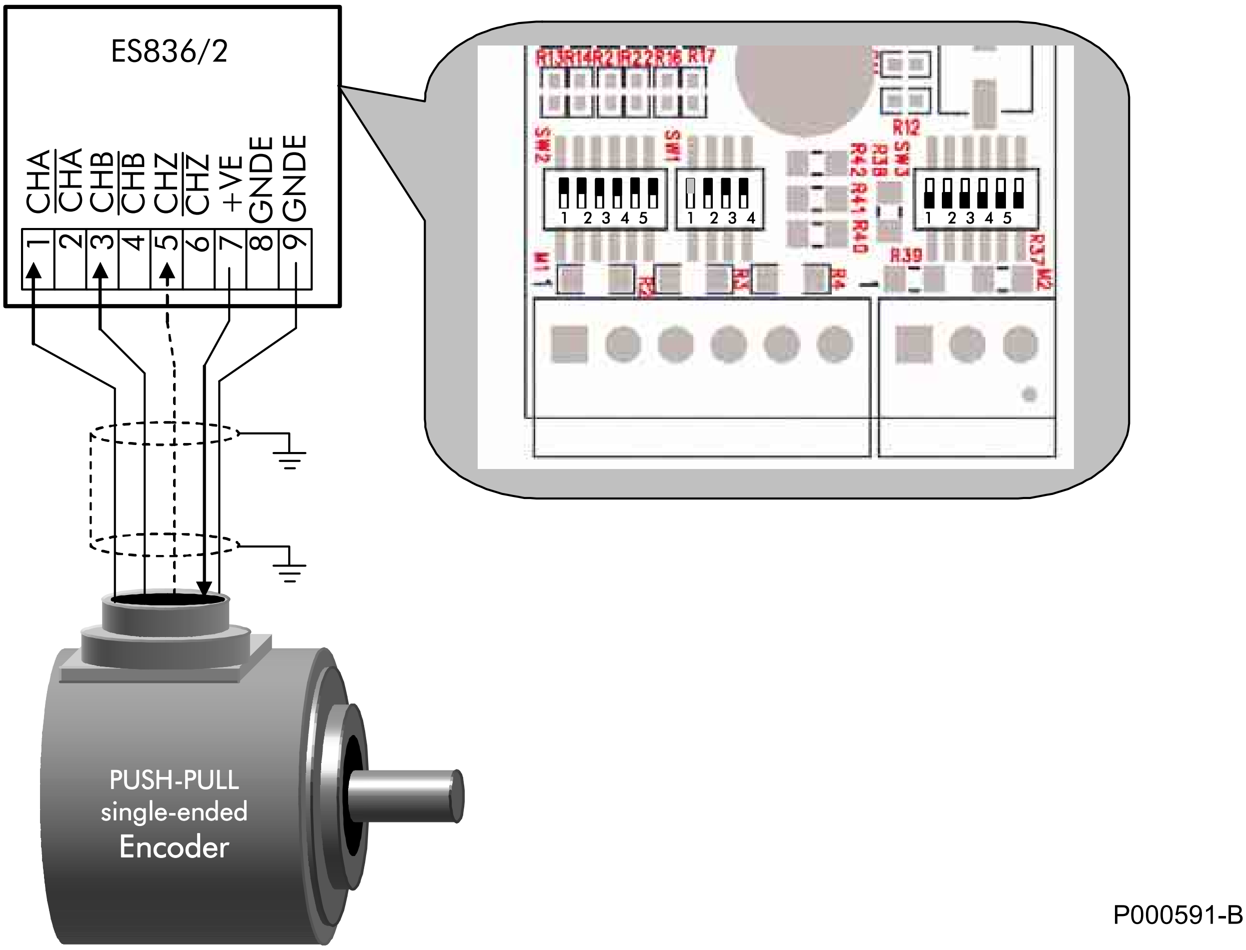


Figure 101: PUSH-PULL encoder with single-ended outputs

CAUTION Because settings required for a single-ended encoder deliver a reference voltage to terminals 2, 4, 6, the latter are not to be connected. Failures will occur if terminals 2, 4, 6 are connected to encoder conductors or to other conductors.

NOTE Only push-pull, single-ended encoders may be used, with an output voltage equal to the supply voltage. Only differential encoders may be connected if their output voltage is lower than the supply voltage.

NOTE Some manufacturers use the acronym HTL for push-pull outputs with a power supply ranging from 18Vdc to 30Vdc. For the acquisition of this type of encoder, the same configuration used for push-pull inverters shall be used for the encoder board.

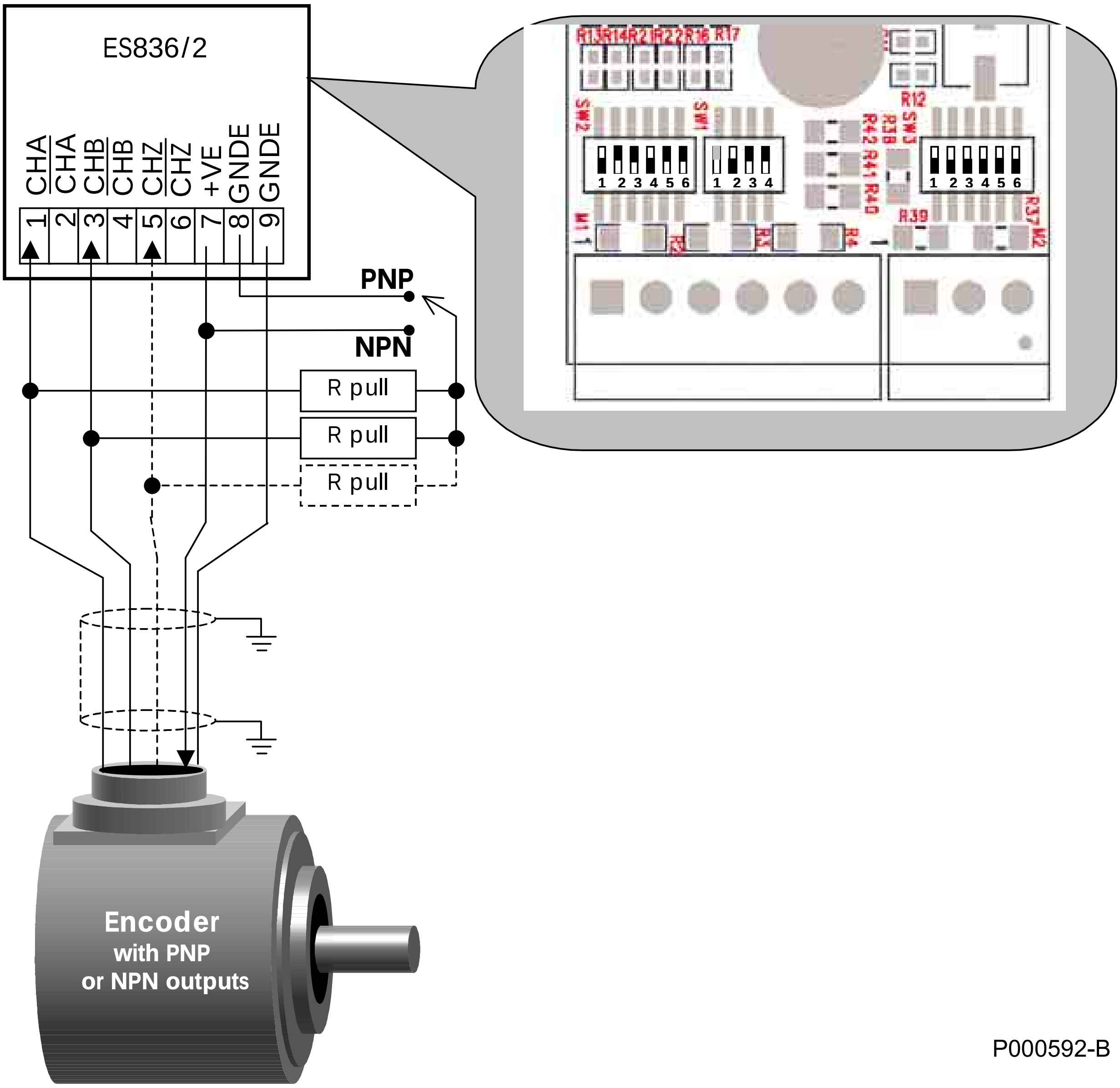


Figure 102: PNP or NPN encoder with single-ended outputs and load resistors with external wiring

NOTE

NPN or PNP encoder outputs require a pull-up or pull-down resistive load to the supply or to the common. As load resistor ratings are defined by the manufacturer of the encoder, external wiring is required, as shown in the figure above. Connect the resistor common to the supply line for NPN encoders supply or to the common for PNP encoders.

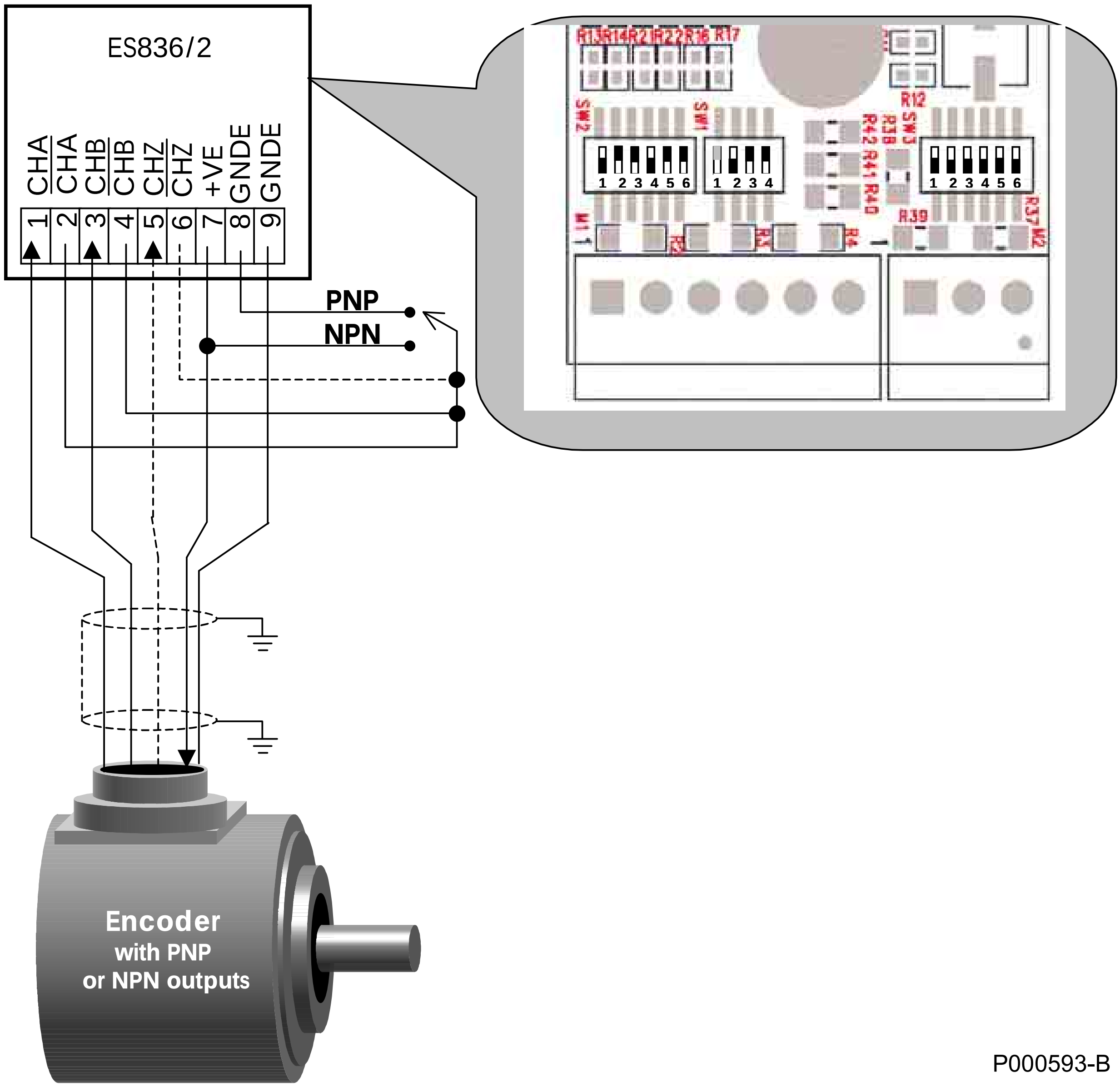


Figure 103: PNP or NPN encoder with single-ended outputs and internal load resistors

NOTE

Incorporated load resistors may be used only if NPN or PNP encoders are compatible with pull-up or pull-down external resistors (4.7kΩ).

NOTE

NPN or PNP encoders cause pulse distortions due to a difference in ramp up and ramp down edges. Distortion depends on the load resistor ratings and the wire stray capacitance. PNP or NPN encoders should not be used for applications with an encoder output frequency exceeding a few kHz dozens. For such applications, use encoders with Push-Pull outputs, or better with a differential line-driver output.

6.6.9. WIRING THE ENCODER CABLE

Use a screened cable to connect the encoder to its control board; screening should be grounded to both ends of the cable. Use the special clamp to fasten the encoder wire and ground the cable screening to the inverter.

P000708-0

Figure 104: Wiring the encoder cable

Do not stretch the encoder wire along with the motor supply cable.
Connect the encoder directly to the inverter using a cable with no intermediate devices, such as terminals or return connectors.
Use a model of encoder suitable for your application (as for connection length and max. rev number).
Preferably use encoder models with complementary LINE-DRIVER or PUSH-PULL outputs. Non-complementary PUSH-PULL, PNP or NPN open-collector outputs offer a lower immunity to noise.
The encoder electrical noise occurs as difficult speed adjustment or uneven operation of the inverter; in the worst cases, it can lead to the inverter stop due to overcurrent conditions.

0 1 2 3 4 5 6 7 8

6.7. ISOLATED SERIAL BOARD ES822/1 (SLOT B)

Isolated serial board RS 232/485 controlling SINUS PENTA inverters allows to connect a computer through RS232 interface or allows a multidrop connection of modbus devices through RS485 interface. It provides galvanic isolation of interface signals relating to both the control board ground and the terminal board common of the control board.

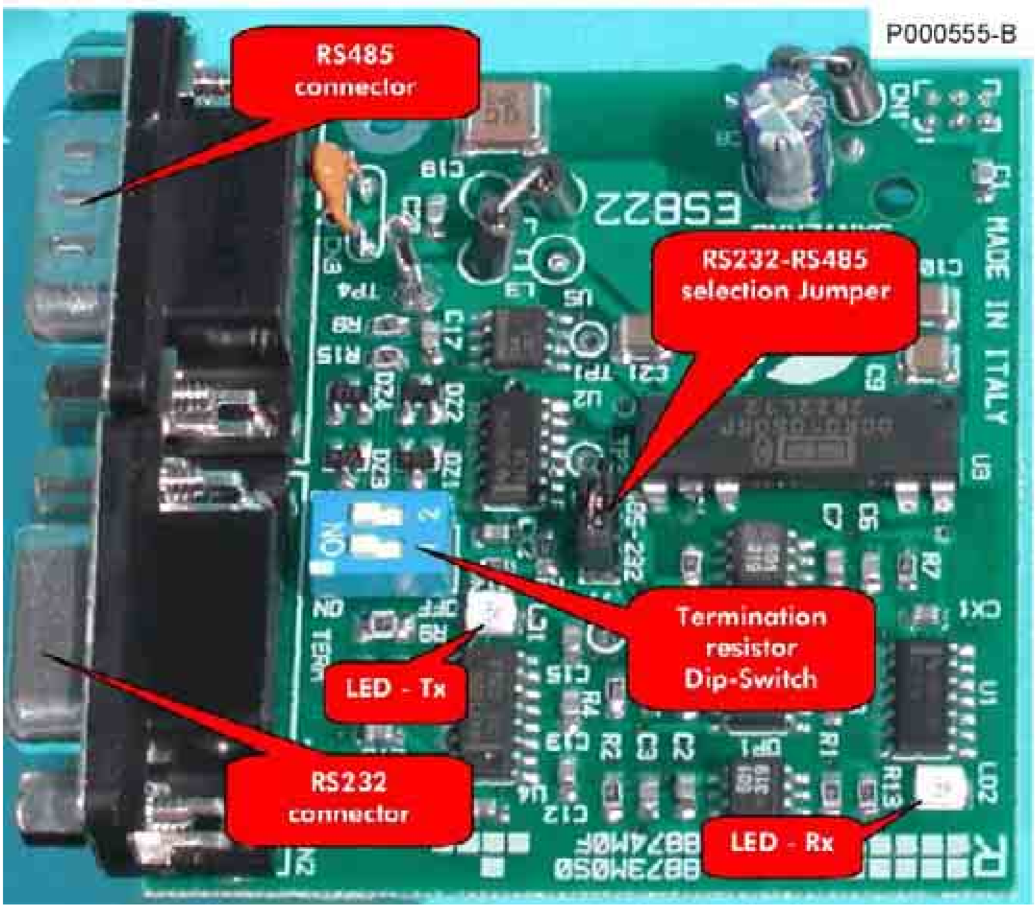


Figure 105: Picture of Board ES822

DESCRIPTION	ID NUMBER
Isolated serial board RS 232/485	ZZ0095850

6.7.1. ENVIRONMENTAL REQUIREMENTS

Operating temperature	0 to +50 °C ambient temperature (contact Elettronica Santerno for higher ambient temperatures)
Relative humidity	5 to 95% (non condensing)
Max. operating altitude	4000 m (a.s.l.)

6.7.2. ELECTRIC FEATURES

WIRING:

Once board ES822 is fitted, connector RS-485 installed on the inverter will automatically disable. D-type, 9-pole male connector (RS- 485) or female connector (RS-232-DTE) located on board ES822 activate depending on the position of J1.

Contacts of CN3, D-type, 9-pole male connector (RS-485) are as follows:

PIN	FUNCTION
1 - 3	(TX/RX A) Differential input/output A (bidirectional) according to standard RS485. Positive polarity with respect to pins 2 – 4 for one MARK.
2 - 4	(TX/RX B) Differential input/output B (bidirectional) according to standard RS485. Negative polarity with respect to pins 1 – 3 for one MARK.
5	(GND) control board zero volt
6 - 7	Not connected
8	(GND) control board zero volt
9	+5 V, max 100mA for the power supply of an auxiliary converter RS-485/RS-232 (if any)

Contacts of CN2, D-type, 9-pole female connector (RS-232-DCE) are as follows:

PIN	FUNCTION
1 - 9	Not connected
2	(TX A) Output according to standard RS232
3	(RX A) Input according to standard RS232
5	(GND) zero volt
4 - 6	To be connected together for loopback DTR-DSR
7-8	To be connected together for loopback RTS-CTS

6.7.3. Installing Board ES822 on the Inverter (Slot B)

1. Turn off the inverter and wait at least 5 minutes.
2. Remove the cover allowing to gain access to the inverter control terminals. The mounting columns for the encoder board and signal connector are located on the right.

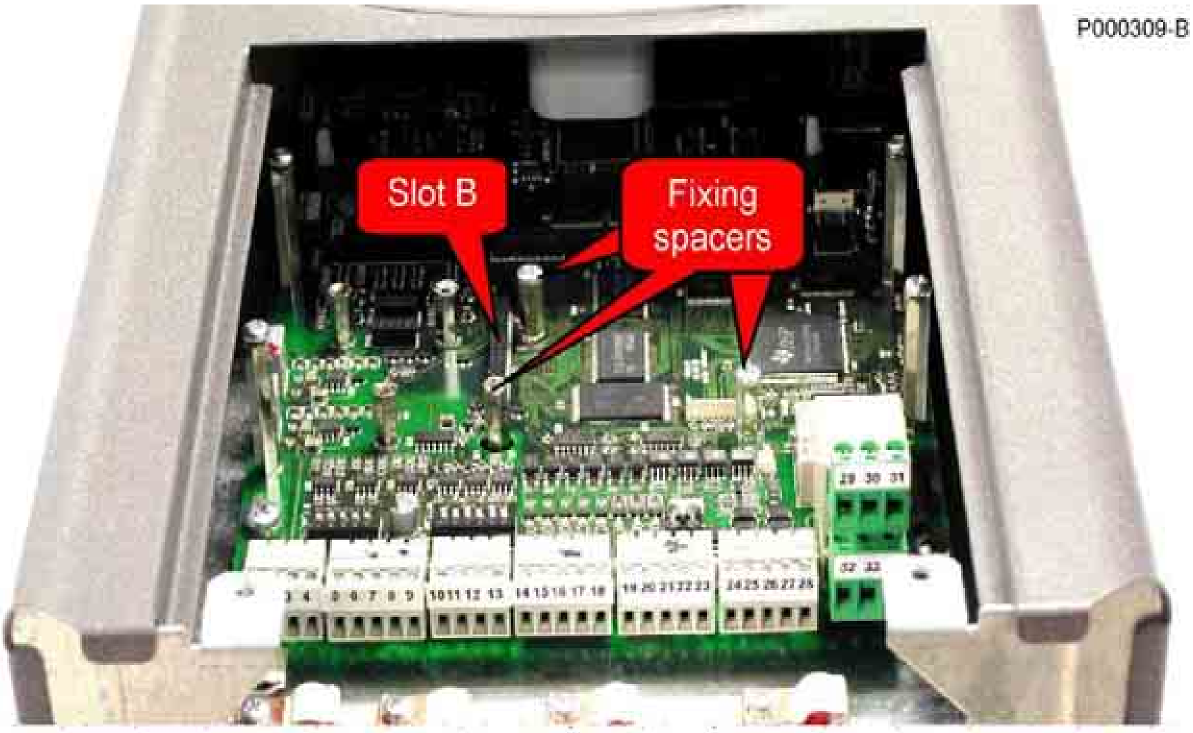


Figure 106: Position of the slot for the installation of the serial isolated board

3. Fit encoder board ES822 and make sure that all contacts enter the relevant housing in the signal connector. Fasten the encoder board to the metal columns using the screws supplied.
4. Configure dip-switches and the jumper located on the encoder board based on the connected encoder.

6.7.4. Setting Board ES822

6.7.4.1. Jumper for RS232 / RS485 Selection

Jumper J1 allows to set board ES822 to operate as interface RS-485 or as interface RS-232.
Jumper between pin1-2: CN3-(RS-485) is enabled
Jumper between pin2-3: CN2-(RS-232) is enabled

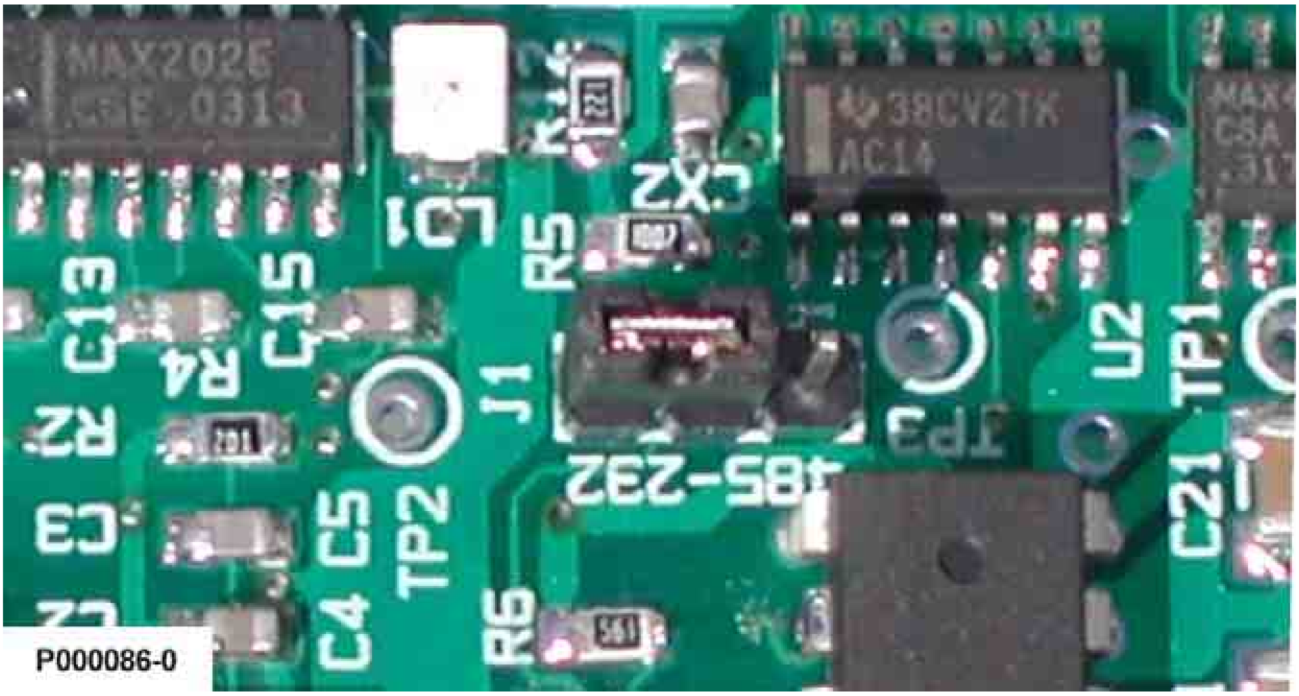


Figure 107: Jumper setting RS232/RS485

6.7.4.2. DIP-SWITCH FOR TERMINATOR RS-485

Please refer to section SERIAL COMMUNICATIONS):
For serial line RS-485 in control board ES822, the line terminator is selected through dip-switch SW1 as shown in the figure below.
When the line master (computer) is located at the beginning or at the end of the serial link, the line terminator of the farthest inverter from the master computer (or the only inverter in case of direct connection to the master computer) shall be enabled.
Line terminator enables by setting selector switches 1 and 2 to ON in dip-switch SW1. The line terminator of the other inverters in intermediate positions shall be disabled: dip switch SW1, selector switches 1 and 2 in position OFF(default setting).
To use line RS-232-DTE, no adjustment of dip-switch SW1 is required.

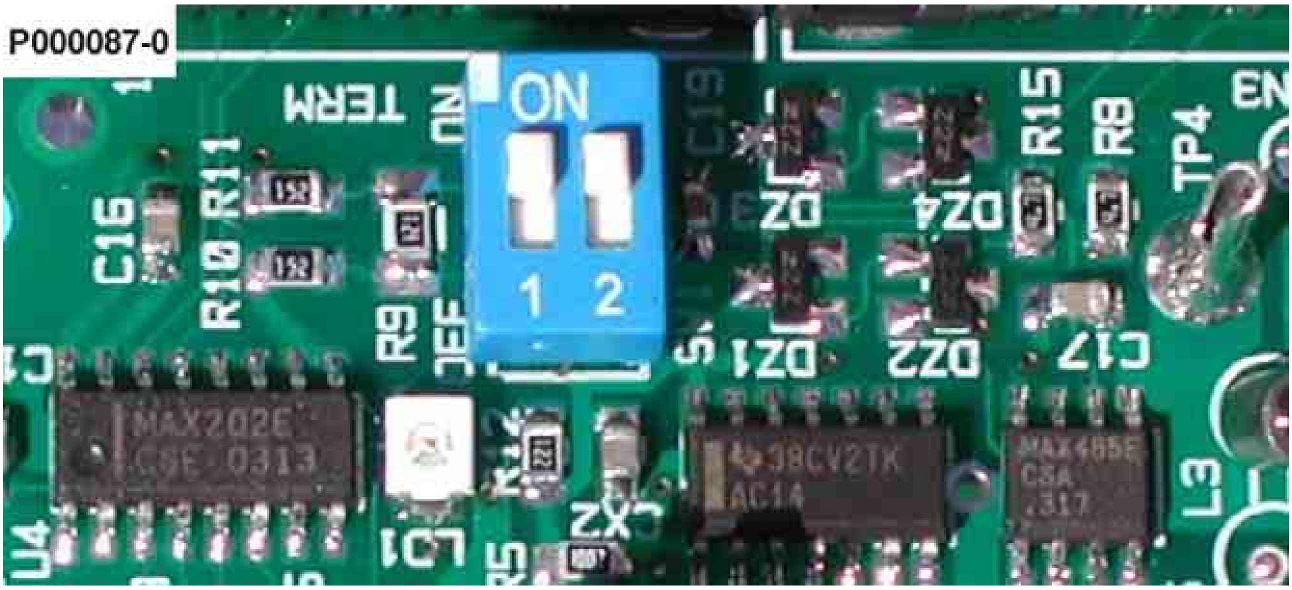


Figure 108: Configuration of terminator dip switch for line RS485

6.8. ES847 I/O EXPANSION BOARD (SLOT C)

6.8.1. ES847 BOARD FOR SIGNAL CONDITIONING AND ADDITIONAL I/O

ES847 Board allows implementing an additional I/O set for any product of the PENTA series. Additional functionality includes:

- Three “fast” sampling analog inputs, 12-bit, ±10V f.s.;
- Two “fast” sampling analog inputs, 12-bit, for AC current measure via ATs or for 0-20mA sensor measures; resolution: 11 bits;
- Four “slow” sampling inputs, 12-bit, configurable as 0-10V f.s., 0-20 mA f.s., 0-100 mV f.s., temperature acquisition via two-wire thermistor PT100;
- Two “slow” sampling analog inputs, 12-bit, 0-10V f.s.;
- Eight PNP, 24V multifunction digital inputs; three of them are “fast propagation” inputs and can be used for the acquisition of a PUSH-PULL, 24V encoder;
- six multifunction digital outputs, OC outputs free from potential to be used both as PNP and NPN inputs, Vomax=48V, Iomax=50mA, providing short-circuit protection through resettable fuse.

