• 15P0102B1 •

SINUS PENTA

MULTIFUNCTION AC DRIVE

INSTALLATION INSTRUCTION

Upd. 18/11/03
R. 00

English

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GENERAL DESCRIPTION

Inverters are electronic devices capable of controlling speed and torque of an electric motor at AC voltage. 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.
Inverters of the PENTA series may also 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.

Available SINUS PENTA models range from 1.3kW to 1,200kW.

AVAILABLE SINUS PENTA MODELS:

NOTE

It is possible to change some technical features and to customize the inverter enclosures shown in the picture. The proportion of one enclosure to the other is shown as an example and is not binding.

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FEATURE LIST

• One product, five functions:
- vectorial-modulation IFD software for general-purpose applications (V/f pattern) (*);
- sensorless, vectorial VTC software for high torque demanding performance (direct torque control);
- vectorial FOC functionality with an encoder for accurate torque requirements and a wide speed range
- vectorial SYN functionality for applications with brushless, synchronous motors with permanent magnets, requiring very accurate torque values and excellent energy performances [1)]
- RGN functionality for the inverter application as an AC/DC converter for the DC supply of multiple drives [1)]

• • Wide range of supply voltage values (200VAC ~ 500VAC) for stand-alone models and up to 690VAC for cabinet models. Standard power supply: 280VDC ~ 705VDC. (970VDC for cabinet models).

• Wide range of voltage values and power values for the electrical motor to be connected to any inverter size. Stand-alone model: up to 450kW; cabinet: up to 1200kW.

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.

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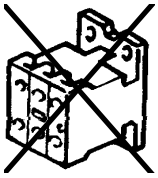


• No line contactor included. The new hardware configuration is standard supplied with a safety system including redundant contacts for the inhibition of firing pulses in the power circuit, in compliance with the latest requirements of the safety regulations in force. (However, respect the specific rules of the field of application).

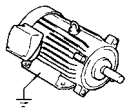
• Beyond performance enhancement, the new series of SINUS PENTA models are more compact than the prior models. The overall dimensions have been reduced up to 50% in order to install the inverter in small-sized, light-weight control panels. A compact, book-like structure allows an easy side-by-side installation. The SINUS PENTA may be installed in cabinets and its system 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 S30). 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 a weaker 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 a high modulation frequency programmable up to 16kHz.

• Integrated motor control through a 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.

1) BEING DEVELOPED AT THE MOMENT

- Parameter saving to remotable keypad/display 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 five 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.)

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.

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

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

DANGER: The inverter may generate an output frequency up to 800Hz; this may cause a motor rotation speed up to 16 (sixteen) times the motor rated speed: never use the motor at a higher speed than the max. allowable speed stated on the motor nameplate.

DANGER: 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.

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

DANGER: 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.

DANGER: 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.

DANGER: 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.

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

CAUTION: 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.

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

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

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

CAUTION: Operate the inverter only if a proper grounding is provided.

CAUTION: 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 of the alarm trip.

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

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

CAUTION: Do not connect single-phase motors.

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

CAUTION: Respect the environmental requirements for the equipment installation.

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

CAUTION: 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.

1 EQUIPMENT DESCRIPTION AND INSTALLATION

Inverters of the SINUS PENTA series are full digital inverters capable of controlling asynchronous motors and brushless motors up to 1,200 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; vectorial 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.
Inverters of the SINUS PENTA series are provided with the following standard features:
power supply from 380-500VAC mains (-10%,+5%) up to 690VAC for SINUS CABINET;

- EMC filters for industrial environment incorporated in any inverter Size;
- EMC filters for domestic environment incorporated in Sizes S05 and S10;
- possibility of AC power supply;
- 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±10VDC, 0(4)÷20mA; one input may be configured as a motor PTC input
- 8 optoisolated digital inputs (PNP);
- 3 configurable analog outputs 0÷10V, 4÷20mA, 0÷20mA;
- 1 optoisolated, “open collector” digital output;
- 1 optoisolated, “push-pull” digital output;
- 2 relay digital outputs with reverse contacts.

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”.

1.2 PRODUCTS COVERED IN THIS MANUAL

This manual covers any inverter of the SINUS PENTA series equipped with the following application software: standard functionality, IFD, VTC, FOC, SYN and RGN software.

1.3 INSPECTION UPON RECEIPT OF THE GOODS

Make sure the equipment is not damaged and 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 1.4 "Installing the Equipment"). The equipment guarantee covers any manufacturing defect. The manufacturer has no responsibility for possible damages due to the inverter 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 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:

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 size
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 660÷690VAC; 930÷970VDC.
5	Type of power supply T = three-phase S = single-phase (available by request)
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 users, 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 K = with a control panel and a back-lit, 16x2 character LCD display.
9	Degree of protection 0 = IP00 2 = IP203 = IP24 5 = IP54

1.3.1 INVERTER NAMEPLATE

Typical nameplate for inverter SINUS PENTA 200T

ZZ0102007. 72003						SINUS PENTA 0020 2T BA2K2	
Input AC3PH 200..240V +5/-15% 50/60Hz						33 A	Size S10
Output AC3PH 0 240V 26,0 kVA max						I nom. 30 A	I max 36 A
Applicable motor power (kW)						Immunity : EN50082-1-2 EN61800-3 ed.2 Emission : EN550011 gr.2 cl.A Safety : EN61800-5-1 : EN50178 ; EN60204-1 ; IEC 22/G/109/NP	
Motor voltage	light	standard	heavy	strong			
200-240V	9,4	9,4	7,2	5,8			
Mot. Curr. (A)	30,0	30,0	24,0	20,0			
Fuse 40 A	Circuit breaker 40 A				Cont.AC1 45 A		Wire size 10 mmq

PERICOLO!: TENSIONE PERICOLOSA FINO A 5 MINUTI DALLA DISALIMENTAZIONE DELL'APPARECCHIATURA

DANGER! HAZARDOUS VOLTAGE REMAIS UP TO 5 MINUTES AFTER REMOVING MAIN POWER
DANGER ! VOLTAGE RESIDU DANGEREUX Jusqu'à 5 MINUTES APRES LE DEBRANCHEMENT DE L'APPAREILLAGE
WARNUNG !: NACH ABSCHALTUNG DER EINRICHTUNG STEHT NOCH 5 MINUTEN LANG GEFAEHRLICHE SPANNUNG AN
PELIGRO !: VOLTAJE PELIGROSO PERMANECE POR 5 MINUTOS DESPUES DE LA DESACTIVACION DE L'EQUIPO

CONSULTARE IL MANUALE DI ISTRUZIONI PRIMA DELL'USO
CHECK THE OPERATION MANUAL
CONSULTER LE MANUEL D'INSTRUCTION
SIEHE DAZU BETRIEBSANLEITUNGEN
CONSULTAR EL MANUAL DE ISTRUCCIONES

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Typical nameplate for inverter SINUS PENTA 400T

ZZ0102001. 14003

SINUS PENTA 0005 4T BIK2

Input AC3PH 380 500v +5/-15% 50/60Hz **33** A Size S05
Output AC3PH 0 500V **9,1** kVAmax I nom. **10,5** A I max **11,5** A

Applicable motor power (kW)				
Motor voltage…	light	standard	heavy	strong
380-415V	4,7	4	3	2,2
440-460V	5,5	4,4	3,3	2,5
480-500V	6	4,8	3,6	2,7
Mot. Cur. (A)	**10,5**	**8,5**	**6,5**	**5,0**

Immunity :
EN50082-1-2 EN61800-3 ed.2
Emission :

Safety : EN61800-5-1 : EN50178 ;
EN60204-1 ; IEC 22/G/109/NP

Fuse **16** A Circuit Breaker 16A Cont. AC1 25A Wire Size 2,5 mmq

PERICOLO!: TENSIONE PERICOLOSA FINO A 5 MINUTI DALLA DISALIMENTAZIONE DELL'APPARECCHIATURA

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SIEHE DAZU BETRIEBSANLEITUNGEN
CONSULTAR EL MANUAL DE ISTRUCCIONES

MADE IN ITALY

CE

1.4 INSTALLING THE EQUIPMENT

Inverters of the SINUS PENTA series—degree of protection IP20–may 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 hot exhaust air.

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

1.4.1 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; do not install in salty environments.
Altitude	Up to 1000 m above sea level. For higher altitudes, derate the output current of 2% 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.

1.4.2 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
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

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 are shown in the ratings table.

To calculate the air delivery required consider coefficients for ambient temperature of about 35°C and altitudes lower than or equal to 1000m a.s.l.

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

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

For sheet-steel enclosures, power dissipated from the cabinet walls 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 m3 per hour) circulating through the ventilation slots and is the main dimensioning factor to be considered to choose the most suitable air cooling systems.

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

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

generated from the inverter	**Pi**	2150
W 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	**L**	0.6m
height	**H**	1.8m
depth	**P**	0.6m

Free external surface of the enclosure **S:**
S = (**L** x **H**) + (**L** x **H**) + (**P** x **H**) + (**P** x **H**) + (**P** x **L**) = 4.68 m^2

Thermal power dissipated outside the enclosure **Pdsu** (only for sheet-steel enclosures):
Pdsu = 5.5 x **Δt** x **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**) / **Δt**) x 3.5 = 1426 m^3/h

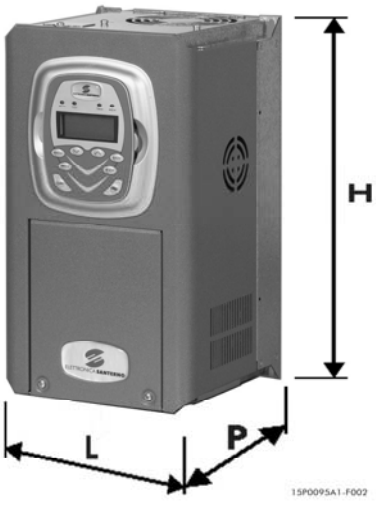
The air delivery resulting value is to be divided by one or multiple fans or air exhausting tower fans.

1.4.3 SIZE, WEIGHT AND DISSIPATED POWER

1.4.3.1 MODELS STAND-ALONE IP20 AND IP00.

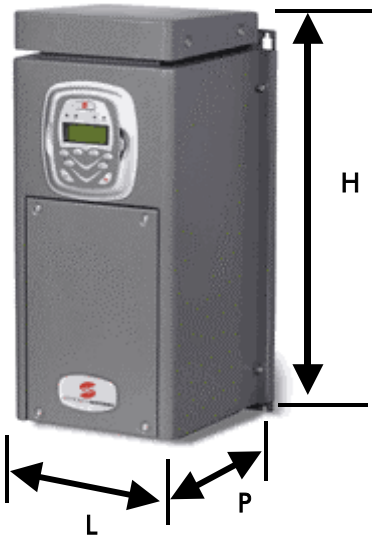
Size	MODEL	L	H	P	Wgt	Power dissipated at Inom.
		mm	mm	mm	kg	W
S05	SINUS PENTA 0005	170	340	175	7	215
	SINUS PENTA 0007				7	240
	SINUS PENTA 0009				7	315
	SINUS PENTA 0011				7	315
	SINUS PENTA 0014				7	315
S10	SINUS PENTA 0017	215	391	216	10.5	380
	SINUS PENTA 0020				10.5	420
	SINUS PENTA 0025				11.5	525
	SINUS PENTA 0030				11.5	525
	SINUS PENTA 0035				11.5	525
S15	SINUS PENTA 0040	225	466	331	22.5	820
S20	SINUS PENTA 0049	279	610	332	33.2	950
	SINUS PENTA 0060				33.2	1050
	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 0547	890	1310	530	260	7400
	SINUS PENTA 0524				260	8400
	SINUS PENTA 0598 (*)				260	11000

NOTE: (*) Water cooling



1.4.3.2 MODELS STAND-ALONE IP54

Size	MODEL	L	H	P	Wgt	Power to be dissipated at Inom.
		mm	mm	mm	kg	W
S05	SINUS PENTA 0005	245	540	225	11	215
	SINUS PENTA 0007				11	240
	SINUS PENTA 0009				11	315
	SINUS PENTA 0011				11	315
	SINUS PENTA 0014				11	315
S10	SINUS PENTA 0017	290	595	268	15	380
	SINUS PENTA 0020				15	420
	SINUS PENTA 0025				16	525
	SINUS PENTA 0030				16	525
	SINUS PENTA 0035				15	525
S15	SINUS PENTA 0040	305	665	381	32	820
S20	SINUS PENTA 0049	359	810	382	58	950
	SINUS PENTA 0060				58	1050
	SINUS PENTA 0067				58	1250
	SINUS PENTA 0074				60	1350
	SINUS PENTA 0086				60	1500
S30	SINUS PENTA 0113	382	948	471	70	2150
	SINUS PENTA 0129				70	2300
	SINUS PENTA 0150				74	2450
	SINUS PENTA 0162				74	2700



1.4.3.3 MODELS BOX IP54*

Size	MODEL	L	H	P	Wgt	Power dissipated at Inom.
		mm	mm	mm	kg	W
S05B	SINUS BOX PENTA 0005	300	400	215	17	215
	SINUS BOX PENTA 0007				17	240
	SINUS BOX PENTA 0009				17	315
	SINUS BOX PENTA 0011				17	315
	SINUS BOX PENTA 0014				17	315
S10B	SINUS BOX PENTA 0017	380	600	355	32	380
	SINUS BOX PENTA 0020				32	420
	SINUS BOX PENTA 0025				33	525
	SINUS BOX PENTA 0030				33	525
	SINUS BOX PENTA 0035				33	525
S15B	SINUS BOX PENTA 0040	380	600	355	47	820
S20B	SINUS BOX PENTA 0049	600	760	355	87	950
	SINUS BOX PENTA 0060				87	1050
	SINUS BOX PENTA 0067				87	1250
	SINUS BOX PENTA 0074				89	1350
	SINUS BOX PENTA 0086				89	1500

*Size and weight may vary depending on optional components required.

AVAILABLE OPTIONAL COMPONENTS:

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

1.4.3.4 MODELS CABINET IP24 AND IP54*

Size	MODEL	L	H	P	Wgt	Power dissipated at Inom
		mm	mm	mm	kg	W
S20C	SINUS CABINET PENTA 0049	600	2000	500	155	950
	SINUS CABINET PENTA 0060				155	1050
	SINUS CABINET PENTA 0067				155	1250
	SINUS CABINET PENTA 0074				157	1350
	SINUS CABINET PENTA 0086				157	1500
S30C	SINUS CABINET PENTA 0113	600	2200	800	188	2150
	SINUS CABINET PENTA 0129				188	2300
	SINUS CABINET PENTA 0150				192	2450
	SINUS CABINET PENTA 0162				192	2700
S40C	SINUS CABINET PENTA 0179	800	2200	800	248	3200
	SINUS CABINET PENTA 0200				248	3650
	SINUS CABINET PENTA 0216				257	4100
	SINUS CABINET PENTA 0250				257	4250
S50C	SINUS CABINET PENTA 0312	1200	2200	800	348	4900
	SINUS CABINET PENTA 0366				348	5600
	SINUS CABINET PENTA 0399				348	6400
S60C	SINUS CABINET PENTA 0457	1400	2200	800	463	7400
	SINUS CABINET PENTA 0524				463	8400
S70C	SINUS CABINET PENTA 0598 (2)	1600	2200	800	510	11000
	SINUS CABINET PENTA 0748				510	12000
	SINUS CABINET PENTA 0831				510	13300

NOTE:

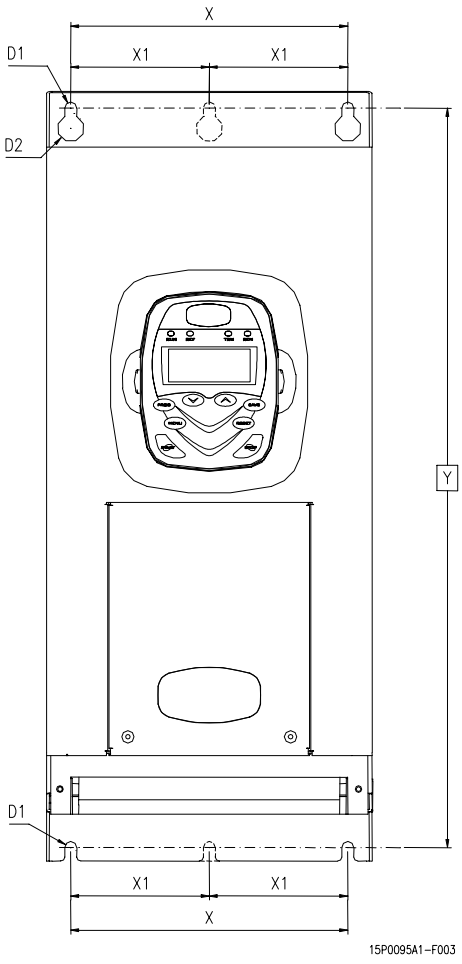
(1)Weight and dimension may change according to the requested optional
(2) Water cooling

AVAILABLE OPTIONAL COMPONENTS:

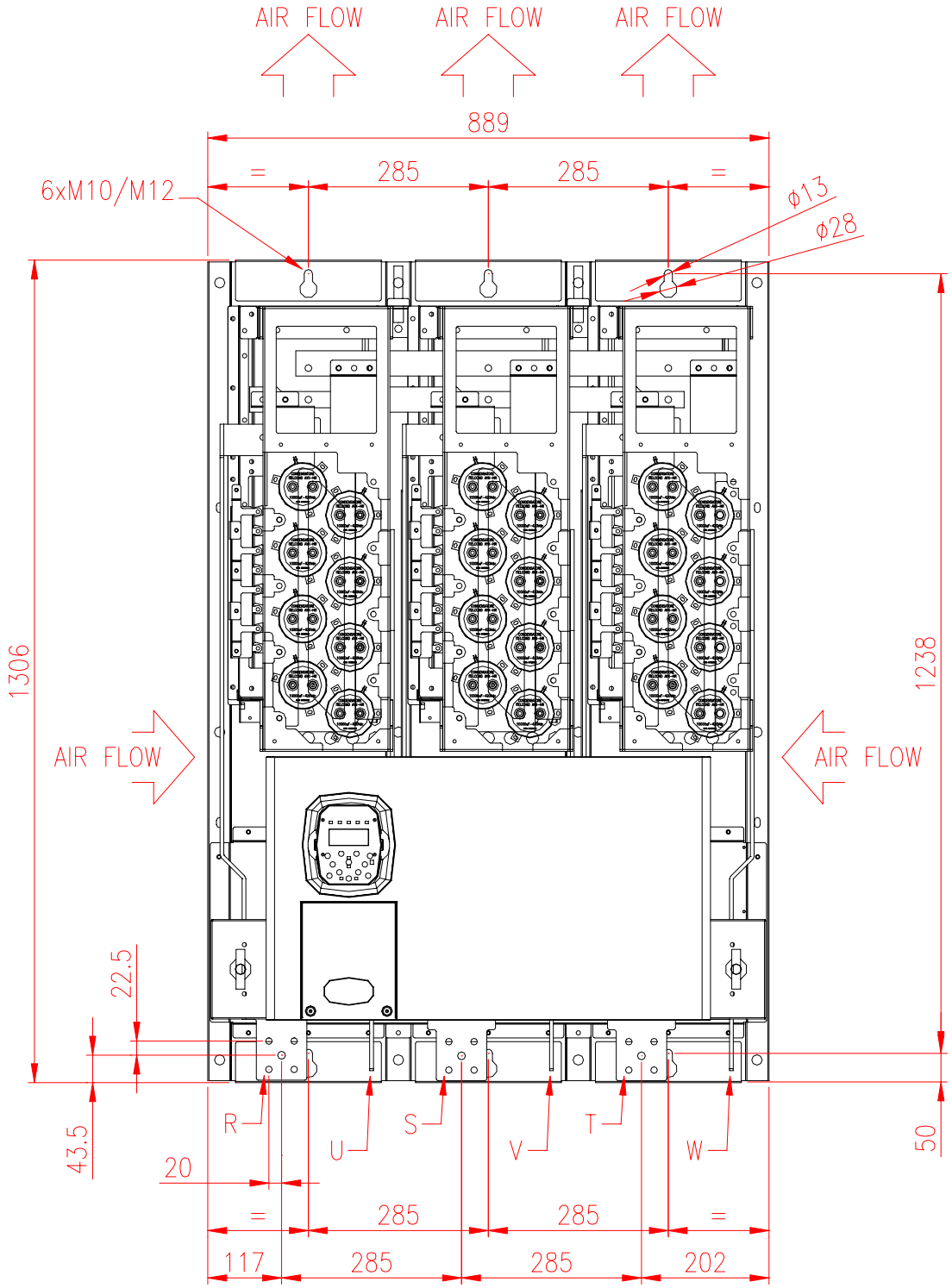
- Disconnecting switch with line fast fuses.
- Line magnetic circuit breaker with release coil.
- Line contactor in AC1.
- Front control through key-operated selector switch for LOCAL/REMOTE control and EMERGENCY push-button.
- Line input impedance.
- Motor-side output impedance.
- Additional terminal board for input/output wires.
- Output toroid filter.
- Motor fan-cooling circuit.
- Braking module for size ≥ S40.
- Anticondensation resistance.
- Devices PT100 for motor temperature control.
- Optional components by request.

1.4.4 STANDARD MOUNTING AND PIERCING TEMPLATES

SINUS PENTA Size	Fixing template (mm) (standard mounting)					
	X	X1	Y	D1	D2	Fastening screws
S05	156	-	321	4.5	-	M4
S10	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



Size S60 is only avaible open frame in IP00 protection degree and it is only suitable for installation in cabinet.



1.4.5 THROUGH-PANEL ASSEMBLY AND PIERCING TEMPLATES

The through panel allow to divide the air flow through the cooling of power part avoiding to dissipate inside the case the power related to the inverter loss. The inverters avaible for the throught panel are from size S05 to S50, both IP20 and IP00.

SINUS PENTA S05
For this inverter size, the air flow of the power section is segregated from the air flow of the control section through the installation of two optional mechanical parts to be assembled with five self-forming screws M4 (see Fig. 1.1).

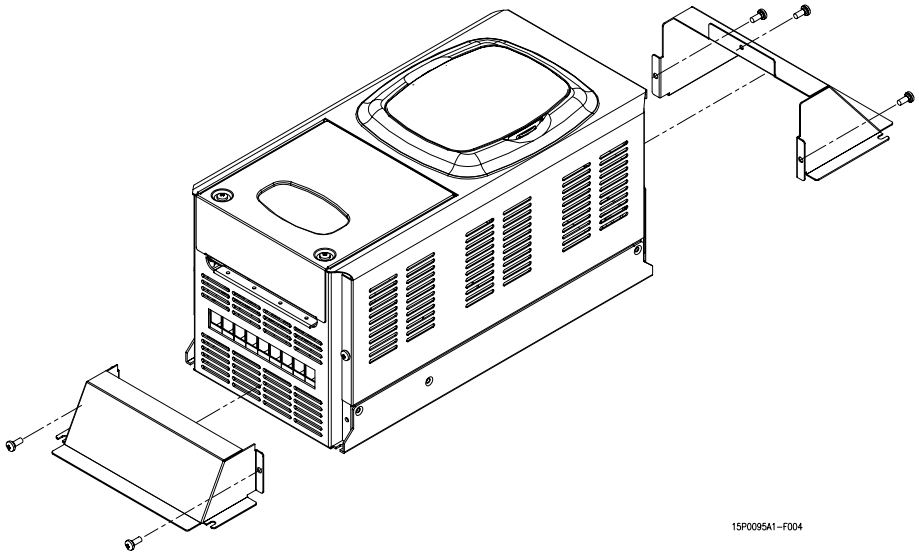


Fig.1.1 Fittings for through-panel assembly for SINUS PENTA S05

The equipment height becomes 488 mm with the two additional components (see figure on the left).
Fig. 1.2 also shows the piercing template of the mounting panel, including four holes M4 for the inverter mounting and two slots (142 x 76 mm and 142 x 46 mm) for the air-cooling of the power section.