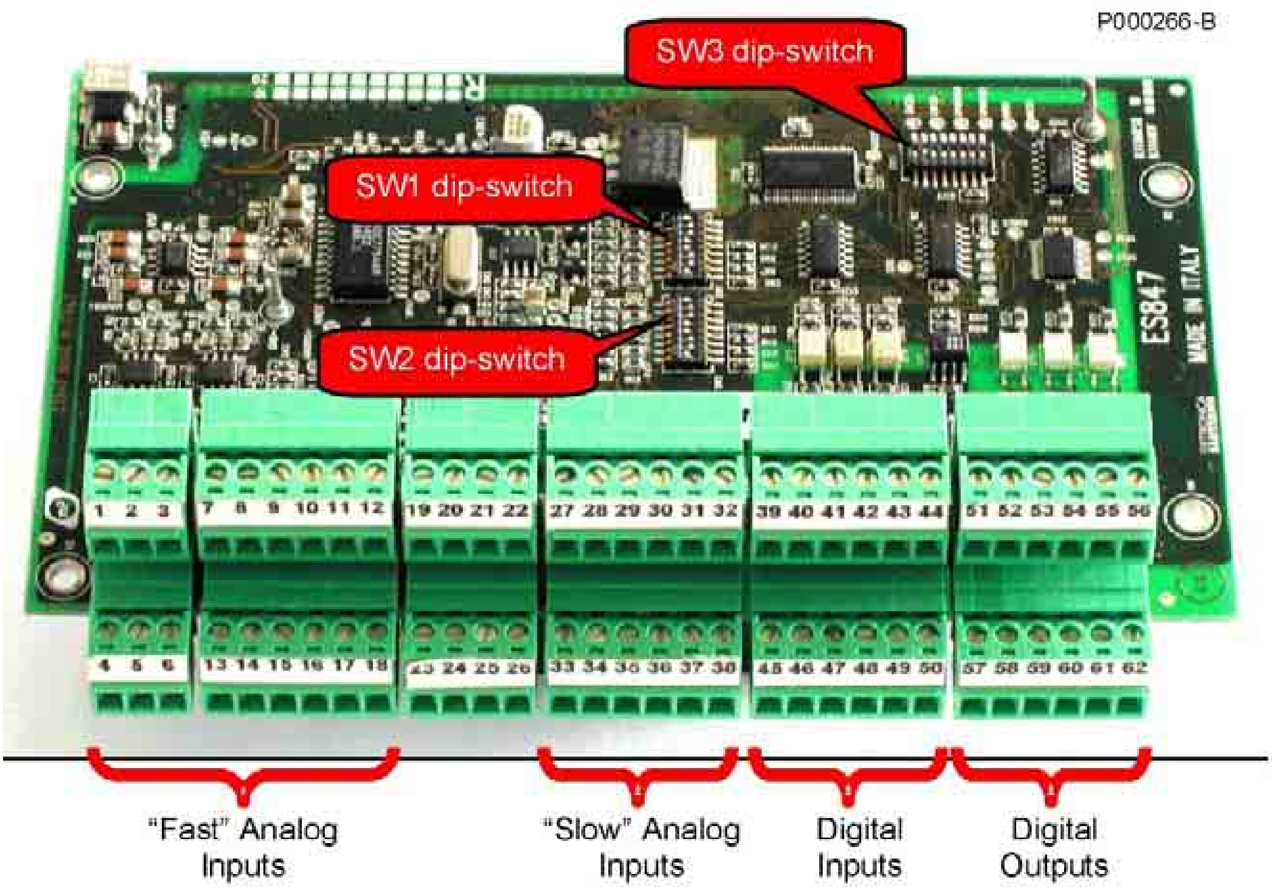


Figure 109: Signal and additional I/O ES847 conditioner board

6.8.2. IDENTIFICATION DATA

Description	*Ordering code*	*Compatibility*
Additional I/O PENTA ES847 board	ZZ0101812	Any inverter of the SINUS “PENTA” series

6.8.3. INSTALLING BOARD ES847 ON THE INVERTER (SLOT C)

1) Remove voltage from the inverter and wait at least 5 minutes.

2) Remove the inverter cover by loosening the four hexagonal screws located on the top side and bottom side of the inverter to reach the fixing spacers and the signal connector (Figure 110– Slot C.)

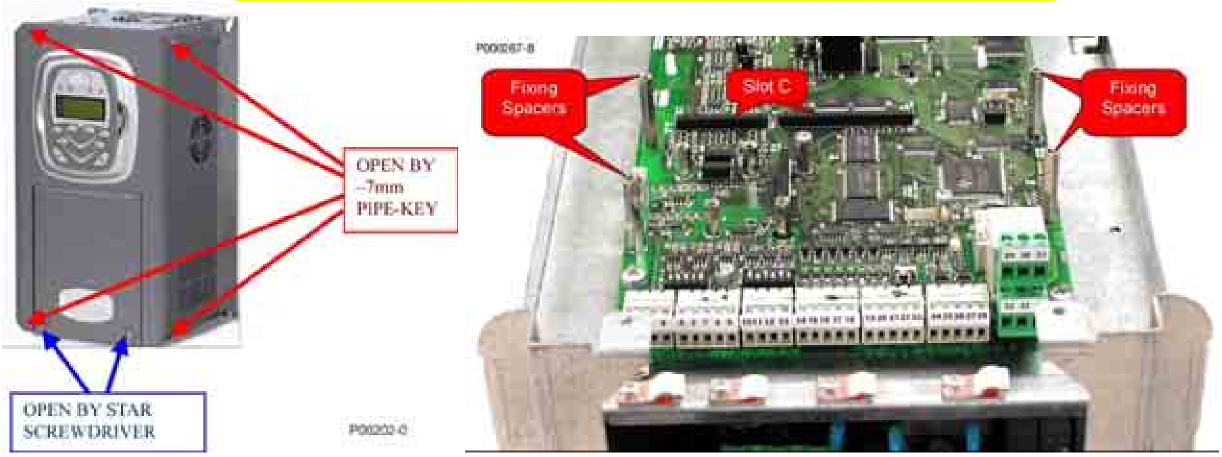


Figure 110: Removing the inverter cover; location of slot C

3) Insert the two contact strips supplied in the bottom part of board ES847; make sure that each contact enters its slot in the connector. Insert board ES847 over the control board of the PENTA inverter; make sure that each contact enters its slot in the signal connector. Use the screws supplied to fasten board ES847 to the fixing spacers. (Figure 111).

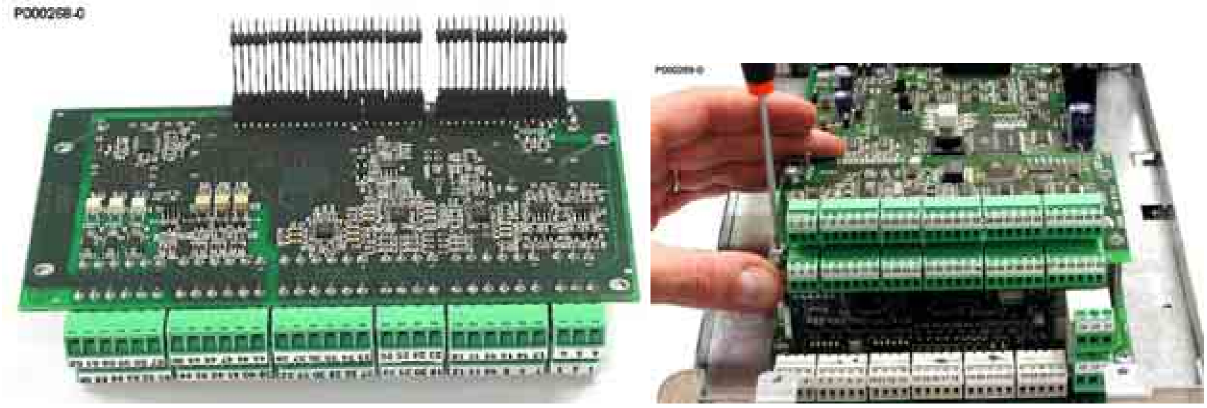


Figure 111: Fitting the strips inside board ES847 and fixing the board on slot C

4) Configure the Dip-switches located on board ES847 based on the type of signals to be acquired (see relevant section).
5) For the terminal board wiring, follow the instructions given in the section below.
6) Power on the inverter and configure the parameters relating to the operation of board ES847 (see Sinus Penta's Programming Instructions manual).

	DANGER	Before removing the terminal board cover, remove voltage and wait at least 5 minutes to allow for capacitor discharge and to avoid electrical shock hazard.
	CAUTION	Electrical shock hazard: do not connect/disconnect the signal terminals or the power terminals when the inverter is on. This also prevents the inverter from being damaged.
	NOTE	All the screws used to fasten removable parts (terminals cover, serial interface connector, cable plates, etc.) are black, round-head, cross-head screws. When wiring the inverter, remove only this type of screws. If different screws or bolts are removed, the inverter guaranty will be no longer valid.

6.8.4. Board ES847 Terminals

Screwable terminal board including 12 sections (each section can be individually removed) for 0.08÷1.5mm^2 (AWG 28-16) cables.

N.	Name	Description	I/O Features	Dip-switch/Notes
1-2	-	Not used	Vfs = ±10V, Rin= 10k Ω; Resolution: 12 bits	
3	CMA	0V for analog inputs (common to control 0V)	Control board zero Volt	
4-5	+15VM-15VM	Stabilized, bipolar output protected from short-circuits for auxiliary circuits.	+15V, -15V; Iout max: 100mA	
6	CMA	0V for analog inputs (common to control 0V)	Control board zero Volt	
7-8	XAIN2+ XAIN2 -	"Fast" differential auxiliary analog input, ±10V f.s. number 2	Vfs = ±10V, Rin= 10k Ω; Resolution: 12 bits	
9-10	XAIN3+ XAIN3 -	"Fast" differential auxiliary analog input, ±10V f.s. number 3	Vfs = ±10V, Rin= 10k Ω; Resolution: 12 bits	
11-12	XAIN4+ XAIN4 -	"Fast" differential auxiliary analog input, ±10V f.s. number 4	Vfs = ±10V, Rin= 10k Ω; Resolution: 12 bits	
13	XAIN5	"Fast" auxiliary analog input (current input), number 5	Ifs = ±20mA, Rin= 200 Ω; Resolution: 12 bits	
14	CMA	0V for analog inputs for XAIN5 return	Control board zero Volt	
15	XAIN6	"Fast" auxiliary analog input (current input), number 6	Ifs = ±20mA, Rin= 200 Ω; Resolution: 12 bits	
16	CMA	0V for analog inputs for XAIN6 return	Control board zero Volt	
17	-	Not used	Ifs = ±160mA, Rin= 33.33 Ω; Resolution: 12 bits	
18	CMA	0V for analog inputs for XAIN7 return	Control board zero Volt	
19-26	N.C.	Terminals not available or reserved to ES personnel – Do not use		
27	XAIN8/T1+	"Slow" configurable auxiliary analog input, number 8	Vfs = 10V, Rin = 30k Ω	SW1.3 = ON SW1.1-2-4 = OFF
			Vfs = 100mV, Rin = 1M Ω	SW1.4 = ON SW1.1-2-3 = OFF
			Ifs = 20mA, Rin = 124,5 Ω	SW1.2 = ON SW1.1-3-4 = OFF
		Thermistor temperature measure, number 1	Temperature measure with PT100	SW1.1-4 = ON SW1.2-3 = OFF
28	CMA/T1-	0V for analog inputs for XAIN8 return	Control board zero Volt	
29	XAIN9/T2+	"Slow" configurable auxiliary analog input, number 9	Vfs = 10V, Rin = 30k Ω	SW1.7 = ON SW1.5-6-8 = OFF
			Vfs = 100mV, Rin = 1M Ω	SW1.8 = ON SW1.5-6-7 = OFF
			Ifs = 20mA, Rin = 124,5 Ω	SW1.6 = ON SW1.5-7-8 = OFF
		Thermistor temperature measure, number 2	Temperature measure with PT100	SW1.5-8 = ON SW1.6-7 = OFF
30	CMA/T2-	0V for analog inputs for XAIN9 return	Control board zero Volt	
31	XAIN10/T3+	"Slow" configurable auxiliary analog input, number 10	Vfs = 10V, Rin = 30k Ω	SW2.3 = ON SW2.1-2-4 = OFF
			Vfs = 100mV, Rin = 1M Ω	SW2.4 = ON SW2.1-2-3 = OFF
			Ifs = 20mA, Rin = 124,5 Ω	SW2.2 = ON SW2.1-3-4 = OFF
		Thermistor temperature measure, number 3	Temperature measure with PT100	SW2.1-4 = ON SW2.2-3 = OFF
32	CMA/T3-	0V for analog inputs for XAIN10 return	Control board zero Volt	
33	XAIN11/T4+	"Slow" configurable auxiliary analog input, number 11	Vfs = 10V, Rin = 30k Ω	SW2.7 = ON SW2.5-6-8 = OFF
			Vfs = 100mV, Rin = 1M Ω	SW2.8 = ON SW2.5-6-7 = OFF
			Ifs = 20mA, Rin = 124,5 Ω	SW2.6 = ON SW2.5-7-8 = OFF
		Thermistor temperature measure, number 4	Temperature measure with PT100	SW2.5-8 = ON SW2.6-7 = OFF

34	CMA/T4-	0V for analog inputs for XAIN11 return	Control board zero Volt	
35	XAIN12	"Slow" auxiliary analog input, 10V f.s., number 12	Fs = 10V; Rin= 30k Ω;	
36	CMA	0V for analog inputs for XAIN12 return	Control board zero Volt	
37	XAIN13	"Slow" auxiliary analog input, 10V f.s., number 13	Fs = 10V; Rin= 30k Ω;	
38	CMA	0V for analog inputs for XAIN13 return	Control board zero Volt	
39	XMDI1	Multifunction auxiliary digital input 1	24Vdc Optoisolated digital inputs; positive logic (PNP): active with high level signal with respect to CMD (terminals 43 and 50). In compliance with EN 61131-2 as type 1 digital inputs (24Vdc rated voltage).	Maximum response time to processor: 500µs
40	XMDI2	Multifunction auxiliary digital input 2		
41	XMDI3	Multifunction auxiliary digital input 3		
42	XMDI4	Multifunction auxiliary digital input 4		
43	CMD	0 V digital input isolated to control 0 V		
44	+24V	Auxiliary supply output for optoisolated multifunction digital inputs		
45	XMDI5	Multifunction digital input 5		
46	XMDI6 / ECHA / FINA	Auxiliary multifunction digital input 6 / Single-ended, push-pull 24V encoder input, phase A / Frequency input A		
47	XMDI7 / ECHB	Auxiliary multifunction digital input 7 / Single-ended, push-pull 24V encoder input, phase B		Maximum response time to processor: 600ns
48	XMDI8 / FINB	Auxiliary multifunction digital input 8 / Frequency input B		
49	+24V	Auxiliary supply output for optoisolated multifunction digital inputs	+24V±15% ; Imax: 200mA Protected by resettable fuse	
50	CMD	0 V digital input isolated to control 0 V	Optoisolated digital input zero volt	
51	XMDO1	Multifunction auxiliary digital output 1 (collector)	Open collector isolated digital outputs, Vomax = 48V; Iomax = 50mA	
52	CMDO1	Multifunction auxiliary digital output 1 (emitter)		
53	XMDO2	Multifunction auxiliary digital output 2 (collector)		
54	CMDO2	Multifunction auxiliary digital output 2 (emitter)		
55	XMDO3	Multifunction auxiliary digital output 3 (collector)		
56	CMDO3	Multifunction auxiliary digital output 3 (emitter)		
57	XMDO4	Multifunction auxiliary digital output 4 (collector)		
58	CMDO4	Multifunction auxiliary digital output 4 (emitter)		
59	XMDO5	Multifunction auxiliary digital output 5 (collector)		
60	CMDO5	Multifunction auxiliary digital output 5 (emitter)		
61	XMDO6	Multifunction auxiliary digital output 6 (collector)		
62	CMDO6	Multifunction auxiliary digital output 6 (emitter)		

NOTE

All digital outputs are inactive under the following conditions:
- inverter off
- inverter initialization stage after power on
- alarm tripped (see Sinus Penta's Programming Instructions manual)
- software updating

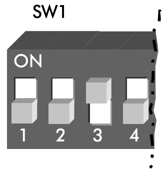
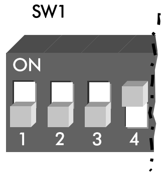
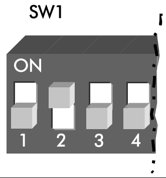
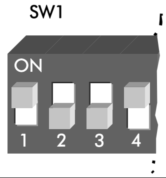
Consider this when choosing the inverter application.

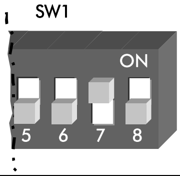
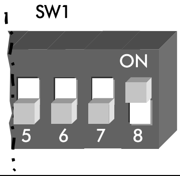
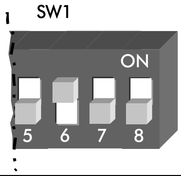
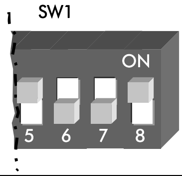
6.8.5. SET-UP DIP-SWITCHES

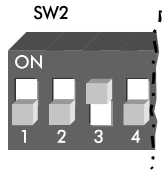
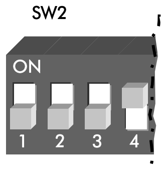
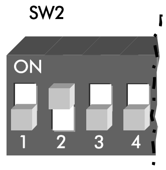
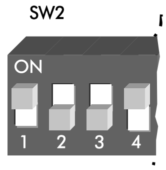
Board ES847 is provided with three configuration dip-switches (Figure 98) allowing to set the operating mode (see table below).

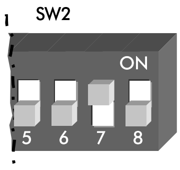
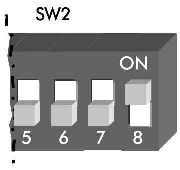
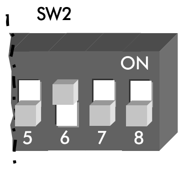
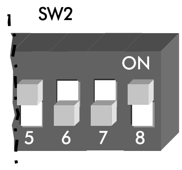
SW1	Sets the operating mode for "slow" analog inputs XAIN8 and XAIN9
SW2	Sets the operating mode for "slow" analog inputs XAIN10 and XAIN11
SW3	Factory-setting: SW3.2=ON, SW3.5=ON; the other dip-switches are OFF – Do not alter factory-setting–

6.8.6. POSSIBLE SETTINGS FOR DIP-SWITCHES SW1 AND SW2

Configuring Slow Analog Channel XAIN8			
Mode: 0-10V f.s. (Default configuration)	Mode: 0-100mV f.s.	Mode: 0-20mA f.s.	Temperature Reading with Thermistor PT100
			

Setting Slow Analog Channel XAIN9			
Mode: 0-10V f.s. (Default configuration)	Mode: 0-100mV f.s.	Mode: 0-20mA f.s.	Temperature Reading with Thermistor PT100
			

Setting Slow Analog Channel XAIN10			
Mode: 0-10V f.s. (Default configuration)	Mode: 0-100mV f.s.	Mode: 0-20mA f.s.	Temperature Reading with Thermistor PT100
			

Setting Slow Analog Channel XAIN11			
Mode: 0-10V f.s. (Default configuration)	Mode: 0-100mV f.s.	Mode: 0-20mA f.s.	Temperature Reading with Thermistor PT100
			

Five acquisition software modes are available (see Sinus Penta's Programming Instructions manual) corresponding to four hardware settings (see table below).

Type of Preset Acquisition	Mode Set for SW1 and SW2	Full-scale Values and Notes
Voltage: 0÷10V	Mode: 0-10V f.s.	0÷10V
Voltage: 0÷100mV	Mode: 0-100mV f.s.	0÷100mV
Current: 0÷20 mA	Mode: 0-20mA f.s.	0mA ÷ 20mA
Current: 4÷20 mA	Mode: 0-20mA f.s.	4mA ÷ 20mA; "cable disconnection" alarm with measure lower than 2mA
Temperature	Temperature Reading with Thermistor PT100	-50°C ÷ 125 °C. Disconnection alarm or short-circuit sensor if resistance measure is lower/higher than the preset range.

NOTE Software settings must be consistent with dip-switch settings. Otherwise, unpredictable results for real acquisition are produced.

NOTE A voltage/current value exceeding the input range will be saturated at minimum or maximum value.

CAUTION Inputs configured as voltage inputs have high input impedance and must be closed when active. The disconnection of the conductor relating to an analog input configured as a voltage input does not ensure that the channel reading is "zero". Proper "zero" reading occurs only if the input is connected to a low-impedance signal source or is short-circuited. Do not series-connect relay contacts to inputs to obtain "zero" reading.

6.8.7. WIRING DIAGRAMS

6.8.7.1. CONNECTION OF "FAST" DIFFERENTIAL ANALOG INPUTS

A differential input allows to weaken disturbance due to "ground potentials" generated when the signal is acquired from remote sources. Disturbance is weaker only if wiring is correct.
Each input is provided with a positive terminal and a negative terminal of the differential amplifier. They are to be connected to the signal source and to its ground respectively. Common voltage for the signal source ground and the ground of the CMA auxiliary inputs must not exceed the maximum allowable value.
To reduce noise for a differential input, do the following:

- ensure a common path for the differential torque
- connect the source common to CMA input in order not to exceed the common mode input voltage
- use a screened cable and connect its braiding to the terminal located next to the inverter terminal boards.

Board ES847 is also provided with an auxiliary supply output protected by a fuse which can be used to power external sensors. Do not exceed the max. current ratings.
Wiring is shown in the figure below:

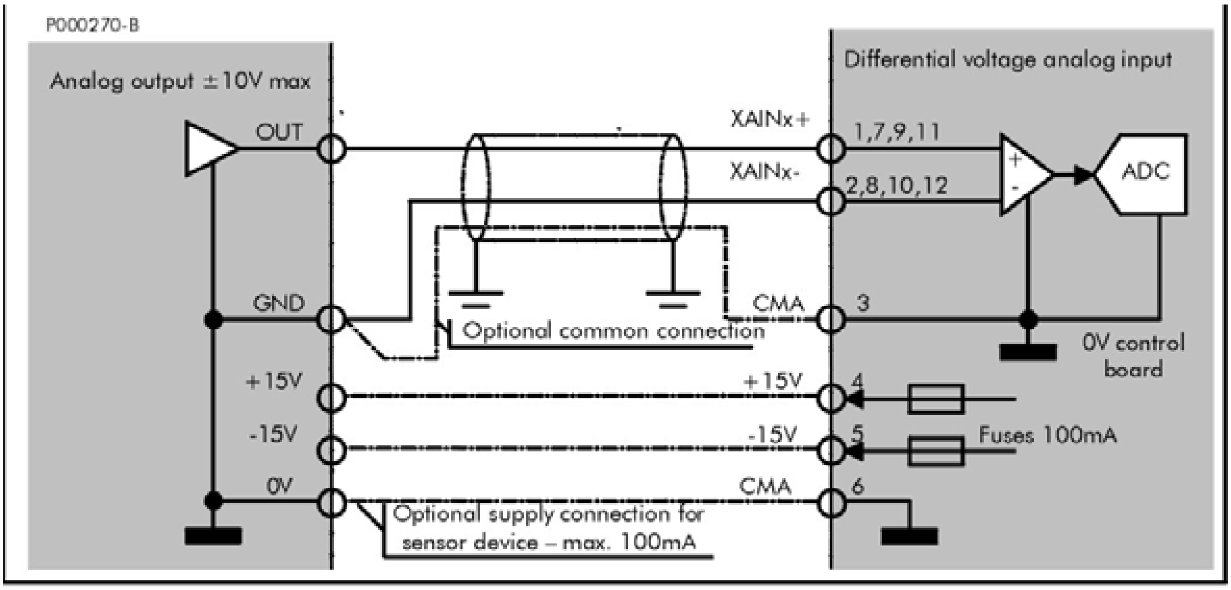


Figure 112: Connection of a bipolar voltage source to a differential input

NOTE Connecting terminal CMA to the signal source ground ensures better acquisition standards. Wiring can be external to the screened cable or it can consist of the optional common connection of the auxiliary supply.

NOTE Auxiliary supply outputs are electronically protected against temporary short-circuits. After wiring the inverter, check output voltage, because a permanent short-circuit can damage the inverter.

6.8.7.2. CONNECTION OF "FAST" CURRENT INPUTS

Three "fast" low-impedance analog inputs are available, which are capable of acquiring sensors with current output.
The correct wiring is shown in the diagram below.

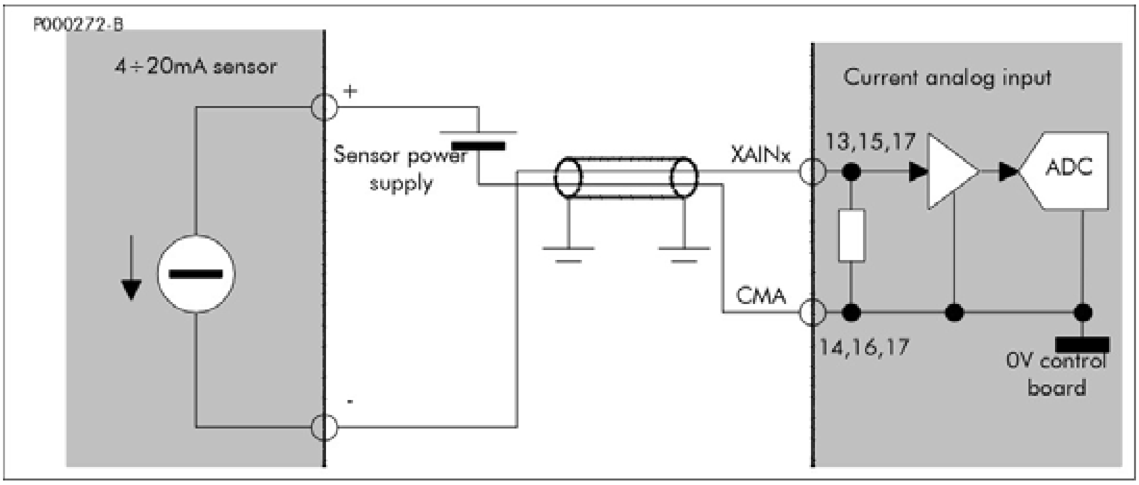


Figure 113: Connecting 0÷20mA (4÷20mA) sensors to "fast" current inputs XAIN5, XAIN6, XAIN7.

NOTE

Do not use +24V power supply, available on terminals 44 and 49 in ES847 board, to power 4÷20mA sensors, because it is to be used for the common of the digital inputs (CMD – terminals 43 and 50), not for the common of the analog inputs (CMA). Terminals 44 and 49 are galvanically isolated and must be kept galvanically isolated.

6.8.7.3. CONNECTING "SLOW" ANALOG INPUTS TO VOLTAGE SOURCES

Use a screened pair data cable and connect its braiding to the side of board ES847. Connect the cable braiding to the inverter frame using the special conductor terminals located next to the terminal boards.
Although "slow" acquisition analog channels have a cut-off frequency slightly exceeding 10Hz and the mains frequency, which is the main disturbance source, is weakened, make sure that wiring is correct, particularly if the full-scale value is 100mV and if wires are longer than 10 m. The figure below shows a wiring example for the acquisition of a voltage source.
Properly set the dip-switches for the configuration of the analog channel being used: set the full-scale value to 10V or to 100mV. The setting of the programming parameter must be consistent with the hardware setting.

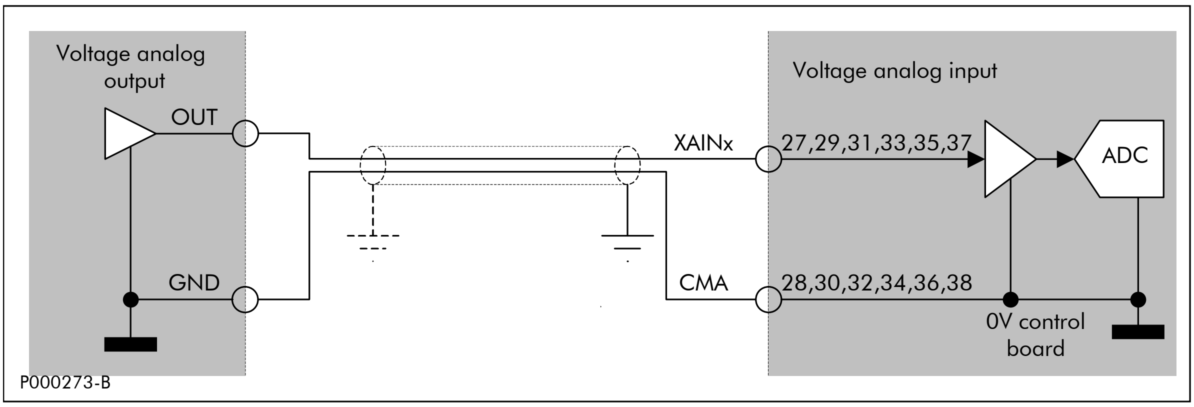


Figure 114: Connecting a voltage source to a "slow" analog input

0 1 2 3 4 5 6 7 8

6.8.7.4. CONNECTING "SLOW" ANALOG INPUTS TO VOLTAGE SOURCES

Figure 113 shows how to connect slow analog inputs to current sources. Channels XAIN8, XAIN9, XAIN10, XAIN11—corresponding to terminals 27, 29, 31, 33—are capable of acquiring current signals with a full-scale value of 20mA. Properly set the dip-switches for the configuration of the analog channel being used: set the full-scale value to 20mA and set the relevant programming parameter to 0÷20mA or 4÷20mA.

6.8.7.5. CONNECTING "SLOW" ANALOG INPUTS TO THERMISTOR PT100

ES847 board allows reading temperatures directly from the connection of standard thermistors PT100 complying with DIN EN 60751. Two-wire connection is used for easier wiring. Use relatively short cables and make sure that cables are not exposed to sudden temperature variations when the inverter is running. Proper wiring is shown in Figure 115: use a screened cable and connect its braiding to the inverter metal frame through the special conductor terminals.
If a cable longer than approx. 10 metres is used, measure calibration is required. For example, if a 1mm^2 (AWG 17) screened pair data cable is used, this results in a reading error of approx. +1°C every 10 metres.
To perform measure calibration, instead of the sensor connect a PT100 sensor emulator set to 0°C (or a 100Ω 0.1% resistor) to the line terminals, then enable the measure reset function. More details are given in Sinus Penta's Programming Instructions manual.
PT100 emulator allows to check measure before connecting the sensor.

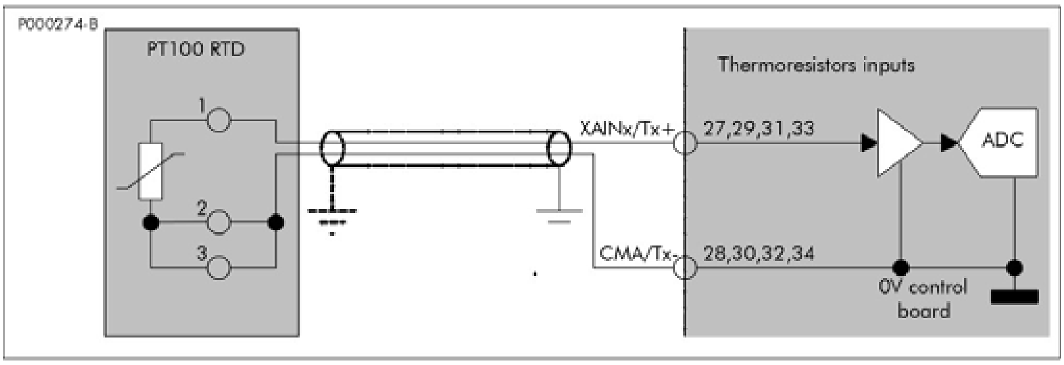


Figure 115: Connecting thermoresistors PT100 to analog channels XAIN8 – 11 /T1 - 4

NOTE	Software settings must be consistent with dip-switch settings. Otherwise, unpredictable results for real acquisition are produced.
NOTE	A voltage/current value exceeding the input range will be saturated at minimum or maximum value.
CAUTION	Inputs configured as voltage inputs have high input impedance and must be closed when active. The disconnection of the conductor relating to an analog input configured as a voltage input does not ensure that the channel reading is zero. Proper "zero" reading occurs only if the input is connected to a low-impedance signal source or is short-circuited. Do not series-connect relay contacts and inputs to obtain "zero" reading.

6.8.7.6. CONNECTING ISOLATED DIGITAL INPUTS

All digital inputs are galvanically isolated from zero volt of the inverter control board. To activate isolated digital inputs, use either isolated supply delivered to terminals 44 and 49 or 24Vdc auxiliary supply.
Figure 116 shows the digital input control mode exploiting power inside the inverter and exploiting the output of a control device, such as a PLC. Internal supply (+24 Vdc, terminals 44 and 49) is protected by a 200mA self-resetting fuse.

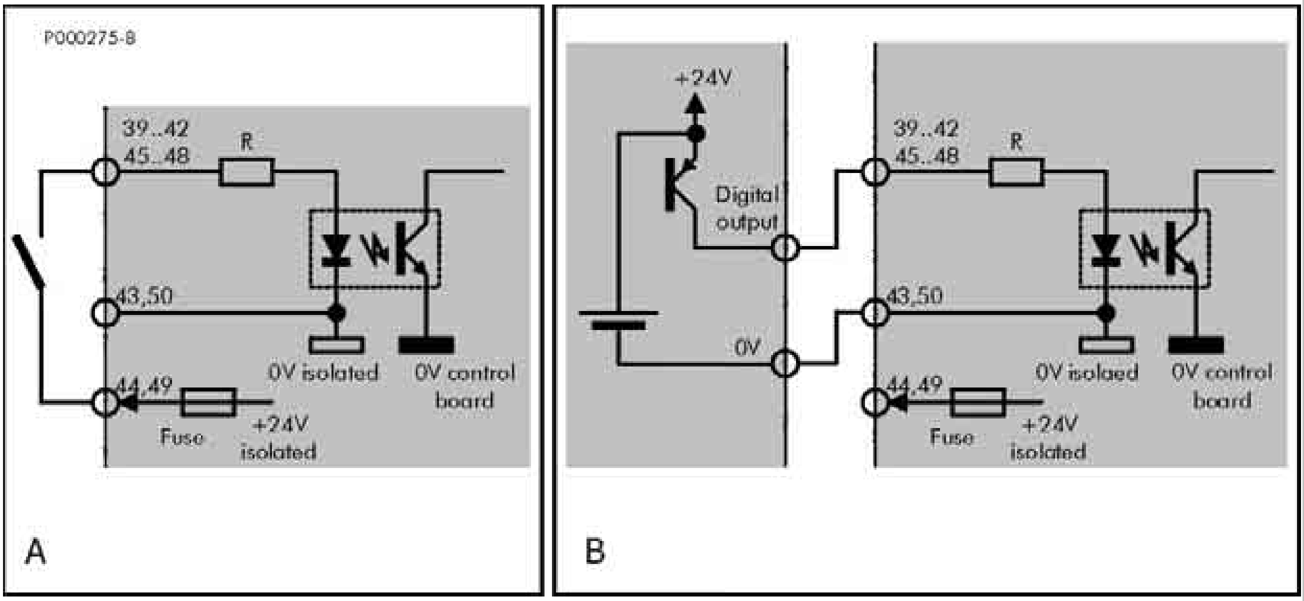


Figure 116: A PNP Command (active to +24V) via voltage-free contact

B PNP Command (active to +24V) sent from a different device (PLC, digital output board, etc.)

6.8.7.7. Connection to an Encoder or a Frequency Input

Auxiliary digital inputs XMDI6, XMDI7 and XMDI8 are capable of acquiring fast digital signals and can be used to be connected to a push-pull, single-ended, incremental encoder or for the acquisition of a frequency input. When fitting board ES847, encoder B functions are no more implemented by the basic terminal board of board ES821, but are implemented by board ES847. The incremental encoder must be connected to "fast" digital inputs XMDI6 and XMDI7, as shown in Figure 117.

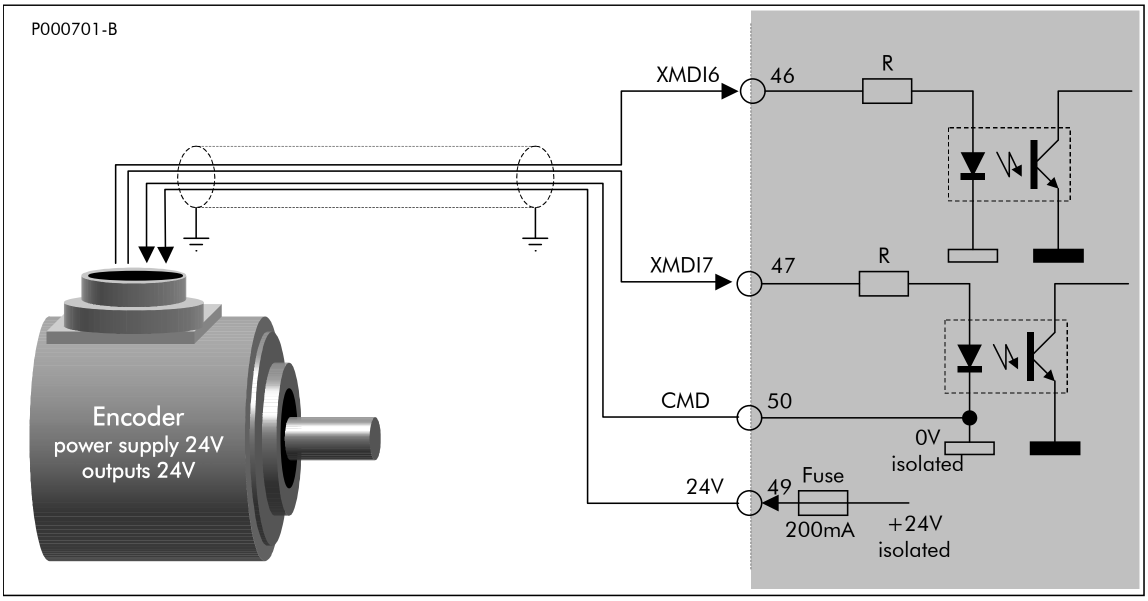


Figure 117: Connecting the incremental encoder to fast inputs XMDI7 and XMDI8

The encoder shall have PUSH-PULL outputs; its 24V power supply is delivered directly by the isolated supply internal to the inverter—terminals +24V (49) and CMD (50). The maximum allowable supply current is 200mA and is protected by a resettable fuse.
Only encoders described above can be acquired directly by the terminal board of the SINUS PENTA; encoder signals shall have a maximum frequency of 155kHz, corresponding to 1024 pulse/rev at 9000 rpm.
Input XMDI8 can also acquire a square-wave frequency signal ranging from 10kHZ to 100kHz, which is converted into an analog value to be used as a reference. Frequency values corresponding to the min. and max. reference can be set up as parameters. Do not exceed the allowable duty-cycle ratings for the frequency inputs.
Signals are sent from a 24V Push-pull output with a reference common to terminal CMD (50), as shown in Figure 118).

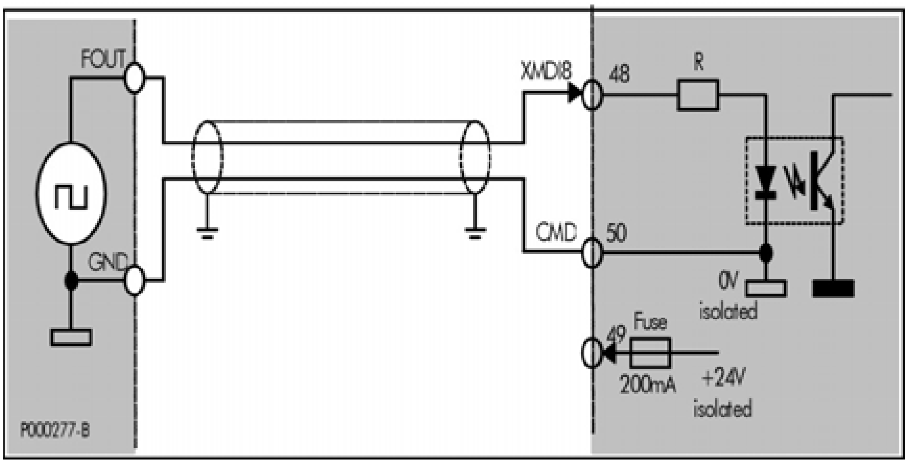


Figure 118: Signal sent from a 24V, Push-pull frequency output

6.8.7.8. CONNECTION TO ISOLATED DIGITAL OUTPUTS

Multifunction outputs XMDO1..8 (terminals 51..62) are all provided with a common terminal (CMDO1..8) which is isolated from the other outputs. They can be used to control both PNP and NPN loads, based on the wiring diagrams shown in Figure 109 and Figure 110.
Electrical conductivity (similar to a closed contact) is to be found between terminal MDO2 and CMDO2 when the output is active, i.e. when the ▮ symbol is displayed next to the output. Loads connected as PNP or as NPN are activated.
Outputs can be powered by the inverter isolated power supply or by an external source (24 or 48V – see dashed lines in the figure below).

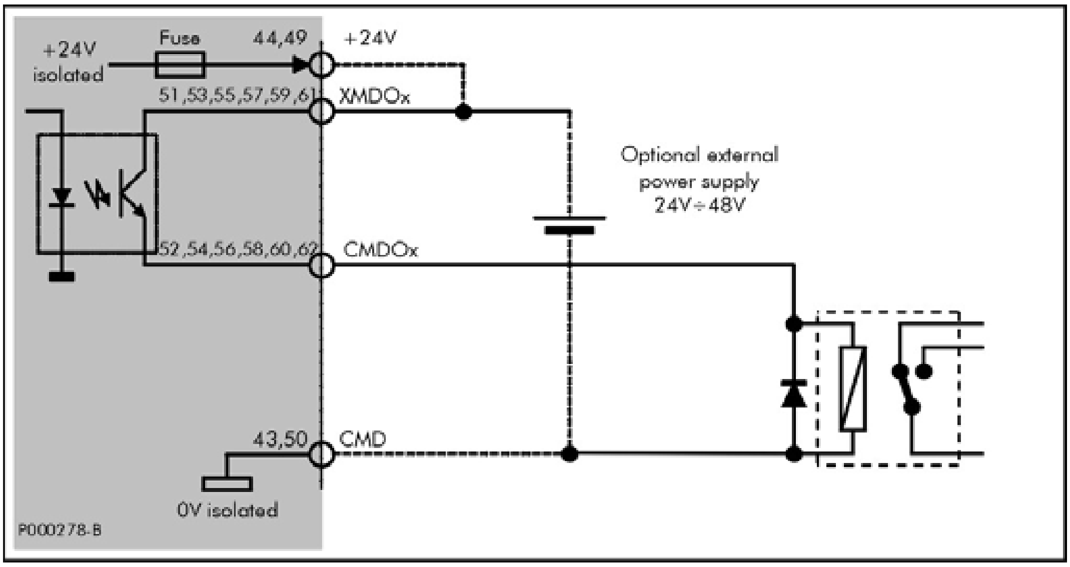


Figure 119: Connection of a PNP output for relay control

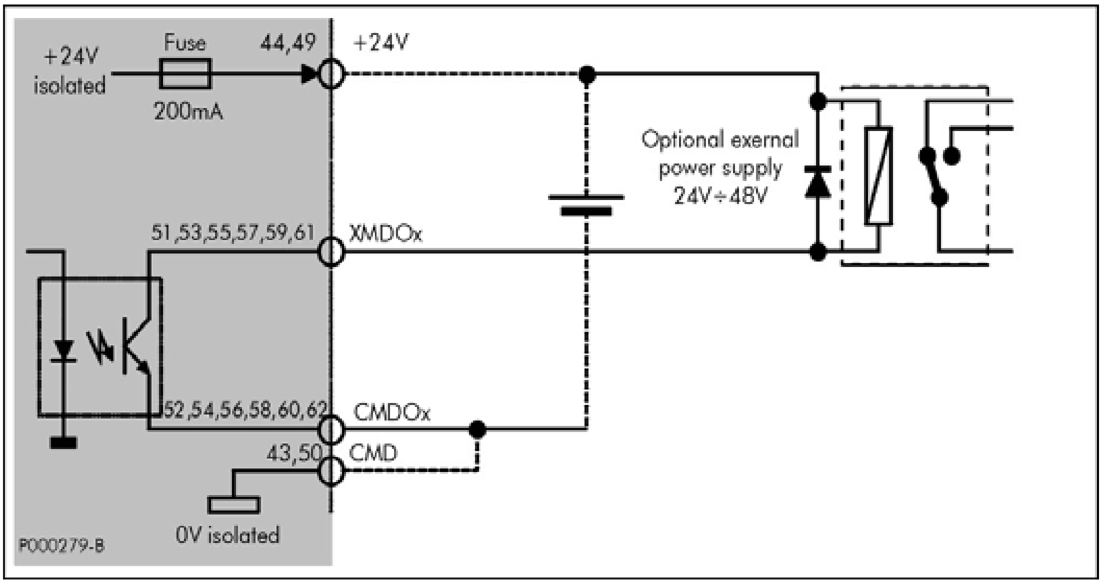


Figure 120: Connection of an NPN output for relay control

0 1 2 3 4 5 6 7 8

CAUTION	When inductive loads (e.g. relay coils) are connected, always use the freewheel diode, which is to be connected as shown in the figure.
NOTE	Do not simultaneously connect the isolated internal supply and the auxiliary supply to power the isolated digital outputs. Dashed lines in the figures are alternative to standard wiring.
NOTE	Digital outputs XMDO1..8 are protected from a temporary short-circuit by a resettable fuse. After wiring the inverter, check the output voltage, as a permanent short-circuit can cause irreversible damage.

6.8.8. ENVIRONMENTAL REQUIREMENTS

Operating temperature:	ambient temperature, 0 to + 50° C (contact Elettronica Santerno for lower/higher temperatures)
Relative humidity:	5 to 95% (non-condensing)
Max. operating altitude	4000 m (a.s.l.)

6.8.9. Electrical Ratings

6.8.9.1. Analog Inputs

Fast Sampling Analog Inputs, ±10V f.s.	*Value*			
	Min.	*Type*	*Max.*	*Unit*
Input impedance		10		kΩ
Offset cumulative error and gain with respect to full-scale value		0.5		%
Temperature coefficient of the gain error and offset			200	ppm/°C
Digital resolution			12	bit
Value of voltage LSB		5.22		mV/LSB
Common mode maximum voltage over differential inputs	-15		+15	V
Permanent overload over inputs with no damage	-30		+30	V
Input filter cut-off frequency (2nd order Butterworth filter)		5.1		kHz
Sampling time (depending on the software being used)	0.2		1.2	ms

Fast Sampling Analog Inputs for Current Measure	*Value*			
	Min.	*Type*	*Max.*	*Unit*
Input impedance		200		Ω
Offset cumulative error and gain with respect to full-scale value		0.5		%
Temperature coefficient of the gain error and offset			200	ppm/°C
Digital resolution			12	bit
Value of current LSB		13		μA/LSB
Equivalent resolution in 0-20mA acquisition mode			10.5	bit
Permanent overload over inputs with no damage	-5		+5	V
Input filter cut-off frequency (2nd order Butterworth filter)		5.1		kHz
Sampling time (depending on the software being used)	0.2		1.2	ms

Slow Sampling Analog Inputs Configured in 0-10V mode	*Value*			
	Min.	*Type*	*Max.*	*Unit*
Input impedance		40		kΩ
Offset cumulative error and gain with respect to full-scale value		0.5		%
Temperature coefficient of the gain error and offset			200	ppm/°C
Digital resolution			12	bit
Value of voltage LSB		2.44		mV/LSB
Permanent overload over inputs with no damage	-30		+30	V
Input filter cut-off frequency (1st order low pass filter)		13		Hz
Sampling time (depending on the software being used)	10		1000	ms

Slow Sampling Analog Inputs Configured in 0-20mA mode	*Value*			
	Min.	*Type*	*Max.*	*Unit*
Input impedance		124.5		Ω
Offset cumulative error and gain with respect to full-scale value		0.5		%
Temperature coefficient of the gain error and offset			200	ppm/°C
Digital resolution			12	bit
Value of current LSB		4.90		μA/LSB
Permanent overload over inputs with no damage	-3.7		+3,7	V
Input filter cut-off frequency (1st order low pass filter)		13		Hz
Sampling time (depending on the software being used)	10		1000	ms

Slow Sampling Analog Inputs Configured in 0-100mV mode	*Value*			
	Min.	*Type*	*Max.*	*Unit*
Input impedance	1			MΩ
Offset cumulative error and gain with respect to full-scale value		0.2		%
Temperature coefficient of the gain error and offset			50	ppm/°C
Digital resolution			12	bit
Value of voltage LSB		24.7		μV/LSB
Permanent overload over inputs with no damage	-30		+30	V
Input filter cut-off frequency (1st order low pass filter)		13		Hz
Sampling time (depending on the software being used)	10		1000	ms

Slow Sampling Analog Inputs Configured in PT100 Temperature Measure Mode	*Value*			
	Min	*Type*	*Max*	*Unit .*
Type of probe	Two-wire PT100 Thermistor			
Measure range	-50		260	°C
Polarization current for PT100		0.49		mA
Measure temperature coefficient			50	ppm/°C
Digital resolution			11	bit
Measure max. cumulative error for temperature ranging from -40 to +50°C		0.5	1.5	°C
Mean value of temperature LSB (linearization SW function)		0.135		°C/LSB
Permanent overload over inputs with no damage	-10		+10	V
Input filter cut-off frequency (1st order low pass filter)		13		Hz
Sampling time (depending on the software being used)	10		1000	ms

6.8.9.2. DIGITAL INPUTS

Features of the Digital Inputs	*Value*			
	Min.	*Type*	*Max.*	*Unit*
Input voltage for XMDIx with respect to CMD	-30		30	V
Voltage corresponding to logic level 1 between XMDIx and CMD	15	24	30	V
Voltage corresponding to logic level 0 between XMDIx and CMD	-30	0	5	V
Current absorbed by XMDIx at logic level 1	5	9	12	mA
Input frequency over "fast" inputs XMDI6..8			155	kHz
Allowable duty-cycle for frequency inputs	30	50	70	%
Min. time at high level for "fast" inputs XMDI6..8	4.5			µs
Isolation test voltage between terminals CMD (43 and 50) with respect to terminals CMA (3-6-14-16-18-28-30-32-34-36-38)	500Vac, 50Hz, 1min.			

6.8.9.3. DIGITAL OUTPUTS

Features of the Digital Outputs	*Value*			
	Min.	*Type*	*Max.*	*Unit*
Working voltage range for outputs XMDO1..8	20	24	50	V
Max. current that can be commutated from outputs XMDO1..8			50	mA
Voltage drop of outputs XMDO1..8, when active			2	V
Leakage current of outputs XMDO1..8, when active			4	µA
Isolation test voltage between terminals CMDO1..8 and CMA	500Vac, 50Hz, 1min.			

6.8.9.4. Supply Outputs

Features of the Analog Supply Outputs	*Value*			
	Min.	*Type*	*Max.*	*Unit*
Voltage available on terminal +15V (4) with respect to CMA (6)	14.25	15	15.75	V
Voltage available on terminal -15V (5) with respect to CMA (6)	-15.75	-15	-14.25	V
Max. current that can be delivered from +15V output and that can be absorbed by output –15V			100	mA

Features of the Digital Supply Outputs	*Value*			
	Min.	*Type*	*Max.*	*Unit*
Voltage available on +24V terminals (44, 49) with respect to CMD (43, 50)	21	24	27	V
Max. current that can be delivered from +24V output			200	mA

CAUTION Irreversible faults occur if the min./max. input/output voltage ratings are exceeded.

NOTE The isolated supply output and the analog auxiliary output are protected by a resettable fuse capable of protecting the feeder inside the inverter against short-circuits. Nevertheless, in case of short-circuit, it can happen that the inverter does not temporarily lock and does not stop the motor.

6.9. OPTION BOARDS FOR FIELD BUS (SLOT B)

Four interfacing option boards are available for the connection of the inverters of the Sinus PENTA series to automation systems based on Fieldbus. Four fieldbus standards are also available. Option boards allow to interface systems based on:

- Profibus,
- DeviceNet (CAN),
- CANopen (CAN),
- Ethernet (Modbus TCP + IT functions).

The inverters of the Sinus PENTA series can house only one option board per fieldbus. This board allows to control the inverter through the desired bus starting from a control device (PLC, industrial computer, etc.). The control method from fieldbus integrates the control methods from local terminals, remote terminals (through MODBUS serial link) and from keypad, which are provided from the inverter. For more details on the inverter command modes and the possible matching among the different sources, refer to the Sinus Penta's Programming Instructions ("Control Method" and "Fieldbus" sections).
The sections below cover the installation procedure and the configuration and diagnostics of the different types of option boards.

NOTE — The read/write scan rate for Sinus Penta drives is 2ms. Please refer to the Programming Instructions manual for details.

6.9.1. IDENTIFICATION DATA

Each kit including option boards for fieldbuses also includes a CD-ROM containing detailed documentation (instruction manuals in English, utilities and configuration files), which is required for the inverter configuration and integration to the automation system based on fieldbus.

Description	*Code*	*Compatibility*
ANYBUS-S PROFIBUS-DP KIT	ZZ4600040	All the inverters of the Sinus PENTA series
ANYBUS-S DeviceNet KIT	ZZ4600050	
ANYBUS-S CANopen KIT	ZZ4600070	
ANYBUS-S Ethernet KIT	ZZ4600100	

6.9.2. INSTALLING THE FIELDBUS BOARD ON THE INVERTER (SLOT B)

1) Remove voltage from the inverter and wait at least 5 minutes.
2) The electronic components in the inverter and the communications board are sensitive to electrostatic discharge. Be careful when you reach the component parts inside the inverter and when you handle the communications board. The board should be installed in a workstation equipped with proper grounding and provided with an antistatic surface. If this is not possible, the installer must wear a ground bracelet properly connected to the PE conductor.

3) Loosen the two front screws located in the lower part of the inverter cover to remove the covering of the terminal board. In the PENTA's control board, you can then reach the slot B, where you can install the Profibus communications board.

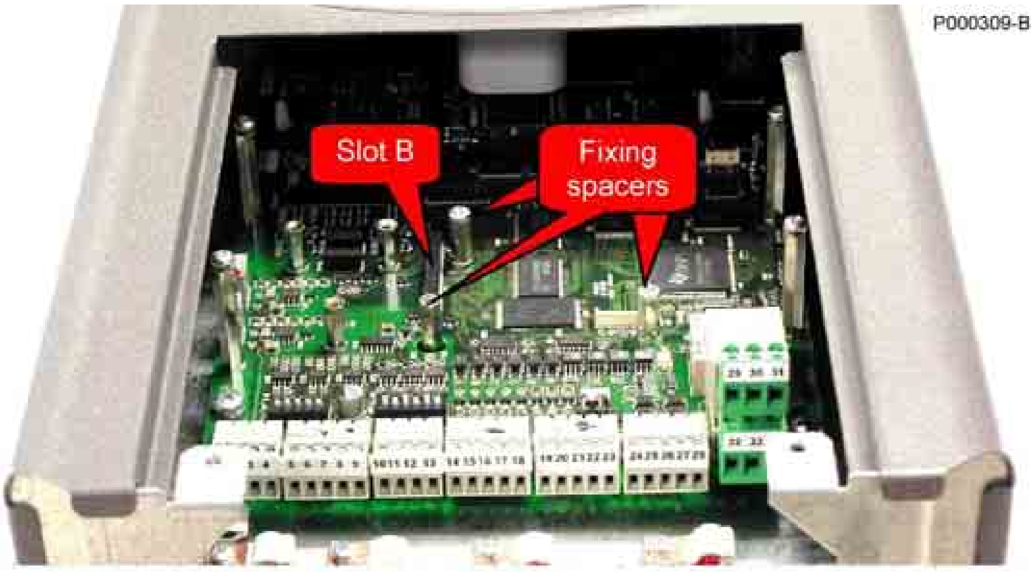


Figure 121: Location of the slot B inside the terminal board cover of the Sinus PENTA inverters

4) Insert the communications board in the slot B; make sure that the comb connector in the board is inserted in the front part of the slot only, and that the last 6 pins are not connected. If installation is correct, the three fastening holes will match with the housings of the fastening screws for the fixing spacers. Tighten the board fixing screws as shown in Figure 122 and Figure 123.

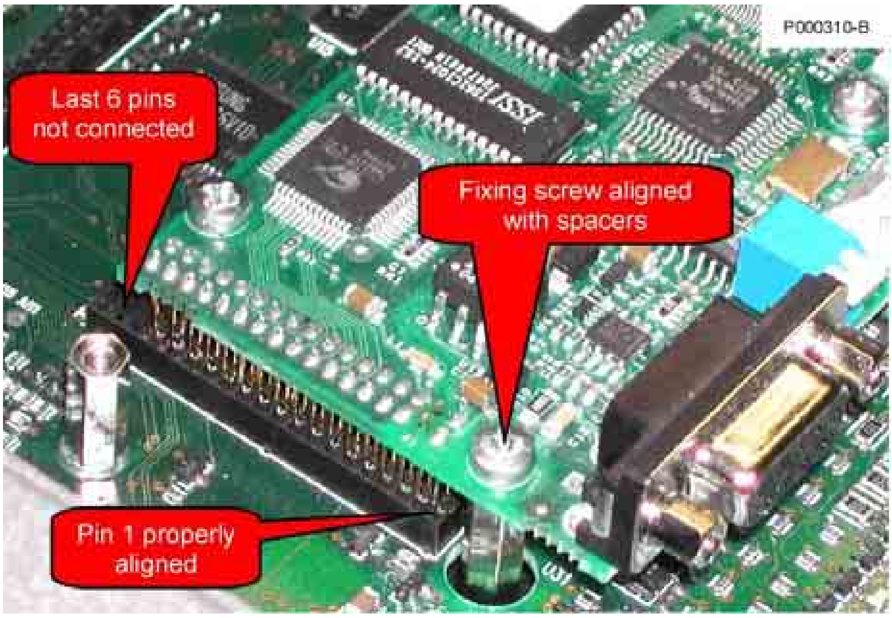


Figure 122: Checking contacts in the slot B

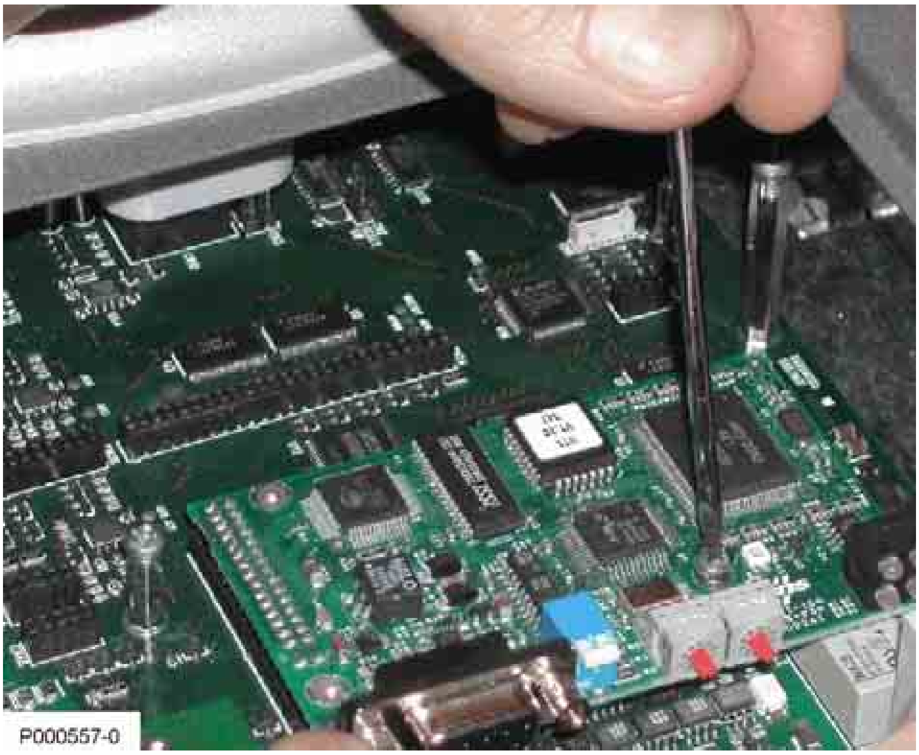


Figure 123: Fastening the communications board to the slot B

5) Configure the dip-switches and rotary-switches following the instructions given in the relevant section.

6) Connect the Fieldbus cable by inserting its connector or by connecting wires to the terminals.

7) Power on the inverter and set the parameters relating to the option Fieldbus board (see programming section in the Sinus PENTA's Programming Instructions manual).

	DANGER	Before gaining access to the components inside the inverter, remove voltage from the inverter and wait at least 5 minutes. Wait for a complete discharge of the internal components to avoid any electrical shock hazard.
	CAUTION	Electrical shock hazard: do not connect/disconnect the signal terminals or the power terminals when the inverter is on. This also prevents the inverter from being damaged.
	NOTE	All the screws used to fasten removable parts (terminals cover, serial interface connector, cable plates, etc.) are black, round-head, cross-head screws. When wiring the inverter, remove only this type of screws. If different screws or bolts are removed, the inverter guaranty will be no longer valid.

6.9.3. FIELDBUS PROFIBUS-DP COMMUNICATIONS BOARD

The Profibus communications board allows interfacing between an inverter of the Sinus PENTA Series and an external control unit, such as a PLC, using a PROFIBUS-DP communications interface.
The Sinus PENTA inverter operates as a Slave device and is controlled by a Master device (PLC) through command messages and reference values which are equivalent to the ones sent via terminal board. The Master device is also capable of detecting the operating status of the inverter. More details about Profibus communications are given in the Sinus Penta's Programming Instructions manual.
Profibus communications board has the following features:

- Type of fieldbus: PROFIBUS-DP EN 50170 (DIN 19245 Part 1) with protocol version 1.10
- Automatic detection of the baud rate ranging from 9600 bits/s to 12 Mbits/s
- Communications device: PROFIBUS bus link, type A or B as mentioned in EN50170
- Type of fieldbus: Master-Slave communications; max. 126 stations in multidrop connection
- Fieldbus connector: female, 9-pin, DSUB connector
- Wire: copper twisted pair (EIA RS485)
- Max. length of the bus: 200m @ 1.5Mbits/s (can be longer if repeaters are used)
- Isolation: the bus is galvanically isolated from the electronic devices via a DC/DC converter
- The bus signals (link A and link B) are isolated via optocouplers
- PROFIBUS –DP communications ASIC: chip Siemens SPC3
- Hardware configurability: bus terminator switch and rotary-switch assigning the address to the node
- Status indicators: indicator Led for board status and indicator Led for fieldbus status.