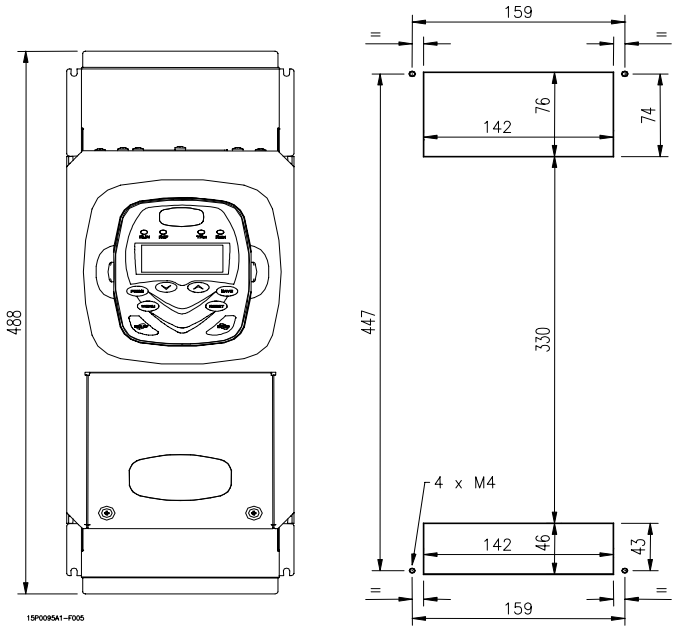


Fig. 1.2 Piercing templates for through-panel assembly for SINUS PENTA S05

SINUS PENTA S10

A through-panel assembly kit is provided for this inverter size, to be mounted on the inverter (see Fig. 1.3). No. 13 self-forming M4 screws are used for this type of assembly.

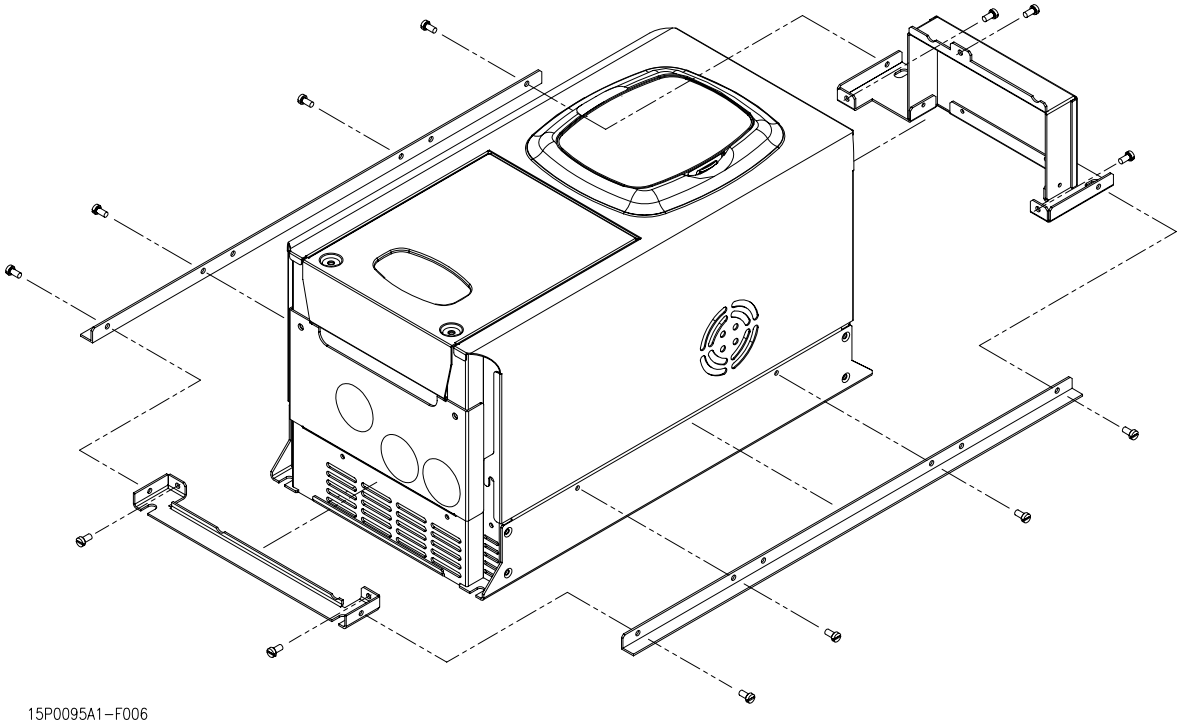


Fig. 1.3 Fittings for through-panel assembly for SINUS PENTA S10

The overall dimensions of the equipment including the through-panel assembly kit are 452 x 238 mm (see Fig. 1.4). 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).

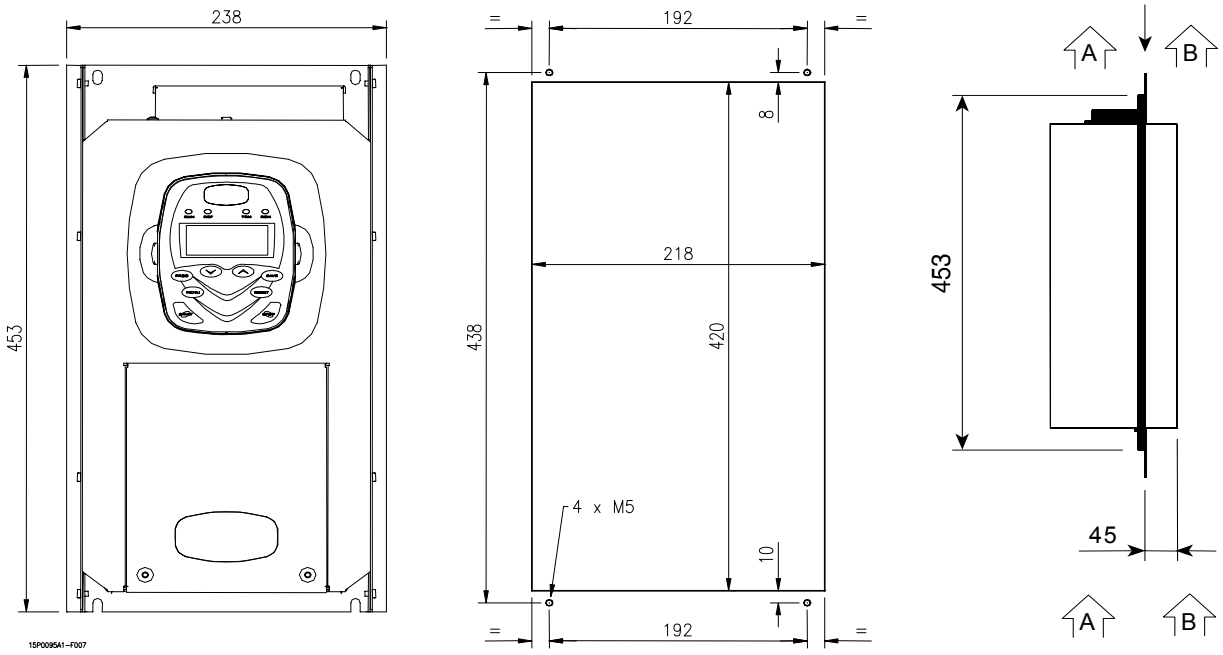


Fig. 1.4 Piercing template for through-panel assembly for SINUS PENTA S10

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).

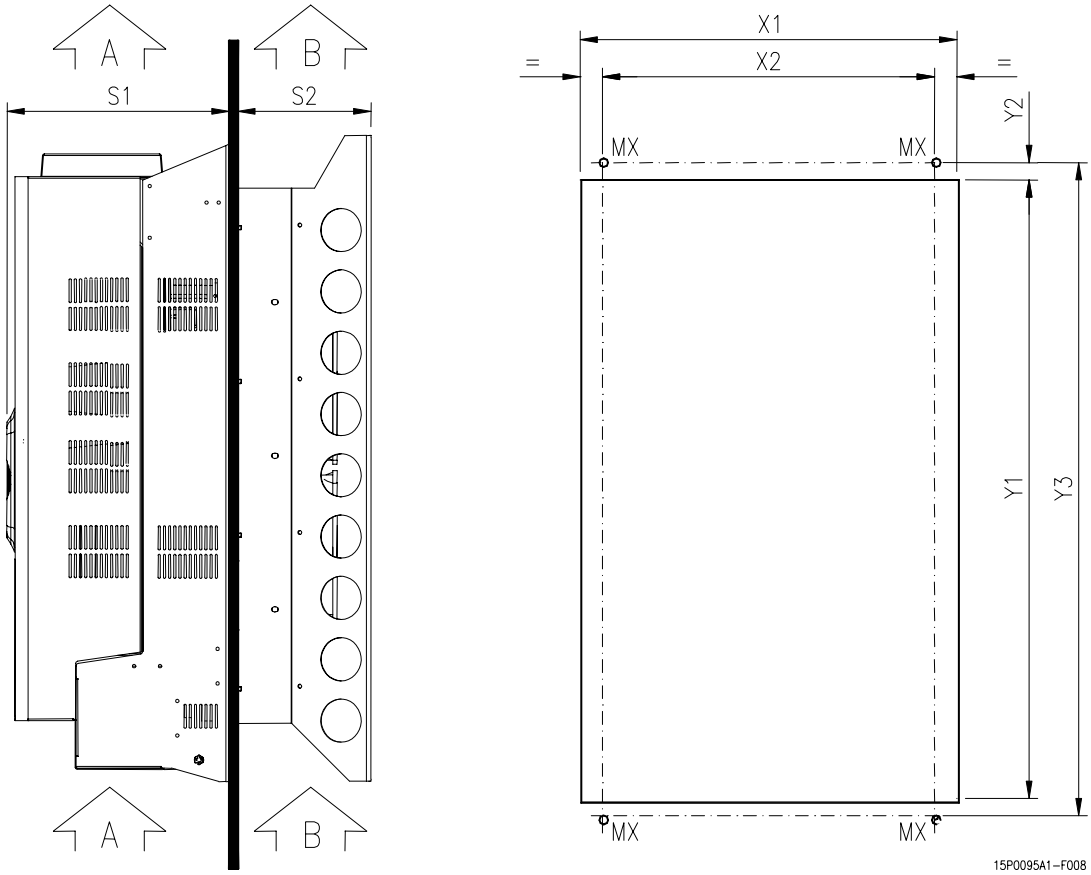
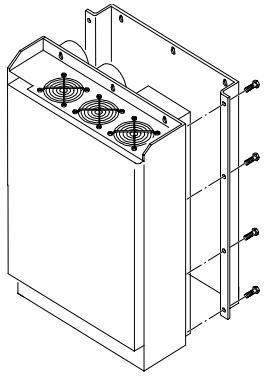


Fig.1.5 Through-panel assembly and piercing template for Sinus PENTA S15, S20, S30

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

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).

Fig.1.6 Removing the mounting plate in SINUS PENTA S40 for through-panel assembly.

The piercing template shown in Fig. 1.7 is to be made on the mounting panel (see relevant measures). The 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).

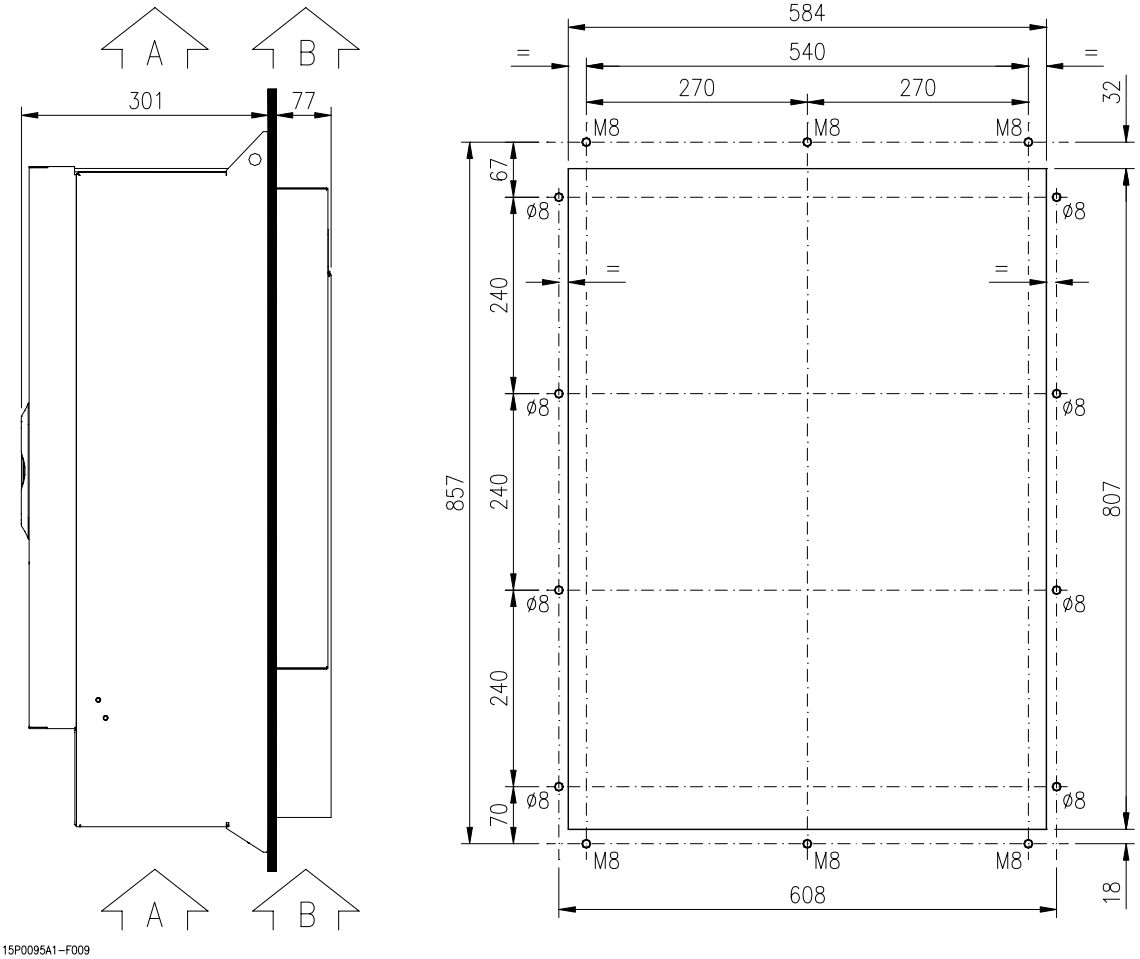
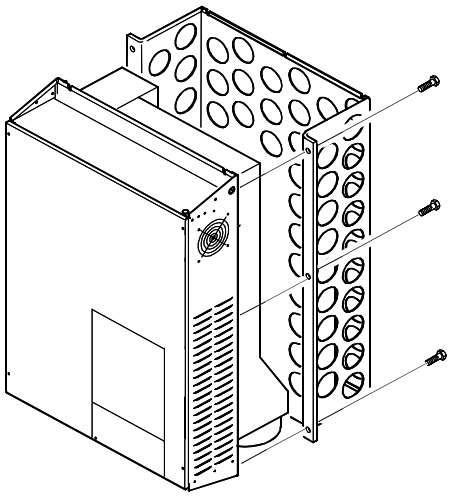


Fig. 1.7 Through-panel assembly and piercing templates for SINUS PENTA S40

SINUS PENTA S50

For the through-panel assembly of this inverter size, remove the bottom mounting plate. Fig. 1.7 shows how to disassemble the mounting plate.



To disassemble the mounting plate, remove 6 screws M8 (the figure shows the three screws in one side of the inverter).

Fig.1.8 Removing the mounting plate in SINUS PENTA S50 for through-panel assembly

The piercing template shown in the figure below (right) is to be made on the mounting plate (see relevant measures). Fig. 1.9 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).

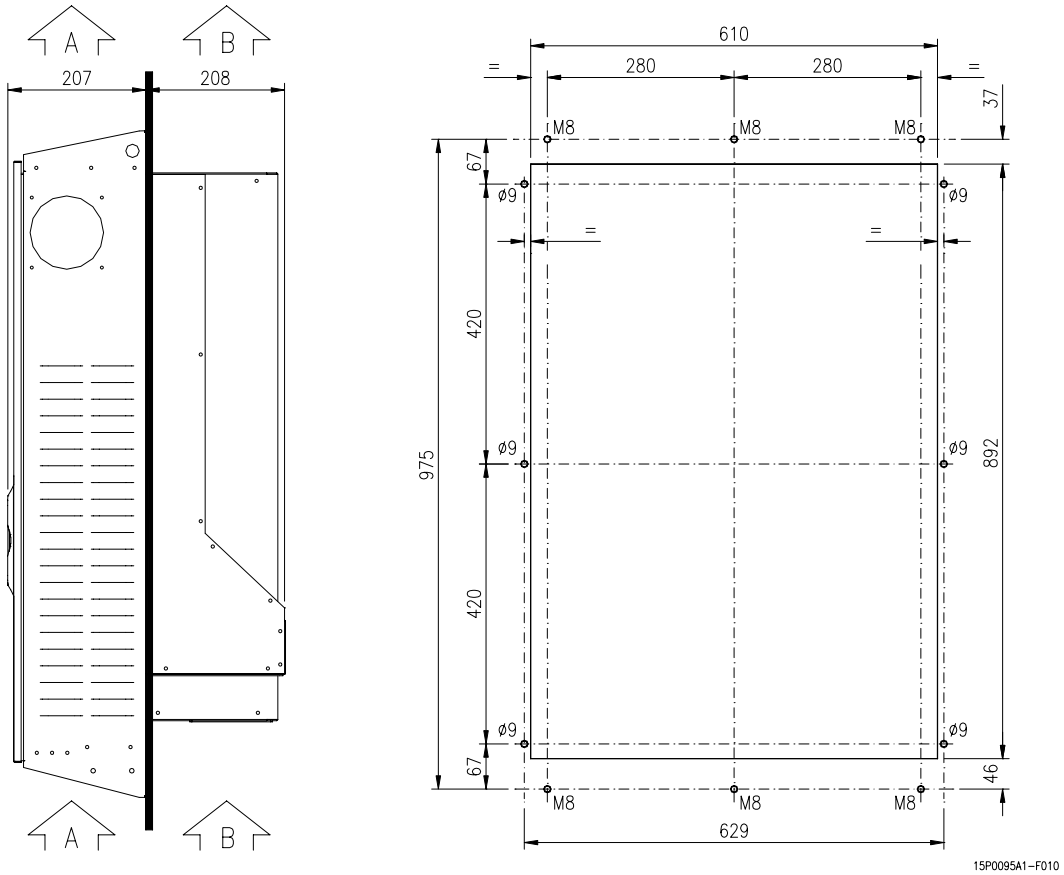


Fig. 1.9 Through-panel assembly and piercing templates for SINUS PENTA S50

1.5 WIRING

1.5.1 WIRING DIAGRAM

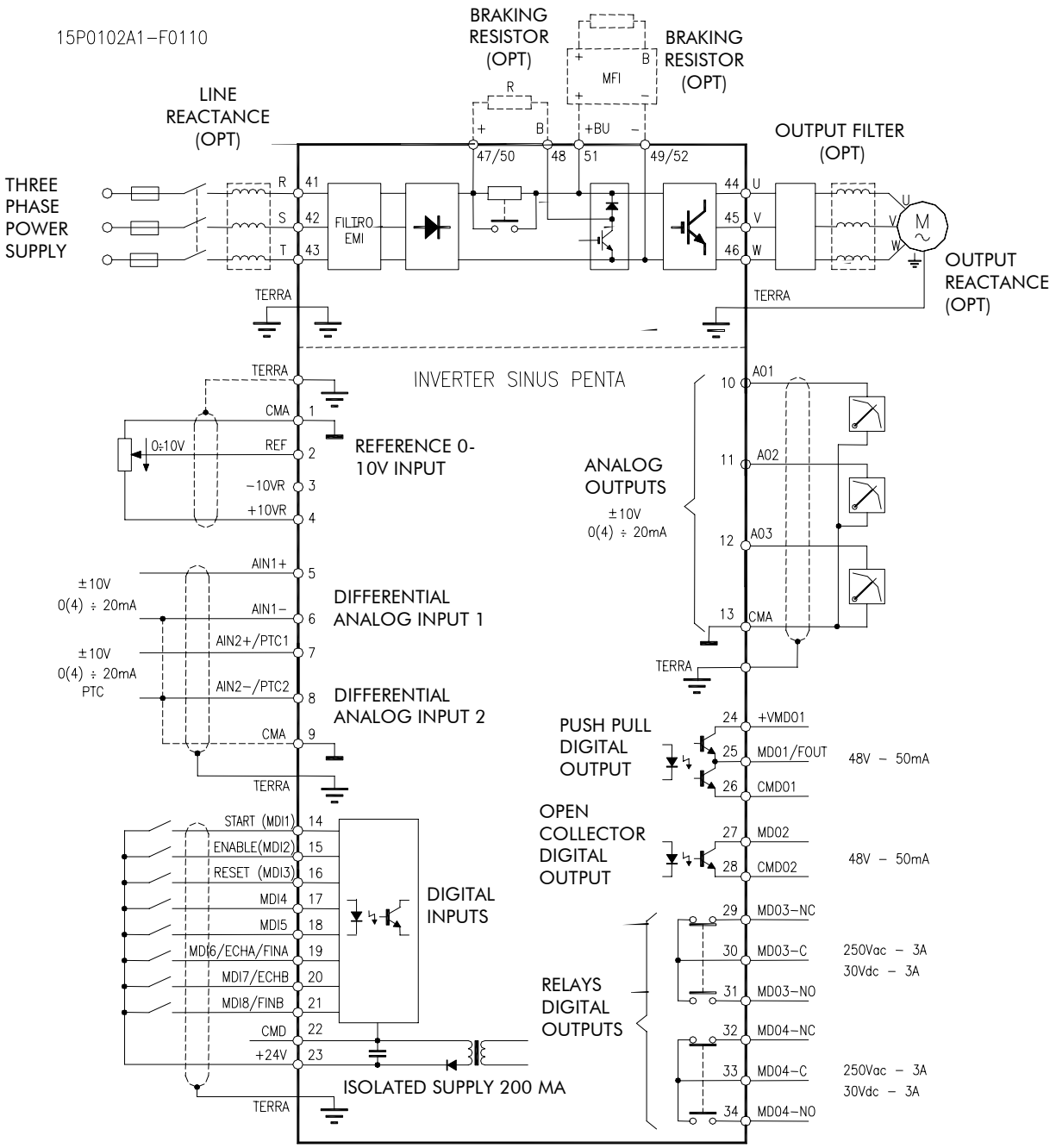


Fig. 1.10 Wiring diagram

- The wiring diagram relates to the factory setting.
- Connection terminals of the braking resistor: from Size S05 to Size S20 (terminals 47 and 48; Size S30 terminals 50 and 48).
- Connection terminals of the external braking module: Size S40: terminals 51 and 52; Size S50: terminals 51 and 49.
- Terminals for inverter power supply from DC source: terminals 47 and 49.