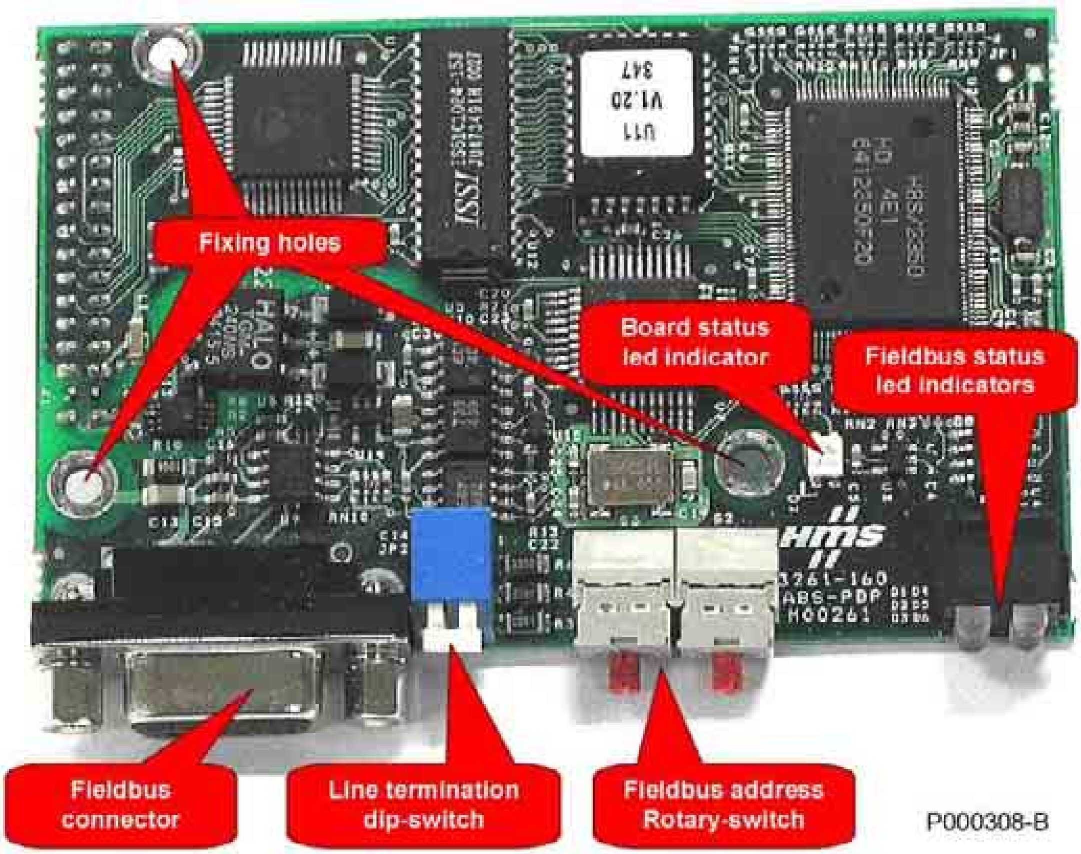


Figure 124: PROFIBUS-DP fieldbus communications board

6.9.3.1. PROFIBUS FIELDBUS CONNECTOR

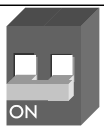
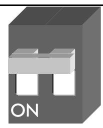
Female, 9-pin, D-sub connector.

Pin location:

N.	*Name*	*Description*
-	Screen	Connector frame connected to PE
1	N.C.	
2	N.C.	
3	B-Line	Positive RxD/TxD according to RS 485 specifications
4	RTS	Request To Send – active high level when sending
5	GND	Bus ground isolated from control board 0V
6	+5V	Bus driver supply isolated from control board circuits
7	N.C.	
8	A-Line	Negative RxD/TxD according to RS 485 specifications
9	N.C.	

6.9.3.2. CONFIGURATION OF THE PROFIBUS-DP COMMUNICATIONS BOARD

PROFIBUS-DP communications board is provided with one dip-switch and two rotary-switches used to set the operating mode.
The dip-switch located next to the fieldbus connector allows to activate the line terminator. The terminator is activated by pushing the lever downwards, as shown below.

Fieldbus terminator on	Termination of fieldbus line cut out
	

The termination of the fieldbus line should be cut in only with the first and last device of a chain, as explained with Figure 125.
The figure shows a common configuration where the first device is the Master (PLC, Bus Bridge or Repeater), but this device can be connected also in central position. Anyway, the rule stating that termination should always be connected to first or last device, is always valid.

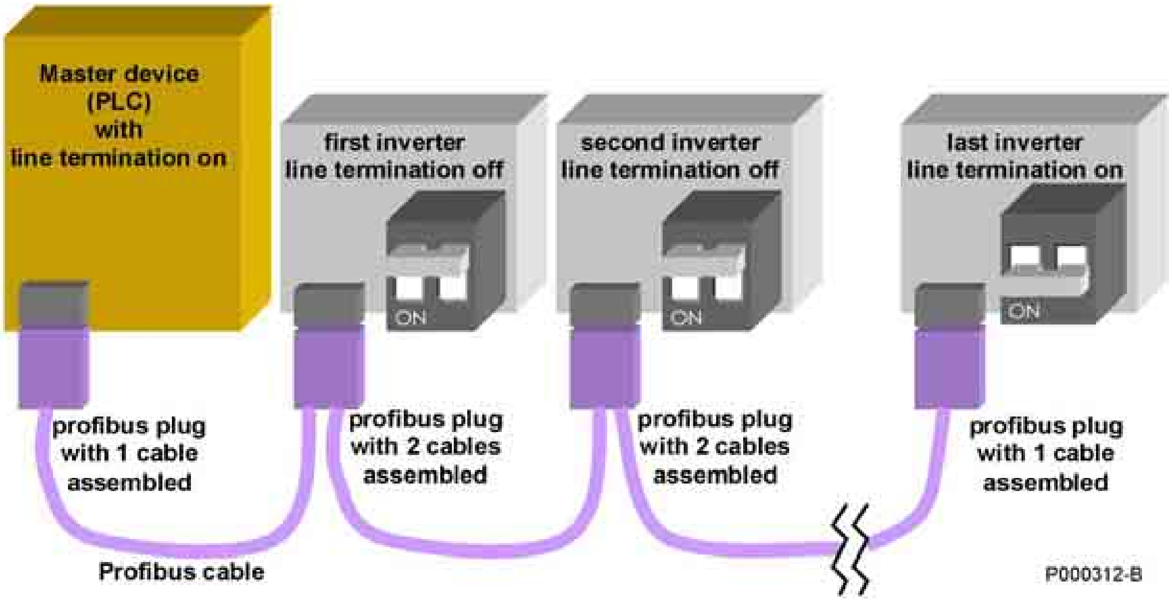


Figure 125: Example of a Profibus multidrop network; the correct setting of the line terminators is highlighted

Each device in the network must have its own Profibus address. The addresses of the inverters of the Sinus PENTA series are set through the rotary-switches installed in the interface board. Each rotary-switch is provided with a pin that can be turned to position 0-9 using a small screwdriver.
The left rotary-switch allows to set the tenths of the Profibus address, while the right rotary switch allows to set the units. Figure 126 shows an example of the correct position to set address "19".

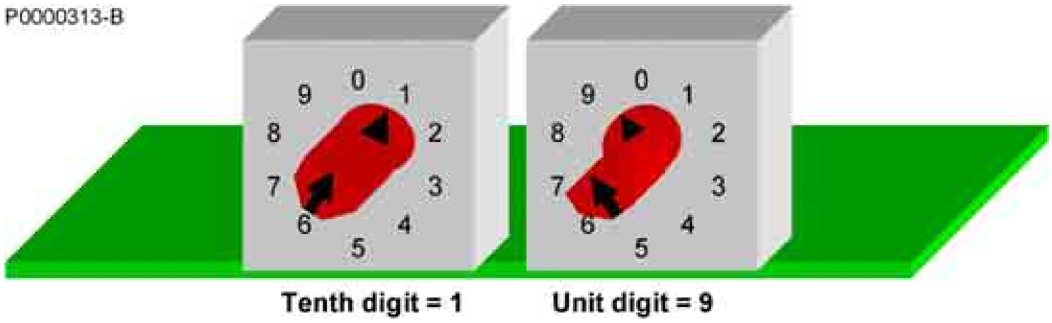
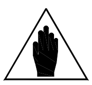


Figure 126: Example of the rotary-switch position to set Profibus address "19"



NOTE

The rotary-switches allow to set Profibus addresses ranging from 1 to 99. Addresses exceeding 99 are not yet allowed.

6.9.3.3. CONNECTION TO THE FIELDBUS

Make sure that wiring is correct, specially if the fieldbus operates at high baud rates (higher than or equal to 1.5Mb/s).
Figure 116 is an example of a Profibus link connecting multiple devices.
Use special Profibus cables ("Profibus Standard Bus Cable", Type A); do not exceed the max. allowable connection length based on the baud rate; use proper connectors.
The table below shows the standard baud rate values and the corresponding max. length of the bus if cables of Type A are used.

Allowable Baudrate	*Max. Length for Cable of Type A*
9.6 kbits/s	1.2 km
19.2 kbits/s	1.2 km
45.45 kbits/s	1.2 km
93.75 kbits/s	1.2 km
187.5 kbits/s	1 km
500 kbits/s	400 m
1.5 Mbits/s	200 m
3 Mbits/s	100 m
6 Mbits/s	100 m
12 Mbits/s	100 m

We recommend that Profibus FC (FastConnect) connectors be used. They offer the following benefits:
- No welding required for the connections inside the cable
- One ingoing cable and one outgoing cable can be used, so that connections of intermediate nodes can be stubless, thus avoiding signal reflections
- The internal resistors can be connected through a switch located on the connector frame
- Profibus FC connectors are provided with an internal impedance adapting network to compensate for the connector capacity.

NOTE

If you use Profibus FC connectors with internal terminators, you can activate either the connector terminal or the board terminals (in the first/last device only). Do not activate both terminators at a time and do not activate terminators in intermediate nodes.

NOTE

A more comprehensive overview of the Profibus is given at http://www.profibus.com/. In particular, you can download the "Installation Guideline for PROFIBUS DP/FMS", containing detailed wiring information, and the document named "Recommendations for Cabling and Assembly" containing important guidelines to avoid the most common wiring errors. The links below allow to access directly to these documents:
~/documentationfree/Inst_Guide_PA_2092_V22_Feb03.pdf
~/documentationfree/Recommendation_Assembling_8022_V103_Nov05_72DPI.pdf

6.9.4. DeviceNet Fieldbus Communications Board

The DeviceNet communications board allows to interface a Sinus PENTA inverter with an external control unit through a communications interface using a CAN protocol of the DeviceNet 2.0 type. The baud rate and the MAC ID can be set through the on-board dip-switches. Max. 512 bytes for input/output data are available; some of them are used for the interfacing with the inverter. Refer to the Sinus PENTA'S Programming Instructions manual for more details on the inverter control modes through the DeviceNet fieldbus board.
The main features of the interface board are the following:

- Baud Rate: 125, 250, 500 kbits/s
- DIP switch for baud rate and MAC ID selection
- Optically isolated DeviceNet interface
- Max. 512 bytes for input & output data
- Max. 2048 bytes for input & output data through mailbox
- DeviceNet Specification version: Vol 1: 2.0, Vol 2: 2.0
- Configuration test version: A-12

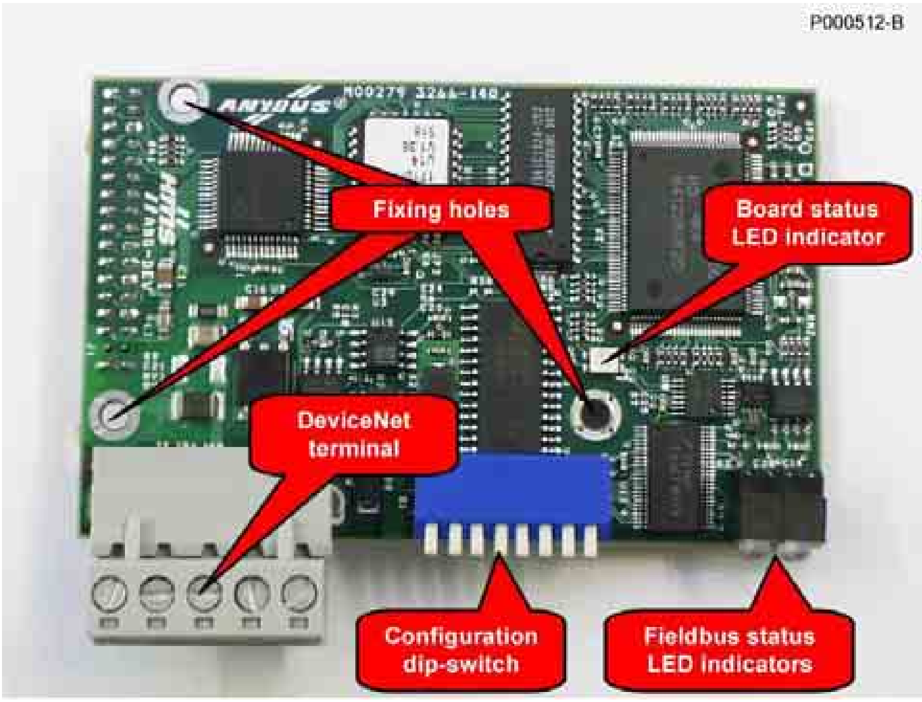


Figure 127: DeviceNet Fieldbus communications board

6.9.4.1. DeviceNet Fieldbus Terminals

The DeviceNet Fieldbus communications board is provided with a removable, screwable terminal board (pitch 5.08). The bus interface circuitry has an external supply of 24VDC ±10%, as prescribed from the CAN DeviceNet specifications.

Terminal arrangement as stated in the table:

N.	*Name*	*Description*
1	V-	Negative voltage for bus supply
2	CAN_L	CAN_L bus line
3	SHIELD	Cable shielding
4	CAN_H	CAN_H bus line
5	V+	Positive voltage for bus supply

6.9.4.2. Board Configuration

The on-board dip-switches allow to set the baud rate and the MAC ID identifying the device in the DeviceNet network.
Dip-switches 1 and 2 allow to set the baud rate, that must be the same for all the related devices. The DeviceNet standard allows three baud rates: 125, 250 and 500 kbits/s. Possible settings are the following:

Baudrate	*Setting of sw.1 & sw.2*	
125 kbits/s	sw.1=OFF	sw.2=OFF
250 kbits/s	sw.1=OFF	sw.2=ON
500 kbits/s	sw.1=ON	sw.2=OFF

The MAC ID can be set between 0 and 63 by entering the configuration of the binary number for six dip-switches, from sw.3 to sw.8. The most significant bit (MSB) is set through sw.3, while the least significant bit (LSB) is set through sw.8.
Some possible settings are shown in the table below:

MAC ID	sw.3 (MSB)	sw.4	sw.5	sw.6	sw.7	sw.8 (LSB)
0	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
…..	…..	…..	…..	…..	…..	…..
62	ON	ON	ON	ON	ON	OFF
63	ON	ON	ON	ON	ON	ON

If multiple devices are connected to the same bus, different MAC IDs are to be set.

6.9.4.3. CONNECTION TO THE FIELDBUS

The wiring quality is fundamental for the best reliability of the bus operation. The higher the baud rates, the shortest the bus lengths allowed.
Reliability is strongly affected by the type of wiring and the wire topology. The DeviceNet standard allows four types of wires based on the type of related devices. It also allows to connect signal dispatching nodes, line terminators and supply couplers. Two types of lines are defined: the trunk line and the drop lines. The figure below illustrates the topology of a typical DeviceNet trunk line.

P000513-B

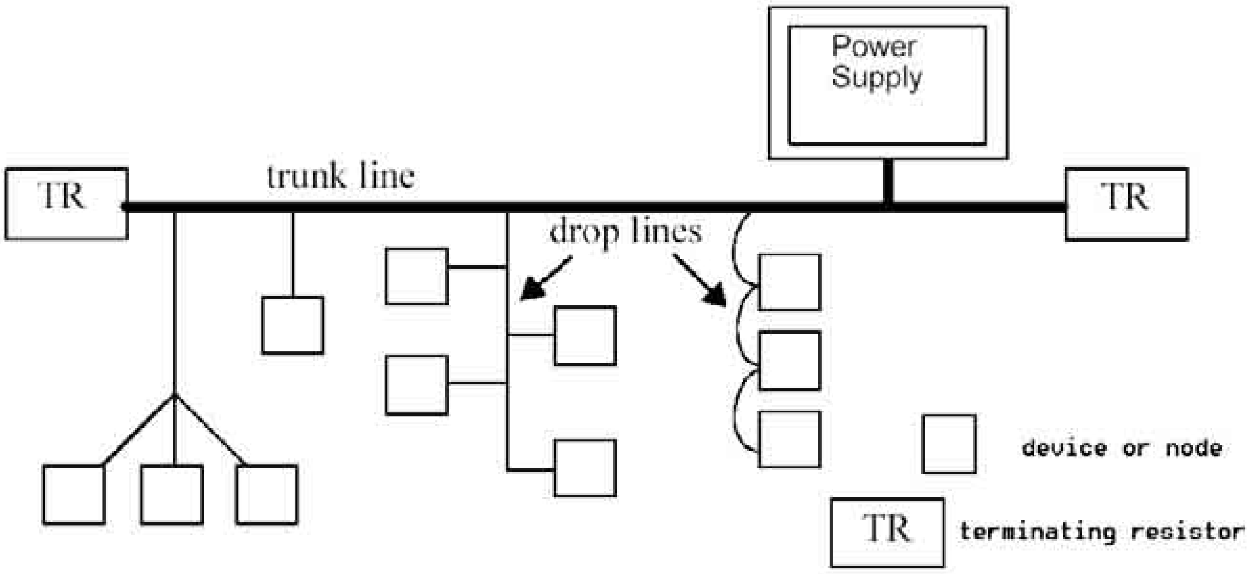


Figure 128: Outline of the topology of a DeviceNet trunk line

The inverter equipped with a DeviceNet interface board is typically connected through a drop line consisting of a 5-conductor shielded cable. The DeviceNet standard defines three shielded cables based on their diameter: THICK, MID, and THIN cables. The maximum electric length between two DeviceNet devices depends on the baud rate and the type of cable being used. The table below shows the maximum lengths that are recommended based on these variables. The FLAT cable can be used for the main trunk line if drop lines are connected through a system that does not require welding.

Baud Rate	Max. length with FLAT cable	Max. length with THICK cable	Max. length with MID cable	Max. length with THIN cable
125 kbits/s	420m	500m	300m	100m
250 kbits/s	200m	250m	250m	100m
500 kbits/s	75m	100m	100m	100m

NOTE Each DeviceNet trunk line must meet some geometric requirements and must provide two terminator nodes and at least one supply node, because devices can be totally or partially powered via the bus. The type of the cable being used also determines the max. supply current available for the bus devices.

For a more comprehensive overview of the DeviceNet standard, go to ODVA's home page (http://www.odva.org).

NOTE In particular, you can refer to the "Planning and Installation Manual - DeviceNetTM Cable System" document at
http://www.odva.org/10_2/Cable_Manual/Cable_Guide/Cable_Guide_Print.pdf

NOTE In case of failures or disturbance in the DeviceNet communications, please fill in the "DeviceNet Baseline & Test Report" form in the Appendix C of the "Planning and Installation Manual" before contacting the After-sales service.

6.9.5. CANopen Fieldbus Communications Board

The CANopen communications board allows to interface a Sinus PENTA inverter with an external control unit using communications interface operating with a CAN protocol of the CANopen type complying with the CIA DS-301 V3.0 specifications. The baud rate and the Device Address can be set through the on-board rotary switches. Eight baud rate levels can be set, up to 1Mbit/s. Refer to the Sinus PENTA's Programming Instructions manual for more details on the inverter control modes through the CANopen fieldbus board.
The main features of the interface board are the following:

- Unscheduled data exchange support
- Synch & Freeze operating mode
- Possibility of setting Salve Watch-dog timer
- Eight baud rate levels, from 10kbits/s to 1Mbit/s
- Possibility of setting different Device Addresses up to max. 99 nodes
- Optically isolated CAN interface
- CANopen conformity: CIA DS-301 V3.0

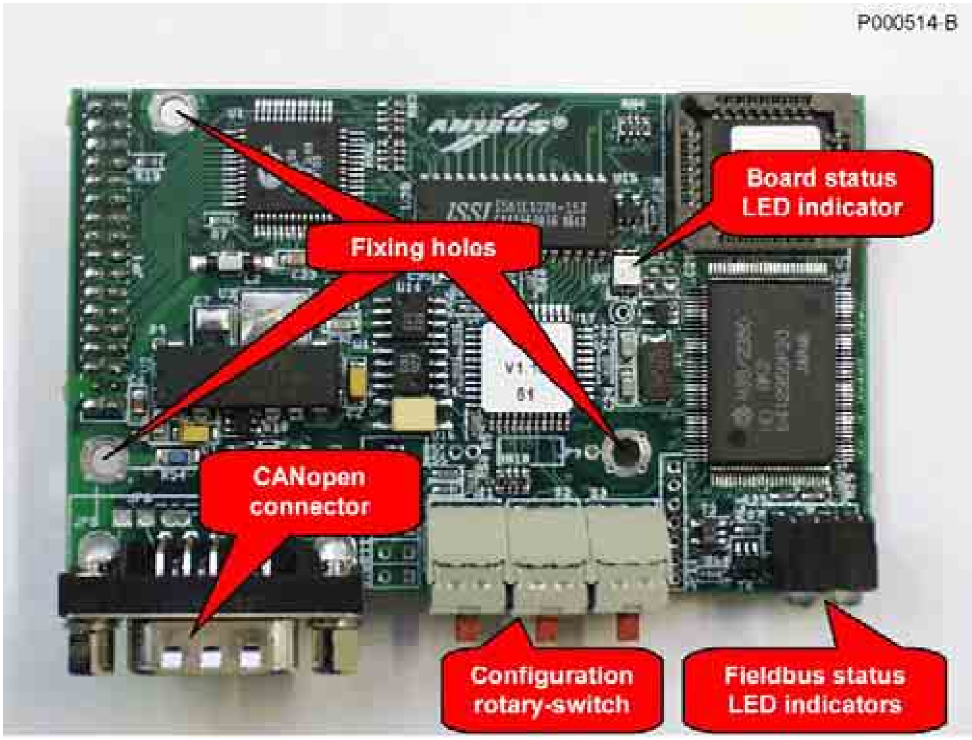


Figure 129: CANopen fieldbus communications board

0 1 2 3 4 5 6 7 8

6.9.5.1. CANopen Fieldbus Connector

The CANopen communications board is provided with a 9-pin male "D" connector. The bus interface circuitry is internally supplied, as prescribed by the CANopen specifications.

Pins are arranged as follows:

N.	*Name*	*Description*
Shell	CAN_SHLD	Cable shielding
1	-	
2	CAN_L	CAN_L line
3	CAN_GND	Common terminal of the CAN driver circuit
4	-	
5	CAN_SHLD	Cable shielding
6	GND	Option common terminal internally connected to pin 3
7	CAN_H	CAN_H line
8	-	
9	(reserved)	do not use

CAUTION

The CANopen connector is the same type as the connector fitted in all the inverters of the Sinus PENTA series for the Modbus serial communications, but the pin arrangement and the internal circuitry are totally different. Make sure that connectors are not mismatched! A wrong connection of the CANopen connector to the Modbus interface or vice versa can damage the inverter and the other devices connected to the Modbus and CANopen networks.

6.9.5.2. Board Configuration

The CANopen communications board shall be used with three rotary-switches for configuration, which are required to set up the inverter operating mode. The rotary-switches also allow to set the baud rate and the Device Address. The figure below shows the position of the rotary-switches and a setting example with a baud rate of 125kbits/s and a Device Address equal to 29.

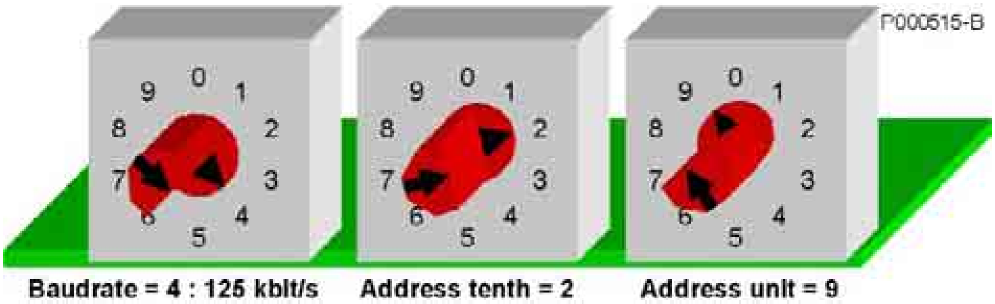


Figure 130: Example of the position of the rotary-switches for 125kbits/s and Device Address 29.

NOTE

Device Address = 0 is not allowed by the CANopen specifications. Values ranging from 1 to 99 can be selected.

The table below shows the possible settings of the rotary-switches for the baud rate selection.

Rotary-switch setting	*Baudrate*
0	setting not allowed
1	10 kbits/s
2	20 kbits/s
3	50 kbits/s
4	125 kbits/s
5	250 kbits/s
6	500 kbits/s
7	800 kbits/s
8	1000 kbits/s
9	setting not allowed

6.9.5.3. CONNECTION TO THE FIELDBUS

High quality wiring is fundamental for the correct operation of the bus. For CANopen wiring, a shielded twisted pair with known resistance and impedance is recommended. The conductor unit is also fundamental for the quality of the signal. The higher the baud rates, the shortest the bus lengths allowed. The maximum length of the bus is also affected by the number of nodes. The tables below indicate the cable specifications based on the cable length and the variation features of the max. length based on the number of nodes and the cross-section of the conductors.
Tables refer to copper wires with a characteristic impedance of 120Ω and a typical propagation delay of 5ns/m.

Bus length [m]	Max. specific resistance of the cable [mΩ/m]	Recommended cross-section for conductors [mm^2]	Recommended terminator resistance [Ω]	Max. baud rate [Kbit/s]
0÷40	70	0.25÷0.34	124	1000 kbits/s
40÷300	60	0.34÷0.6	150÷300	500 kbits/s (max. 100m)
300÷600	40	0.5÷0.75	150÷300	100 kbits/s (max. 500m)
600÷1000	26	0.75÷0.8	150÷300	50 kbits/s

The total resistance of the cable and number of nodes determine the max. allowable length for the cable as per static features, not for dynamic features. Indeed, the max. voltage delivered by a node with a dominant bus is reduced by the resistive divider consisting of the cable resistor and the terminator resistors. The residual voltage must exceed the dominant voltage of the receiving node. The table below indicates the max. length values based on the cable cross-section, i.e. the cable resistance, and the number of nodes.

Cross-section of the conductors [mm^2]	Max. wiring length [m] based on the number of nodes		
	node n. < 32	node n. < 64	node n. < 100
0,25	200	170	150
0,5	360	310	270
0,75	550	470	410

NOTE

Each CANopen trunk line shall meet particular geometric requirements and shall be equipped with two terminator nodes provided with adequate resistors. Refer to the document CiA DR303-1 "CANopen Cabling and Connector Pin Assignment" and to all the application notes available at http://www.can-cia.org/canopen/.

6.9.6. ETHERNET COMMUNICATIONS BOARD

Ethernet communications board allows to interface a Sinus PENTA inverter to an external control unit with a communications interface operating with a Modbus/TCP Ethernet (IEEE 802) protocol complying with the Modbus-IDA V1.0 specifications. The IP rating for the communications board can be configured both through the on-board dip-switches and automatically (network assignation through a DHCP protocol).
The communications board performs automatic negotiation with the mains if the baud rate is set to 10 or 100 Mbits/s.
The module also supports IT (Information Technology) functionality with FTP, HTTP, SMTP standard protocols, allowing to exchange files through the internal storage, operate as Web Servers with dynamic pages and send e-mail messages. These functions can be used by advanced users and are detailed in the Instruction Manual contained in the CD-ROM supplied with the communications board.
The main features of the interface board are the following:

- Parameter configuration for Ethernet connection through DIP-switches, DHCP/BOOTP, ARP or internal Web server
- Modbus/TCP slave functions of class 0, class 1 and partially class 2
- Possibility of supporting EtherNet/IP level 2 I/O Server CIP (ControlNet &DeviceNet)
- Transparent socket interface for potential implementation of "over TCP/IP" dedicated protocols
- Ethernet interface galvanically isolated through a transformer
- E-mail (SMTP) functionality
- Resident WEB pages that can be downloaded through an FTP server

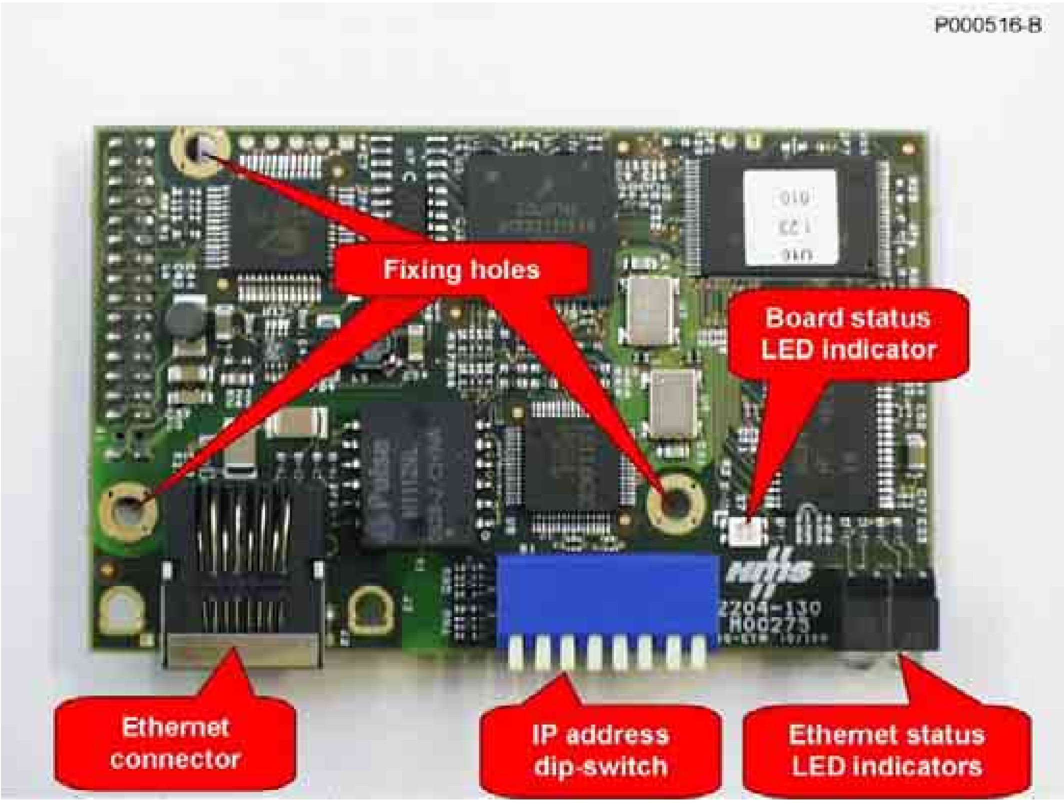


Figure 131: Ethernet Fieldbus Communications Board

6.9.6.1. ETHERNET CONNECTOR

The board is provided with a standard RJ-45 connector (IEEE 802) for Ethernet connection 10/100 (100Base-TX, 10Base-T). The pin arrangement is the same as the one used for each network board computers are equipped with.
Pin arrangement:

N.	Name	Description
1	TD+	Positive signal transmission line
2	TD-	Negative signal transmission line
3	RD+	Line receiving positive signals
4	Term	Terminated pair – not used
5	Term	Terminated pair – not used
6	RD-	Line receiving negative signals
7	Term	Terminated pair – not used
8	Term	Terminated pair – not used

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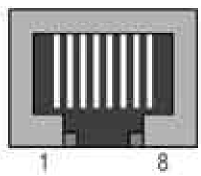
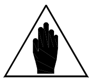


6.9.6.2. CONNECTION TO THE NETWORK

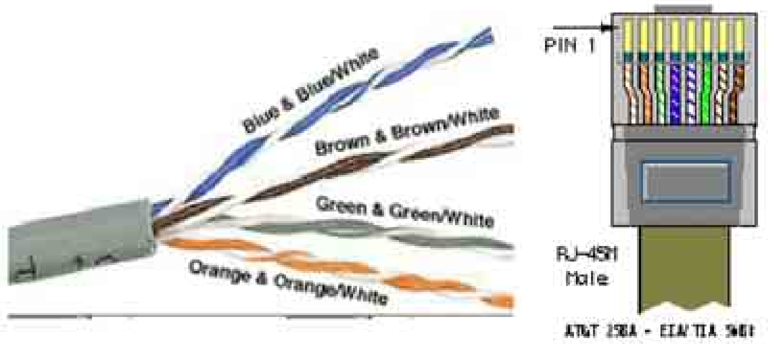
Ethernet interface board can be connected to an Ethernet control device with a Modbus/TCP master protocol (computer or PLC) through a LAN (Ethernet business network) or a direct point-to-point connection.
The board connection through a LAN is similar to a computer connection. Use a standard cable for a Switch or Hub connection or a Straight-Through Cable TIA/EIA-568-B of class 5 UTP (Patch cable for LAN).



NOTE The Ethernet interface board cannot be connected to old LANs using Thin Ethernet (10base2) coaxial cables. Connection to this type of LANs is possible using a Hub provided with both Thin Ethernet (10base2) connectors and 100Base-TX or 10Base-T connectors. The LAN topology is a star one, with each node connected to the Hub or the Switch through its cable.

The figure below shows the pair arrangement in a 5 UTP cable and the standard colour arrangement to obtain the Straight-Through cable.

P000518-B



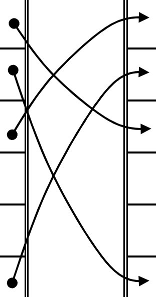
Pin	Wire color
1	orange/white
2	orange
3	green/white
4	blue
5	blue/white
6	green
7	brown/white
8	brown

Figure 132: Cable of Cat. 5 for Ethernet and standard colour arrangement in the connector

0 1 2 3 4 5 6 7 8

Direct point-to-point connection is obtained with a Cross-Over Cable TIA/EIA-568-B, cat. 5. This type of cable performs a cross-over of the pairs so that the TD+/TD- pair corresponds to the RD+/RD- pair, and vice versa. The table below shows the colour matching on the connector pins for the Cross-Over Cable and the cross-over diagram of the two pairs used from 100Base-TX or 10Base-T connection.

Pin and wire colour (first part of the connector)		
1	white/orange	
2	orange	
3	white/green	
4	blue	
5	white/blue	
6	green	
7	white/brown	
8	brown	



Pin and wire colour (last part of the connector)		
1	white/green	
2	green	
3	white/orange	
4	white/brown	
5	brown	
6	orange	
7	blue	
8	white/blue	

NOTE: The inverter is typically installed with other electric/electronic devices inside a cubicle. Normally, the electromagnetic pollution inside the cubicle is remarkable and is due to both radiofrequency disturbance caused by the inverters and to bursts caused by the electromechanical devices. To avoid propagating disturbance to Ethernet cables, they must be segregated and kept as far as possible from the other power cables and signal cables in the cubicle.
Disturbance propagation to Ethernet cables may affect the correct operation of the inverter and the other devices (computers, PLCs, Switches, Routers) connected to the same LAN.

NOTE: The maximum length of the LAN cable, cat. 5 UTP allowed by IEEE 802 standards results from the max. transit time allowed from the protocol and is equal to 100m. The longer the cable length, the higher the risk of communications failure.

NOTE: For Ethernet wiring, only use cables certified for LAN cables of 5 UTP category or higher. For standard wiring, avoid creating your own cables; Straight-Through or Cross-Over cables should be purchased from an authorised dealer.

NOTE: For a proper configuration and utilisation of the communications board, the user should know the basics of the TCP/IP protocol and should get familiar with the MAC address, the IP address and the ARP (Address Resolution Protocol). The basic document on the Web is RFC1180 – "A TCP/IP Tutorial". The English version can be downloaded from: http://www.faqs.org/ftp/rfc/pdf/rfc1180.txt.pdf.

6.9.6.3. BOARD CONFIGURATION

The first step in configuring the Ethernet interface board consists in communicating with the board through a computer in order to update the configuration file (etccfg.cfg) stored to the non-volatile memory of the board. The configuration procedure is different if you use a point-to-point connection to the computer, if the board is connected to a LAN that is not provided with a DHCP server and if the board is connected to a LAN that is provided with a DHCP server. The section below covers these types of connection.

NOTE: For the connection to the LAN, consult your network administrator, who can tell if the LAN is provided with a DHCP server. If this is not the case, your network administrator will assign the static IP addresses for each inverter.

0 1 2 3 4 5 6 7 8

Point-to-point connection to the computer

If a point-to-point connection to the computer is used, first configure the network board of the computer by setting a static IP address as 192.168.0.nnn, where nnn is any number ranging from 1 to 254.

To set the static IP address with Windows 2000™ or Windows XP™, open the Network Properties folder; in the field for the properties of the TCP/IP protocol, set the address value, e.g. 192.168.0.1. Figure 133 shows the correct setting of the computer properties for Windows 2000™. Settings are very similar for computers running on Windows XP™.

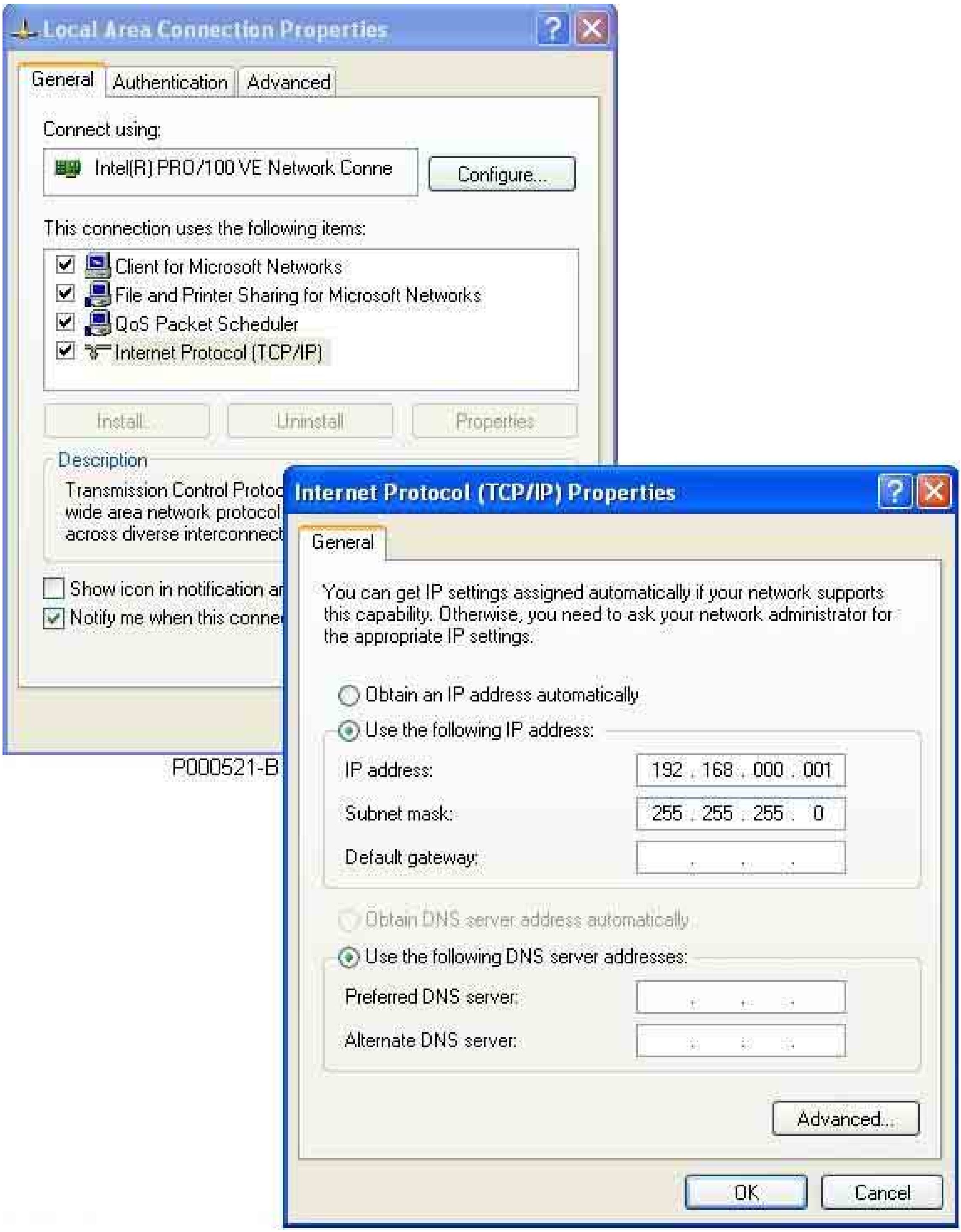


Figure 133: Setting a computer for a point-to-point connection to the inverter

After configuring your computer as described above, in the dip-switches of the communications board set a binary number different from 0, different from 255 and different from the number set in the low portion of the IP address of the computer. For example, number 2 can be set by lowering (logic 1) only switch 7 as shown in the figure below.

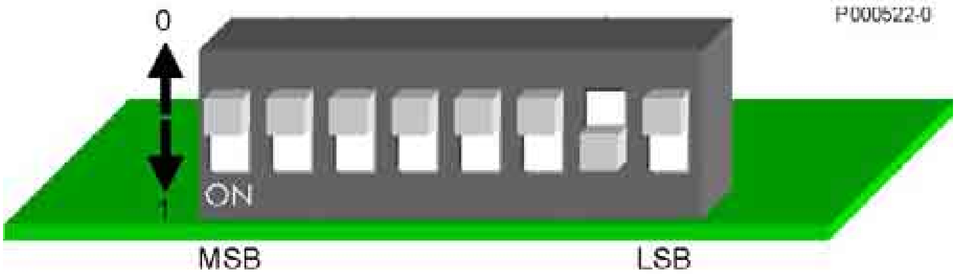


Figure 134: Setting the dip-switches to set the IP address 192.168.0.2.

If the computer is connected to the inverter through a Cross-Over Cable, a local network is created, which is composed of two participant nodes (the computer and the inverter), with 192.168.0.1 and 192.168.0.2 as IP addresses respectively. When the inverter is powered on, the LINK LED (see below) in the interface board should turn on. The following command:

```
ping 192.168.0.2
```

launched by a command line window of the computer performs the correct connection to the board.

Connection with a computer through a LAN without any DHCP server
The network administrator will assign a static IP address for each inverter to be connected to the LAN.
Suppose that the IP address assigned from the administrator to an inverter is 10.0.254.177 and proceed as follows:

- Set all the dip-switches in the Ethernet interface board to 0 (“up” position)
- Connect the board to the LAN using a Straight-Through cable and power on the inverter
- Make sure that the green light of the LINK LED (see below) comes on
- Note down the MAC address of the Ethernet board that is written on a label placed at the bottom of the printed circuit.
  Suppose that the MAC address of the interface board is 00-30-11-02-2A-02
- In a computer connected to the same LAN (connected to the same sub-network, i.e. with an IP address equal to 10.0.254.xxx), open the command interpreter window and enter the following commands:
  ```
  arp –s 10.0.254.177 00-30-11-02-2A-02
  ping 10.0.254.177
  ```
- ```
  arp –d 10.0.254.177
  ```

In the ARP table of the computer, the first command will create a static entry assigning the matching between the MAC address of the board and the static IP address.
The ping command queries the interface board to check the connection and returns the transit time of the data packet between the computer and the board through the network, as shown in Figure 135.