1.5.2 CONTROL TERMINALS

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

N.	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 a current input.	Vfs = ±10V, Rin: 50k Ω; Resolution: 12 bits	SW1-1: Off
			0 (4) ÷ 20 mA, Rin = 250 Ω; Resolution: 11 bits	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 = ±10V, Rin: 50k Ω; Resolution: 12 bits	SW1-2: Off
6	AIN1-		0 (4) ÷ 20 mA, Rin = 250 Ω; Resolution: 11 bits	SW1-2: On
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 = ±10V, 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
			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 = ±10V; Ioutmax = 5mA ; Resolution: 11 bits	SW2-1: On; SW2-2: Off
			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
			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
			0 (4) ÷ 20 mA; Voutmax = 10V Resolution: 10 bits	SW2-5: Off; SW2-6: On
13	CMA	0V for analog outputs (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 24VDC; 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 24VDC. Max. response time to processor: 500µs	
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 24V single-ended phase A, frequency input A	Optoisolated digital inputs 24VDC; 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 24VDC. Max. response time to processor: 600ns	
20	MDI7 / ECHB	Multifunction digital input 7. Encoder dedicated input, push-pull 24V 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 ÷ 48VDC; IDC = 10mA + output current (max 60mA)	

25	MDO1 /FOUT	Multifunction digital output 1; frequency output	Optoisolated digital output (push-pull); Iout = 50mA max; fout max 100kHz.	
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 = 48V; Iomax = 50mA	
28	CMDO2	Common for multifunction digital output 2	Common for multifunction output 2	

Screwable terminal board in six extractable sections suitable for cross-sections 0.2÷2.5mm^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 (common).		
31	MDO3-NO	Multifunction, relay digital output 3 (NO contact).		
32	MDO4-NC	Multifunction, relay digital output 4 (NC contact).		
33	MDO4-C	Multifunction, relay digital output 4 (common).		
34	MDO4-NO	Multifunction, relay digital output 4 (NO contact).		

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.

1.5.2.1 GAINING ACCESS TO CONTROL TERMINALS AND POWER TERMINALS

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

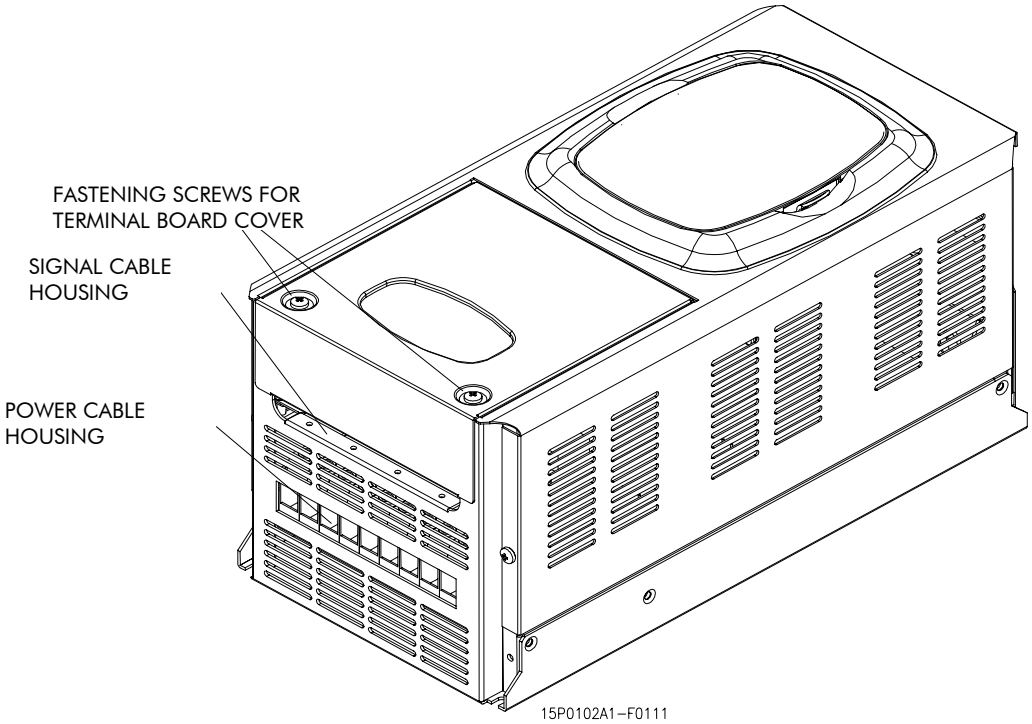


Fig.1.11 Gaining access to the control terminals

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.

1.5.2.2 GROUNDING THE INVERTER AND THE MOTOR

A bolted screw for the inverter enclosure grounding is located close to the power wiring terminals (look for 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.

1.5.2.3 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. Figure 1.12 shows how to wire a screened cable.

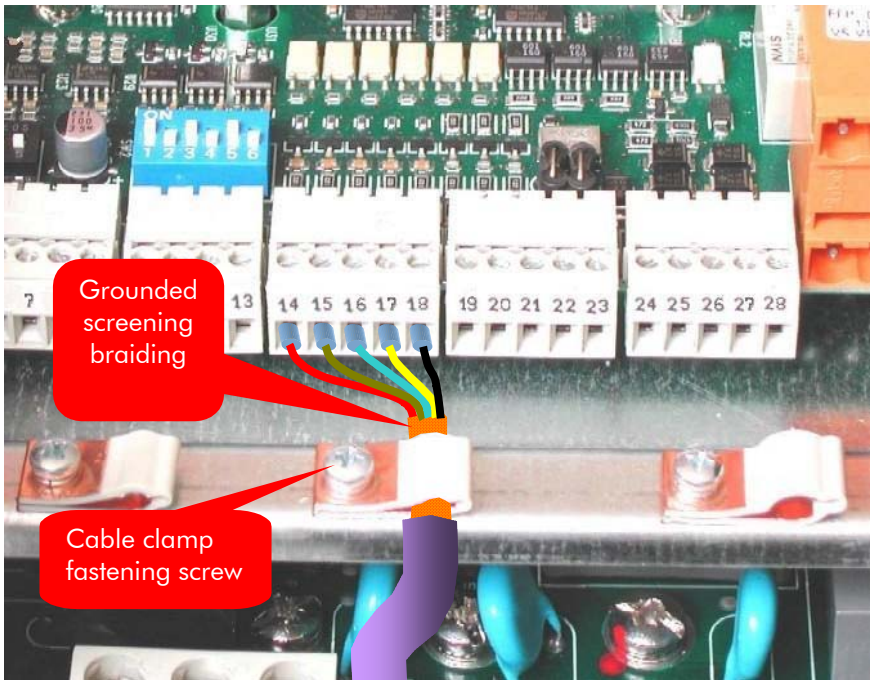


Fig.1.12 Clamping a signal screened cable.

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.

1.5.3 CONTROL BOARD SIGNALS AND PROGRAMMING

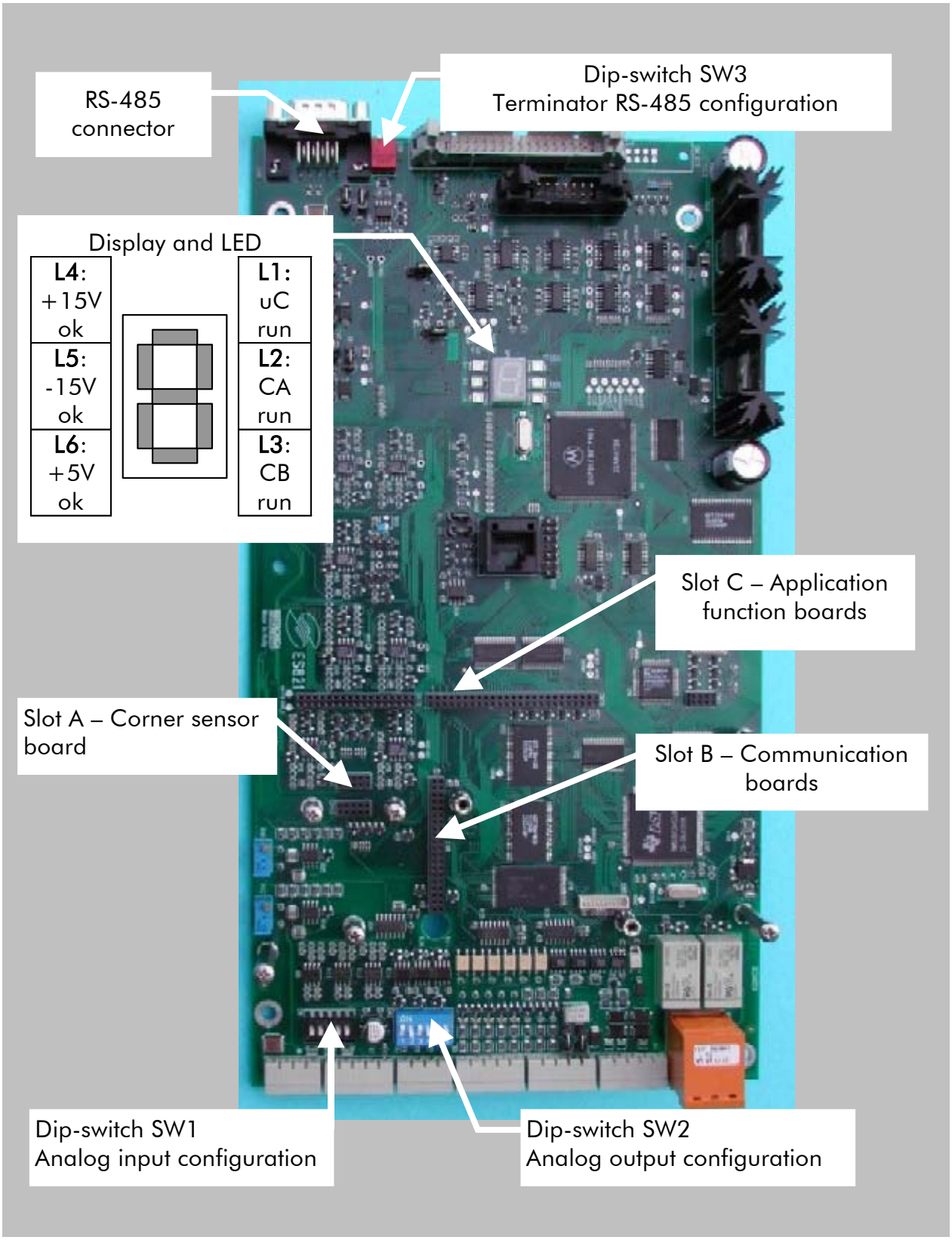


Fig.1.13 Control board: signals and programming

1.5.3.1 DISPLAY AND INDICATOR LEDS

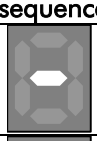
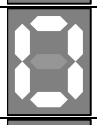
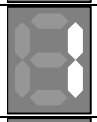
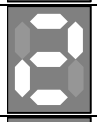
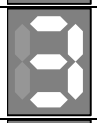
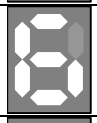
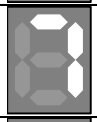
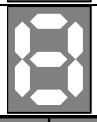
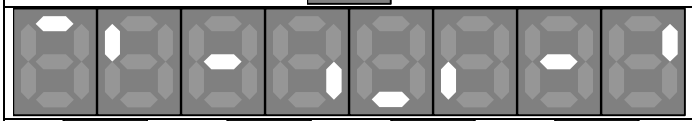
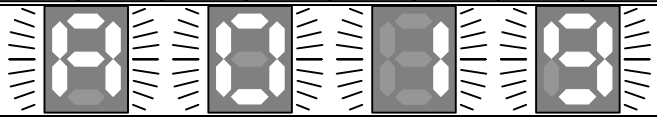
The board display and indicator LEDs allow to view the inverter operating condition even if no user interface (keypad/display) is provided. The keypad housing allows to display the indicator lights.
The indicator LEDs are the following:

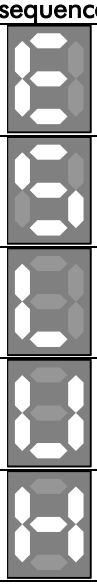
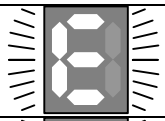
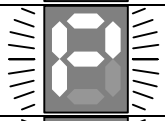
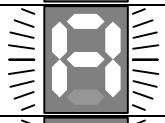
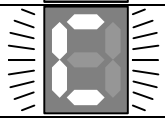
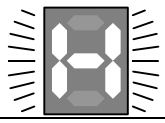
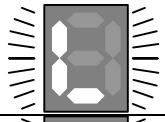
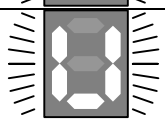
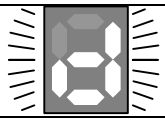
- Green LED L1 (uC run): If on, it indicates that processors are active. If it does not turn on when the inverter is normally operating, this means that the feeder or control board are faulty.
- Yellow LED L2 (CA run): If on, it indicates that the power convertor is commutating and is powering the connected 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:
    - Short-circuit over the power supply delivered to connector RS-485 output.
    - Short-circuit over the power supply delivered to the connector output of the remotable keypad.
    - Parameter quick storage and autoreset procedure due to "VDC undervoltage".

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

Ordinary operation and emergency mode	
Symbol or sequence displayed	Inverter condition
	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: numer 2 fixed, see programming manual Power Down and DC Braking.
	Motor not runnig because the PID value is disabled: number 3 fixed; see programming manual parameter P254 and 255
	Motor not runnig because the PID value is disabled: number 4 fixed; see programming manual parameter P065 and P066
	IFD enabled but waiting of 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 that the current V_{DC} on the inside capacitor exeded the minimum value of running.
	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** Autodiagnostics detected a hardware/software failure. Please contact ELETTRONICA SANTERNO's After-sales 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 (only for SW version 2.00x or later)	
Symbol or sequence displayed	Inverter condition
	Voltage limit while decelerating; letter 'H' flashing if V_{DC} does not exceed dynamic braking rated value by 20%
	Current limit while accelerating or current limit due to overload; letter 'L' flashing if the output current value is limited to the values set for the operation parameters.
	Operatine time of the current limint; letter U flashing when the value of the wanted voltage to the motor is not avaible due to the current V_{DC} too low
	Braking function active; Flashing letter D when the inverter is stopping the motor forcing CC current see programming guide, function DC braking.

1.5.3.2 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.

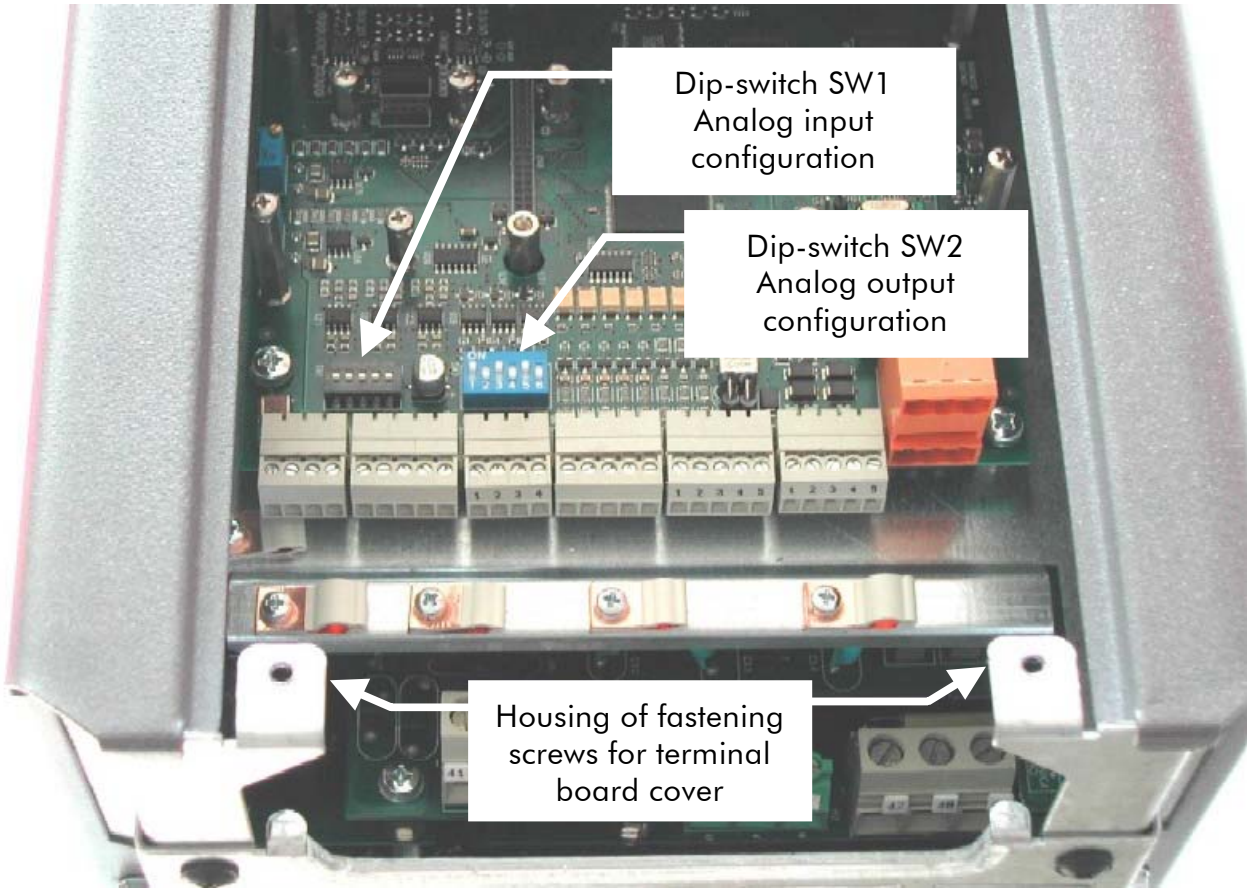


Fig.1.14 Gaining access to dip-switches SW1 and SW2

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.

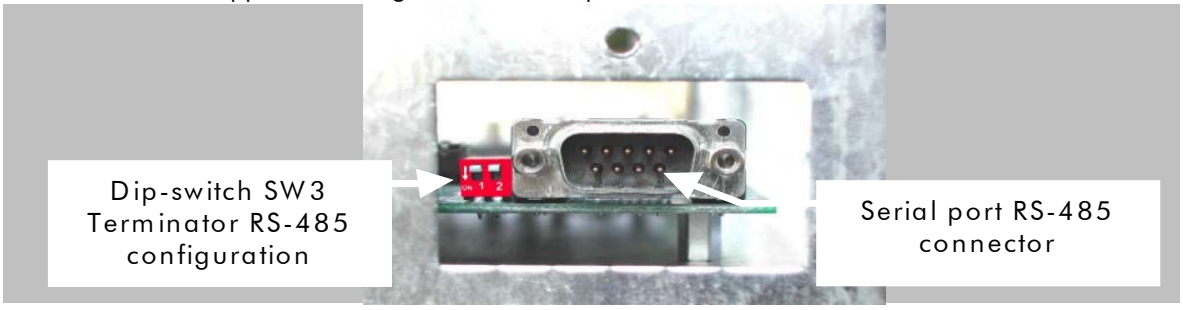


Fig.1.15 Gaining access to dip-switch SW3 and connector RS-485 (SINUS PENTA S05 to S20).

SINUS PENTA S30 to S60: interface connector RS-485 and dip-switch SW3 are located next to the control terminal board cover.

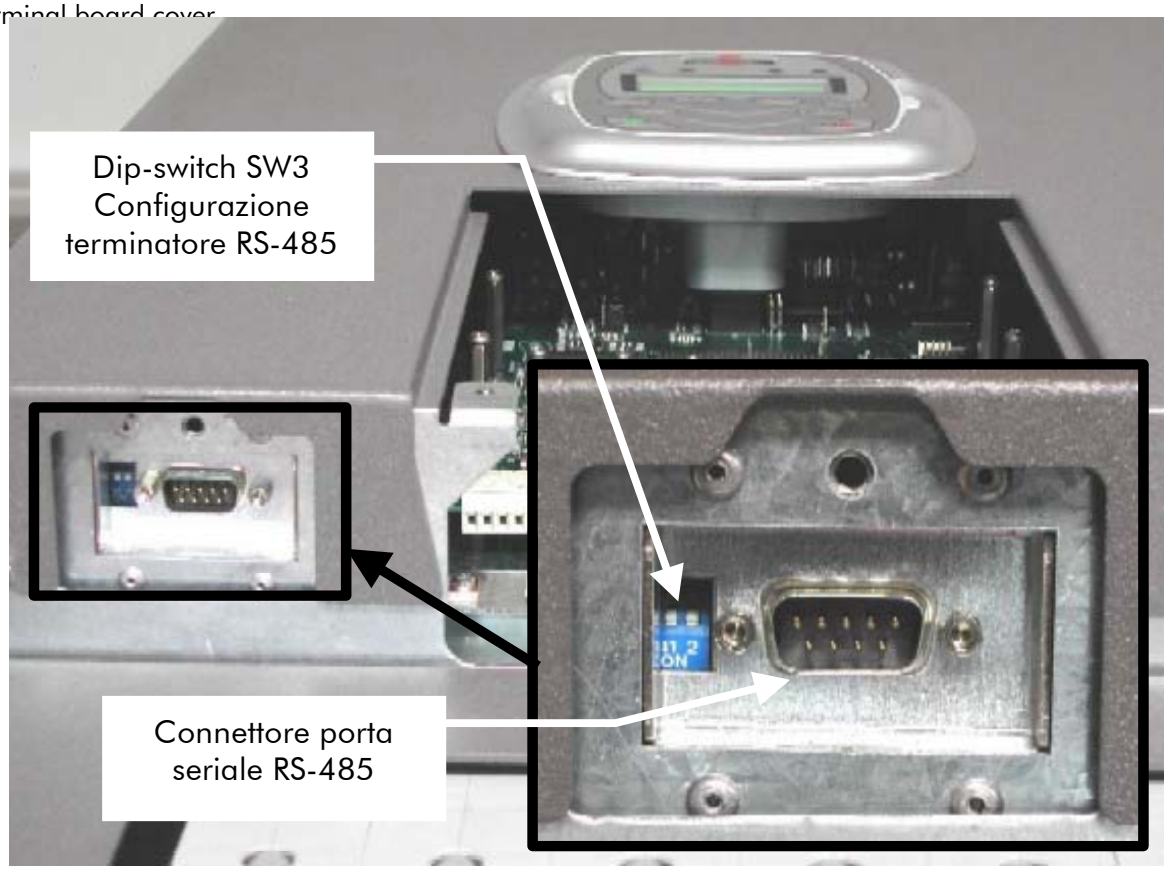


Fig.1.16 Position of dip-switch SW3 and connector RS-485 (SINUS PENTA S30 to S60).

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.

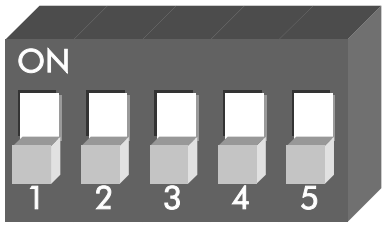
Dip-switch functionality is detailed in the tables below:

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

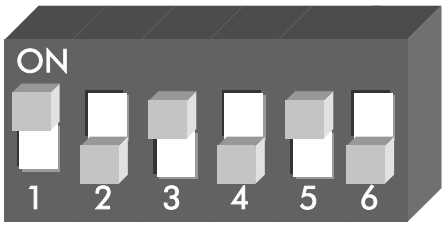
Dip-switch SW2: analog output configuration		
Switches	**Functionality**	
SW2-1, SW2-2	**1=ON, 2=OFF**: AO1 voltage output	**1=OFF, 2=ON**: AO1 current output
SW2-3, SW2-4	**3=ON, 4=OFF**: AO2 voltage output	**3=OFF, 4=ON**: AO2 current output
SW2-5, SW2-6	**5=ON, 6=OFF**: AO3 voltage output	**5=OFF,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

Dip-switch SW3: interface RS-485 terminator		
Switches	**Functionality**	
SW3-1, SW3-2	**Both OFF**: RS-485 terminator disabled	**Both ON**: RS-485 terminator enabled

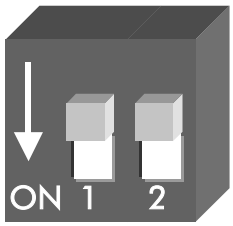
Dip-switch factory setting is as follows:



SW1 – all dip-switches OFF



SW2 – odd dip-switches ON



SW3 -off

1.5.4 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.