0 1 2 3 4 5 6 7 8
  ```

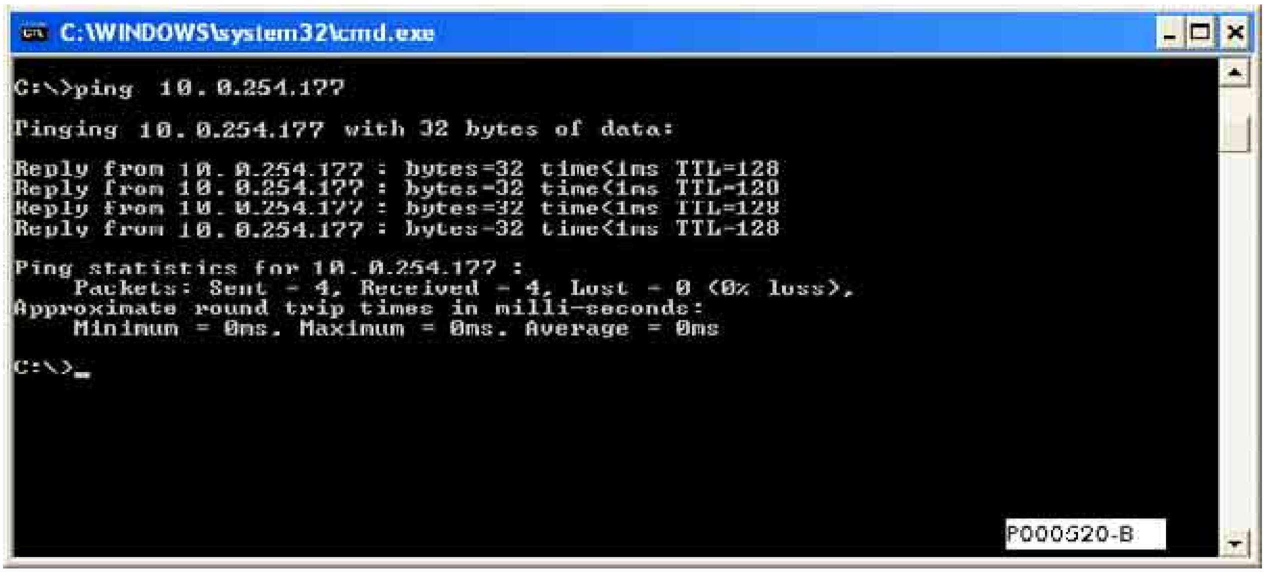


Figure 135: Example of the ping command to the IP address of the inverter interface board

When the interface board is sent the data packet, it gets the MAC address-IP address match as a permanent match, then it compiles and saves an “ethcfg.cfg” file, where the IP address 10.0.254.177 is stored as its own address each time the inverter is turned on.
Command number 3 is optional and removes the static match IP-MAC related to the inverter Ethernet board from the ARP table of the inverter.

Connection with a computer through a LAN equipped with a DHCP server
If an inverter equipped with an Ethernet board is connected to the LAN and if all the dip-switches are set to zero (“up” position), when the inverter is powered on, automatic negotiation with the DHCP server takes place and the inverter is assigned an IP address chosen among the available ones. This configuration is then stored to the “ethcfg.cfg” file.
The “Anybus IP config” utility contained in the CD-ROM can be used to query all the inverters with an Ethernet interface in the LAN from the same computer and, if required, the network access parameters can be reconfigured. The figure below shows the page of the programme when an inverter is acknowledged. Multiple inverters can be identified from the same network through their own value of the MAC address.

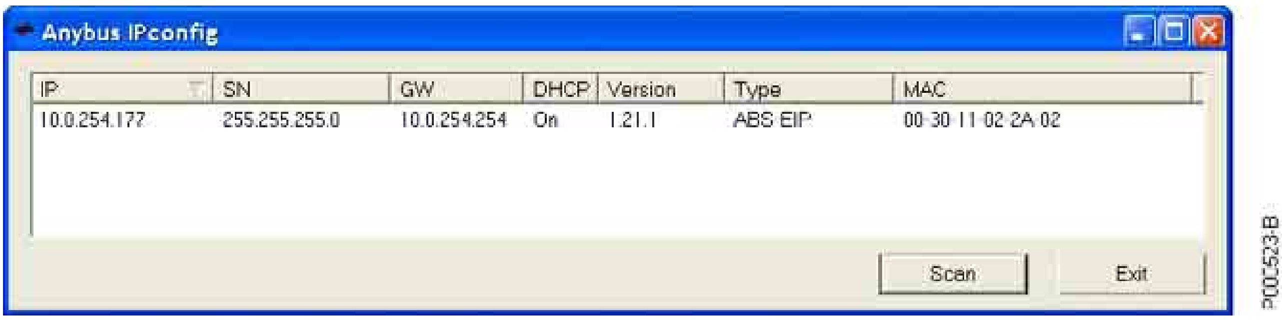
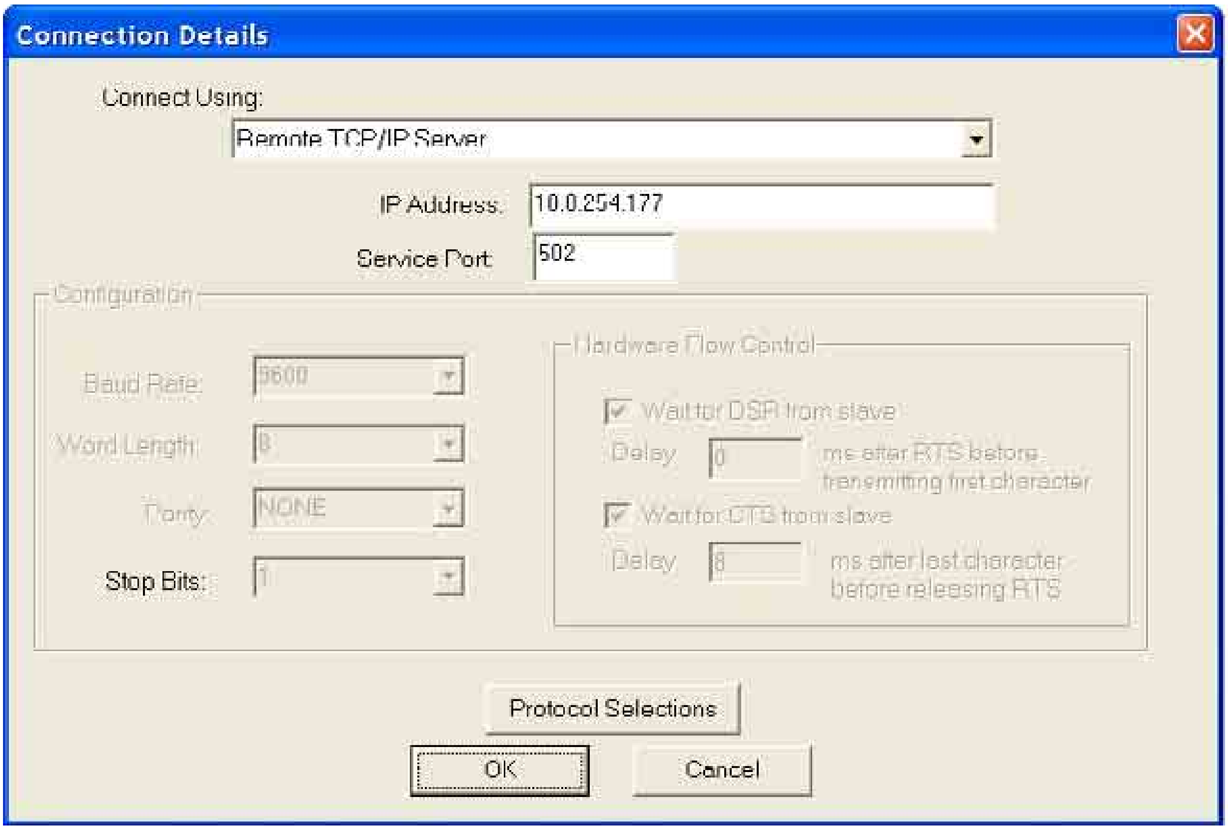


Figure 136: Screen of the Anybus IP config utility

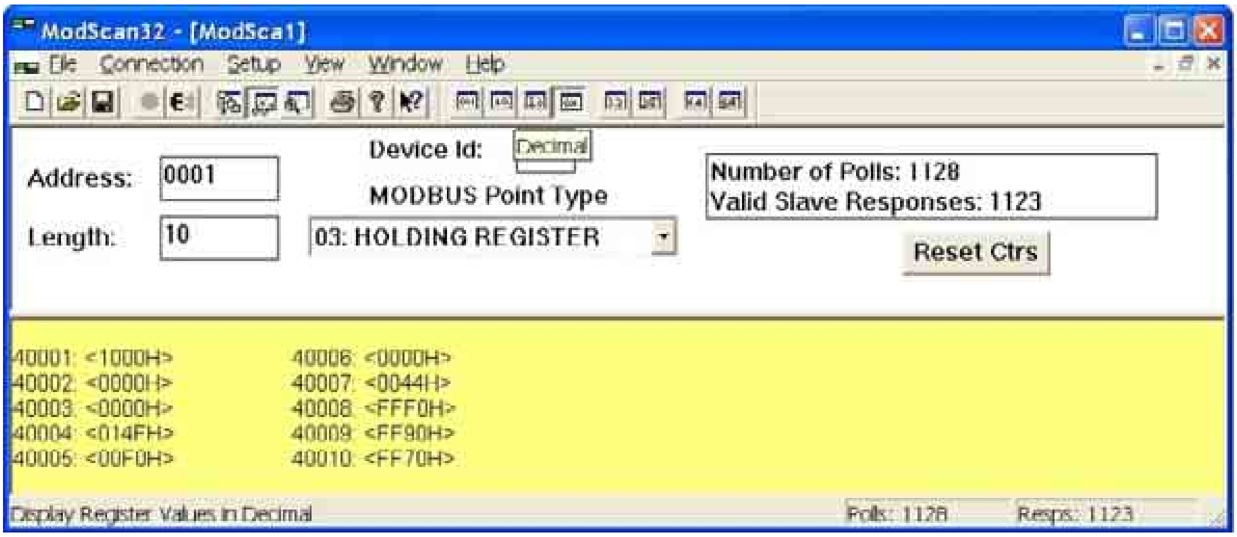
Query of the inverter data through the ModScan programme
Once configuration is achieved and the IP address of the interface board is available, you can query the inverter variables through the Modbus/TCP protocol. WinTECH’s ModScan application (http://www.win-tech.com/) allows to display the variables read with the Modbus.
The figure below shows the setting screen of ModScan for the connection of a board with the IP address 10.0.254.177. For the Modbus/TCP connection, port 502 is provided by the Ethernet interface. Port 502 is to be used for all the Modbus transactions.



P000524-B

Figure 137: Setting ModScan for a Modbus/TCP connection

Figure 138 shows a ModScan screen related to the 10 output variables of the inverter. These variables are acquired in real time and are provided by the Modbus/TCP protocol. Refer to Sinus Penta's Programming Instructions manual ("Fieldbus" section) for any detail about the map and the meaning of the input/output variables.



P000525-B

Figure 138: Display of the output variables of the inverter through the Modbus/TCP protocol

0 1 2 3 4 5 6 7 8

NOTE

Unlike the Modbus RTU connection through the serial link, the Modbus/TCP connection is characterised by an offset of 400h (1024) for write variables, because the Ethernet board dialogues with the inverter and splits a buffer shared for two segments of 1kbyte each. One segment is dedicated to the messages sent from the inverter to the Fieldbus, the other is dedicated to the messages sent from the Fieldbus to the inverter. In order to write the interface variable 001: M042-Speed Reference from FIELDBUS (whole part) (see Programming Instructions), the Modbus/TCP transaction must be addressed to log 1025, not to log 1.

NOTE

The Ethernet board also offers advanced IT functionality. For example, you can send e-mail messages following particular events occurring in the inverter, or you can create a dynamic web page inside the inverter to display its operating conditions. For advanced functionality, refer to the relevant manual contained in the CD-ROM supplied with the option board kit.

6.9.7. STATUS LEDS

Each option fieldbus board is equipped with a column provided with four LEDs installed on its front edge to monitor the bus status and with one LED (red/green) installed on the communications board for debugging, as shown in the figure below.

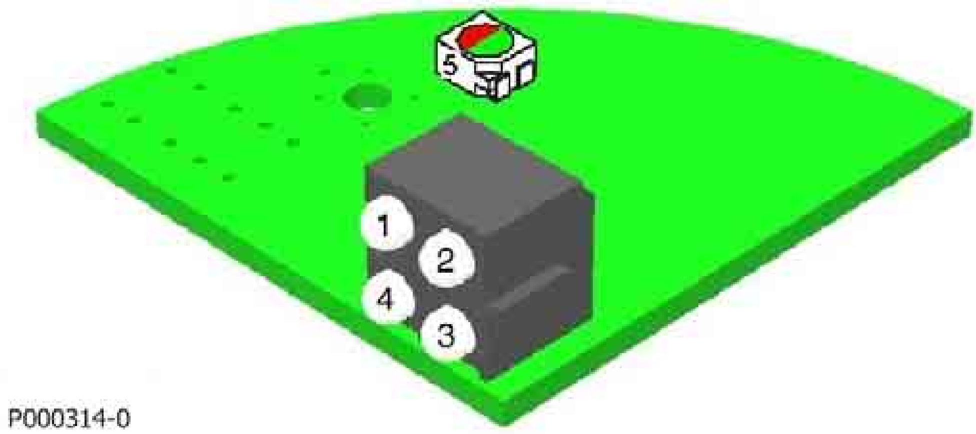


Figure 139: Position of indicator Leds on the board

The red/green LED mounted on the board relates to all interface models, whereas the LEDs mounted on the board column have different meanings based on the type of fieldbus being used.

6.9.7.1. LEDS FOR FIELDBUS INTERFACE CPU DIAGNOSTICS

The LED located on the printed circuit of any version of the interface board indicates the status of the CPU dedicated to communication. The table below shows the possible type of signals.

N. & Name	*Function*
5. Board diagnostic	**Red** – Unknown internal error, or module operating in bootloader mode **1 Hz Red blinker** – RAM fault **2 Hz red blinker** – ASIC or FLASH fault **4 Hz Red blinker** – DPRAM fault **2 Hz green blinker** – Module not initialized **1 Hz green blinker** – Module initialized and operating.

6.9.7.2. LEDs for PROFIBUS-DP Board Diagnostics

In the PROFIBUS-DP board, LED 1 is inactive; the remaining LEDs are described below:

N. & Name	Function
2. On-Line	It indicates that the inverter is on-line on the fieldbus: **Green** – The module is on-line; data exchange is allowed. **Off** – The module is not on-line.
3. Off-Line	It indicates that the inverter is off-line on the fieldbus: **Red** – The module is off-line; data exchange is not allowed. **Off** – The module is not off-line.
4. Fieldbus Diagnostics	It indicates some possible errors: **1 Hz Red blinker** – Configuration error: the length of IN messages and OUT messages set while initializing the module does not match with the message length set while initializing the network. **2 Hz Red blinker** – User Parameter error: the data length and/or contents for the User Parameters set while initializing the module does not match with the data length and/or contents set while initializing the network. **4 Hz Flash blinker** – Error while initializing the Fieldbus communications ASIC. **Off** – No error found.

6.9.7.3. LEDs for DeviceNet Board Diagnostics

In the DeviceNet board, LEDs 1 and 4 are not used; the remaining LEDs are described below:

N. & Name	Function
2. NETWORK STATUS	It indicates the status of the DeviceNet communications: **Off** – The module is not On-Line **Green** – DeviceNet communications in progress and correct **Flashing green** – The module is ready for communication but is not connected to the network **Red** – A critical error occurred (too erroneous data items) and the module switched to the "link failure" status **Flashing red** – A timeout occurred when exchanging data
3. MODULE STATUS	It indicates the status of the communication module: **Off** – The module is off **Green** – The module is operating **Flashing green** – The length of the two data packets exceeds the preset value **Red** – An unresettable event error occurred **Flashing red** – A resettable event error occurred

6.9.7.4. LEDs for CANopen Board Diagnostics

In the CANopen board, LED 1 is not used; the remaining LEDs are described below:

N. & Name	Function
2. RUN	It indicates the status of the CANopen interface of the module: **Off** – The interface is off **One flash** – The interface status is STOP **Flashing** – The interface is being initialized **On** – The interface is operating
3. ERROR	It indicates the error status of the CANopen interface: **Off** – No error **One flash** – The frame error counter has reached the warning limit **Two flashes** – A Control Error event (guard event or heartbeat event) occurred **Three flashes** – A synchronisation error event occurred: the SYNC message was not received within the time-out **On** – The bus is disabled due to an unresettable event error
4. POWER	**Off** – The module is off **On** – The module is on

The word "Flashing" in the table indicates a LED that comes on for 200ms every 200ms; "One flash", "Two flashes" and "Three flashes" indicate a LED that comes on one, twice or three times for 200ms every 200ms and with an inactivity time of 1000ms.

6.9.7.5. LEDs for Ethernet Board Diagnostics

In the Ethernet board, the diagnostics LEDs indicate the status of the connection to the LAN:

N. & Name	Function
1. LINK	**Off** – The module has not detected any legal carrier signal and is not in the LINK status **On** – The module has detected a legal carrier signal and is in the LINK status
2. MODULE STATUS	**Off** – The module is off **Green** – The module is properly operating **Flashing green** – The module was not configured and communication is in stand-by **Flashing red** – the module has detected a resettable event error **Red** – the module has detected an unresettable event error **Flashing red/green** – the module is performing a self-test at power on
3. NETWORK STATUS	**Off** – The IP address has not yet been assigned **Green** – At least one active Ethernet/IP connection is in progress **Flashing green** – No active Ethernet/IP connection is in progress **Flashing red** – "Timeout" of one or more links performed directly to the module **Red** – The module has detected that its IP is used by another device in the LAN **Flashing red/green** – The module is performing a self-test at power on
4. ACTIVITY	**Flashing green** – A data packet is being transmitted or received

6.9.8. Environmental Requirements Common to All Boards

Operating temperature:	0 to +50 °C ambient temperature (contact Elettronica Santerno for higher ambient temperatures)
Relative humidity:	5 to 95% (Non condensing)
Max. operating altitude	4000 m (a.s.l.)

6.10. ES851 DATA LOGGER BOARD (SLOT B)

ES851 Data Logger is an optional board allowing acquiring the operating variables of a plant and interfacing to a supervisor computer, even a remote computer, through different connecting modes for data logging and monitoring of the devices connected to the plant.

The main features of the Data Logger are the following:

- 8-Mb Data Flash, allowing setting how many variables and which variables are acquired, as well as their acquisition time, for optimum performance of the available memory;
- RS485 and RS232 interface with Modbus-RTU protocol;
- Ethernet interface with TCP/IP protocol;
- Interface for the connection via GSM modem and analog modem;
- SMS functionality for events monitored by the Data Logger (available only when a GSM modem is used).

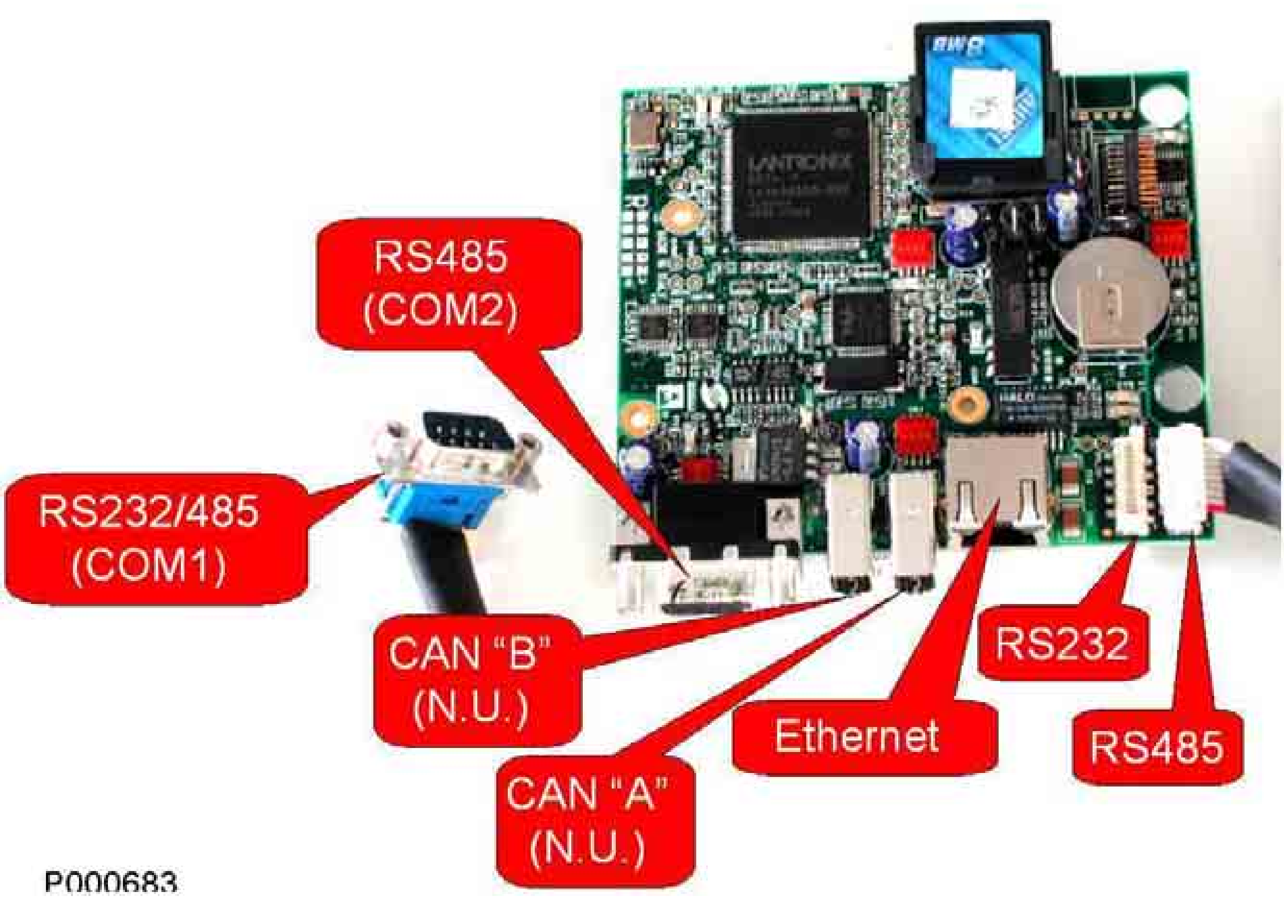


Figure 140: ES851 Data Logger Board

ES851 Data Logger is installed on the control board of the drive. The control board can be accessed through the front opening.

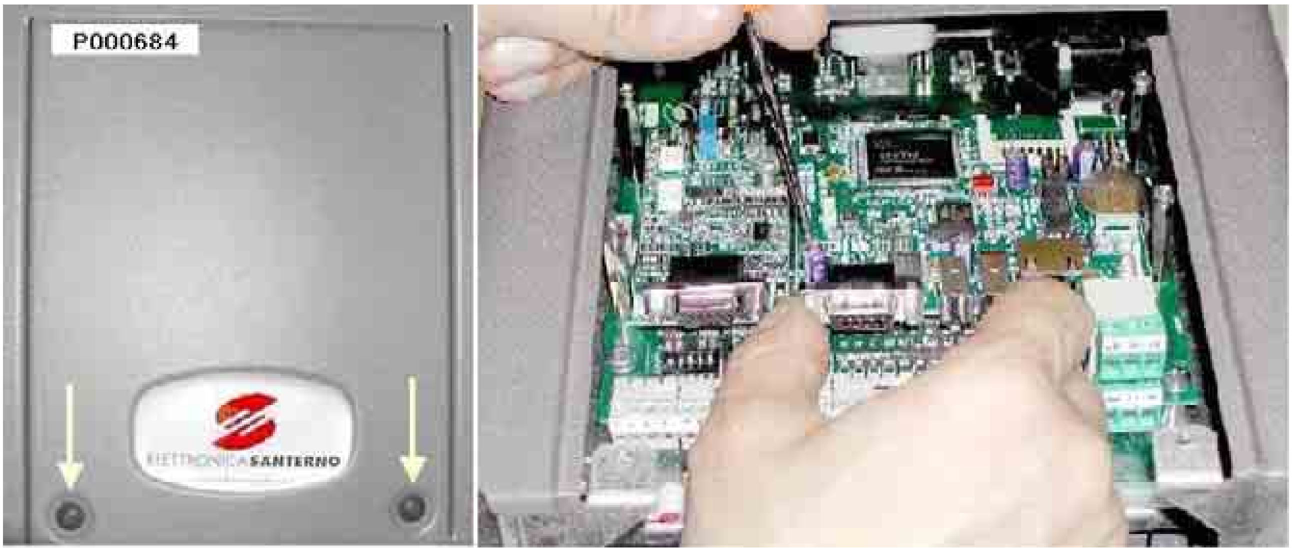


Figure 141: Data Logger board fastened to its slot (Slot B)

Each Data Logger is capable of monitoring up to 15 devices through RS485 or RS232 network with Modbus protocol. ES851 is the master and the connected devices are the slaves.

A remote computer can be connected to the plant via RS485 or RS232 serial links, via modem or via Ethernet. The Remote Sunway software allows performing any operation both on the plant devices and on ES851 (scanning the devices connected to the Data Logger and activating data acquisition except for the devices excluded from logging—see the Programming Instructions of ES851 Data Logger for more details).
The connection modes and specifications are detailed in the following sections.

6.10.1. CONNECTIONS

ES851 serial communication ports are connected to the external interfaces that can be accessed by the user.

CAUTION

Remove voltage from the Penta drive before wiring ES851 Data Logger board. Take any safety measure required before touching the connectors and handling the Data Logger board.

ES851 is provided with the following serial communications ports:

Port	Description	Terminal Board	Link
COM1 RS232	Modem/PC connection	ES851 – CN3	DB9 – Male
COM1 RS485	Slave supervisor connection	ES851 - CN11	DB9 – Male
COM2 RS485	Master Supervisor connection	ES851 - CN8	DB9 - Female
	Ethernet connection	ES851-CN2	RJ45

NOTE

CN3 - RS232 connection replaces CN11 - RS485 connection.
Factory setting is CN3 - RS232.

NOTE

The Master or Slave operating mode of the COM ports can be changed by setting some configuration parameters of ES851 board accordingly (see the Programming Instructions manual of ES851 Data Logger for further details). The preset configurations are given in the table above.

6.10.1.1. WIRING RS232 SERIAL LINK

If ES851/1 board is installed in the Sinus Penta, this is provided with a DB9 connector with DTE standard pinout allowing interfacing with a modem or a computer.

Available pins:

DB9Connector Pin N.	*Name*	*Description*
-	Screen	Frame of the connector connected to the PE
1	CD	Carrier Detect
2	RD	Received Data
3	TD	Transmitted Data
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	RI	Ring Indicator

RS232 links are needed for some communication options required by ES851 Data Logger:

- Direct connection to a computer with a null modem cable (MODBUS RTU protocol in slave mode or PPP protocol);
- Connection via analog/digital modem to a remote computer;
- Connection through an RS232/RS485 converter to the multidrop network of the plant devices (MODBUS RTU protocol in master mode).

For null modem connections, the terminal board or DB9 connector are to be connected through a null modem RS232 cable (cross-over cable) to the computer.

For connections via analog modem, the terminal board or DB9 connector are to be connected through an RS232 cable not crossed to the modem.

For connections through RS232/RS485 converters to a multidrop network, up to 247 devices can be connected. Make sure that the ID of each device is properly preset (see the Programming Instructions manual of ES851 Data Logger).

6.10.1.2. WIRING RS485 SERIAL LINK

RS485 links are needed for certain communication options required by ES851 Data Logger:
- Direct connection to a computer with a properly wired cable and an RS485/USB or RS485/RS232 converter (MODBUS RTU protocol in slave mode or PPP protocol);
- Direct connection to the multidrop network of the plant devices (MODBUS RTU in master mode).

The MODBUS-IDA (http://www.modbus.org) Association defines the type of connection for MODBUS communications over serial link RS485, which is used by the Sinus Penta, as a "2-wire cable". Specifications are the following:

Type of cable	Screened cable composed of a balanced pair named D1/D0 + common conductor ("Common").
Min. cross-section for the conductors	AWG24 corresponding to 0.25sqmm; for long lengths, cross-sections up to 0.75sqmm are recommended.
Maximum length	1000 meters based on the max. distance measured between two stations.
Characteristic impedance	Greater than 100Ω (recommended), typically 120Ω.
Standard colours	Yellow/brown for the D1/D0 pair, grey for the "Common" signal.

The typical wiring diagram recommended by the MODBUS-IDA Association for the connection of "2-wire" devices is shown in Figure 142.

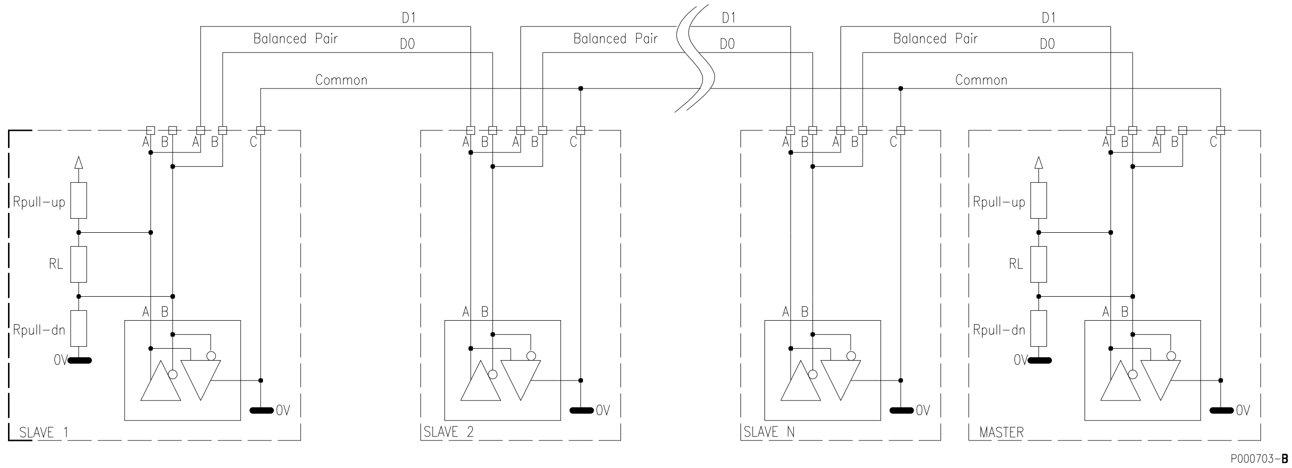


Figure 142: Recommended wiring diagram for the connection of "2-wire" MODBUS devices"

The network composed of the termination resistor and the polarization resistors is incorporated into the inverter and can be activated via dip-switches. The figure above shows the termination network for the devices located at both ends of the network, where the terminator must be installed.

NOTE

Inexpensive and popular 4-pair Category 5 cables are often used for serial links. This type of cable can be used for short paths. The colours of the conductors of Category 5 cables are different from the colours defined by the MODBUS-IDA association. From the four pairs, one must be used for the D1/D0 signals, one as the "Common" conductor and the other pairs should be left disconnected or connected to the "Common" conductor.

For connections through RS232/RS485 converters to a multidrop network, up to 247 devices can be connected. Make sure that the ID of each device is properly preset (see the Programming Instructions manual of ES851 Data Logger).

NOTE

All the devices connected to the communication multidrop network should be grounded to the same conductor (0V) to minimize any difference of ground potentials between devices that can adversely affect communications.

Provide a linear wiring (not a star wiring) for multidrop line RS485: the first device in the multidtrop connection will have only one outgoing line, while the last device will have only one incoming line. The line terminator is to be installed on the first device and the last device. In ES851, the line terminator is selected through the dip-switch located next to the 9-pole D-connector. The line master device (ES851) is typically placed at the beginning or at the end of a multidrop connection; in that case, the line terminator of the farthest inverter from the master computer shall be enabled: dip-switch, selector switches 1 and 2 "ON". The line terminator of the other devices in intermediate positions shall be disabled: dip-switch, selector switches 1 and 2 " OFF".

NOTE

Communication does not take place or is adversely affected if multidrop terminators are not properly set, especially in case of high baud rate. If more than two terminators are fitted, some drivers can enter the protection mode due to thermal overload, thus stopping dialoguing with some of the connected devices.

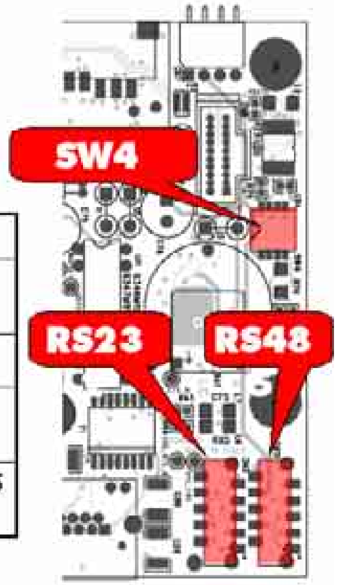
6.10.1.3. COM1 CONFIGURATION AND WIRING

DB9 flying connector (COM1) brings CN3/CN11 connector of ES851/1 board outside the inverter; this should be fastened to a bracket mounted on the right side of the inverter frame.

Starting from version ES851/1, the type of port (RS232 or RS485) to be used can be selected. The flying cable is to be connected to CN3 or CN11 for RS232 or RS485 respectively (factory setting: CN3). Use SW4-1 to activate the port you chose.

P000687-B

SW4 [Default]	Function
1 [ON]	OFF to activate ES485 interface
2 [OFF]	Not used
3 [OFF]	Both ON to activate RS485 terminator
4 [OFF]	Both OFF to deactivate RS485 terminator

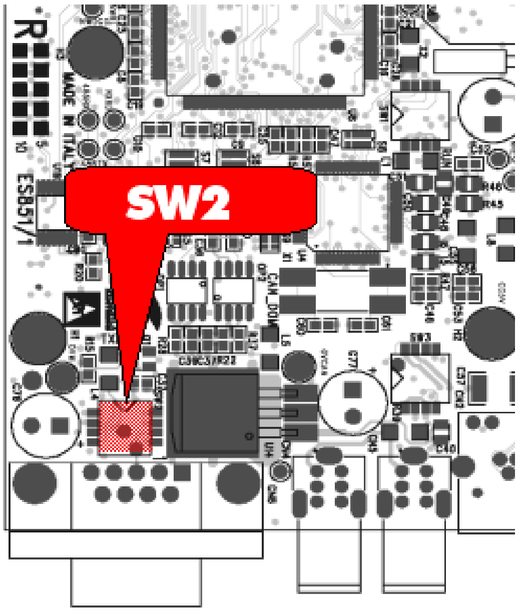


6.10.1.4. COM2 CONFIGURATION AND WIRING

DB9 female connector (COM2) on ES851 is preset as RS485 Modbus Master. A special dip-switch allows RS485 driver power supply to be set as “internal” (via ES851) or as external and allows the line termination to be activated/deactivated.

P000688-B

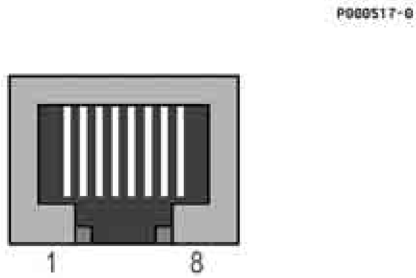
SW2 [Default]	Function
1 [ON]	Both ON to activate the internal power supply of the driver
2 [ON]	OFF to deliver external power supply
3 [OFF]	Both ON to enable line termination
4 [OFF]	Both OFF to disable the terminator



6.10.1.5. Types of Ethernet Connections

The Sunway M XR, if supplied with ES851 Data Logger, is provided with the standard RJ45 connector (IEEE 802) for 10/100 (100Base-TX, 10Base-T) Ethernet connection. Pins are arranged as follows (same layout as in network boards used for personal computers):

N.	Name	Description
1	TD+	Positive signal transmission line
2	TD-	Negative signal transmission line
3	RD+	Positive signal receiving line
4	Term	Terminated pair, not used
5	Term	Terminated pair, not used
6	RD-	Negative signal receiving line
7	Term	Terminated pair, not used
8	Term	Terminated pair, not used



ES851 can be connected, through Ethernet interface, to an Ethernet control device with a master (PC) Modbus/TCP protocol in one of the following ways:

- Through a LAN (Ethernet business network);
- Through a direct point-to-point connection.

The board connection through a LAN is similar to a computer connection. Use a standard cable for a Switch or Hub connection or a Straight-Through Cable TIA/EIA-568-B of class 5 UTP (Patch cable for LAN).

NOTE

The Ethernet interface board cannot be connected to old LANs using Thin Ethernet (10base2) coaxial cables. Connection to this type of LANs is possible using a Hub provided with both Thin Ethernet (10base2) connectors and 100Base-TX or 10Base-T connectors. The LAN topology is a star one, with each node connected to the Hub or the Switch through its cable.

The figure below shows the pair arrangement in a 5 UTP cable and the standard colour arrangement to obtain the Straight-Through cable.

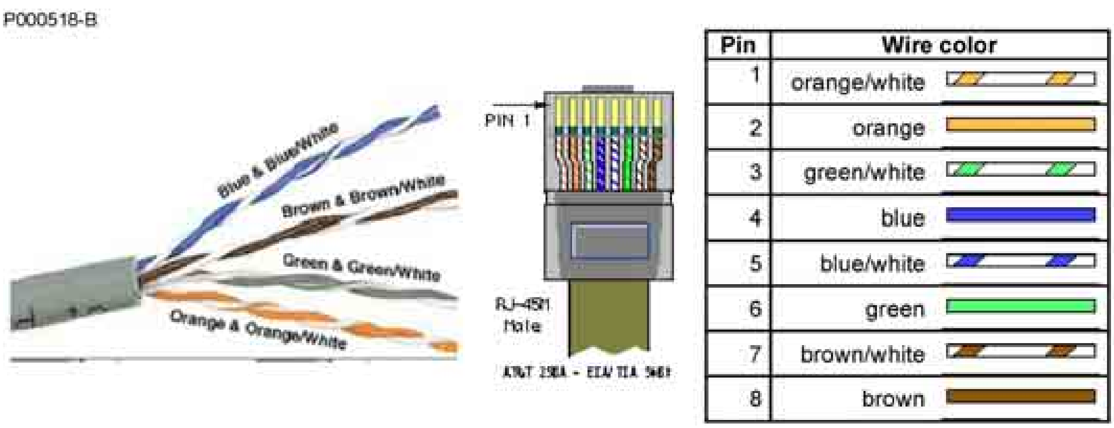
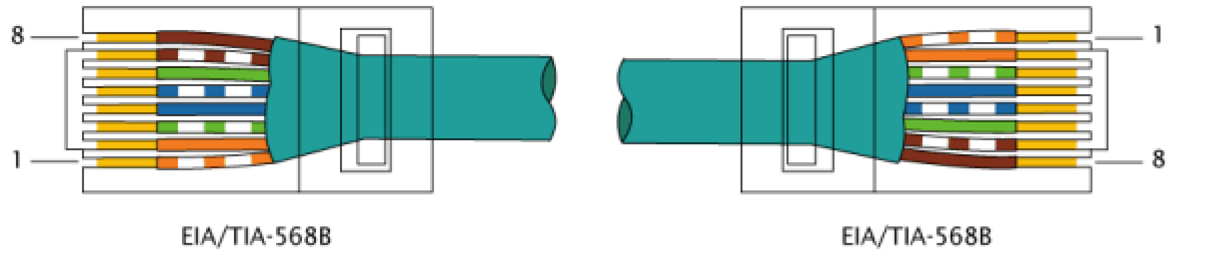


Figure 143: Cable of Cat. 5 for Ethernet and standard colour arrangement in the connector

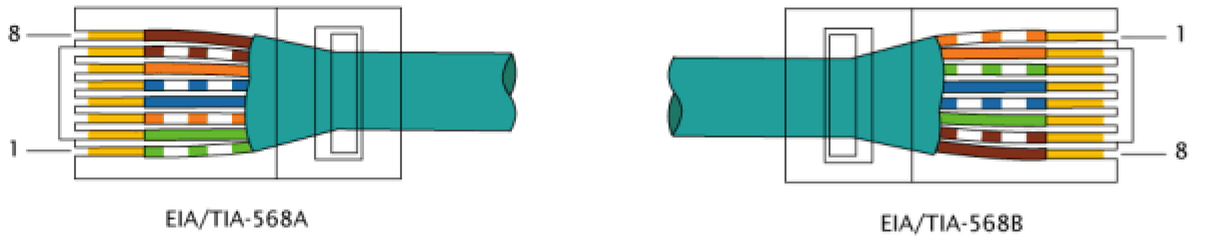
Direct point-to-point connection is obtained with a Cross-Over Cable TIA/EIA-568-B, cat. 5. This type of cable performs a cross-over of the pairs so that the TD+/TD- pair corresponds to the RD+/RD- pair, and vice versa. The table below shows the colour matching on the connector pins for the Cross-Over Cable and the cross-over diagram of the two pairs used from 100Base-TX or 10Base-T connection.

- EIA/TIA 568 standard patch cable, UTP/STP type, cat. 5

P000689-B



- EIA/TIA 568 cross-over cable, UTP/STP type, cat. 5



NOTE	The inverter is typically installed with other electric/electronic devices inside a cubicle. Normally, the electromagnetic pollution inside the cubicle is remarkable and is due to both radiofrequency disturbance caused by the inverters and to bursts caused by the electromechanical devices. To avoid propagating disturbance to Ethernet cables, they must be segregated and kept as far as possible from the other power cables and signal cables in the cubicle. Disturbance propagation to Ethernet cables may affect the correct operation of the inverter and the other devices (computers, PLCs, Switches, Routers) connected to the same LAN.
NOTE	The maximum length of the LAN cable, cat. 5 UTP allowed by IEEE 802 standards results from the max. transit time allowed from the protocol and is equal to 100m. The longer the cable length, the higher the risk of communications failure.
NOTE	For Ethernet wiring, only use cables certified for LAN cables of 5 UTP category or higher. For standard wiring, avoid creating your own cables; Straight-Through or Cross-Over cables should be purchased from an authorised dealer.
NOTE	For a proper configuration and utilisation of the communications board, the user should know the basics of the TCP/IP protocol and should get familiar with the MAC address, the IP address and the ARP (Address Resolution Protocol). The basic document on the Web is RFC1180 – "A TCP/IP Tutorial". The English version can be downloaded from: http://www.faqs.org/ftp/rfc/pdf/rfc1180.txt.pdf.

Figure 144: Location of the Ethernet port

Remove the cover and access to the control board of the Sinus Penta.
Insert the male connector to the female RJ45 connector located on ES851. Press until the tab snaps.

Figure 145: Wiring the Ethernet cable

6.11. ES860 SIN/COS ENCODER BOARD (SLOT A)

The ES860 Sin/Cos Encoder Card interfaces with 1Vpp analogue type outputs to provide feedback of speed and/or position of the inverters of the Sinus PENTA series.
In the same way as many other types of Encoder, the Card can be configured to operate in two different input modes.
The first mode, described below as the three-channel mode, allows an increment in low speed resolution and is suitable for slow rotation speed actuators that require highly accurate measurement of speed and position.
The second mode is described as five-channel below. In the normal input mode of incremental encoders, it allows precise determination of the mechanical position of the inverter prior to starting.
The card characteristics are summarised below:

→ Five channel input of 1vpp balanced line analogue type
→ Two channel input by means of zero crossing and bi-directional digital counter with quadrature direction discriminator and x4 resolution multiplication factor (e.g. 2048 cycles/rev to 4096 pulses/rev)
→ Channel index mark management for accurate alignment
→ Two channel analogue input with 12-bit resolution for precise angle measurement
→ 140kHz maximum input frequency in zero crossing channels for speeds up to 800rpm with 1024 cycles/rev alternatively up to 2000rpm with 5000 cycles/rev
→ Maximum input frequency of 1kHz in analogue channels
→ Ability to re-direct analogue input to zero crossing channels
→ Galvanic isolation in all channels for both digital and analogue input\
→ Encoder power output of 5V and 12V with ability to regulate output, isolated from common power and inverter signal.

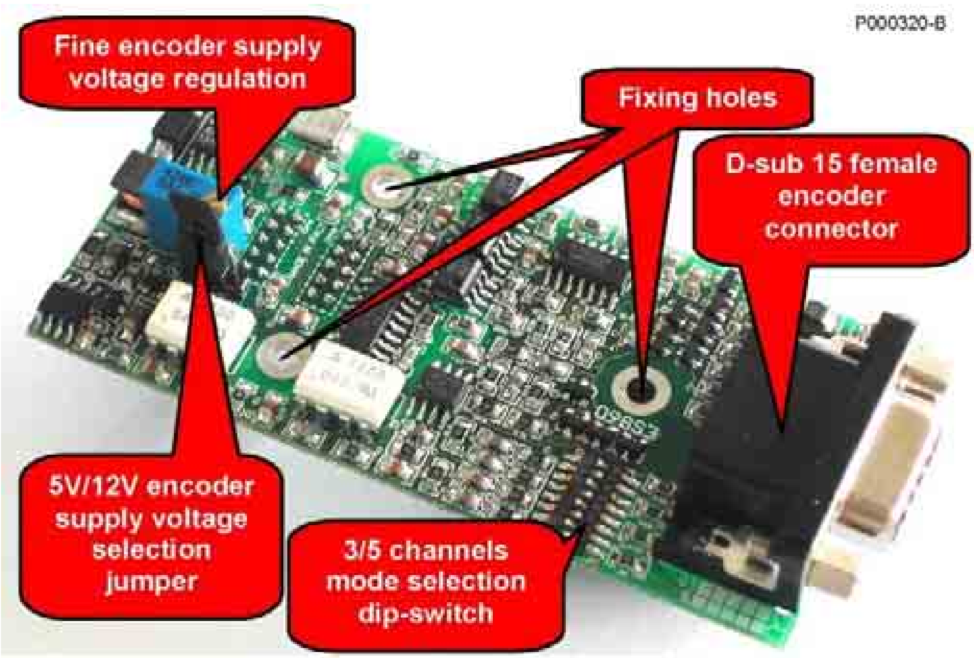


Figure 146: ES860 Sin/Cos Encoder Card

6.11.1. IDENTIFICATION DATA

Description	*Order Code*	*Compatibility*
ES860 Sin/Cos Interface Encoder	ZZ0101830	Any inverter of the Sinus PENTA series. Sin/Cos type Encoder with 5V, 12V, 15V, (5÷15V) power supply and 1Vpp output on 3 or 5 differential channels.

6.11.2. INSTALLING THE BOARD ON THE INVERTER (SLOT A)

1. Remove voltage from the inverter and wait at least 5 minutes.
2. The electronic components in the inverter and the communications board are sensitive to electrostatic discharge. Be careful when you reach the component parts inside the inverter and when you handle the communications board. The board should be installed in a workstation equipped with proper grounding and provided with an antistatic surface. If this is not possible, the installer must wear a ground bracelet properly connected to the PE conductor.

3. Remove the protective cover of the inverter terminal board by unscrewing the two screws on the front lower part of the cover. Slot A of the PENTA control card, into which the ES860 Card will be installed, is now accessible, as shown in the figure below.

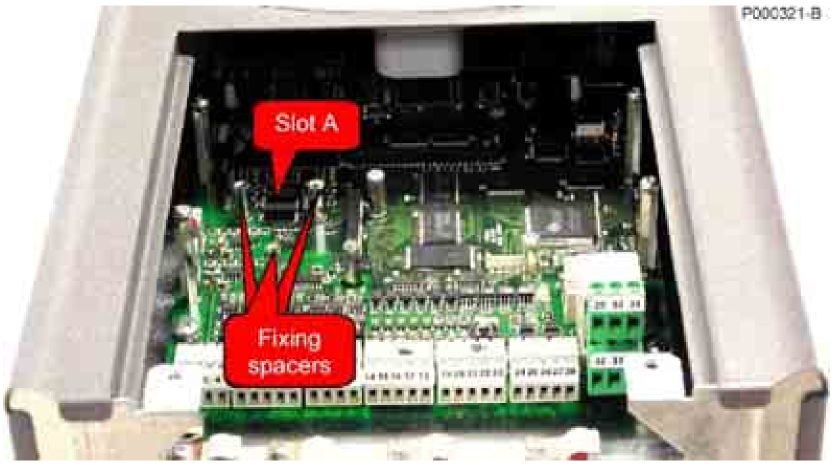


Figure 147: Slot A location inside terminal board cover of PENTA Inverter

4. Insert the Card into Slot A, being careful to correctly align the contact pins of the two slot connectors. If the Card is correctly inserted, the three fixing points and corresponding screw holes in the small metal fixing spacers will be properly aligned. After checking the correct alignment, tighten the three fixing screws of the card as shown in the figure below.

Figure 148: Fitting the ES860 Card inside the Inverter

5. Set the Encoder power supply voltage and the correct position of the mode selection dip-switch.
6. Power up the inverter and check that the voltage supplied to the encoder is correct. Carry out parameter settings for "Encoder A" following the Sinus PENTA Configuration Guide.
7. Switch off power to the inverter, wait for shutdown to fully complete and then connect the encoder cable.

	DANGER	Before removing the terminal board cover and accessing the inside of the inverter, disconnect the power supply and wait at least 5 minutes. There is a risk of electric shock if the inverter has not fully discharged its internal capacity.
	WARNING:	Do not connect or disconnect signal terminals or those of the inverter power supply. In addition to a risk of electric shock there is a possibility of damaging the inverter and/or connected devices.
	NOTE	All the fixing screws removed by the user (terminal board cover, serial interface connector access, cable router etc) are all coloured black, rounded and cross-headed. The removal of any other screws or bolts will invalidate the guarantee.

6.11.2.1. SIN/COS CONNECTOR

The Encoder connector is a high density (three line) D-sub 15 female type. The figure illustrates the connector pin layout viewed from the front.

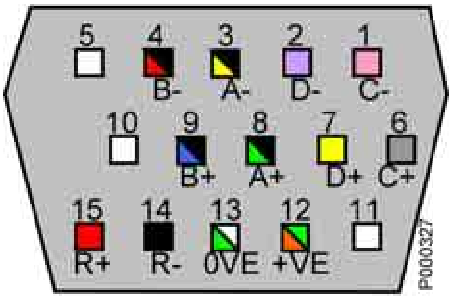


Figure 149: High density connector pin layout

Table of pin layout:

No.	Name	Description
1	C -	Negative sine analogue input signal
2	D -	Negative inverted cosine analogue signal
3	A -	Negative sine signal with zero crossing or analogue
4	B -	Negative inverted cosine signal zero crossing or analogue
5	N.C.	
6	C +	Positive sine analogue input signal
7	D +	Positive cosine analogue input signal
8	A +	Positive sine input signal with zero crossing or analogue
9	B +	Positive inverted cosine input signal with zero crossing or analogue
10	n.c.	
11	n.c.	
12	+VE	Encoder power output
13	0VE	Common power supply and signals
14	R-	Negative signal reference mark with zero crossing
15	R+	Positive signal reference mark with zero crossing
Shell	PE	Connector shield connected to Inverter PE conductor

6.11.3. OPERATING MODES AND CARD CONFIGURATION

The ES860 Encoder Interface Card can be powered by either 5V or 12V and used with two different types of encoder with 1Vpp sinusoidal output:

1	Three channel mode	Sin/Cos Encoder with three-channel 1Vpp (Channel A – sine, B – inverted cosine, R – reference mark)
2	Five channel mode	Sin/Cos Encoder with five-channel 1Vpp (Channel A – sine, B – inverted cosine, R – reference mark, C – one sine period per revolution D –one inverted cosine period per revolution)

The following paragraphs provide details of signal types and their corresponding configuration according the mode of use.

6.11.4. THREE-CHANNEL OPERATING MODE

The figure below shows the Sin/Cos Encoder signals in the three-channel mode. The first two channels receive differential input voltage equal to the sine and inverted cosine of the mechanical angle respectively, with a repeat cycle np times the mechanical revolution, where np is the number of pulses or the number of cycles per revolution set by the decoder. The third channel receives the reference mark that corresponds to a positive differential voltage pulse (or to a half cycle) equating to a zero mechanical angle.
To accept this signal type, the inverter:

- Counts Encoder cycles by means of quadrature discrimination and bi-directional digital count based on Channels A and B.
- Resets the digital counter corresponding to the reference mark in channel R to zero.
- Obtains channels A and B also by means of sampling and analogue/digital conversion, extracting the end value of the angle during the cycle (resolution increment).

The resolution increment of the cycle is obtained within the resolution limits of the ADC converter and noise overlying the analogue signal. In all cases, the resolution increment is only activated at low speed.

In the three-channel, mode it is not possible to ascertain the precise mechanical position of the Encoder when the inverter is switched on. The precise mechanical position becomes known after inverter power up, only after having passed the encoder zero notch for the first time (homing operation). For further information regarding this, refer to the Configuration Guide.

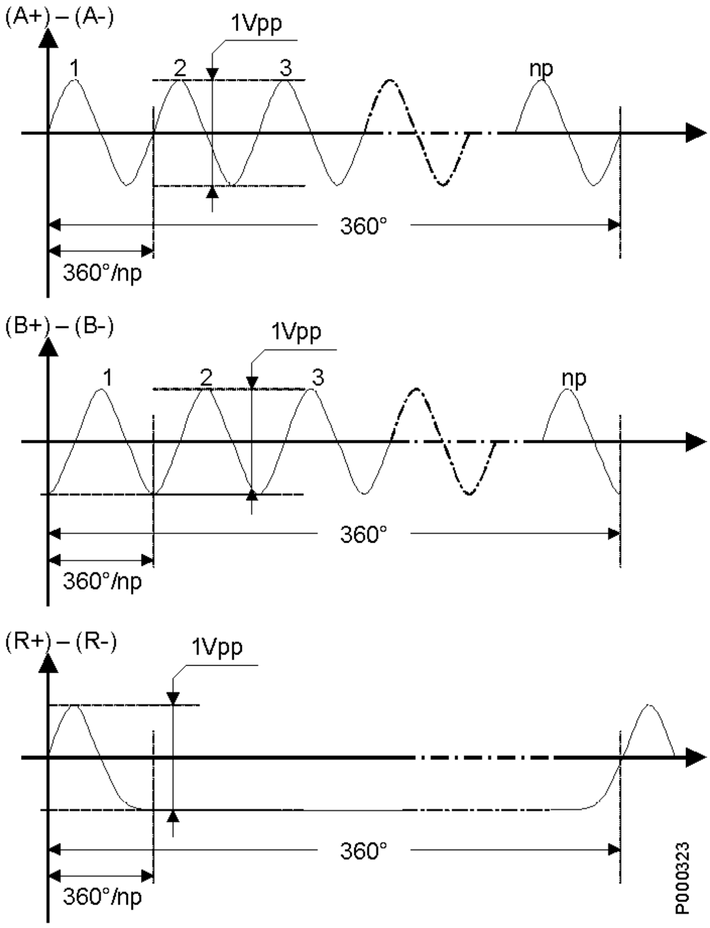


Figure 150: Typical waveform of signals in three-channel mode

Input signals C+, C-, D+, D- are not used with this function mode; the SW1 dip-switch must be set up as in Figure 151, i.e. with odd numbered switches ON and even numbered switches OFF.

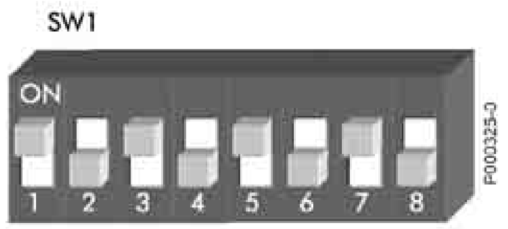


Figure 151: Dip-switch SW1 setup for Three-channel Mode reception

CAUTION — Carefully follow the dip-switch setup and do not change the settings when the inverter is powered up. An unexpected change in settings, even of short duration, will result in irreversible damage to the Encoder.

6.11.5. FIVE-CHANNEL OPERATING MODE

Figure 152 shows the Sin/Cos Encoder signals in five-channel mode. The first three channels receive signals in the same way as in the three-channel mode, i.e. in addition to the reference mark, sine and inverted cosine of the mechanical angle repeated **np** times the mechanical revolution. In this mode, the Card also receives non-sinusoidal signals in channels A, B and R: therefore, it is possible to accept rectangular waves provided by a normal incremental, differential, line-driver encoder.

The other two channels, C and D, still accept 1Vpp type signals but with form equal to the sine and cosine of the mechanical angle with a cycle per revolution.

To accept this signal type, the inverter:

- Counts Encoder cycles by means of quadrature discrimination and bi-directional digital count based on Channels A and B.
- Resets the digital counter corresponding to the reference mark in channel R to zero.
- Obtains channels C and D by means of sampling and analogue/digital conversion, extracting the value of the angle during the revolution cycle (precise position).

The calculation of the precise position during the cycle is obtained within the limits of the ADC converter resolution and noise overlying the analogue signal. In all cases, the calculation of the precise position is only activated at low speed, whereas the alignment of the encoder measuring position at high speed is guaranteed by the reference mark.

In the five-channel, mode it is possible to ascertain the precise mechanical position of the Encoder when the inverter is switched on. The precise mechanical position is established through the appropriate trigometric functions starting from analogue values measured from the voltage differentials in channels C and D, known before inverter start up. For further information regarding this, refer to the Configuration Guide.

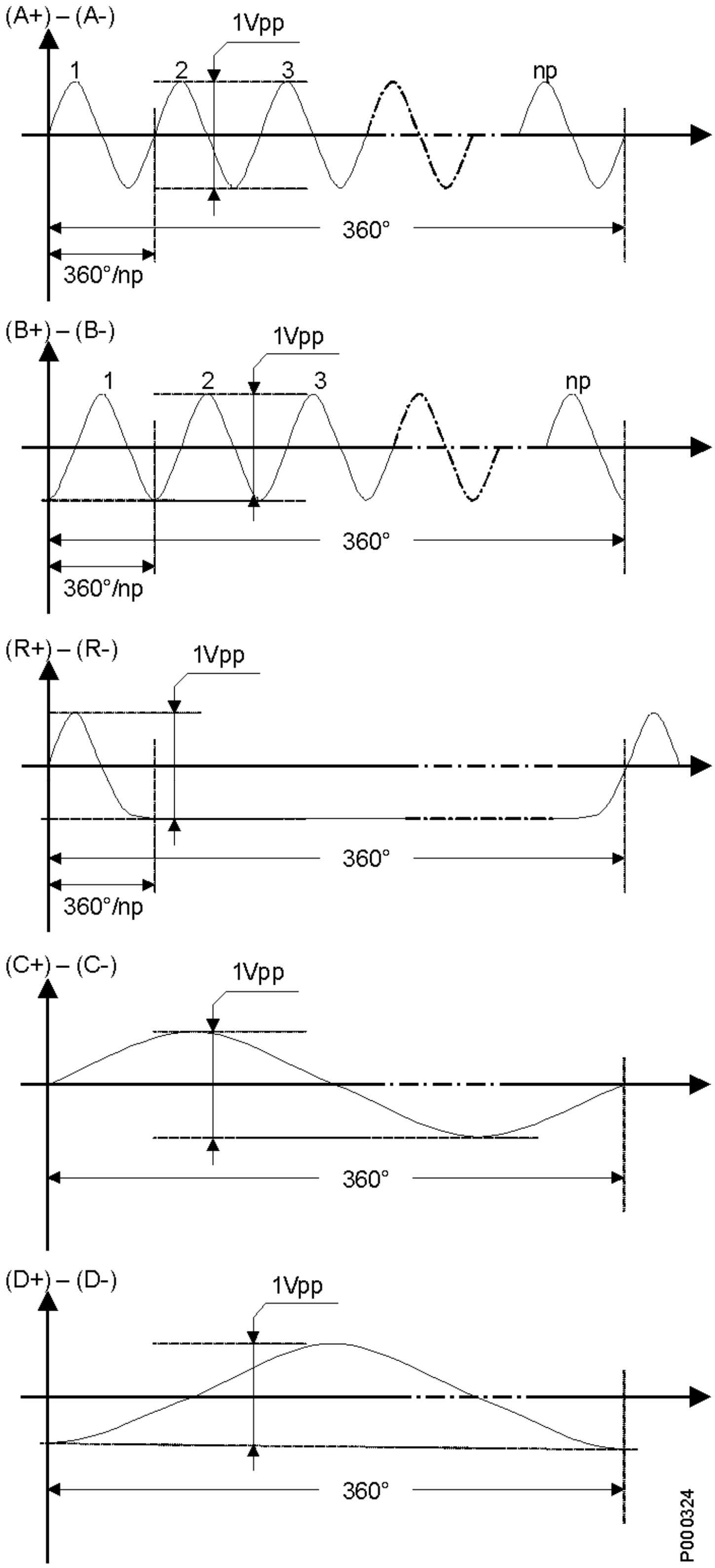


Figure 152: Typical signal waveform in Five-channel Mode

All input signals are used with this function mode; the SW1 dip-switch must be set up as in the figure below, i.e. with even numbered switches ON and odd numbered switches OFF.

Figure 153: Dip-switch setup for Five-channel Mode reception

CAUTION

Carefully follow the dip-switch setup and do not change the settings when the inverter is powered up. An unexpected change in settings, even of short duration, will result in irreversible damage to the Encoder.

6.11.6. Configuration and Regulation of Encoder Power Supply Voltage

The ES860 Card permits the encoder to be powered with different supply voltages. A selection Jumper and a power supply voltage regulation Trimmer are provided as shown in the figure below.

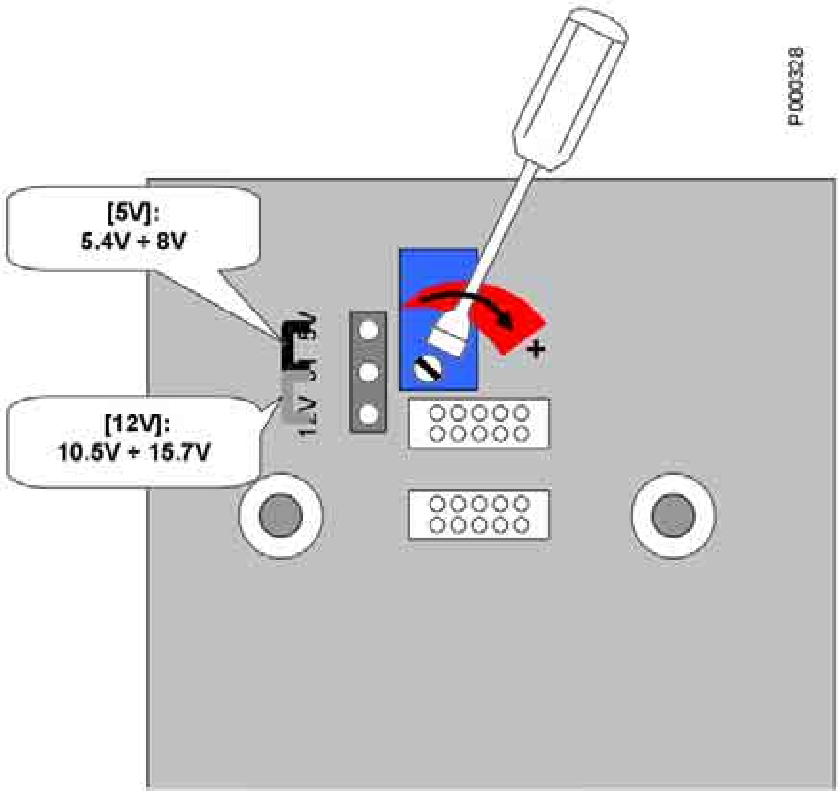


Figure 154: Position of Jumper and Voltage Regulation Trimmer

The Card is factory-set with a minimum output voltage of 5.4V, suitable for a nominal encoder power supply of 5V ±10%, to take account of the unavoidable voltage drop in the cable and its connection contacts. Using the Trimmer it is possible to raise the voltage up to 8V.
To raise the voltage to higher values, for example with an encoder power supply of 12V or 15V, it is necessary to set the Jumper selection to the 12V position. In this position it is possible to adjust the Trimmer to regulate the voltage between 10.5 and 15.7V. Regulation is carried out by rotating the Trimmer in a clockwise direction to increase the output voltage.
Supply voltage is always measured directly from the encoder power supply terminals so that it will take account of the voltage drop along the connection cable, especially if it is long.

	CAUTION	Powering the Encoder with an inadequate voltage can damage the component. Always use a tester to check the voltage supplied by the ES836 Card, having first configured it before connecting the cable.
	NOTE	The Encoder power circuit has an electronic current limiter and a re-settable fuse. In the event of an accidental short-circuit of the output supply, switch off the inverter and wait several minutes before resetting the fuse.

6.11.7. CONNECTION OF ENCODER CABLE

The Encoder cable connection is the most critical connection for the proper functioning of the inverter. "High-speed" signals in the cable are input with a bandwidth of up to several hundred kHz and are taken directly from the sensor position that is a point in the motor that is continuously electrically "disturbed" due to the reversing of the inverter. It is recommended to always make the connection following "good practice"; using shielded cables and correctly connecting the shields.

The recommended connection method is to use multi-polar shielded cables with double shields, connecting the internal shield to the connection frame of the ES860 Card and the external shield to the Encoder frame, usually common with the motor frame. If the internal Encoder shielding does not permit connection to the frame it is possible to connect it to the internal braiding.
The motor must always be earthed as instructed with a dedicated conductor attached directly to the inverter earthing point and routed parallel to the motor power supply cables.
It is not advisable to route the Encoder cable parallel to the motor power cables, it is preferable to use a dedicated signal cable conduit.
The figure below illustrates the recommended connection method.

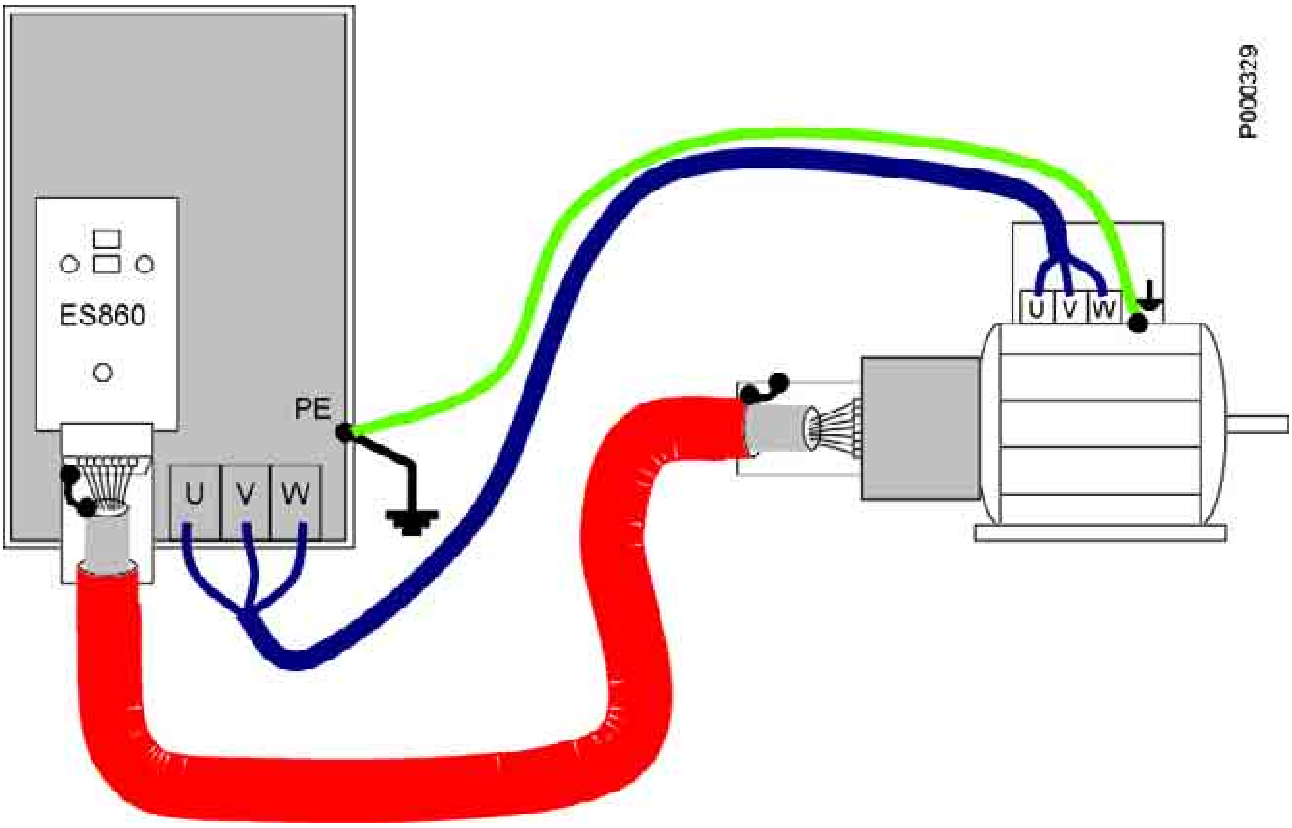


Figure 155: Recommended Double Shielding Connection Method for Encoder Cable.

NOTE

The output encoder power supply and common encoder signals are isolated with respect to common analogue signals of the inverter terminal board (CMA). Do not carry out cabling using conduits shared with encoder signals and signals in the inverter terminal board otherwise the isolation will be invalidated.

WARNING:

Correctly fix the cable and connecters either to the Encoder side or the ES860 Card side. The disconnection of a cable or of a single conductor can lead to damage of the inverter and overspeed the motor.

6.11.8. Environmental Requirements

Operating temperature:	ambient temperature, 0 to + 50° C (contact Elettronica Santerno for lower/higher temperatures)
Relative humidity:	5 to 95% (non-condensing)
Max. operating altitude	4000 m (a.s.l.)

6.11.9. Electrical Ratings

Encoder output supply	*Value*			
	Min	*Type*	*Max*	*Unit*
Encoder current output in 12V configuration			300	MA
Encoder current output in 5V configuration			500	MA
Short-circuit protection level			900	MA
Encoder supply voltage regulation range in 5V Mode	5.4	5.3	8.0	V
Encoder supply voltage regulation range in 12V Mode	10.5	12.0	15.7	V

Signal static input characteristics	*Value*			
Input signal type A, B	Differential analogue type ~1Vpp			
• Peak to peak input differential voltage range	0.8	1.0	1.2	Vpp
• Common input mode voltage range	0		5	V
• Input Impedance	120			Ohm
Input signal type C, D	Differential analogue type ~1Vpp			
• Input differential voltage range	0,8	1.0	1.2	Vpp
• Common input mode voltage range	0		5	V
• Input Impedance	1			Kohm
Input signal type R	Differential analogue type ~0.5Vpp/1Vpp			
• Encoder signal input differential voltage range	0,2	0.5	1.1	Vpp
• Common input mode voltage range	0		5	V
• Input Impedance	120			Ohm

Absolute maximum values	*Values*			
	Min	*Type*	*Max*	*Unit*
Maximum allowable common mode voltage range without damage	-20		+25	V
Maximum allowable differential voltage range in channels A, B and R	-3.5		+3.5	V
Maximum allowable differential voltage range in channels C and D	-10		+10	V
Signal static input characteristics	*Value*			
	Min	*Type*	*Max*	*Unit*

WARNING: Exceeding the maximum differential input or common mode voltages will result in irreversible damage to the apparatus.

Signal dynamic input characteristics	*Value*
Maximum signal frequency in analogue by position (Arctan) – channel C, D or channel A, B in three- channel mode	1000Hz (60000rpm @ 1 p/rev) (60 rpm @ 1024 p/rev)
Maximum signal frequency with digital counting on zero crossing – channels A, B	140kHz (1024imp @ 8200rpm)
Minimum duration of zero crossing pulse – channel R	3,5 µs (1024imp @ 8200rpm)

CAUTION Exceeding the maximum input signal frequency limits will result in the incorrect measurement of position and encoder speed. Motor overspeed may occur as a result of the chosen inverter control method.

6.12. "LOC-0-REM" KEY SELECTOR SWITCH AND EMERGENCY PUSH-BUTTON FOR MODEL IP54

Inverter with rating IP54 can be provided with a key selector switch and an emergency push-button (optional devices supplied by request).

The key selector switch selects the following operating modes:

POSITION	OPERATING MODE	DESCRIPTION
LOC	INVERTER IN LOCAL MODE	The inverter operates in "Local" mode; the Start command and the frequency/speed reference are sent via keypad. Press the Start button to start the inverter; the Enable command (terminal 15) is sent from the selector switch if terminals 1 and 2 are connected together (factory-setting). <u>Important:</u> C180 = MDI 4 (Local/Remote command selection for digital input MDI4).
0	INVERTER DISABLED	Inverter disabled
REM	INVERTER IN REMOTE MODE	The control mode is defined by programming in parameters C140 ÷ C147 of the "Control Method" menu. The Enable command (terminal 15) is sent from the selector switch if terminals 1 and 2 are connected together (factory-setting).

When pressed, the emergency push-button immediately stops the inverter.

An auxiliary terminal board with voltage-free contacts is provided for the selector switch status, the emergency push-button status and the Enable command.

TERMINALS	FEATURES	FUNCTION	DESCRIPTION
1	Optoisolated digital input	ENABLE	Connect terminal 1 to terminal 2 to enable the inverter (terminals 1 and 2 are connected together—factory-setting)
2	0 V digital inputs	CMD	digital input ground
3-4	voltage-free contacts (220 V - 3 A, 24 V - 2.5 A)	STATUS OF LOC-0-REM SELECTOR SWITCH	contacts closed: selector switch in position LOC; contacts open: selector switch in position 0 or REM
5-6	voltage-free contacts (220 V - 3 A, 24 V - 2.5 A)	STATUS OF LOC-0-REM SELECTOR SWITCH	contacts closed: selector switch in position REM; contacts open: selector switch in position 0 or REM
7-8	voltage-free contacts (220 V - 3 A, 24 V - 2.5 A)	STATUS OF EMERGENCY PUSH-BUTTON	contacts closed: emergency push-button not depressed contacts open: emergency push-button depressed

NOTE

When the key selector switch and the emergency push-button are installed, multifunction digital input MDI4 (terminal 12) cannot be used.
The ground of multifunction digital inputs is available also on terminal 2 in the auxiliary terminal board.

6.12.1. Wiring IP54 Inverters with Optional "LOC-0-REM" Key Selector Switch and Emergency Push-button

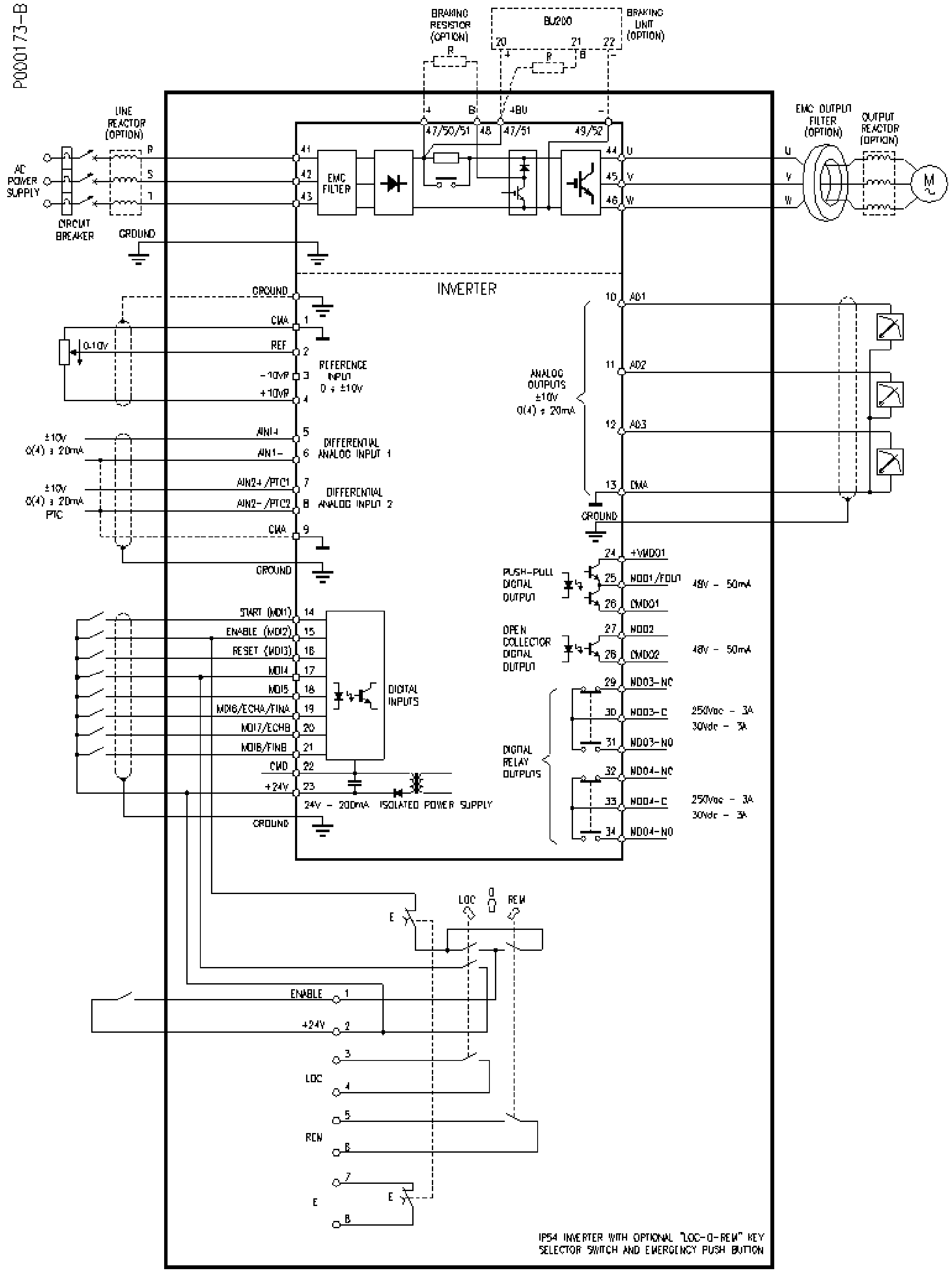


Figure 156: Wiring IP54 inverters with "LOC-0-REM" key selector switch and emergency push-button.

7. NORMATIVE REFERENCES

Electromagnetic Compatibility 89/336/CEE and following amendments 92/31/CEE, 93/68/CEE, and 93/97/CEE.
In most systems, the processing control also requires additional devices, such as computers, captors, and so on, that are usually installed one next to the other, thus causing disturbance:
- Low frequency – harmonics.
- High frequency – electromagnetic interference (EMI)

High frequency interference

High frequency interference is disturbance or radiated interference with >9kHz frequency. Critical values range from 150kHz to 1000MHz.
Interference is often caused by commutations to be found in any device, i.e. switching feeders and drive output modules. High frequency disturbance may interfere with the correct operation of the other devices. High frequency noise produced by a device may cause malfunctions in measurement systems and communication systems, so that radio receivers only receive electrical noise. This may cause unexpected faults.
Two fields may be concerned: immunity (EN50082-1-2, EN61800-3/A11 and following EN 61800-3 issue 2) and emissions (EN 55011group 1 and 2 cl. A, EN 55011 group 1 cl.B, EN61800-3-A11 and following EN 61800-3 issue 2).
Standards EN55011 and 50082, as well as standard EN61800-3, define immunity and emission levels required for devices designed to operate in different environments. Drives manufactured by ELETTRONICA SANTERNO are designed to operate under the most different conditions, so they all ensure high immunity against RFI and high reliability in any environment.

The table below defines PDS (Power Drive Systems) of EN 61800-3:2002 (which will become EN61800-3 issue 2).

FIRST ENVIRONMENT	Environment including domestic devices and industrial devices which are connected directly to a low-voltage mains (with no intermediate transformer) for domestic usage.
SECOND ENVIRONMENT	Environment including industrial connections different from “First Environment” connections.
PDS of Category C1	PDS with rated voltage lower than 1000 V to be used in the First Environment.