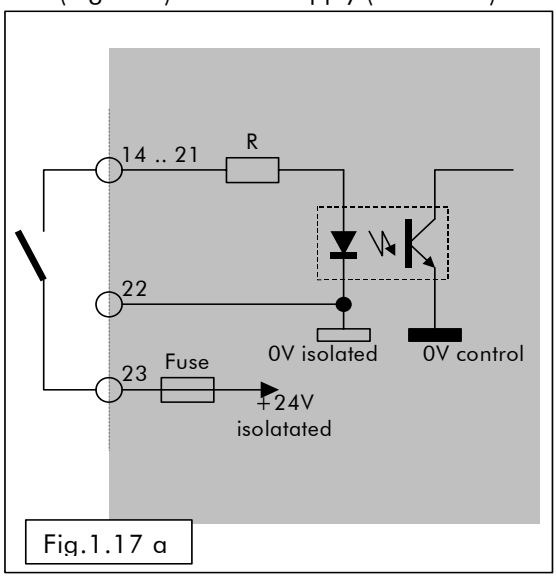


Fig.1.17 a

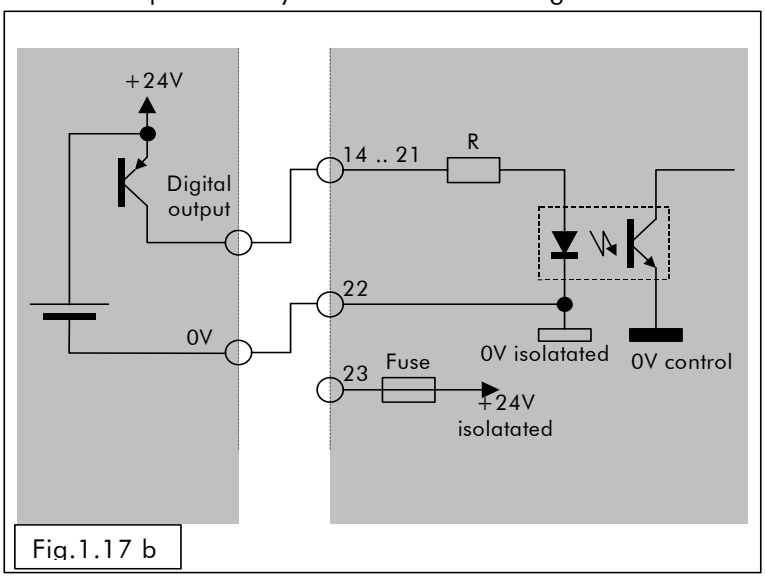


Fig.1.17 b

Fig.1.17 a) PNP command (active to +24V) through a voltage-free contact
Fig.1.17 b) PNP command (active to +24V), 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 keypad/display 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.

1.5.4.1 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.

1.5.4.2 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.

1.5.4.3 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.

1.5.4.4 CONNECTING THE ENCODER AND FREQUENCY INPUT

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.

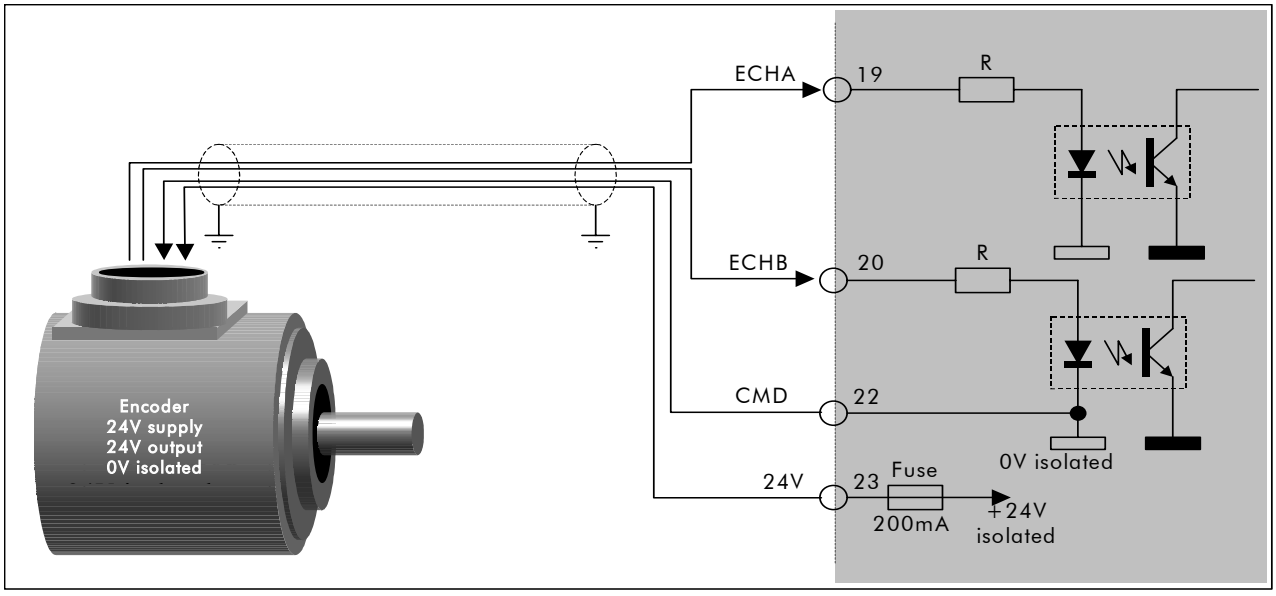


Fig.1.18 Connecting an incremental encoder

An incremental encoder must have PUSH-PULL outputs and 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).

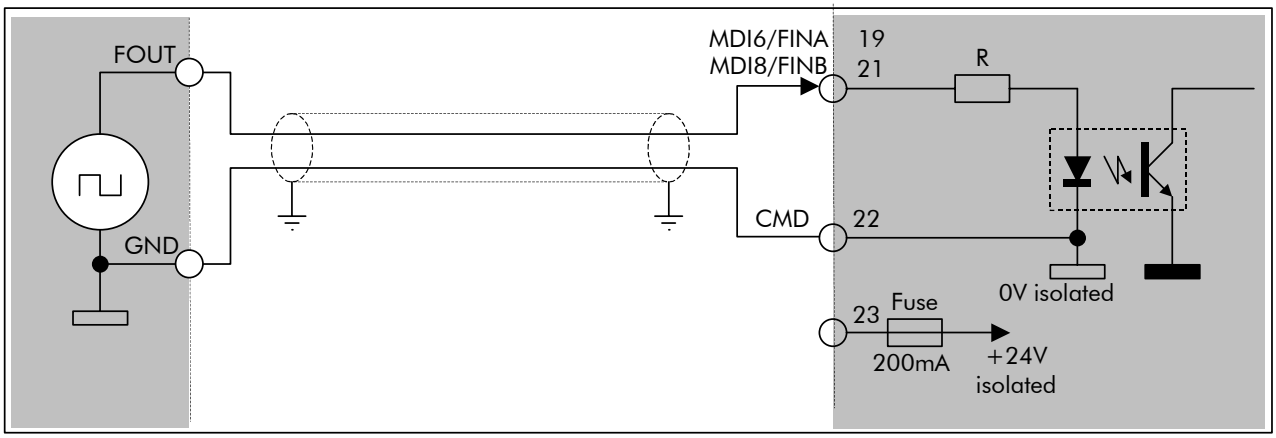


Fig. 1.19 Signal sent from a Push-pull, 24 V output

1.4.4.5 TECHNICAL SHEET FOR DIGITAL INPUTS

Specification	Min.	Type	Max.	Unit 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) related to GNDR (1) and GNDI (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.

1.5.5 ANALOG INPUTS (TERMINALS 1 TO 9)

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. An input may be used to acquire a PTC thermistor in compliance with DIN44081/DIN44082 for the motor thermal protection. Two reference outputs with rated values +10V and –10V 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 1.4.3.2).
Five acquisition modes are available for three hardware settings as shown in the table:

Type of preset data acquisition	HWconfiguration for SW1	Full-scale values and notes
Unipolar 0÷10V	Voltage input	0÷10V
Bipolar ± 10V	Voltage input	-10V ÷ +10V
Unipolar 0÷20 mA	Current input	0mA ÷ 20mA
Unipolar 4÷20 mA	Current input	4mA ÷ 20mA; wire disconnection alarm with current values under 2mA
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.

1.5.5.1 SINGLE-ENDED REFERENCE INPUT REF (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.

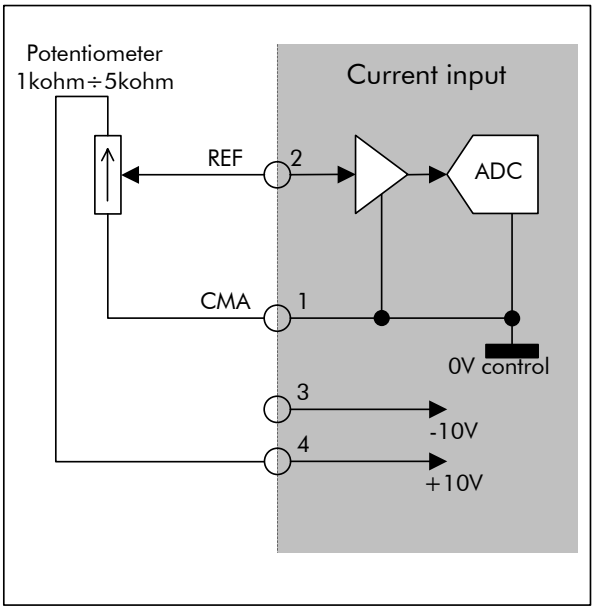


Fig.1.20 a) Potentiometer wiring for unipolar command 0 ÷REFMAX

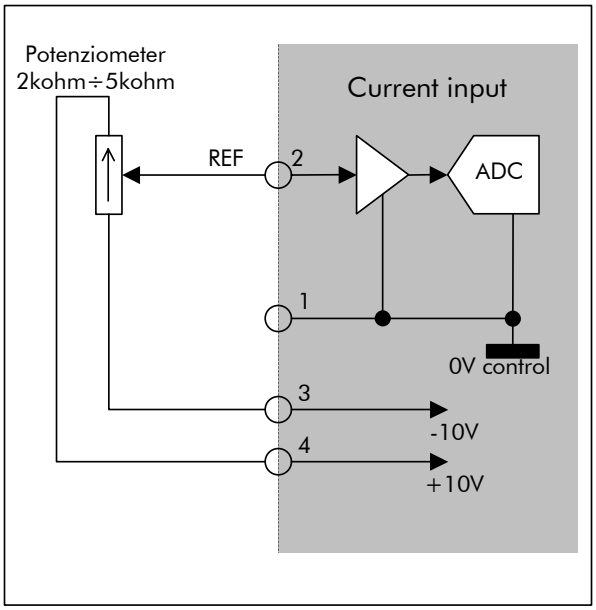


Fig.1.20 b) Potentiometer wiring for bipolar command -REFmax÷+REFmax

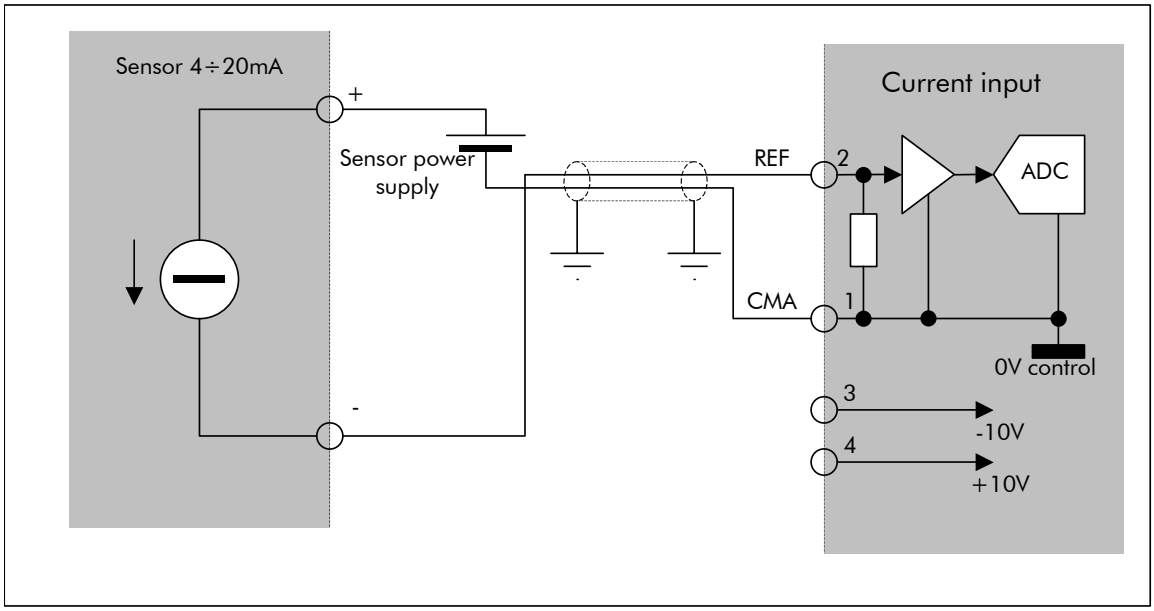


Fig.1.20 c) 4÷20mA sensor wiring

1.5.5.2 DIFFERENTIAL AUXILIARY INPUTS

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.
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.

Typical wiring is shown below:

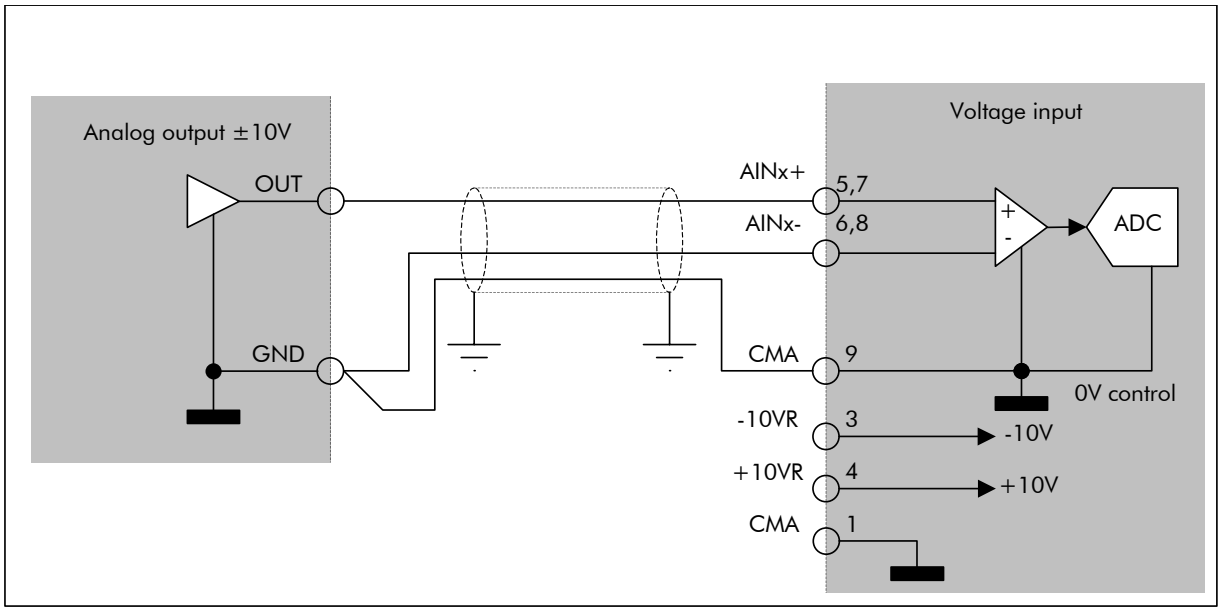


Fig.1.21 Wiring of a PLC analog output, axis control board, etc.

NOTE

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

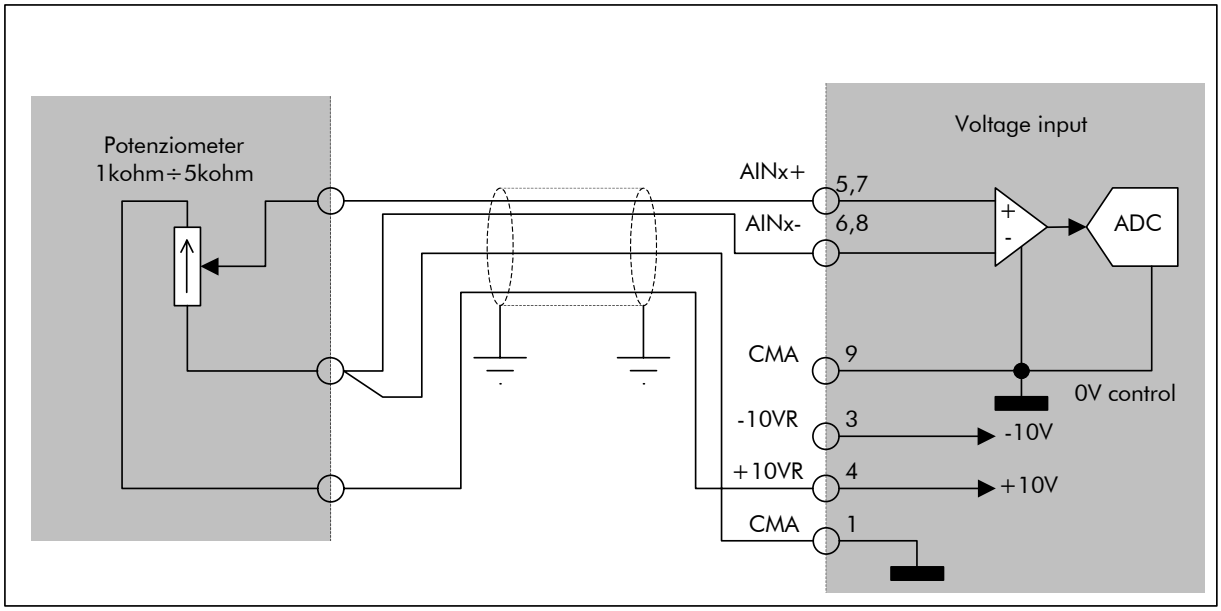


Fig.1.22 Wiring of unipolar remote potentiometer 0÷REFmax

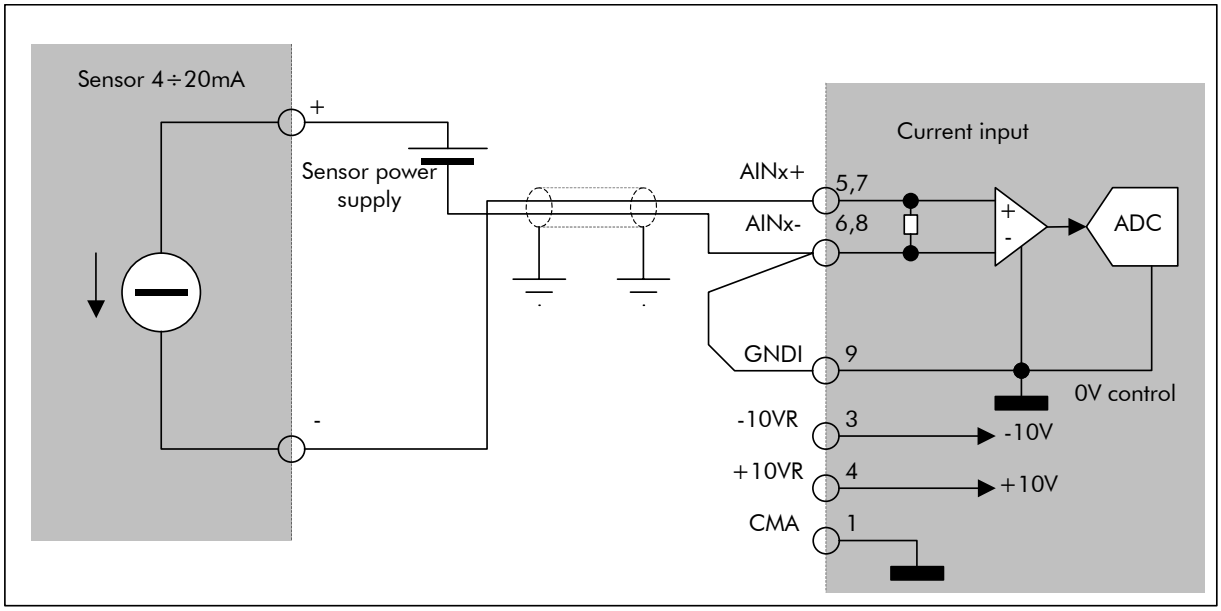


Fig.1.23 Wiring of sensor 4÷20mA

1.5.5.3 MOTOR THERMAL PROTECTION INPUT

The inverter manages the signal sent from a thermistor incorporated in the motor windings to obtain a hardware thermal protection of the motor. The thermistor ratings must comply with BS4999 Pt.111 (DIN44081/DIN44082):

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

Where Tr is the thermistor 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, but does not display the real temperature of the motor windings.

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 thermistor between terminals 7 and 8 in the control board,
3) In the "Thermal protection" menu, set the motor protection method with PTC.

CAUTION:

PTC is 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.

1.5.5.4 TECHNICAL SHEET FOR ANALOG INPUTS

Specification	Min.	Typ.	Max.	Unit 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
Tolerance of reference output voltage +10VR, -10VR			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.

1.5.6 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.

1.5.6.1 PUSH-PULL MDO1 OUTPUT AND WIRING DIAGRAMS

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).

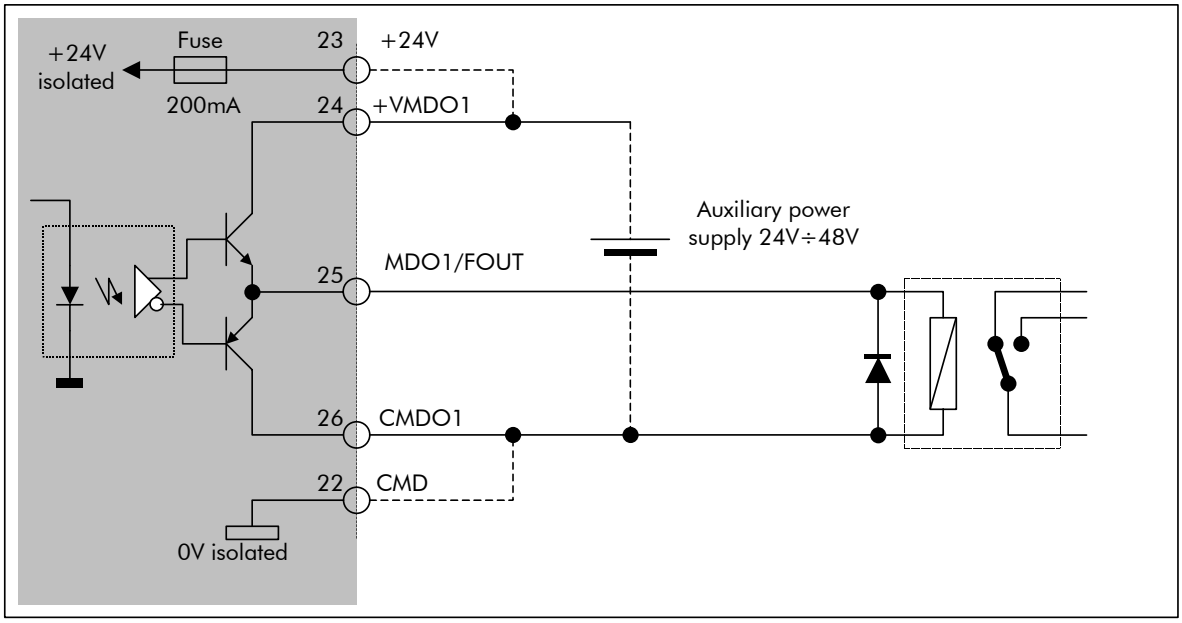


Fig.1.23 PNP output wiring for relay control

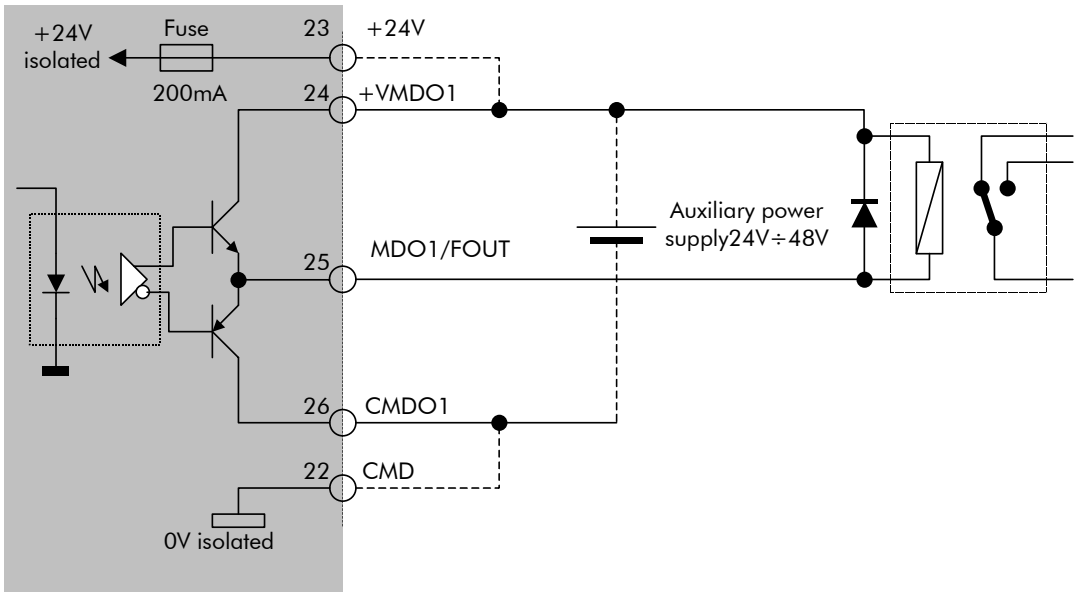


Fig.1.25 NPN output wiring for relay control

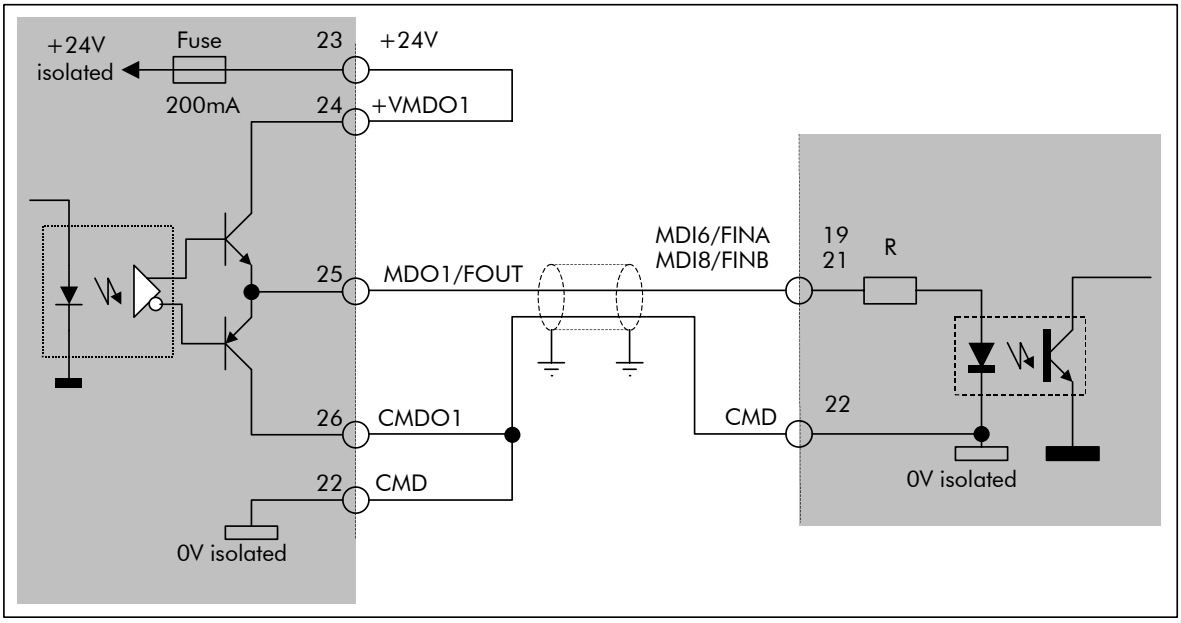


Fig.1.26 Cascade-connection frequency output ->frequency input.

CAUTION: For inductive loads (e.g. relay coils), always use a freewheeling diode. 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).

1.5.6.2 OPEN-COLLECTOR MDO2 OUTPUT AND WIRING DIAGRAMS

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).

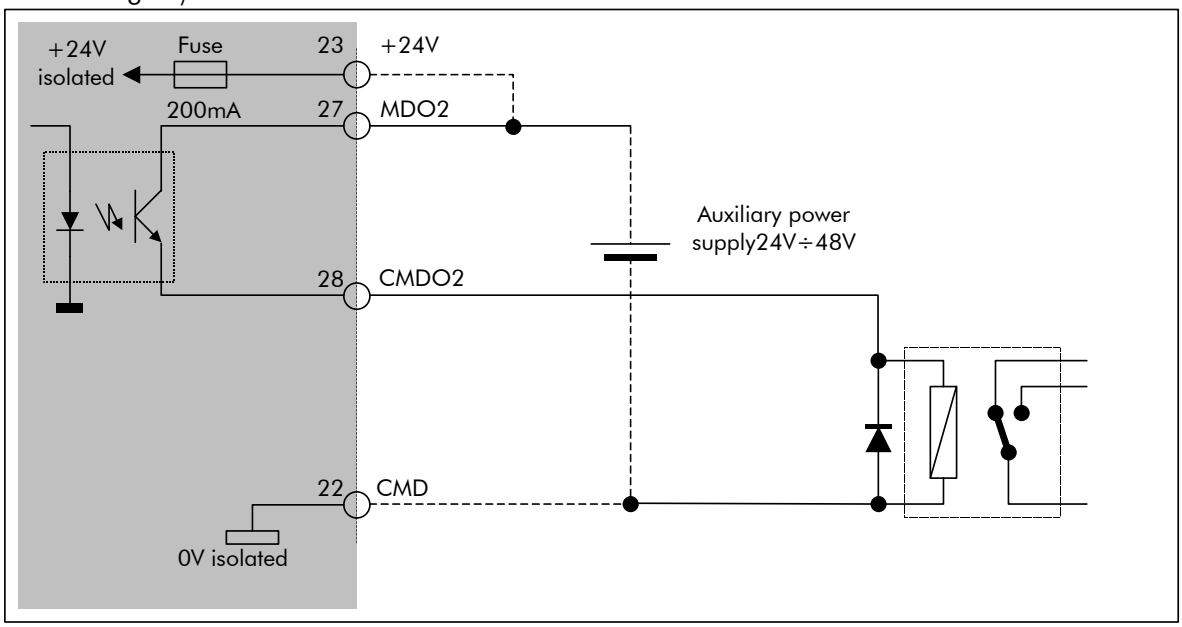


Fig.1.27 PNP output wiring for relay control

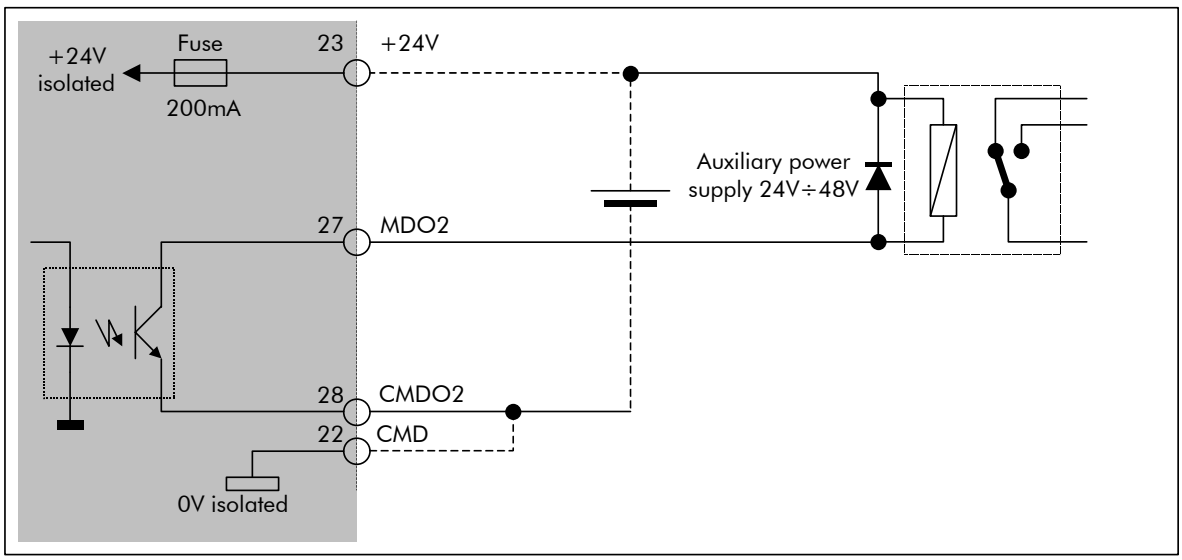


Fig.1.28 NPN output wiring for relay control

CAUTION: For inductive loads (e.g. relay coils), always use a freewheeling diode. 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).

1.5.6.3 RELAY OUTPUTS

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.

1.5.6.4 TECHNICAL SHEET FOR DIGITAL INPUTS

Specification	Min.	Type	Max.	Unit m.
Voltage range for MDO1 and MDO2 outputs	20	24	50	V
Max. current to be commuted 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.

1.5.7 ANALOG OUTPUTS (TERMINALS 10 TO 13)

Three analog outputs AO1 (terminal 10), AO2 (terminal 11), AO3 (terminal 12) are provided, which relate to 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.

1.5.7.1 TECHNICAL SHEET FOR ANALOG OUTPUTS

Specifications	Min.	Type	Max.	Unit 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.

1.5.8 POWER TERMINALS ARRANGEMENT

LEGEND:

41/R – 42/S – 43/T = input for three-phase power supply (the phase sequence is not binding)
44/U – 45/V – 46/W = output for motor three-phase supply.

Terminals S05-S10-S15-S20:

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

Important: Terminals **47/+** and **49/-** may be used both for DC voltage supply of the inverter and for the connection of the braking module.

Terminals S30:

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

Important: Terminals **50/+** and **48/B** connect the braking resistance.
Terminals **47/+** and **49/-** may be used for the inverter DC voltage supply.

Terminals S40:

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

IMPORTANT: Terminals **51/+** and **52/-** connect the inverter bar to the external braking module.
Terminals **47/+** and **49/-** may be used for the inverter DC voltage supply.

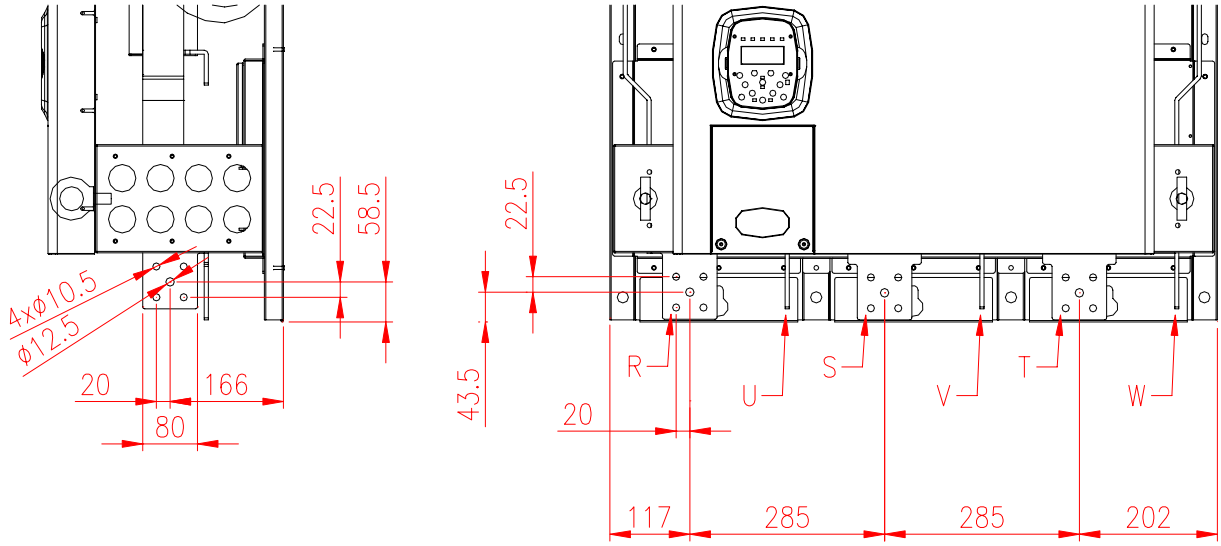
Connection bars for S50:

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

Terminals **47/+** and **49/-** may be used both for DC voltage supply of the inverter and for the connection of the braking module.

Connection bars for S60:

The drawing shows the locations and size of the bars connecting S60 inverters to the mains and the motor.



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: Use only B-type differential circuit breakers.

CAUTION: Connect the power supply line to supply terminals only. The connection of the power supply line to any other terminal will damage the inverter.

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

CAUTION: 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.

CAUTION: 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.

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

CAUTION: **Do not apply single-phase voltage.**

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

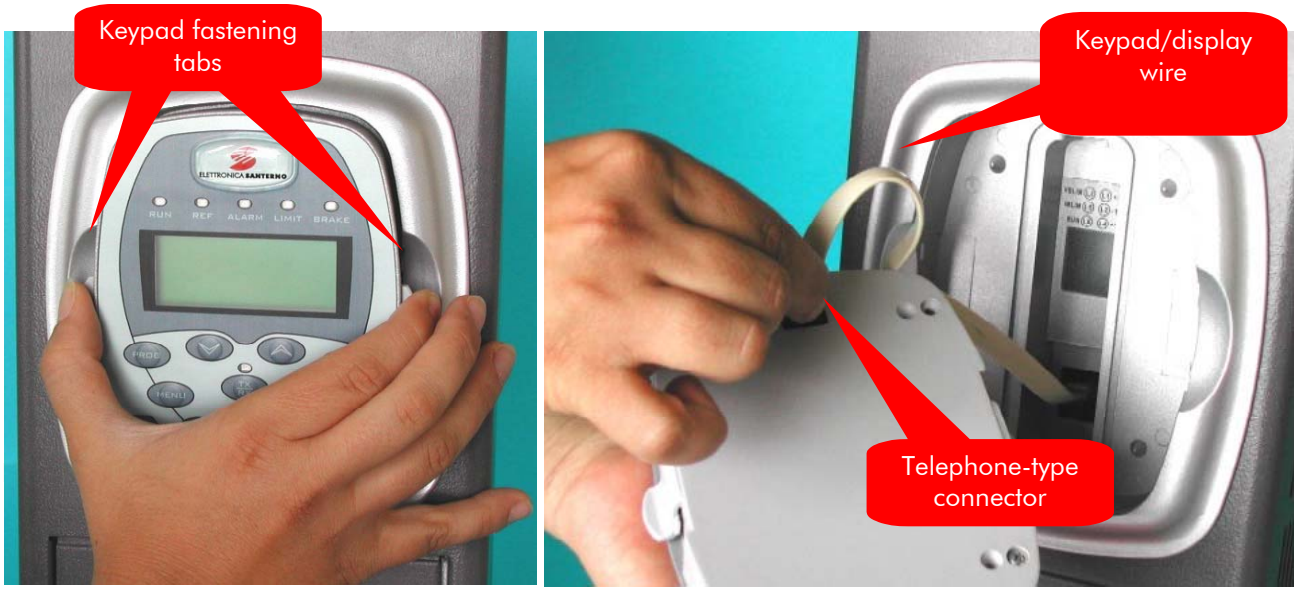
CAUTION: At power on, if the inverter commands "ENABLE" (terminal 6) and "START" (terminal 7) are active, the motor will immediately start when the main reference is other than zero. This may be very dangerous. To prevent the motor from accidentally starting, see the Programming Manual to set configuration parameters accordingly. In that case, the motor will start only after opening and closing the command contact on terminal 6.

1.5.9 Cross-sections of Power Connection Wires and Size of Protection Devices

Size	SINUS PENTA Size	Inverter Rated Current	Terminal Cross-section	Wire Peeling	Tightening Torque	Wire Cross-section Mains Side and Motor Side	Fast Fuses + Disconn. Switches	Magnetic Circuit Breaker	Contactor AC1
		Amp	mm^2	mm	Nm	mm^2	Amp	Amp	Amp
S05	0005	10.5	0.5÷10	10	1.2-1.5	2.5	16	16	25
	0007	12.5	0.5÷10	10	1.2-1.5	2.5	16	16	25
	0009	16.5	0.5÷10	10	1.2-1.5	4	25	25	25
	0011	16.5	0.5÷10	10	1.2-1.5	4	25	25	25
	0014	16.5	0.5÷10	10	1.2-1.5	4	32	32	30
S10	0017	30	0.5÷10	10	1.2-1.5	10	40	40	45
	0020	30	0.5÷10	10	1.2-1.5	10	40	40	45
	0025	41	0.5÷10	10	1.2-1.5	10	63	63	55
	0030	41	0.5÷10	10	1.2-1.5	10	63	63	60
	0035	41	0.5÷10	10	1.2-1.5	10	100	100	100
S15	0040	72	4÷25	15	2.5	25	100	100	100
S20	0049	80	25÷50	24	6-8	25	100	100	100
	0060	88	25÷50	24	6-8	35	125	125	115
	0067	103	25÷50	24	6-8	50	125	125	125
	0074	120	25÷50	24	6-8	50	160	160	145
	0086	135	25÷50	24	6-8	50	200	160	160
S30	0113	180	35÷155	30	10	95	250	200	250
	0129	195	35÷155	30	10	120	250	250	250
	0150	215	35÷155	30	10	120	315	400	275
	0162	240	35÷155	30	10	120	400	400	275
S40	0179	300	70÷240	40	25-30	185	400	400	350
	0200	345	70÷240	40	25-30	210	400	400	400
	0216	375	70÷240	40	25-30	240	500	630	450
	0250	390	70÷240	40	25-30	240	630	630	450
S50	0312	480	Bus bar	-	30	2x150	800	630	550
	0366	550	Bus bar	-	30	2x210	800	800	600
	0399	630	Bus bar	-	30	2x240	800	800	700
S60	0457	720	Bus bar	-	30	2x240	1000	800	800
	0524	800	Bus bar	-	35	3x210	1250	1000	1000
S70	0598	900	Bus bar	-	35	3x210	1250	1250	1000
	0748	1000	Bus bar	-	35	3x240	2x800	1250	2x700
	0831	1200	Bus bar	-	35	3x240	2x1000	1600	2x800

1.6 OPERATING AND REMOTING THE KEYPAD

For the parameter programming and view a keypad/display is located on the front part of SINUS PENTA inverters. The keypad/display is fitted on the inverter front part; press the side tabs to remove the keypad/display. A short wire with 8-pole telephone connectors is used to connect the keypad/display to the inverter. Press the cable tab to disconnect it.
Before fitting the keypad/display in its housing, make sure that the telephone connector is in on keypad side and inverter side, check to see if the wire is folded within the special raceway, fit the keypad in its housing and press until tabs are secured.



Remove the keypad/display to do the following:
- remote the keypad/display (see following section),
- data (parameter) transfer from one inverter to another.

To transfer data to another inverter, upload the inverter parameters using the keypad/display and connect the source inverter to the target inverter to download the parameters just copied. For more details, see the Programming 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 keypad/display.

1.6.1 INDICATOR LEDS ON THE KEYPAD/DISPLAY

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 Programming Manual.
The figure below shows the location of the indicator Leds and their functionality.

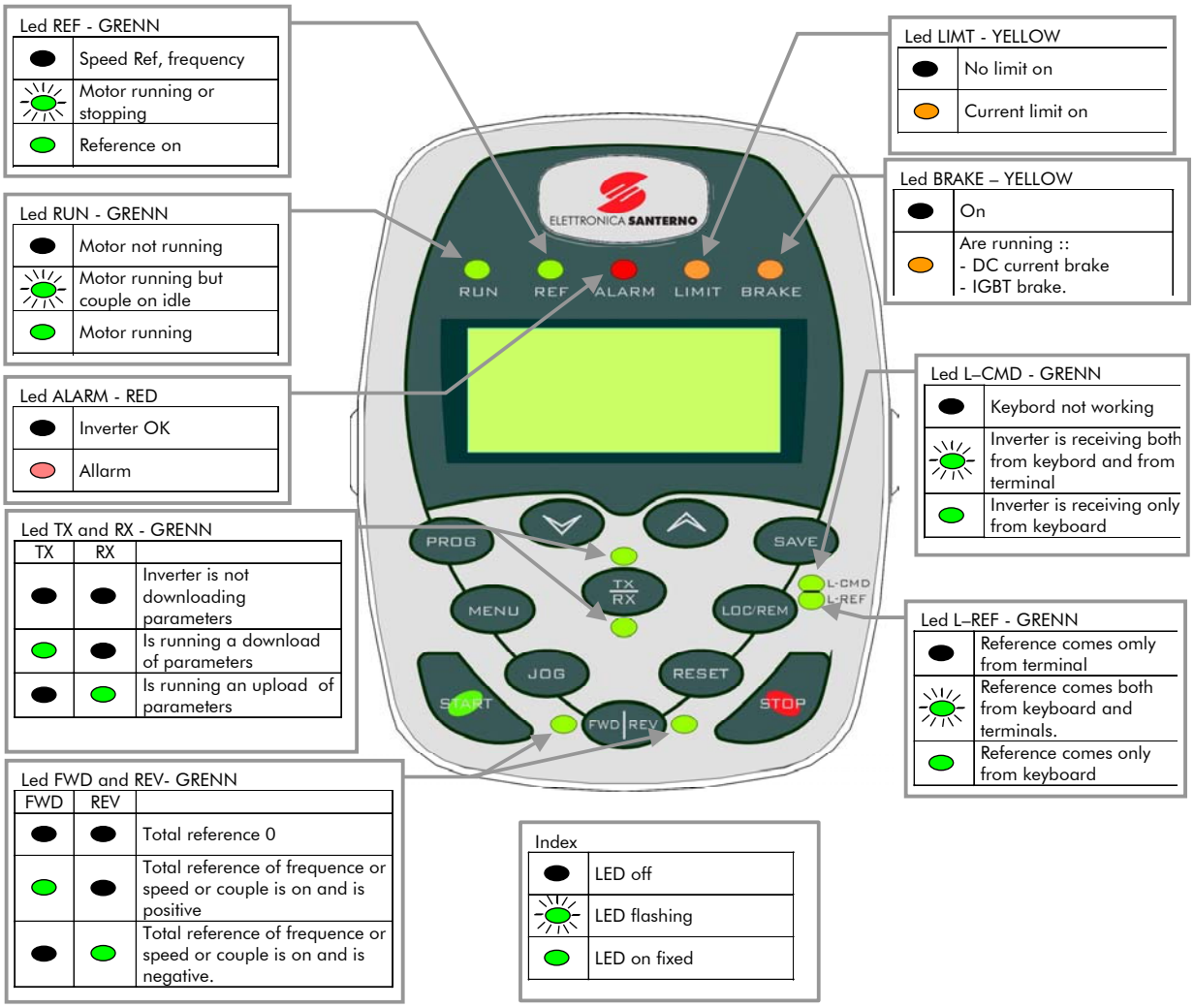


Fig.1.30 Keypad/display

1.6.2 FUNCTION KEYS

The table below details the keypad/display function keys:

Key	Functions
PROG	Allows to enter and quit the menus and submenus and enables altering the inverter parameters (when switching from parameter display to parameter programming, the cursor starts flashing). Hold it down with the SAVE key to set the page being displayed as default page at power on. When the KEYPAD page is displayed, press it for more than 4 seconds to access the editing mode of the displayed measures.
⌄	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	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.
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. If pressed from a different page than the pages above, that page is included in the display sequence, thus becoming step 5.
TX | RX	If depressed along with the MENU key, it allows to access the parameter DOWNLOAD from the keypad to an inverter (TX) or the parameter UPLOAD from an inverter to the keypad (RX). Press TX|RX again to change your selection.
LOC | REM	If pressed once, commands and reference are forced via keypad; press it again to return to the prior configuration.
RESET	It allows to reset the alarm tripped once the cause responsible for the alarm has disappeared.
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 Programming Manual for any detail.