PDS of Category C2	PDS with rated voltage lower than 1000 V; if used in the First Environment, they are intended to be installed and commissioned by professional users only.
PDS of Category C3	PDS with rated voltage lower than 1000 V to be used in the Second Environment.
PDS of Category C4	PDS with rated voltage equal to or higher than 1000 V or with a current equal to or higher than 400A to be used in complex systems installed in the Second Environment.

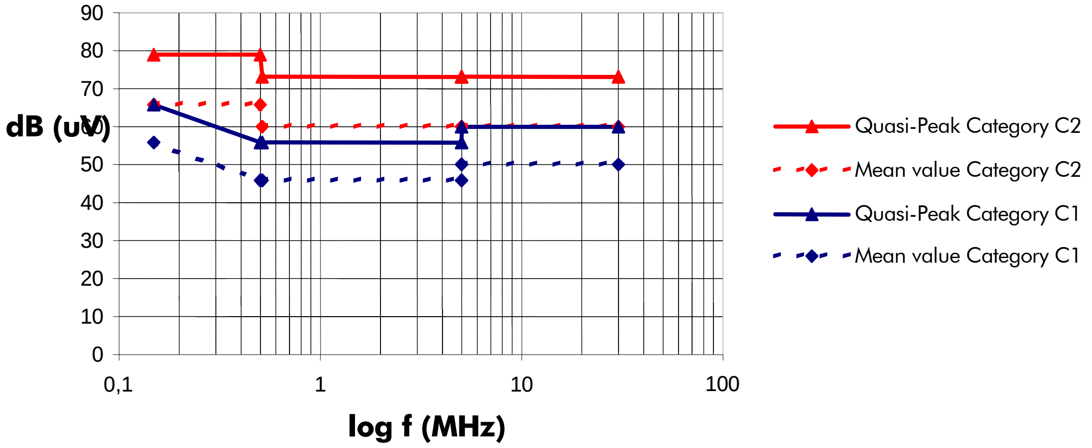
0 1 2 3 4 5 6 7 8

Emission Limits

The standards in force also define the allowable emission level for different environments.
The diagrams below show emission limits allowed by Pr EN 61800-3 issue 2 (corresponding to EN61800-3/A11).

P000091-A

“FIRST ENVIRONMENT” Disturbance Limits

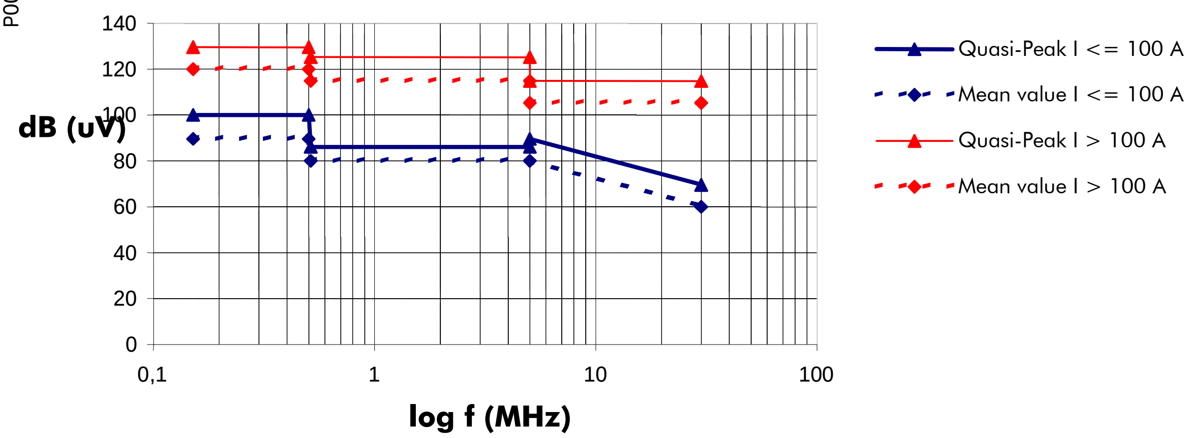


A1 = EN 61800-3 issue 2 FIRST ENVIROMENT, Category C2, EN55011 gr.1 cl. A, EN50081-2, EN61800-3/A11.

B = EN 61800-3 issue 2 FIRST ENVIROMENT, Category C1, EN55011 gr.1 cl. B, EN50081-1,-2, EN61800-3/A11.

P000092-A

“SECOND ENVIRONMENT” Disturbance Limits



A2 = EN 61800-3 issue 2 SECOND ENVIRONMENT Category C3, EN55011 gr.2 cl. A, EN61800-3/A11.

Inverters manufactured by ELETTRONICA SANTERNO allow to choose among four levels:
I no suppression of the emissions for users who use power drive systems in a non-vulnerable environment and who directly provide for the suppression of the emissions;
A1 suppression of the emissions for power drive systems installed in the FIRST ENVIRONMENT, Category C2.
A2 suppression of the emissions for power drive systems installed in the SECOND ENVIRONMENT, Category C3.
B suppression of the emissions for power drive systems installed in the FIRST ENVIRONMENT, Category C1.
ELETTRONICA SANTERNO is the only manufacturer offering power drive systems with built-in A2-level filters up to 1200kW. All those classes are provided with the Declaration of European Conformity.
Additional external RFI filters may be installed to bring emissions of devices of level I or A1 to level B.

As for lifts, standard UNI EN 12015 relating to electromagnetic compatibility requires incorporated A1-type filters for currents under 25 A and incorporated A2-type filters for currents over 25 A.

Immunity levels
Electromagnetic disturbance is caused by harmonics, semiconductor commutations, voltage variation-fluctuation-dissymmetry, mains failures and frequency variations; electrical equipment must be immune from electromagnetic disturbance.
According to standards EN61800-3:1996/A11:2000 and Pr EN61800-3:2002, immunity is provided by the following tests:

89/336/CEE Electromagnetic Compatibility Directive and following amendments, 92/31/CEE, 93/68/CEE, and 93/97/CEE.	- Immunity: EN61000-4-2/IEC1000-4-2 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 2: Electrostatic Discharge Immunity Test. Basic EMC Publication. EN61000-4-3/IEC1000-4-3 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 3: Radiated, Radio-frequency, Electromagnetic Field Immunity Test. EN61000-4-4/IEC1000-4-4 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 4: Electrical Fast Transient/Burst Immunity Test. Basic EMC Publication. EN61000-4-5/IEC1000-4-5 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 5: Surge Immunity Test. EN61000-4-6/IEC1000-4-6 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 6: Immunity from Radiofrequency Fields Induced Disturbance.

ELETTRONICA SANTERNO certifies all its products in compliance with immunity standards in force. All classes are provided with CE Declaration of European Conformity according to Electromagnetic Compatibility 89/336/CEE – 92/31/CEE – 23/68/CEE-93/97/CEE (reproduced on the last pages of the instruction manual).

CAUTION

Products with ID "I" in column 7 in the nameplate (see section 1.2):
These devices are not provided with RFI filters. They can produce radio interference in domestic environments; additional measures should be taken to suppress radio interference.

CAUTION

Products with ID "A1" in column 7 in the nameplate (see section 1.2); the following regulation is provided:
These are category C2 devices according to EN61800-3. They can produce radio interference in domestic environments; additional measures should be taken to suppress radio interference.

CAUTION

Products with ID "A2" in column 7 in the nameplate (see section 1.2):
These are category C3 devices according to EN61800-3. They can produce radio interference in domestic environments; additional measures should be taken to suppress radio interference.

<table>
<tr><td rowspan="7">Low Voltage Directive (73/23/CEE and following amendment 93/68/CEE)</td><td>IEC61800-5-1</td><td>Adjustable speed electrical power drive systems. Part 5-1:
Safety requirements – Electrical, thermal and energy.</td></tr>
<tr><td>IEC-22G/109/NP</td><td>Adjustable speed electrical power drive systems. Part 5-2:
Safety requirements – Functional</td></tr>
<tr><td>EN60146-1-1/IEC146-1-1</td><td>Semiconductor convertors.
General Requirements and line-commutated convertors.
Part 1-1: Specifications of basic requirements</td></tr>
<tr><td>EN60146-2/IEC1800-2</td><td>Adjustable speed electrical power drive systems.
Part 2: General requirements – Rating specifications for low voltage adjustable frequency AC power drive systems.</td></tr>
<tr><td>EN60204-1/IEC204-1</td><td>Safety of machinery. Electrical equipment of machines. Part: General requirements.</td></tr>
<tr><td>EN60529/IEC529</td><td>Degrees of protection provided by enclosures (IP Code).</td></tr>
<tr><td>EN50178 (1997-10)</td><td>Electronic equipment for power systems.</td></tr>
</table>

ELETTRONICA SANTERNO is capable of providing Declaration CE of Conformity according to the requirements of LOW VOLTAGE DIRECTIVE 73/23/CEE-93/68/CEE and to MACHINES DIRECTIVE, 89/392/CEE, 91368/CEE-93/44/CEE (reproduced on the last pages of the instruction manual).

7.1. RADIOFREQUENCY DISTURBANCE

Radiofrequency disturbance (RFI) may occur where the inverter is installed.
Electromagnetic emissions produced by the electrical components installed inside a cabinet may occur as conduction, radiation, inductive coupling or capacitive coupling.
Emissions disturbance can be the following:
a) Radiated interference from electrical components or power wiring cables inside the cabinet;
b) Disturbance and radiated interference from outgoing cables (feeder cables, motor cables, signal cables).

The figure shows how disturbance takes place:

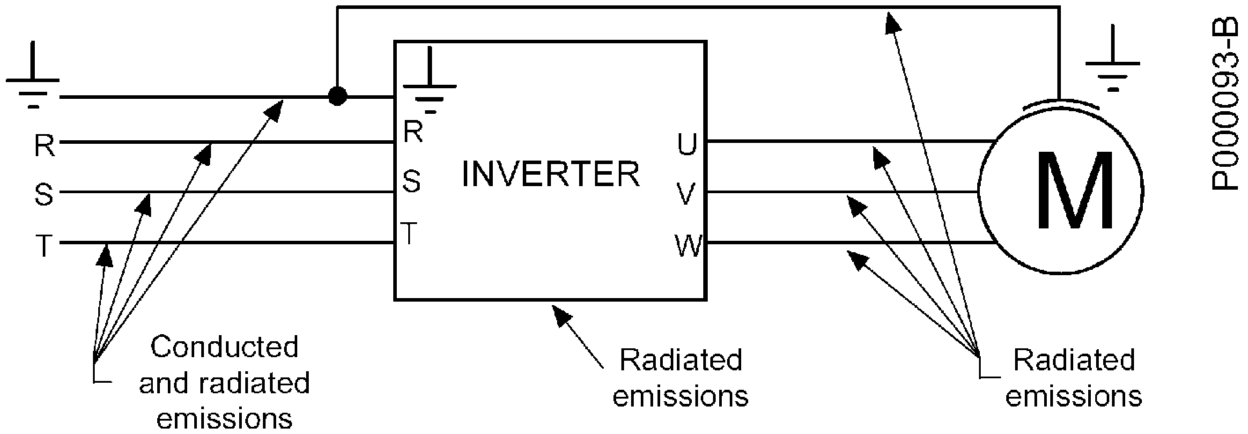


Figure 157: Disturbance sources in a power drive system equipped with an inverter

The measures to be taken to suppress disturbance include: grounding enhancement; changes made to the cabinet structure; installation of mains filters on the line and installation of output toroid filters on the motor cables; optimization of the wiring and cable screening.
Always restrict as much as possible the area exposed to disturbance, so as to limit interferences with the other components in the cabinet.

Grounding
Disturbance occurring in the grounding circuit affects the other circuits through the grounding mains or the casing of the connected motor.
Disturbance may interfere with the following appliances which are installed on the machines and which are sensitive to radiated interference, as they are measurement circuits operating at low voltage (μV) or current signal levels (μA):

- transducers (tachos, encoders, resolvers);
- thermoregulators (thermocouples);
- weighing systems (loading cells);
- PLC or NC inputs/outputs;
- photocells or magnetic proximity switches.

Disturbance is mainly due to high-frequency currents flowing in the grounding mains and the machine metal components; disturbance occurs in the sensitive sections of components (optical transducer, magnetic transducer, capacitive transducer). Disturbance may also occur in appliances installed on machines with the same grounding or metal and mechanical interconnections.
A possible solution is to enhance the inverter, motor and cabinet grounding, as high-frequency currents flowing in the grounding between the inverter and the motor (capacity distributed to the ground of the motor cable and casing) may cause a strong difference of potential in the system.

7.1.1. THE MAINS

Disturbance and radiated interference occur in the mains.
Limiting disturbance results in weakening radiated interference.
Disturbance on the mains may interfere with devices installed on the machine or devices installed even some hundred meters far from the machine and which are connected to the same mains.

The following appliances are particularly sensitive to disturbance:
- computers;
- radio receivers and TV receivers;
- biomedical equipment;
- weighing systems;
- machines using thermoregulation;
- telephone systems.

Mains disturbance may be limited by installing a mains filter to reduce RFI.

ELETTRONICA SANTERNO adopted this solution to suppress RFI.

7.1.2. OUTPUT CHOKES

Ferrite is a simple radiofrequency filter. Ferrite cores are high-permeable ferromagnetic materials used to weaken cable disturbance:
- in case of three-phase conductors, all phases must go through the ferrite;
- in case of single-phase conductors (or 2-wire line) both phases must go through the ferrite (incoming and outcoming conductor cables that are to be filtered must go through the ferrite).

7.1.3. THE CABINET

To prevent input and output of electromagnetic emissions to and from the cabinet, draw particular attention to the cabinet doors, opening and cable paths.
A) Use a seam-welded metal frame ensuring electrical continuity.
Provide an unpainted, reference grounding support on the frame bottom. This steel sheet or metal grill is to be connected to the metal frame, which is also connected to the ground mains of the equipment. All components must be bolted directly to the grounding support.
B) Hinged parts or mobile parts (i.e. doors) must be made of metal and capable of restoring electrical conductivity once closed.
C) Segregate cables bases on the type and intensity of electrical quantities and the type of devices which they are connected to (components that may generate electromagnetic disturbance and components that are particularly sensitive to disturbance):

A. Hinged parts or mobile parts (i.e. doors) must be made of metal and capable of restoring electrical conductivity and avoiding any cracking once closed.

B. Segregate cables bases on the type and intensity of electrical quantities and the type of devices which they are connected to (components that may generate electromagnetic disturbance and components that are particularly sensitive to disturbance):

high sensitivity	Analog inputs and outputs: voltage reference and current reference sensors and measurement circuits (ATs and VTs) DC supply (10V, 24V)
low sensitivity	digital inputs and outputs: optoisolated commands, relay outputs
low perturbation	filtered AC supply
high perturbation	Power circuits in general inverter non-filtered AC supply contactors inverter-motor wires

Measures to take when wiring the cabinet or the system:

- Sensitive signals and perturbator signals must never exist within a cable.
- Avoid that cables carrying sensitive signals and perturbator signals run parallel at short distance: whenever possible, paths of cables carrying sensitive signals and perturbator signals should be reduced to a minimum.
- Move away as much as possible any cables carrying sensitive signals and perturbator signals. The distance between segregated cables should be proportional to the cable length. Whenever possible, cable crossing should be perpendicular.

Wires connecting the motor or load mainly generate disturbance. Disturbance is important in inverter power drive systems or the devices installed on the machine, and could interfere with any equipment installed on the machine or with local communication circuits located near the inverter (radiotelephones, mobile phones).
Follow the instructions below to solve these problems:

- Provide for a motor cable path as short as possible.
- Screen the power cables to the motor; ground screening both to the inverter and to the motor. Excellent results are obtained using cables in which the protection connection (yellow-green cable) is external to the screening (this type of cables are available on the market with a cross-section up to 35mm^2 per phase); if no screened cable having a suitable cross-section is available, segregate power cables in grounded, metal raceways.
- Screen signal cables and ground screening on the inverter side.
- Segregate power cable from signal cables.
- Leave a clearance of at least 0.5m between signal cables and Motor cables.
- Series-connect a common mode inductance (toroid) (approx. 100 μH) to the inverter-Motor connection.

Limiting the disturbance in the motor cables will also limit mains disturbance.

Screened cables allow both signal sensitive cables and perturbator cables to run in the same raceway. When using screened cables, 360° screening is obtained with collars directly bolted to the ground support.

The figure below illustrates the correct wiring of an enclosure containing an inverter; example of the correct wiring of an inverter installed inside an enclosure.

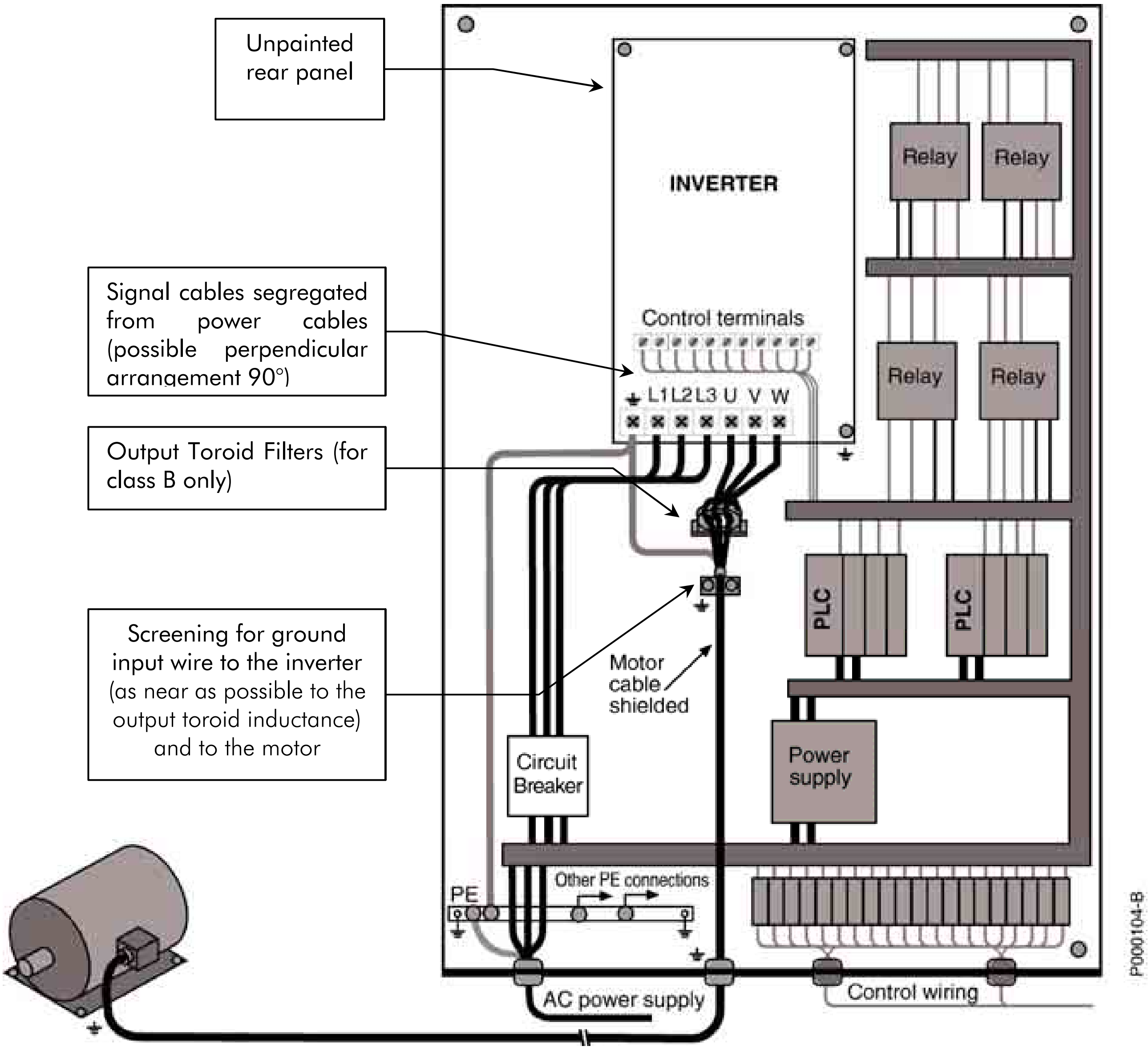


Figure 158: Example of correct wiring of an inverter inside a cabinet

7.1.4. INPUT AND OUTPUT FILTERS

The inverters of the SINUS PENTA series may be delivered with incorporated input filters; in that case, models are marked with A1, A2, B in the ID number.
If built-in filters are fitted, disturbance amplitude ranges between allowable emission limits (see section 5 "Provisions").
As for devices of group 1, class B for standard EN55011 and VDE0875G, just install an additional output toroid filter (e.g. type 2xK618) on the models with incorporated filter A1; make sure that the three cables between the motor and the inverter go through the core. The figure shows the wiring diagram for the line, the inverter and the motor.

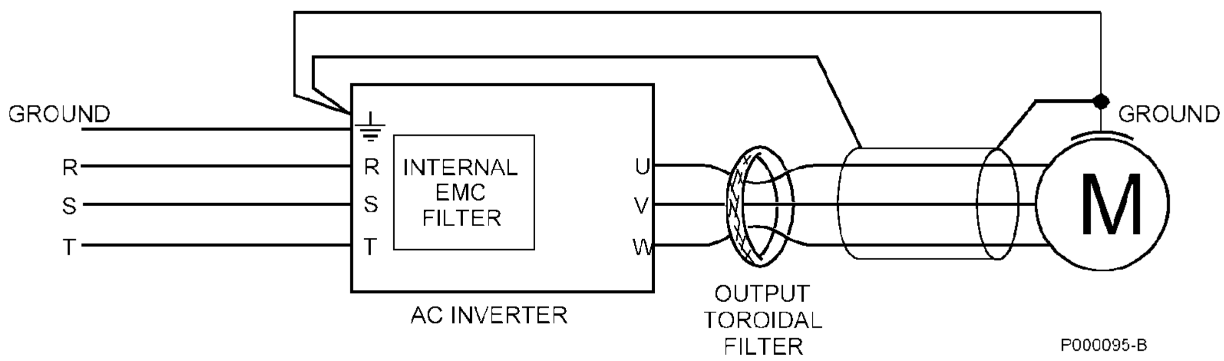


Figure 159: Wiring the toroid filter for the inverter of the SINUS PENTA series

	NOTE	Install the output filter near the inverter to comply with the standards in force (leave a minimum clearance for the cable connections).
	NOTE	Install the toroid filter by leading the connection cables between the motor and the inverter inside the toroid.

7.2. Declarations of conformity

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Elettronica Santerno S.p.A.

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AS MANUFACTURER

DECLARE

UNDER OUR SOLE RESPONSABILITY

THAT THE DIGITAL THREE-PHASE AC INVERTER FROM

SINUS PENTA LINE,

AND RELATED ACCESSORIES,

TO WHICH THIS DECLARATION RELATES,

APPLIED UNDER CONDITIONS SUPPLIED IN THE USER'S MANUAL,

ARE IN CONFORMITY TO WITH THE FOLLOWING STANDARDS:

CEI EN 61800-3 2ª ed. **(2005 - 04)**	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods.

FOLLOWING THE PROVISIONS OF ELECTROMAGNETIC COMPATIBILITY
DIRECTIVE 2004/108/CE

PLACE AND DATE
Casalfiumanese, 05/03/2007

General Manager
BOMBARDA ING. GIORGIO

ELETTRONICA SANTERNO S.p.A.
General Manager
Giorgio Bombarda

GRUPPO CARRARO

Elettronica Santerno Spa
Società soggetta all'attività di direzione e coordinamento di Carraro Spa

Stabilimenti e uffici
Via G. Di Vittorio 3
40020 Casalfiumanese (Bo) Italia
Tel. +39 0542 668611
Fax +39 0542 668600
www.elettronicasanterno.com
sales@elettronicasanterno.it

Divisione R&D
S.S. Selice 47
40060 Imola (Bo)
Tel. +39 0542 687711
Fax +39 0542 687722

Ufficio Milano
Via Trieste 99
20064 Gorgonzola (Mi)
Tel. +39 02 95138126
Tel. +39 02 95179254
Tel. +39 02 95179458
Fax +39 02 95139216

Cap. Soc. € 2.500.000 i.v.
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R.E.A. PD 328951
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UNDER OUR SOLE RESPONSABILITY

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TO WHICH THIS DECLARATION RELATES,

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ARE IN CONFORMITY TO WITH THE FOLLOWING STANDARDS:

EN 60204-1 (1997)	Safety of machinery - Electrical equipment of machines – Part 1: General requirements
EN 60204-1 Amendment 1 (1988)	Electrical equipment of industrial machines. Part 2: Item designation and examples of drawings, diagrams, tables and instructions.

AND MUST NOT BE PUT INTO SERVICE UNTIL THE MACHINERY INTO WHICH IT IS TO BE INCORPORED HAS BEEN DECLARED IN CONFORMITY WITH THE PROVISIONS OF MACHINERY DIRECTIVE 89/392/EEC AND SUBSEQUENT AMENDMENTS 91/368/EEC, 93/44/EEC AND 93/68/EEC AND THEIR RIFUSION AS 2006/42/CE

PLACE AND DATE
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General Manager
BOMBARDA ING. GIORGIO

Elettronica Santerno Spa
Società soggetta all'attività di direzione e coordinamento di Carraro Spa

GRUPPO CARRARO

Stabilimenti e uffici
Via G. Di Vittorio 3
40020 Casalfiumanese (Bo) Italia
Tel. +39 0542 668611
Fax +39 0542 668600
www.elettronicasanterno.com
sales@elettronicasanterno.it

Divisione R&D
S.S. Selice 47
40060 Imola (Bo)
Tel. +39 0542 687711
Fax +39 0542 687722

Ufficio Milano
Via Trieste 99
20064 Gorgonzola (Mi)
Tel. +39 02 95138126
Tel. +39 02 95179254
Tel. +39 02 95179458
Fax +39 02 95139216

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APPLIED UNDER CONDITIONS SUPPLIED IN THE USER'S MANUAL,

ARE IN CONFORMITY TO WITH THE FOLLOWING STANDARDS:

CEI EN 61800-5-1: (2005)	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – Electrical, thermal and energy.
prEN 61800-5-2: (2006)	Adjustable speed electrical power drive systems. Part 5-2: Safety requirements – Functional.
EN 60146-1-1 (1995) + A1 (1998)	Semiconductor converters. General requirements and line commutated converters. Part 1-1: Specifications of basic requirements.
EN 60146-2 (2001)	Semiconductor converters. Part 2: Self-commutated semiconductor converters including direct d.c. converters.
CEI EN 61800-2 (1999)	Adjustable speed electrical power drive systems. Part 2: General requirements – Rating specifications for low voltage adjustable frequency a.c. power drive systems.
EN 60204-1 (2005 -10)	Safety of machinery – Electrical equipment of machines Part 1:General requirements
EN 60529 (1992) /EC(1993) / A1(2000)	Degrees of protection provided by enclosures (IP Code).
IEC 62103 (2003)	Electronic equipment for use in power installations
EN 50178 (1999)	Electronic equipment for use in power installations

FOLLOWING THE PROVISIONS OF LOW VOLTAGE DIRECTIVE 2006/95/CE

LAST TWO DIGITS OF THE YEAR IN WHICH THE CE MARKING WAS AFFIXED **CE: 03**

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ELETTRONICA SANTERNO S.p.A.
General Manager
Giorgio Bombarda

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Elettronica Santerno Spa
Società soggetta all'attività di direzione e coordinamento di Carraro Spa

Stabilimenti e uffici
Via G. Di Vittorio 3
40020 Casalfiumanese (Bo) Italia
Tel. +39 0542 668611
Fax +39 0542 668600
www.elettronicasanterno.com
sales@elettronicasanterno.it

Divisione R&D
S.S. Selice 47
40060 Imola (Bo)
Tel. +39 0542 687711
Fax +39 0542 687722

Ufficio Milano
Via Trieste 99
20064 Gorgonzola (Mi)
Tel. +39 02 95138126
Tel. +39 02 95179254
Tel. +39 02 95179458
Fax +39 02 95139216

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AND RELATED ACCESSORIES,

TO WHICH THIS DECLARATION RELATES,

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CEI EN 61800-3 2ª ed. **(2005 - 04)**	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods.

FOLLOWING THE PROVISIONS OF ELECTROMAGNETIC COMPATIBILITY DIRECTIVE
2004/108/CE

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Casalfiumanese, 05/03/2007

General Manager
[illegible]BARDA ING. GIORGIO
General M...
Giorgio Bet...

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Società soggetta all'attività di direzione e coordinamento di Carraro Spa

Stabilimenti e uffici
Via G. Di Vittorio 3
40020 Casalfiumanese (Bo) Italia
Tel. +39 0542 668611
Fax +39 0542 668600
www.elettronicasanterno.com
sales@elettronicasanterno.it

Divisione R&D
S.S. Selice 47
40060 Imola (Bo)
Tel. +39 0542 687711
Fax +39 0542 687722

Ufficio Milano
Via Trieste 99
20064 Gorgonzola (Mi)
Tel. +39 02 95138126
Tel. +39 02 95179254
Tel. +39 02 95179458
Fax +39 02 95139216

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General Manager
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General Manager
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Società soggetta all'attività di direzione e coordinamento di Carraro Spa

Stabilimenti e uffici
Via G. Di Vittorio 3
40020 Casalfiumanese (Bo) Italia
Tel. +39 0542 668611
Fax +39 0542 668600
www.elettronicasanterno.com
sales@elettronicasanterno.it

Divisione R&D
S.S. Selice 47
40060 Imola (Bo)
Tel. +39 0542 687711
Fax +39 0542 687722

Ufficio Milano
Via Trieste 99
20064 Gorgonzola (Mi)
Tel. +39 02 95138126
Tel. +39 02 95179254
Tel. +39 02 95179458
Fax +39 02 95139216

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EN 50178 (1999)	Electronic equipment for use in power installations
EN 60439-1 (2000)	Low voltage switchgear and control-gear assemblies Part 1: Requirements for type-tested and partially type-tested assemblies.

FOLLOWING THE PROVISIONS OF LOW VOLTAGE DIRECTIVE 2006/95/CE

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Casalfiumanese, 05/03/2007

General Manager
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Società soggetta all'attività di direzione e coordinamento di Carraro Spa

GRUPPO CARRARO

Stabilimenti e uffici
Via G. Di Vittorio 3
40020 Casalfiumanese (Bo) Italia
Tel. +39 0542 668611
Fax +39 0542 668600
www.elettronicasanterno.com
sales@elettronicasanterno.it

Divisione R&D
S.S. Selice 47
40060 Imola (Bo)
Tel. +39 0542 687711
Fax +39 0542 687722

Ufficio Milano
Via Trieste 99
20064 Gorgonzola (Mi)
Tel. +39 02 95138126
Tel. +39 02 95179254
Tel. +39 02 95179458
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