1.6.3 SETTING THE OPERATING MODE

The keypad/display 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.

1.6.3.1 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.

1.6.3.2 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 keypad/display. 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
SW Vers.	-	Software version of the keypad/display (cannot be altered by the user)
Language	ITA	Dialogue language: Italian
	ENG	Dialogue language: English
	ESP	Dialogue language: Spanish
	POR	Dialogue language: Portuguese
	FRA	Dialogue language: French
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 keypad/display ([2])
	1÷247	MODBUS address of the inverter: allows to select an inverter among multidrop inverters connected to one keypad/display([2])

NOTE: (1) – Not yet supported by SINUS PENTA's software.
(2) – An optional wiring kit for the keypad/display is required.

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

1.6.4 REMOTING THE KEYPAD/DISPLAY

The REMOTING KIT is required to remote the keypad. The remoting kit includes:
- Keypad mounting plate
- Fastening brackets
- Remoting wire (length: 5m).

Front view

Rear view

Remove the keypad/display by disconnecting the wire connecting the keypad to the control board.
Pierce the holes as shown in the figure (template 138 x109 mm).
Fasten the keypad/display mounting plate using the brackets supplied and tighten the fastening screws. Four self-threaded screws are supplied to fasten the brackets to the mounting plate; four tightening screws are also supplied to fasten the mounting plate to the panel.
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. The remoting kit, if well installed, gives a protection degree IP54 on the front panel

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 keypad/display. A remoting wire with different specifications may cause disturbance and affect any dialog between the inverter and the keypad/display.

CAUTION: Properly connect the remoting wire by grounding its braiding as explained above. The remoting wire must not be parallel to the power wires connecting the motor or feeding the inverter.
This will reduce disturbance between inverter and keypad/display connection to a minimum.

1.7 SERIAL COMMUNICATION

1.7.1 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 keypad/display. 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 a serial communication. The inverter may be connected directly to a computer or a multidrop network of inverters controlled by a master computer (see diagram below).

1.7.2 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.

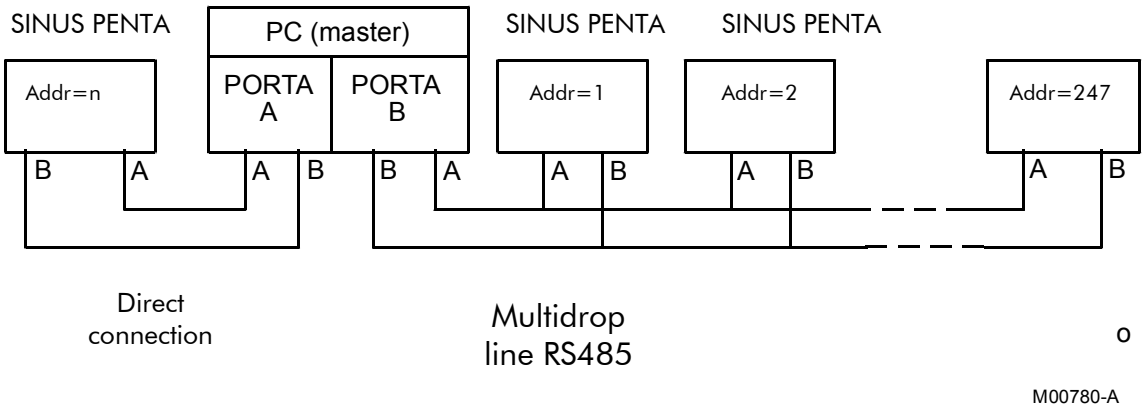
Elettronica Santerno may supply both converters as optional components.

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).

1.7.3 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 ID number that can be set in the Serial network submenu.



1.7.4 WIRING

For the connection to the serial link 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) depending on standard RS485. Positive polarity with respect to pins 2 – 4 for one MARK.
2 – 4	(TX/RX B) Differential input/output B (bidirectional) depending on standard RS485. Negative polarity with respect to pins 1 – 3 for one MARK.
5	(GND) control board zero volt
6	(VTEST) input reserved– **do not connect**
7 – 8	not connected
9	+5 V, max 100mA for power supply of optional convertor 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.

NOTE: All devices connected to the communication multidrop 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.

1.7.5 LINE TERMINATIONS

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 multidtrop connection will have only one outgoing line, while the last device will have only one incoming line. Line terminator is to be installed on the first device and the last device. Terminator is selected through dip-switch SW3 for SINUS PENTA inverters (See section 1.5.3.2) 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 SW1, selector switches 1 and 2 in position ON.
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).

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.

1.7.6 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.

1.7.7 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:	NO
Stop bit:	2
Protocol:	MODBUS RTU
Supported functions:	03h (Read Holding Registers) 10h (Preset Multiple Registers)
Device address:	configurable between 1 and 247 (default value: 1)
Electrical standard:	RS485
Inverter response delay:	configurable between 0 and 500 ms (default value: 0 ms)
End of message timeout:	configurable between 0 and 2000 ms (default value: 0 ms)

2 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 Section 5.
For more details on the equipment functionality, please consult SINUS PENTA's Programming 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 and check to see if the direction of rotation is correct.

CAUTION: When an alarm message is displayed, find the cause responsible for the alarm trip before restarting the equipment.

2.1 FIRST STARTUP (Factory Setting)

The startup procedures described below relate to commands sent via terminal board (factory setting). For terminal configuration, see section 1.4.2. "Control Terminals" and 1.4.8. "Power Terminals Arrangement".
SINUS PENTA inverters are factory set with the IFD application software, allowing to perform the first startup of the equipment. The terminal default functions are given in this section. For more details, please check the Programming Manual.

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

2) Power on: Power on the inverter; the wiring to the ENABLE input (terminal 15) is to be open, so that the inverter is disabled.

3) Parameter alteration: Set parameter P00 (Key parameter) to 'Yes'. Use the PROG, ↓, ↑ and SAVE keys to access the other parameters. See the "Submenu Tree" in the Programming Manual.

4) Motor parameters: Access the "First motor" menu and set 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.

Press SAVE each time a new parameter value is set.

5) Overload: Set parameters in the "Motor limits 1" submenu depending on the max. desired current.

6) 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 the motor is rotating in the right direction. If not, operate on terminal MDI8 (terminal 21) (CW/CCW) or open the ENABLE and START terminals. Shut off the inverter, wait at least 5 minutes and reverse two of the motor phases.

7) Possible failures: If no failure occurred, go to step 8. Otherwise, check the inverter connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the Measure submenu, 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 readings match with the measured values.

8) Additional parameter alterations: Note that you can change Cxxx parameters in the CONFIGURATION menu only when the inverter is DISABLED or STOPPED.
Always set parameter P00 to 1 before changing any parameter. You can write down any customized parameter in the table on the last pages of the Programming Manual.

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

2.2 FIRST STARTUP ("VTC" Motor Control)

The startup procedures described below relate to commands sent via terminal board (factory setting). For terminal configuration, see section 1.4.2. "Control Terminals" and 1.4.8. "Power Terminals Arrangement".

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

2) Power on: Link to terminal Enable (terminal 15)) is to be open when the inverter is started (inverter disabled).

3) Parameter alteration: Set parameter P000 (Key parameter) to 'Yes'. Use the PROG, ↓, ↑ and SAVE keys to access the other parameters. See the "Submenu Tree" in the Programming Manual.

4) Motor parameters: Access the "First motor" menu and set C010 (Control Algorithm) as VTC Direct Torque. 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 (inductance of stator leakage of one phase for a star connection or one third of the leakage of one phase for a delta connection). If values to be set for C022 and C023 are not known, either perform parameter autotuning (see step 5) or go to step 6. Press SAVE each time a new parameter is set.

5) Autotuning: Access the "Autotune" menu and set C000 (Autotuning enabled) as motor tune; close the Enable command and wait until autotuning is over (warning "W32 Open Enable" is displayed). The inverter 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, the Enable command has opened before autotuning was over. In that case, reset the equipment sending a command of terminal MDI3, or press the Reset key in the keypad/display and repeat the autotuning procedure.

6) Overload: Set parameter C48 (Limits M1 submenu) depending on the maximum torque that can be generated.

7) 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 the motor is rotating in the right direction. If not, operate on input MDI8 (terminal 21), which is factory-set to CW/CCW, or open the START and ENABLE inputs. Shut off the inverter, wait at least 5 minutes and reverse two of the motor phases.

8) Speed regulator adjustment: If an overdisplacement occurs when the speed setpoint is reached or if a system instability is detected (uneven motor operation) adjust the parameters relating to the speed loop ("Speed loop" submenu). 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 an overdisplacement takes place when the setpoint is reached. 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 that the motor runs smoothly at constant speed.

9) Possible failures: If no failure occurred, go to step 10. Otherwise, check the inverter connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the Measure submenu, 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 readings

match with the measured values.

10) Additional parameter alterations: Note that you can change Cxxx parameters in the CONFIGURATION menu only when the inverter is DISABLED (Enable contact inactive). Always set parameter P000 to 1 before changing any parameter. You can write down any customized parameter in the table on the last pages of the Programming Manual.

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

2.3 FIRST STARTUP ("FOC" Motor Control)

3 TECHNICAL SPECIFICATIONS

Power Range

• kW connected motor/voltage range
1.3~395kW 200÷240VAC, 3phase
2.2~630kW 380÷415VAC, 3phase
2.5~751kW 440÷460VAC, 3phase
2.7~819kW 480÷500VAC, 3phase
470~981kW 575VAC, 3phase
563~1177kW 660÷690VAC, 3phase
Degree of protection/size
STAND ALONE: IP20 from Size S05 to Size S40, IP00 Size S50 and S60, IP54 from Size S05 to Size S30
BOX: IP54
CABINET: IP24 and IP54.

• Motor voltage range/precision
0÷Vmains, +/-2%
• Current/torque to motor/time
105÷200% for 2min. every 20min. up to S30.
105÷200% for 1min. every 10min. from S40.
• Starting torque/max. time
240% for a short time
• Output frequency/resolution
0÷1000Hz, resolution 0.01Hz
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÷16kHz
S20 = 0.8÷12.8kHz
S30 = 0.8÷10kHz (5kHz for 0150 and 0162)
≥S40 = 0.8÷4kHz

Mains

• VAC supply voltage/tolerance
200÷240VAC, 3phase, -15% +10%
380÷500VAC, 3phase, -15% +5%
500÷575VAC, 3phase, -15% +10%
660÷690VAC, 3phase, -15% +10%
• VDC supply voltage/tolerance
280÷360VDC, -15% +10%
530÷705VDC, -15% +5%
705÷810VDC, -15% +10%
930÷970VDC, -15% +10%
• Supply frequency (Hz)/tolerance
50÷60Hz, +/-10%

Environmental Requirements

• Ambient temperature
0÷40°C no derating
(40°C to 50°C derating 2% of rated current every degree beyond 40°C)
• Storage temperature
-25÷+70°C
• Humidity
5÷95% (non condensing)
• Altitude
Up to 1000m a.s.l.
For higher altitudes, derate the output current of 2% every 100m beyond 1000m (max. 4000m)
• Vibrations
Lower than 5.9m/sec^2 (=0.6G)
• Installation environment
Do not install in direct sunlight and in places exposed to conductive dust, corrosive gases, vibrations, water sprinkling or dripping (if not protected by an adequate degree of protection). Do not install in salty environments.
• Operating atmospheric pressure
86÷106kPa
• Cooling system:
Forced air-cooling (excluded for S60 2598 water cooled)

(*) NOTE: max. output frequency limited by the preset carrier value allowing at least 16 PWM pulse per period for output voltage.

CONTROL	Control methods		IFD = Voltage/Frequency with symmetrical PWM modulation VTC = Vector Torque Control (Sensorless vectorial, direct torque control) FOC = Field adjustment with field regulation and torque for synchronous motors SYN = Field adjustment with torque control for synchronous motors RGN = Regenerative feeder
	Frequency/speed setting resolution		Digital reference: 0.1Hz (IFD SW); 1 rpm (VTC SW) 12bit Analog reference: 4,096 dots with respect to speed range
	Speed precision		Open loop: 2% of max. speed Closed loop (with an encoder): < 0.5% of max. speed
	Overload capacity		Up to 2 times rated current for 120sec.
	Starting torque		Up to 200% Cn for 120sec and 240% Cn for a short duration
	Torque boost		Programmable for a rated torque increase
OPERATION	Input signals	Operation method	Operation through 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 fixed inputs (ENABLE, START, RESET) and 5 configurable inputs
		Multispeed	15 sets of programmable speed values +/-32,000 rpm
		Ramps	4 + 4 accel./decel. ramps, 0 to 6,500sec; 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÷48VDC, 50mA max. 1 open collector, NPN/PNP output, 5÷48VDC, 50mA max 2 relay outputs with reverse contacts, 250VAC, 30VDC, 3A
		Auxiliary voltage	24VDC +/-5%, 200mA
		Reference voltage for potentiometer	+10VDC ±0,8%, 10mA -10VDC ±0,8%, 10mA
		Analog outputs	3 configurable analog outputs, -10÷10VDC, 0÷10VDC, 0(4)÷20mA, resolution 9/11bits
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.
	Warnings		INVERTER OK, INVERTER ALARM, acceleration – constant rpm – deceleration, current/torque limiting, POWER DOWN, SPEED SEARCHING, DC braking, autotuning.
COMMUNICATION DISPLAY	Operating data		Frequency/torque/speed reference, output frequency, motor speed, required torque, 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		AB Communicator: optional MODBUS/field bus converter (Profibus DP; Can Bus; Device Net; Ethernet; etc.). Each device may control up to 4 inverters.
SAFETY REQUIREMENTS			EN 61800-5-1, EN50178, EN60204-1, IEC 22G/109/NP
CE Mark			Provided

3.1 CHOOSING THE PRODUCT

The inverter of the SINUS PENTA series are dimensioned based on allowable current and overload.
Each inverter model may be connected to 4 different motor power sizes depending on load performance.
Four types of torque/current overload are available; their duration is 120sec every 20min up to S30 and 60 sec every 10min from S40 to S70:

LIGHT overload 105%÷120%; may be connected to light loads with constant/quadratic torque (pumps, fans, etc.);

STANDARD overload 120%÷140%; may be connected to standard loads with constant torque (conveyors, mixers, extruders, etc.)

HEAVY overload 150%÷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 200%; may be applied to very heavy loads with constant torque (mandrels, axis control, etc.).

The SINUS PENTA series is dimensioned with 2 current values: current Imot, for the stated torque overload, and current Inom, representing the max. deliverable continuous current.
The rated current of the connected motor should be lower than Inom (tolerance: +5%). In case of the connection of multiple motors, the sum of their rated current values must not exceed Inom (an output inductance is recommended in that case).

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.

3.1.1 TECHNICAL SHEET FOR LIGHT APPLICATIONS: OVERLOAD 105%÷120%

Size	MODELLO SINUS PENTA	MOTORE APPLICABILE IN FUNZIONE DELLA TENSIONE						CORRENTE EROGABILE		
		200-240Vac	380-415Vac	440-460Vac	480-500Vac	575Vac	660-690Vac	Imot	Inom	Imax
		kW	kW	kW	kW	kW	kW	A	A	A
S05	0005	2,9	4,7	5,5	6,0	-	-	10,5	10,5	11,5
	0007	3,6	5,5	6,7	7,4	-	-	12,5	12,5	13,5
	0009	4,9	7,5	9,2	10	-	-	16,5	16,5	17,5
	0011									21
	0014									25
S10	0017	9,4	15	18	19	-	-	30	30	32
	0020									36
	0025	13	22	25	27	-	-	41	41	48
	0030									56
	0035									72
S15	0040	23	37	44	48	-	-	72	72	75
S20	0049	26	45	50	54	-	-	80	80	96
	0060	29	48	55	59	-	-	88	88	112
	0067	34	55	65	71	-	-	103	103	118
	0074	40	65	76	83	-	-	120	120	144
	0086	44	75	84	91	-	-	135	135	155
S30	0113	59	100	112	122	-	-	180	180	200
	0129	66	110	126	137	-	-	195	195	215
	0150	73	120	138	151	-	-	215	215	270
	0162	81	132	153	167	-	-	240	240	290
S40	0179	101	170	191	209	-	-	300	300	340
	0200	119	200	225	246	-	-	345	345	365
	0216	129	215	245	267	-	-	375	375	430
	0250	134	220	255	278	333	400	390	390	480
S50	0312	165	280	314	342	410	492	480	480	600
	0366	190	315	361	394	472	567	550	550	660
	0399	218	355	414	451	541	649	630	630	720
S60	0457	243	400	462	504	604	725	720	720	880
	0524	270	450	512	559	670	804	800	800	960
	0598 (1)	307	500	584	637	763	916	900	900	1100
S70	0748	343	560	651	710	851	1022	1000	1000	1300
	0831	395	630	751	819	981	1177	1200	1200	1440

NOTE: (1) Water cooled

	CABINET model available only

Legend:
Imot = motor rated current for the stated torque overload
Inom = continuous rated current of the inverter
Imax = max. current the inverter can deliver for 120 sec every 20 min up to S30, for 60 sec every 10 min for S40 and higher

3.1.2 TECHNICAL SHEET FOR STANDARD APPLICATIONS: OVERLOAD 120÷140%

Size	MODELLO SINUS PENTA	MOTORE APPLICABILE IN FUNZIONE DELLA TENSIONE						CORRENTE EROGABILE		
		200-230Vac	380-415Vac	440-460Vac	480-500Vac	575Vac	660-690Vac	Imot	Inom	Imax
		kW	kW	kW	kW	kW	kW	A	A	A
S05	0005	2,4	4	4,4	4,8	-	-	8,5	10,5	11,5
	0007	2,9	4,7	5,5	6,0	-	-	10,5	12,5	13,5
	0009	3,6	5,5	6,7	7,4	-	-	12,5	16,5	17,5
	0011	4,9	7,5	9,2	10	-	-	16,5	16,5	21
	0014									25
S10	0017	7,2	11	14	15	-	-	24	30	32
	0020	9,4	15	18	19	-	-	30	30	36
	0025	11,5	18,5	22	24	-	-	36,5	41	48
	0030	13	22	25	27	-	-	41	41	56
	0035									72
S15	0040	19	30	36	39	-	-	59	72	75
S20	0049	23	37	44	48	-	-	72	80	96
	0060	26	45	50	54	-	-	80	88	112
	0067	34	55	65	71	-	-	103	103	118
	0074	40	65	76	83	-	-	120	120	144
	0086	44	75	84	91	-	-	135	135	155
S30	0113	56	95	106	115	-	-	170	180	200
	0129	59	100	112	122	-	-	180	195	215
	0150	66	110	126	137	-	-	195	215	270
	0162	81	132	153	167	-	-	240	240	290
S40	0179	87	140	166	181	-	-	260	300	340
	0200	101	170	191	209	-	-	300	345	365
	0216	119	200	225	246	-	-	345	375	430
	0250	129	215	245	267	320	384	375	390	480
S50	0312	151	250	288	314	376	451	440	480	600
	0366	165	280	314	342	410	492	480	550	660
	0399	190	315	361	394	472	567	550	630	720
S60	0457	243	400	462	504	604	725	720	720	880
	0524	270	450	512	559	670	804	800	800	960
	0598 (1)	307	500	584	637	763	916	900	900	1100
S70	0748	343	560	651	710	851	1022	1000	1000	1300
	0831	395	630	751	819	981	1177	1200	1200	1440

NOTE: (1) Water cooled

	CABINET model available only

Legend:
Imot = motor rated current for the stated torque overload
Inom = continuous rated current of the inverter
Imax = max. current the inverter can deliver for 120 sec every 20 min up to S30, for 60 sec every 10 min for S40 and higher

3.1.3 TECHNICAL SHEET FOR HEAVY APPLICATIONS: OVERLOAD 150%÷175%

Size	MODELLO SINUS PENTA	MOTORE APPLICABILE IN FUNZIONE DELLA TENSIONE						CORRENTE EROGABILE		
		200-230Vac	380-415Vac	440-460Vac	480-500Vac	575Vac	660-690Vac	Imot	Inom	Imax
		kW	kW	kW	kW	kW	kW	A	A	A
S05	0005	1,8	3	3,3	3,6	-	-	6,5	10,5	11,5
	0007	2,4	4	4,4	4,8	-	-	8,5	12,5	13,5
	0009	2,9	4,7	5,5	6	-	-	10,5	16,5	17,5
	0011	3,6	5,5	6,7	7,4	-	-	12,5	16,5	21
	0014	4,9	7,5	9,2	10	-	-	16,5	16,5	25
S10	0017	5,8	9,2	11	12	-	-	20	30	32
	0020	7,2	11	14	15	-	-	24	30	36
	0025	9,4	15	18	19	-	-	30	41	48
	0030	11,5	18,5	22	24	-	-	36	41	56
	0035	13	22	25	27	-	-	41	41	72
S15	0040	15	25	29	32	-	-	48	72	75
S20	0049	19	30	36	39	-	-	59	80	96
	0060	23	37	44	48	-	-	72	88	112
	0067	26	45	50	54	-	-	80	103	118
	0074	29	48	55	59	-	-	88	120	144
	0086	34	55	65	71	-	-	103	135	155
S30	0113	44	75	84	91	-	-	135	180	200
	0129	51	85	96	105	-	-	155	195	215
	0150	59	100	112	122	-	-	180	215	270
	0162	66	110	126	137	-	-	195	240	290
S40	0179	73	120	138	151	-	-	215	300	340
	0200	81	132	153	167	-	-	240	345	365
	0216	87	140	166	181	-	-	260	375	430
	0250	101	170	191	209	250	300	300	390	480
S50	0312	129	215	245	267	320	384	375	480	600
	0366	151	250	288	314	376	451	440	550	660
	0399	165	280	314	342	410	492	480	630	720
S60	0457	190	315	361	394	472	567	550	720	880
	0524	218	355	414	451	541	649	630	800	960
	0598 (1)	243	400	462	504	604	725	720	900	1100
S70	0748	307	500	584	637	763	916	900	1000	1300
	0831	343	560	651	710	851	1022	1000	1200	1440

NOTE: (1) Water cooled

	CABINET model available only

Legend:
Imot = motor rated current for the stated torque overload
Inom = continuous rated current of the inverter
Imax = max. current the inverter can deliver for 120 sec every 20 min up to S30, for 60 sec every 10 min for S40 and higher

3.1.4 TECHNICAL SHEET FOR STRONG APPLICATIONS: OVERLOAD 200%

Size	MODELLO SINUS PENTA	MOTORE APPLICABILE IN FUNZIONE DELLA TENSIONE						CORRENTE EROGABILE		
		200-230Vac	380-415Vac	440-460Vac	480-500Vac	575Vac	660-690Vac	Imot	Inom	Imax
		kW	kW	kW	kW	kW	kW	A	A	A
S05	**0005**	1,3	**2,2**	2,5	2,7	-	-	5	10,5	11,5
	0007	1,8	**3**	3,3	3,6	-	-	6,5	12,5	13,5
	0009	2,4	**4**	4,4	4,8	-	-	8,5	16,5	17,5
	0011	2,9	**4,7**	5,5	6,0	-	-	10,5	16,5	21
	0014	3,6	**5,5**	6,7	7,4	-	-	12,5	16,5	25
S10	**0017**	4,9	**7,5**	9,2	10	-	-	16,5	30	32
	0020	5,8	**9,2**	11	12	-	-	20	30	36
	0025	7,2	**11**	14	15	-	-	24	41	48
	0030	9,4	**15**	18	19	-	-	30	41	56
	0035	11,5	**18,5**	22	24	-	-	36	41	72
S15	**0040**	13	**22**	25	27	-	-	41	72	75
S20	**0049**	15	**25**	29	32	-	-	48	80	96
	0060	19	**30**	36	39	-	-	59	88	112
	0067	21	**34**	39	43	-	-	64	103	118
	0074	23	**37**	44	48	-	-	72	120	144
	0086	26	**45**	50	54	-	-	80	135	155
S30	**0113**	34	**55**	65	71	-	-	103	180	200
	0129	40	**65**	76	83	-	-	120	195	215
	0150	44	**75**	84	91	-	-	135	215	270
	0162	53	**90**	100	109	-	-	160	240	290
S40	**0179**	59	**100**	112	122	-	-	180	300	340
	0200	66	**110**	126	137	-	-	195	345	365
	0216	73	**120**	138	151	-	-	215	375	430
	0250	81	**132**	153	167	200	240	240	390	480
S50	**0312**	101	**170**	191	209	250	300	300	480	600
	0366	119	**200**	225	246	295	354	345	550	660
	0399	134	**220**	255	278	333	400	390	630	720
S60	**0457**	189	**250**	359	392	470	564	550	720	880
	0524	217	**280**	412	449	538	646	630	800	960
	0598 (1)	249	**315**	473	516	618	741	720	900	1100
S70	**0748**	311	**355**	591	644	772	927	900	1000	1300
	0831	338	**400**	641	700	839	1006	1000	1200	1440

NOTE: (1) Water cooled

	CABINET model available only

Legend:
Imot = motor rated current for the stated torque overload
Inom = continuous rated current of the inverter
Imax = max. current the inverter can deliver for 120 sec every 20 min up to S30, for 60 sec every 10 min for S40 and higher

3.2 CARRIER FREQUENCY SETTING (WHERE APPLICABLE) AND PEAK CURRENT

The continuous current generated by the inverter in continuous operation type S1 at 40°C depends on the carrier frequency.
Do not exceed the carrier values stated in the table below. Carrier values may be set through min. and max. switching frequency parameters in the Carrier Frequency menu.

Size	SINUS PENTA MODEL	Max. Recommended Carrier Frequency					Peak Current	
		LIGHT	STANDARD	HEAVY	STRONG	Max. Carrier	@ 20ms	Instant
		(kHz)	(kHz)	(kHz)	(kHz)	(kHz)	(A_{RMS})	(A_{peak})
S05	0005	8	10	16	16	16	15	28
	0007	8	10	16	16	16	17	33
	0009	8	10	16	16	16	24	47
	0011	8	10	16	16	16	29	56
	0014	8	10	12.8	16	16	35	67
S10	0017	3	5	12.8	16	16	40	77
	0020	3	5	12.8	16	16	45	87
	0025	3	5	12.8	16	16	59	114
	0030	3	5	10	12.8	16	69	133
	0035	3	5	10	12.8	16	87	167
S15	0040	3	5	12.8	16	16	90	173
S20	0049	3	5	12.8	12.8	12.8	118	228
	0060	3	5	12.8	12.8	12.8	138	266
	0067	3	5	12.8	12.8	12.8	146	280
	0074	3	5	12.8	12.8	12.8	180	347
	0086	3	5	10	12.8	12.8	194	373
S30	0113	3	5	10	10	10	251	484
	0129	3	5	10	10	10	270	520
	0150	3	4	5	5	5	310	596
	0162	3	4	5	5	5	333	640
S40	0179	3	4	4	4	4	420	807
	0200	3	4	4	4	4	450	867
	0216	2	3	4	4	4	537	1033
	0250	2	3	4	4	4	599	1153
S50	0312	2	3	4	4	4	751	1444
	0366	2	3	4	4	4	826	1589
	0399	2	3	4	4	4	901	1733
S60	0457	2	2	3	4	4	1080	2078
	0524	2	2	3	4	4	1213	2333
S70	0598	2	2	3	4	4	1350	2597
	0748	2	2	3	4	4	1595	3069
	0831	2	2	3	4	4	1767	3400

4 ACCESSORIES

4.1 BRAKING RESISTORS

4.1.1 APPLICATION TABLES

From size S05 to size S30, SINUS K inverters are supplied with a built-in braking module. The braking resistor is to be incorporated in the inverter and connected to terminal B and terminal + (see section 1.4 "Wiring"). For IFD SW only, the braking module is enabled through programming parameter C57, Special Functions submenu. An external braking module is used for higher sizes (MFI). When choosing the braking resistor, consider its Ohm value and rated power. The Ohm value determines the instant power dissipated in the braking resistor and is 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 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.

4.1.1.1 BRAKING RESISTORS FOR APPLICATIONS WITH BRANKING DUTY CYCLE OF 10% AND 380-500VAC SUPPLY VOLTAGE

Size	MODEL		Min. resistor to be connected to the inverter Ω	DUTY CYCLE 10%	
				Degree of Protection IP54 or IP55 up to 25Ω/1800W IP20 for higher power values	Code
S05	0005	4T BA2X2	50	75Ω–1100W	RE3063750
	0007	4T BA2X2	50	75Ω–550W	RE3063750
	0009	4T BA2X2	50	50Ω–1100W	RE3083500
	0011	4T BA2X2	50	50Ω–1100W	RE3083500
	0014	4T BA2X2	50	50Ω–1100W	RE3083500
S10	0017	4T BA2X2	50	50Ω–1500W	RE3093500
	0020	4T BA2X2	50	50Ω–1100W	RE3093500
	0025	4T BA2X2	20	25Ω–1800W	RE3103250
	0030	4T BA2X2	20	25Ω–1800W	RE3103250
	0035	4T BA2X2	20	25Ω–1800W	RE3103250
S15	0040	4T BA2X2	15	15Ω–4000W	RE3483150
S20	0049	4T BA2X2	10	15Ω–4000W	RE3483150
	0060	4T BA2X2	10	10Ω–8000W	RE3763100
	0067	4T BA2X2	10	10Ω–8000W	RE3763100
	0074	4T BA2X2	8,5	10Ω–8000W	RE3763100
	0086	4T BA2X2	8,5	10Ω–8000W	RE3763100
S30	0113	4T BA2X2	6	6,6Ω–12000W	RE4022660
	0129	4T BA2X2	6	6,6Ω–12000W	RE4022660
	0150	4T BA2X2	5	6,6Ω–12000W	RE4022660
	0162	4T BA2X2	5	6,6Ω–12000W	RE4022660
S40	0179	4T XA2X2	2*MFI-E 4T 90	10Ω–10Ω–8000W **(nota1)**	2*RE3763100
	0200	4T XA2X2	2*MFI-E 4T 90	6,6Ω–6,6Ω–12000W**(nota1)**	2*RE4022660
	0216	4T XA2X2	2*MFI-E 4T 90	6,6Ω–6,6Ω–12000W**(nota1)**	2*RE4022660
	0250	4T XA2X2	2*MFI-E 4T 90	6,6Ω–6,6Ω–12000W**(nota1)**	2*RE4022660
S50	0312	4T XA2X0	3*MFI-E 4T 90	6,6Ω–6,6Ω–6,6Ω–12000W**(nota1)**	3*RE4022660
	0366	4T XA2X0	3*MFI-E 4T 90	6,6Ω–6,6Ω–6,6Ω–12000W**(nota1)**	3*RE4022660
	0399	4T XA2X0	3*MFI-E 4T 90	6,6Ω–6,6Ω–6,6Ω–12000W**(nota1)**	3*RE4022660

(note 1): For the connection of MFI and braking resistors, see manual relating to MFI braking module.

PERICOLO: Braking resistors may reach temperatures higher than 200°C.

ATTENZIONE: Power dissipated by braking resistors may be equal to approx. 10% of the connected motor rated power. Use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

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

4.1.1.2 BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF 20% AND 380-500VAC SUPPLY VOLTAGE

Size	MODEL		Min. resistor to be connected to the inverter Ω	DUTY CYCLE 20%	
				Degree of Protection IP54 or IP55 up to 25Ω/2200W IP20 for higher power values	Code
S05	0005	4T BA2X2	50	50Ω–1000W	RE3083500
	0007	4T BA2X2	50	50Ω–1000W	RE3083500
	0009	4T BA2X2	50	50Ω–1100W	RE3083500
	0011	4T BA2X2	50	50Ω–1500W	RE3093500
	0014	4T BA2X2	50	50Ω–1500W	RE3093500
S10	0017	4T BA2X2	50	50Ω–2200W	RE3113500
	0020	4T BA2X2	50	50Ω–4000W	RE3483500
	0025	4T BA2X2	20	25Ω–4000W	RE3483250
	0030	4T BA2X2	20	25Ω–4000W	RE3483250
	0035	4T BA2X2	20	25Ω–4000W	RE3483250
S15	0040	4T BA2X2	15	15Ω–4000W	RE3483150
S20	0049	4T BA2X2	10	10Ω–8000W	RE3763100
	0060	4T BA2X2	10	10Ω–8000W	RE3763100
	0067	4T BA2X2	10	10Ω–12000W	RE4023100
	0074	4T BA2X2	8,5	10Ω–12000W	RE4023100
	0086	4T BA2X2	8,5	10Ω–12000W	RE4023100
S30	0113	4T BA2X2	6	3,3Ω+3,3Ω–8000W **(nota 1)**	2*RE3762330
	0129	4T BA2X2	6	3,3Ω+3,3Ω–8000W **(nota 1)**	2*RE3762330
	0150	4T BA2X2	5	10Ω//10Ω–12000W **(nota 2)**	2*RE4023100
	0162	4T BA2X2	5	10Ω//10Ω–12000W **(nota 2)**	2*RE4023100
S40	0179	4T XA2X2	2*MFI-E 4T 90	6,6Ω–6,6Ω–12000W**(nota3)**	2*RE4022660
	0200	4T XA2X2	2*MFI-E 4T 90	6,6Ω–6,6Ω–12000W**(nota3)**	2*RE4022660
	0216	4T XA2X2	3*MFI-E 4T 90	6,6Ω–6,6Ω–12000W**(nota3)**	3*RE4022660
	0250	4T XA2X2	3*MFI-E 4T 90	6,6Ω–6,6Ω–6,6Ω–12000W**(nota3)**	3*RE4022660
S50	0312	4T XA2X0	4*MFI-E 4T 90	6,6Ω–6,6Ω–6,6Ω–6,6Ω–12000W**(nota3)**	4*RE4022660
	0366	4T XA2X0	4*MFI-E 4T 90	6,6Ω–6,6Ω–6,6Ω–6,6Ω–12000W**(nota3)**	4*RE4022660
	0399	4T XA2X0	4*MFI-E 4T 90	6,6Ω–6,6Ω–6,6Ω–6,6Ω–12000W**(nota3)**	4*RE4022660

(note 1): Two series-connected resistors, 3.3Ohm/8000W
(note 2): Two parallel-connected resistors, 10Ohm/12000W
(note 3): For the connection of MFI and braking resistors, see manual relating to MFI braking module.

PERICOLO: Braking resistors may reach temperatures higher than 200°C.

ATTENZIONE: Power dissipated by braking resistors may be equal to approx. 20% of the connected motor rated power. Use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

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

4.1.1.3 BRAKING RESISTORS FOR APPLICATIONS WITH A DUTY CYCLE OF 50% AND 380-500VAC SUPPLY VOLTAGE

Size	MODEL		Min. resistor to be connected to the inverter Ω	DUTY CYCLE 50%	
				Degree of Protection IP23	Code
S05	0005	4T BA2X2	50	50Ω–4000W	RE3503500
	0007	4T BA2X2	50	50Ω–4000W	RE3503500
	0009	4T BA2X2	50	50Ω–4000W	RE3503500
	0011	4T BA2X2	50	50Ω–4000W	RE3503500
	0014	4T BA2X2	50	50Ω–4000W	RE3503500
S10	0017	4T BA2X2	50	50Ω–8000W	RE3783500
	0020	4T BA2X2	50	50Ω–8000W	RE3783500
	0025	4T BA2X2	20	20Ω–12000W	RE4053200
	0030	4T BA2X2	20	20Ω–12000W	RE4053200
	0035	4T BA2X2	20	20Ω–12000W	RE4053200
S15	0040	4T BA2X2	15	15Ω–16000W	RE4163150
S20	0049	4T BA2X2	10	15Ω–16000W	RE4163150
	0060	4T BA2X2	10	10Ω–24000W	RE4293100
	0067	4T BA2X2	10	10Ω–24000W	RE4293100
	0074	4T BA2X2	8,5	10Ω–24000W	RE4293100
	0086	4T BA2X2	8,5	10Ω–24000W	RE4293100
S30	0113	4T BA2X2	6	6Ω–48000W	RE4452600
	0129	4T BA2X2	6	6Ω–48000W	RE4452600
	0150	4T BA2X2	5	5Ω–64000W	RE4552500
	0162	4T BA2X2	5	5Ω–64000W	RE4552500
S40	0179	4T XA2X2	2*MFI-E 4T 90	6,6Ω–6,6Ω–32000W**(nota 1)**	2*RE4362660
	0200	4T XA2X2	2*MFI-E 4T 90	6,6Ω–6,6Ω–32000W**(nota 1)**	2*RE4362660
	0216	4T XA2X2	2*MFI-E 4T 90	6,6Ω–6,6Ω–32000W**(nota 1)**	2*RE4362660
	0250	4T XA2X2	2*MFI-E 4T 90	6Ω–6Ω–48000W**(nota 1)**	2*RE4452600
S50	0312	4T XA2X0	3*MFI-E 4T 90	6,6Ω–6,6Ω–6,6Ω–32000W**(nota 1)**	3*RE4362660
	0366	4T XA2X0	3*MFI-E 4T 90	6Ω–6Ω–6Ω–48000W **(nota 1)**	3*RE4452600
	0399	4T XA2X0	3*MFI-E 4T 90	6Ω–6Ω–6Ω–48000W **(nota 1)**	3*RE4452600

(note 1): For the connection of MFI and braking resistors, see manual relating to MFI braking module.

PERICOLO: Braking resistors may reach temperatures higher than 200°C.

ATTENZIONE: Power dissipated by braking resistors may be equal to approx. 50% of the connected motor rated power. Use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

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

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

Size	MODEL		Min. resistor to be connected to the inverter Ω	DUTY CYCLE 10%	
				Degree of Protection IP54 or IP55 up to 15Ω/1100W IP20 for higher power values	Code
S05	0005	2T BA2X2	25,0	56Ω–350W	RE2643560
	0007	2T BA2X2	25,0	56Ω–350W	RE2643560
	0009	2T BA2X2	25,0	56//56Ω–350W **(nota1)**	2*RE2643560
	0011	2T BA2X2	25,0	56//56Ω–350W **(nota1)**	2*RE2643560
	0014	2T BA2X2	25,0	56//56Ω–350W **(nota1)**	2*RE2643560
S10	0017	2T BA2X2	25,0	56//56Ω–350W **(nota1)**	2*RE2643560
	0020	2T BA2X2	25,0	56//56Ω–350W **(nota1)**	2*RE2643560
	0025	2T BA2X2	10,0	15Ω–1100W	RE3083150
	0030	2T BA2X2	10,0	15Ω–1100W	RE3083150
	0035	2T BA2X2	10,0	15Ω–1100W	RE3083150
S15	0040	2T BA2X2	7,5	15Ω//15Ω–1100W **(nota2)**	2*RE3083150
S20	0049	2T BA2X2	5,0	5Ω–4000W	RE3482500
	0060	2T BA2X2	5,0	5Ω–4000W	RE3482500
	0067	2T BA2X2	5,0	5Ω–4000W	RE3482500
	0074	2T BA2X2	4,2	5Ω–4000W	RE3482500
	0086	2T BA2X2	4,2	5Ω–4000W	RE3482500
S30	0113	2T BA2X2	3,0	3,3Ω–8000W	RE3762330
	0129	2T BA2X2	3,0	3,3Ω–8000W	RE3762330
	0150	2T BA2X2	2,5	3,3Ω–8000W	RE3762330
	0162	2T BA2X2	2,5	3,3Ω–8000W	RE3762330
S40	0179	2T XA2X2	2*MFI-E 2T 45	3,3//3,3Ω–8000W **(nota3)**	2*RE3762330
	0200	2T XA2X2	2*MFI-E 2T 45	3,3//3,3Ω–8000W **(nota3**	2*RE3762330
	0216	2T XA2X2	2*MFI-E 2T 45	3,3//3,3Ω–8000W **(nota3**	2*RE3762330
	0250	2T XA2X2	2*MFI-E 2T 45	3,3//3,3Ω–8000W **(nota3**	2*RE3762330
S50	0312	2T XA2X0	3*MFI-E 2T 45	3,3//3,3//3,3Ω–8000W **(nota3)**	3*RE3762330
	0366	2T XA2X0	3*MFI-E 2T 45	3,3//3,3//3,3Ω–8000W **(nota3)**	3*RE3762330
	0399	2T XA2X0	3*MFI-E 2T 45	3,3//3,3//3,3Ω–8000W **(nota3)**	3*RE3762330

(note 1): Two parallel-connected resistors, 56Ohm/350W
(note 2): Four parallel-connected resistors, 15Ohm/1100W
(note 3): For the connection of MFI and braking resistors, see manual relating to MFI braking module

PERICOLO: Braking resistors may reach temperatures higher than 200°C.

ATTENZIONE: Power dissipated by braking resistors may be equal to approx. 10% of the connected motor rated power. Use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

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

4.1.1.5 BRAKING RESISTORS FOR APPLICATIONS WITH A BRAKING DUTY CYCLE OF20% AND 200-240VAC SUPPLY VOLTAGE.

Size	MODEL		Min. resistor to be connected to the inverter Ω	DUTY CYCLE 20%	
				Degree of Protection IP54 or IP55 up to 25 Ω /1800W IP20 for higher power values	Code
S05	0005	2T BA2X2	25,0	56Ω–350W	RE2643560
	0007	2T BA2X2	25,0	100Ω//100Ω–350W **(nota1)**	2*RE2644100
	0009	2T BA2X2	25,0	56Ω//56Ω–350W	2*RE2635560
	0011	2T BA2X2	25,0	56Ω//56Ω–350W	2*RE2635560
	0014	2T BA2X2	25,0	100Ω//100Ω//100Ω//100Ω–350W**(nota2)**	4*RE2644100
S10	0017	2T BA2X2	25,0	100Ω//100Ω//100Ω//100Ω–350W**(nota2)**	4*RE2644100
	0020	2T BA2X2	25,0	25Ω–1800W	RE3103250
	0025	2T BA2X2	10,0	75Ω//75Ω//75Ω//75Ω//75Ω//75Ω–550W**(nota3)**	6*RE3063750
	0030	2T BA2X2	10,0	75Ω//75Ω//75Ω//75Ω//75Ω//75Ω–550W**(nota3)**	6*RE3063750
	0035	2T BA2X2	10,0	75Ω//75Ω//75Ω//75Ω//75Ω//75Ω–550W**(nota3)**	6*RE3063750
S15	0040	2T BA2X2	8,0	25Ω//25Ω–18000W**(nota4)**	2*RE3103250
S20	0049	2T BA2X2	5,0	5Ω–4000W	RE3482500
	0060	2T BA2X2	5,0	5Ω–8000W	RE3762500
	0067	2T BA2X2	5,0	5Ω–8000W	RE3762500
	0074	2T BA2X2	4,2	5Ω–8000W	RE3762500
	0086	2T BA2X2	4,2	5Ω–8000W	RE3762500
S30	0113	2T BA2X2	3,0	3,3Ω–12000W	RE4022330
	0129	2T BA2X2	3,0	3,3Ω–12000W	RE4022330
	0150	2T BA2X2	2,5	3,3Ω–12000W	RE4022330
	0162	2T BA2X2	2,5	3,3Ω–12000W	RE4022330
S40	0179	2T XA2X2	2*MFI-E 2T 45	3,3Ω–3,3Ω–8000W **(nota5)**	2*RE3762330
	0200	2T XA2X2	2*MFI-E 2T 45	3,3Ω–3,3Ω–8000W**(nota5)**	2*RE3762330
	0216	2T XA2X2	2*MFI-E 2T 45	3,3Ω–3,3Ω–12000W**(nota5)**	2*RE4022330
	0250	2T XA2X2	2*MFI-E 2T 45	3,3Ω–3,3Ω–12000W**(nota5)**	2*RE4022330
S50	0312	2T XA2X0	3*MFI-E 2T 45	3,3Ω–3,3Ω–3,3Ω–12000W**(nota5)**	3*RE4022330
	0366	2T XA2X0	3*MFI-E 2T 45	3,3Ω–3,3Ω–3,3Ω–12000W**(nota5)**	3*RE4022330
	0399	2T XA2X0	3*MFI-E 2T 45	3,3Ω–3,3Ω–3,3Ω–12000W**(nota5)**	3*RE4022330

(note 1): Two parallel-connected resistors, 100Ohm/350W
(note 2): Four parallel-connected resistors, 100Ohm/350W
(note 3): Six parallel-connected resistors, 75Ohm/550W
(note 4): Two parallel-connected resistors, 25Ohm/1800W
(note 5): For the connection of MFI and braking resistors, see manual relating to MFI braking module.

PERICOLO: Braking resistors may reach temperatures higher than 200°C.

ATTENZIONE: Power dissipated by braking resistors may be equal to approx. 20% of the connected motor rated power. Use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

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

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

Size	MODEL		Min. resistor to be connected to the inverter Ω	DUTY CYCLE 50%	
				Degree of Protection IP54 or IP55 up to 25 Ω /1800W IP20 for higher power values	Code
S05	0005	2T BA2X2	25,0	50Ω–1100W	RE3083500
	0007	2T BA2X2	25,0	50Ω–1100W	RE3083500
	0009	2T BA2X2	25,0	25Ω–1800W	RE3103250
	0011	2T BA2X2	25,0	25Ω–1800W	RE3103250
	0014	2T BA2X2	25,0	25Ω–4000W	RE3483250
S10	0017	2T BA2X2	25,0	25Ω–4000W	RE3483250
	0020	2T BA2X2	25,0	25Ω–4000W	RE3483250
	0025	2T BA2X2	10,0	10Ω–8000W	RE3763100
	0030	2T BA2X2	10,0	10Ω–8000W	RE3763100
	0035	2T BA2X2	10,0	10Ω–8000W	RE3763100
S15	0040	2T BA2X2	8,0	10Ω–8000W	RE3763100
S20	0049	2T BA2X2	5,0	6,6Ω–12000W	RE4022660
	0060	2T BA2X2	5,0	6,6Ω–12000W	RE4022660
	0067	2T BA2X2	5,0	5Ω–8000W	RE3762500
	0074	2T BA2X2	4,2	10Ω//10Ω–8000W**(nota1)**	2*RE3763100
	0086	2T BA2X2	4,2	10Ω//10Ω–8000W**(nota1)**	2*RE3763100
S30	0113	2T BA2X2	3,0	6,6Ω//6,6Ω–12000W**(nota2)**	2*RE4022660
	0129	2T BA2X2	3,0	6,6Ω//6,6Ω–12000W**(nota2)**	2*RE4022660
	0150	2T BA2X2	2,5	10Ω//10Ω//10Ω–12000W**(nota3)**	RE4023100
	0162	2T BA2X2	2,5	10Ω//10Ω//10Ω–12000W**(nota3)**	RE4023100
S40	0179	2T XA2X2	2*MFI-E 2T 45	6,6Ω//6,6Ω–6,6Ω–12000W**(nota4)**	3*RE4022660
	0200	2T XA2X2	2*MFI-E 2T 45	6,6Ω//6,6Ω–6,6Ω//6,6Ω–12000W **(nota4)**	4*RE4022660
	0216	2T XA2X2	2*MFI-E 2T 45	6,6Ω//6,6Ω–6,6Ω//6,6Ω–12000W	4*RE4022660
	0250	2T XA2X2	3*MFI-E 2T 45	6,6Ω//6,6Ω–6,6Ω//6,6Ω–6,6Ω –12000W**(nota4)**	5*RE4022660
S50	0312	2T XA2X0	3*MFI-E 2T 45	6,6Ω//6,6Ω–6,6Ω//6,6Ω–6,6Ω //6,6Ω–12000W**(nota4)**	6*RE4022660
	0366	2T XA2X0	3*MFI-E 2T 45	6,6Ω//6,6Ω//6,6Ω//6,6Ω//6,6Ω //6,6Ω–12000W**(nota4)**	6*RE4022660
	0399	2T XA2X0	4*MFI-E 2T 45	6,6Ω//6,6Ω–6,6Ω//6,6Ω–6,6Ω//6,6Ω –6,6Ω–12000W**(nota4)**	7*RE4022660

(note 1): Two parallel-connected resistors, 10Ohm/8000W
(note 2): Four parallel-connected resistors, 6.6Ohm/12000W
(note 3): Three parallel-connected resistors, 10Ohm/12000W
(note 4): For the connection of MFI and braking resistors, see manual relating to MFI braking module.

PERICOLO: Braking resistors may reach temperatures higher than 200°C.

ATTENZIONE: Power dissipated by braking resistors may be equal to approx. 50% of the connected motor rated power. Use a proper air-cooling system. Do not install braking resistors near heat-sensitive equipment or objects.

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

4.1.2 AVAIBLE MODELS

4.1.2.1 MODEL 56-100OHM/350W

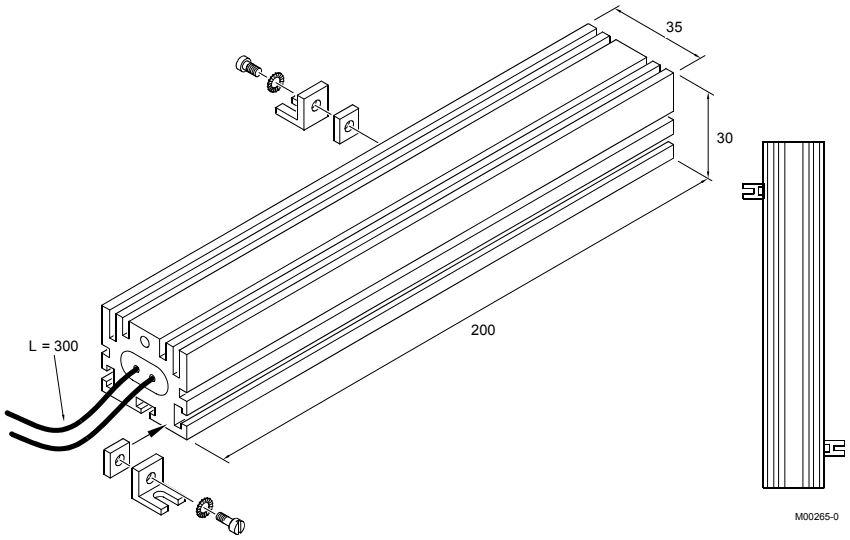


Fig. 4.1: Overall dimensions, resistor 56-100Ω/350W

Overall dimensions, resistor 56-100Ω/350W

Type	Wgt (g)	Degree of protection	Average pwr to be dissipated (W)	Max. duration of continuous operation for 200-240VAC (s)*
56Ohm/350W RE2643560	400	IP55	350	3.5
100Ohm/350W RE2644100	400	IP55	350	3.5

(*) max. value to be set for parameter Brake Enable (C68 (IFD SW) or C60 (VTC SW)). Set Brake Disable C67 (IFD SW) or C59 (VTC SW) so as not to exceed the max. power to be dissipated by the braking resistor. Set Brake Disable=0 and Brake enable≠0 not to limit the operation of the built-in braking module.

4.1.2.2 MODEL 75OHM/1300W

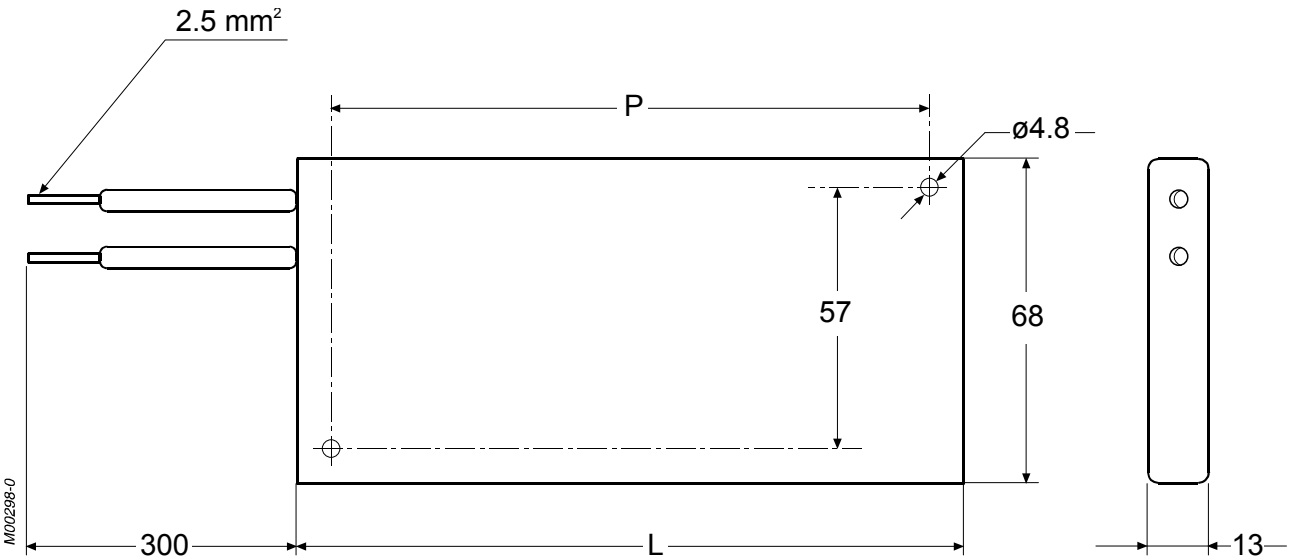


Fig.4.2: Overall dimensions and ratings for braking resistor 75Ω/1300W

Overall dimensions and ratings, resistor 75Ω/1300W

Type	L (mm)	P (mm)	Wgt (g)	Degree of Protection	Average power to be dissipated (W)	Max. duration of continuous operation for 380-500VCA (s)*
75Ohm/750W RE3063750	195	174	500	IP33	550	2.25

(*) max. value to be set for parameter Brake Enable (C68 (IFD SW) or C60 (VTC SW)). Set Brake Disable C67 (IFD SW) or C59 (VTC SW) so as not to exceed the max. power to be dissipated by the braking resistor. Set Brake Disable=0 and Brake enable≠0 not to limit the operation of the built-in braking module.

4.1.2.3 MODELS FROM 1100W TO 2200W

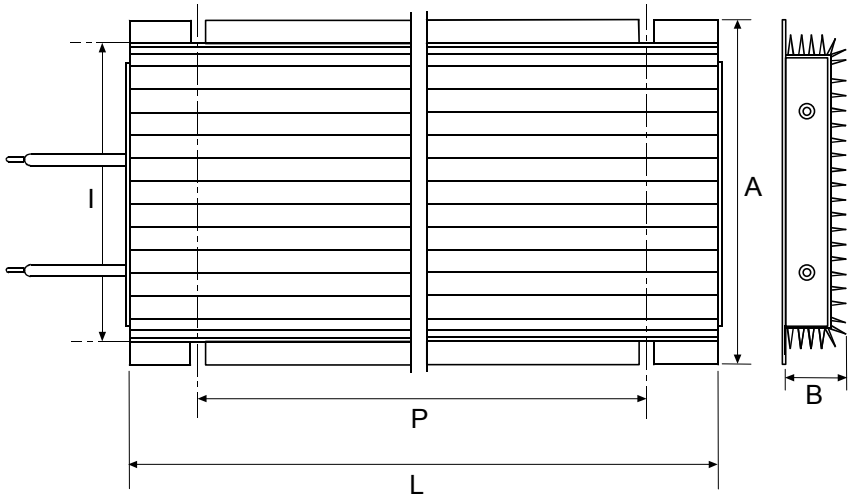


Fig.4.3: Overall dimensions and mechanical features for braking resistors from 1100W to 2200 W

Overall dimensions and mechanical features, braking resistors 1100W to 2200 W

Type	A (mm)	B (mm)	L (mm)	I (mm)	P (mm)	Wgt (g)	Degree of protection	Mean power to be dissipated (W)	Max. duration of continuous operation	
									380-500Vac (s)*	200-240Vac (s)*
15Ohm/1100W RE3083150	95	30	320	80-84	240	1250	IP55	950	not applic.	6
20Ohm/1100W RE3083500									not applic.	8
50Ohm/1100W RE3083500									5	20
10Ohm/1500W RE3093100	120	40	320	107-112	240	2750	IP54	1100	not applic.	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 Brake Enable (C68 (IFD SW) or C60 (VTC SW)). Set Brake Disable C67 (IFD SW) or C59 (VTC SW) so as not to exceed the max. power to be dissipated by the braking resistor. Set Brake Disable=0 and Brake enable≠0 not to limit the operation of the built-in braking module.

4.1.2.4 MODELS 4KW-8KW-12KW

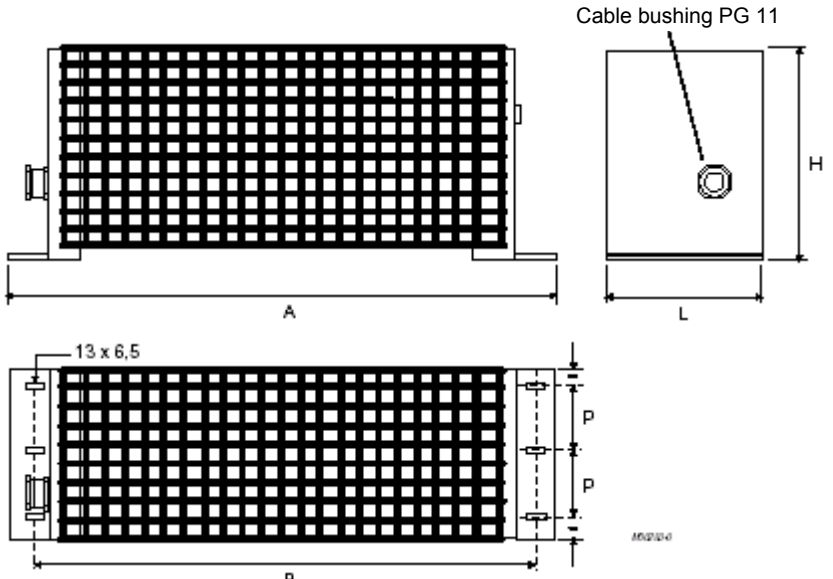


Fig.4.4: Overall dimensions, 4kW, 8kW, and 12kW

RESISTOR	A (mm)	B (mm)	L (mm)	H (mm)	P (mm)	Wgt (Kg)	Degree of protection	Mean power to be dissipated (W)	Max. duration of continuous operation	
									380-500Vac (s)*	200-240Vac (s)*
5Ω4KW RE3482500	620	600	100	250	40	5.5	IP20	4000	not applic.	10
15Ω4KW RE3483150									5	100
25Ω4kW RE3483250									20	not limited
39Ω4kW RE3483390									60	
50Ω4kW RE3483500									90	
3.3Ω/8kW RE3762330	620	600	160	250	60	10.6	IP20	8000	not applic.	5
5Ω/8kW RE3762500									not applic.	40
10Ω/8kW RE3763100									2	100
3.3 Ω/12kW RE4022330	620	600	200	250	80	13.7	IP20	12000	not applic.	70
6.6Ω/12kW RE4022660									5	200
10Ω/12kW RE4023100									12	not limited

(*) max. value to be set in parameter Brake Enable (C68 (IFD SW) or C60 (VTC SW)). Set Brake Disable C67 (IFD SW) or C59 (VTC SW) so as not to exceed the max. power to be dissipated by the braking resistor. Set Brake Disable=0 and Brake enable≠0 not to limit the operation of the built-in braking module.

4.1.2.5 MODELS – BOX RESISTORS IP23, 4KW-64KW

OVERALL DIMENSIONS

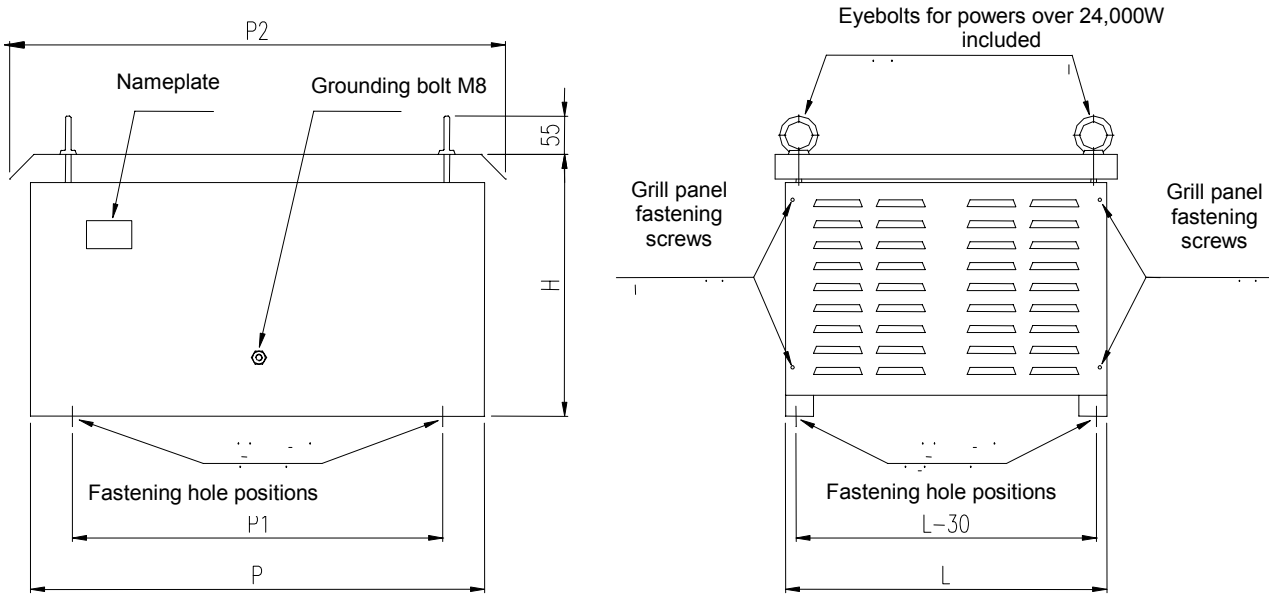


Fig.4.5: Box Resistor IP23

WIRING

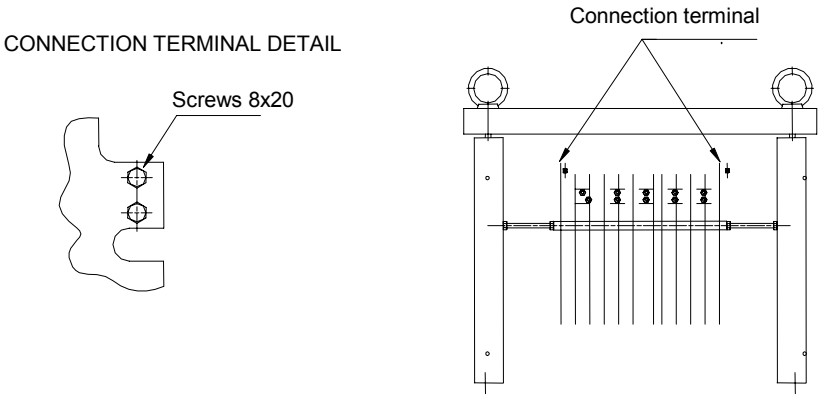


Fig.4.6 Position of electrical connections in box resistors

Remove grids to gain access to wiring terminals.
Important: Figure shows resistor 20Ohm/12kW. For certain models, remove both panels to gain access to wiring terminals.

RESISTOR	P (mm)	P1 (mm)	P2 (mm)	L (mm)	H (mm)	Weight (Kg)	Degree of protection	Mean power to be dissipated (W)	Max. duration of continuous operation (s)*	
									380-500VAC	200-240VAC
50Ω/4KW RE3503500	650	530	710	320	375	20	IP23	4000		not limited
50Ω/8KW RE3783500	650	530	710	380	375	23	IP23	8000		not limited
20Ω/12KW RE4053200	650	530	710	460	375	34	IP23	12000		not limited
15Ω/16KW RE4163150	650	530	710	550	375	40	IP23	16000		not limited
10Ω /24kW RE4293100	650	530	710	750	375	54	IP23	24000		not limited
6.6Ω/32kW RE4362660	650	530	710	990	375	68	IP23	32000		not limited
6Ω/48kW **RE4452600**	650	530	710	750	730	101	IP23	48000		not limited
5Ω/64kW **RE4552500**	650	530	710	990	730	128	IP23	64000		not limited

(*) max. value to be set for parameter Brake Enable (C68 (IFD SW) or C60 (VTC SW)). Set Brake Disable C67 (IFD SW) or C59 (VTC SW) so as not to exceed the max. power to be dissipated by the braking resistor. Set Brake Disable=0 and Brake enable≠0 not to limit the operation of the built-in braking module.

4.2 BRAKING MODULE

A braking module is available to be connected to terminals + and – (see paragraph 1.4 "Wiring") of the inverter for sizes S40 to S70. Braking modules can be used when a high braking torque is needed, particularly when a prompt braking is needed for high inertial loads (e.g. fans).

4.3 REMOTING KIT

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: 5m).

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

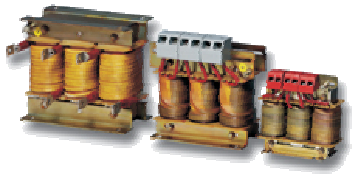
4.4 REACTANCE

4.4.1 INPUT INDUCTANCE

We suggest that a three-phase inductance be installed on the supply line to obtain the following benefits:

- limit input current peaks and improve input current shape;
- reducing supply harmonic current;
- increasing power factor, thus reducing line current;
- increasing the duration of line capacitors inside the inverter.

Harmonic current



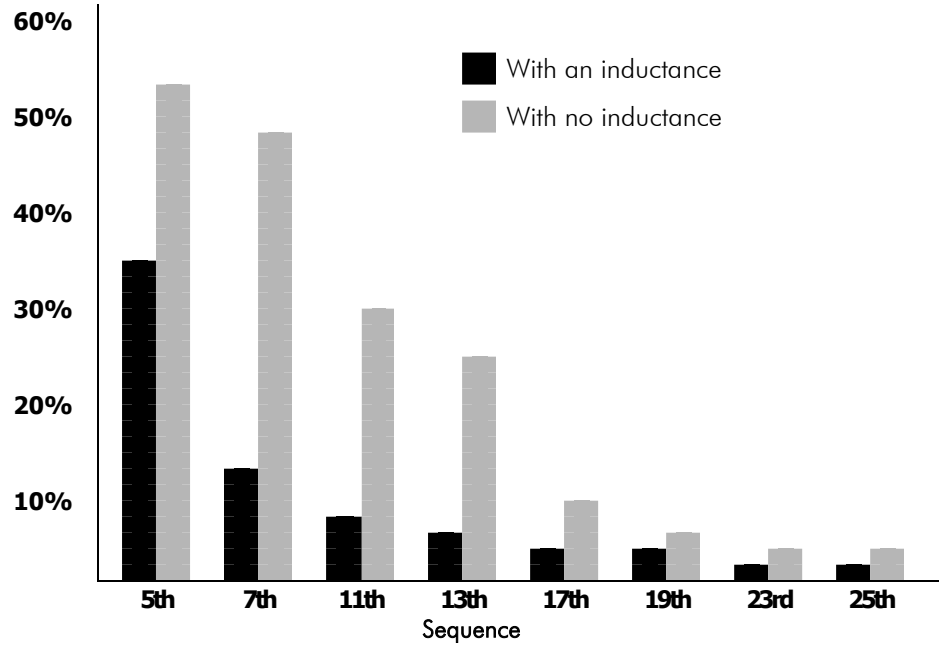
The shapes of the different waves (current or voltage) may be expressed as the sum of the basic frequency (50 or 60Hz) and its multiples. In balanced, three-phase systems, only odd harmonic current exists, as even current is neutralized by symmetrical considerations.
Harmonic current is generated by 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 $n=6K\pm1$ with $K=1,2,3,\ldots$ (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. Unlike DC inductance, AC inductance suppresses most harmonic currents and protects the rectifier from supply voltage peaks.

For >500kW drives, a *12-pulse* inductance is normally used. This suppresses the lowest harmonic current in the supply line. In a 12-pulse inductance, the lowest harmonics 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.

Harmonic currents



Input reactance L2 and L4 are available, having a different inductance value. Section 4.4.2 details the inductance ratings based on the inverter size.

4.4.2 INDUCTANCE RATINGS

INVERTER	MODEL	INVERTER CURRENT	type L2	code	type L4	code
			mH		mH	
S05	0005	10.5	1.1	IM0120204	0.15	3x IM0100354
	0007	12.5	1.1	IM0120204	0.15	3x IM0100354
	0009	16.5	1.1	IM0120204	0.15	3x IM0100354
	0011	16.5	1.1	IM0120204	0.15	3x IM0100354
	0014	16.5	1.1	IM0120204	0.15	3x IM0100354
S10	0017	30	0.3	IM0120254	0.045	IM0122104
	0020	30	0.3	IM0120254	0.045	IM0122104
	0025	41	0.3	IM0120254	0.045	IM0122104
	0030	41	0.3	IM0120254	0.045	IM0122104
	0035	41	0.3	IM0120254	0.045	IM0122104
S15	0040	72	0.3	IM0120254	0.045	IM0122104
S20	0049	80	0.18	IM0120304	0.03	IM0122154
	0060	88	0.18	IM0120304	0.03	IM0122154
	0067	103	0.18	IM0120304	0.03	IM0122154
	0074	120	0.18	IM0120304	0.03	IM0122154
	0086	135	0.12	IM0120354	0.02	IM0122204
S30	0113	180	0.09	IM0120404	0.015	IM0122254
	0129	195	0.09	IM0120404	0.015	IM0122254
	0150	215	0.09	IM0120404	0.015	IM0122254
	0162	240	0.062	IM0120504	0.01	IM0122304
S40	0179	300	0.062	IM0120504	0.01	IM0122304
	0200	345	0.04	IM0120604	0.0062	IM0122404
	0216	375	0.04	IM0120604	0.0062	IM0122404
	0250	390	0.04	IM0120604	0.0062	IM0122404
S50	0312	480	0.04	IM0120604	0.0062	IM0122404
	0366	550	0.025	IM0120704	0.0045	IM0122604
	0399	630	0.025	IM0120704	0.0045	IM0122604

CAUTION: Always use L2 inductance under the following circumstances: mains instability; converters installed for DC motors; loads generating strong voltage variations at startup; mains power exceeding 500 KVA.

4.4.2.1 L2 REACTANCE RATINGS

Code	Current	Inductance	Power loss	Size									Wgt	Figure
tipe L2	A	mH	Watt	A	B	C	E	G	H	J	M	foro	kg	
IM0120154	18	1.1	35	120	75	14	67	55	130	61	25	5	2,5	A
IM0120204	35	0.60	60	170	105	15	125	70	175	90	40	14x7	5	A
IM0120254	70	0.30	80	180	140	35	150	80	160	110	60	14x7	8	B
IM0120304	120	0.18	100	180	145	40	150	80	160	109	60	14x7	9	B
IM0120354	170	0.13	170	240	185	43	200	110	205	145	80	18x7	17	B
IM0120404	235	0.090	170	240	195	39	200	120	205	155	80	18x7	22	B
IM0120504	335	0.062	180	300	215	45	250	130	260	170	100	24x9	43	C
IM0120604	520	0.040	300	300	230	60	250	130	290	170	100	24x9	53	C
IM0120704	780	0.025	410	360	265	55	300	160	310	200	120	24x9	68	C

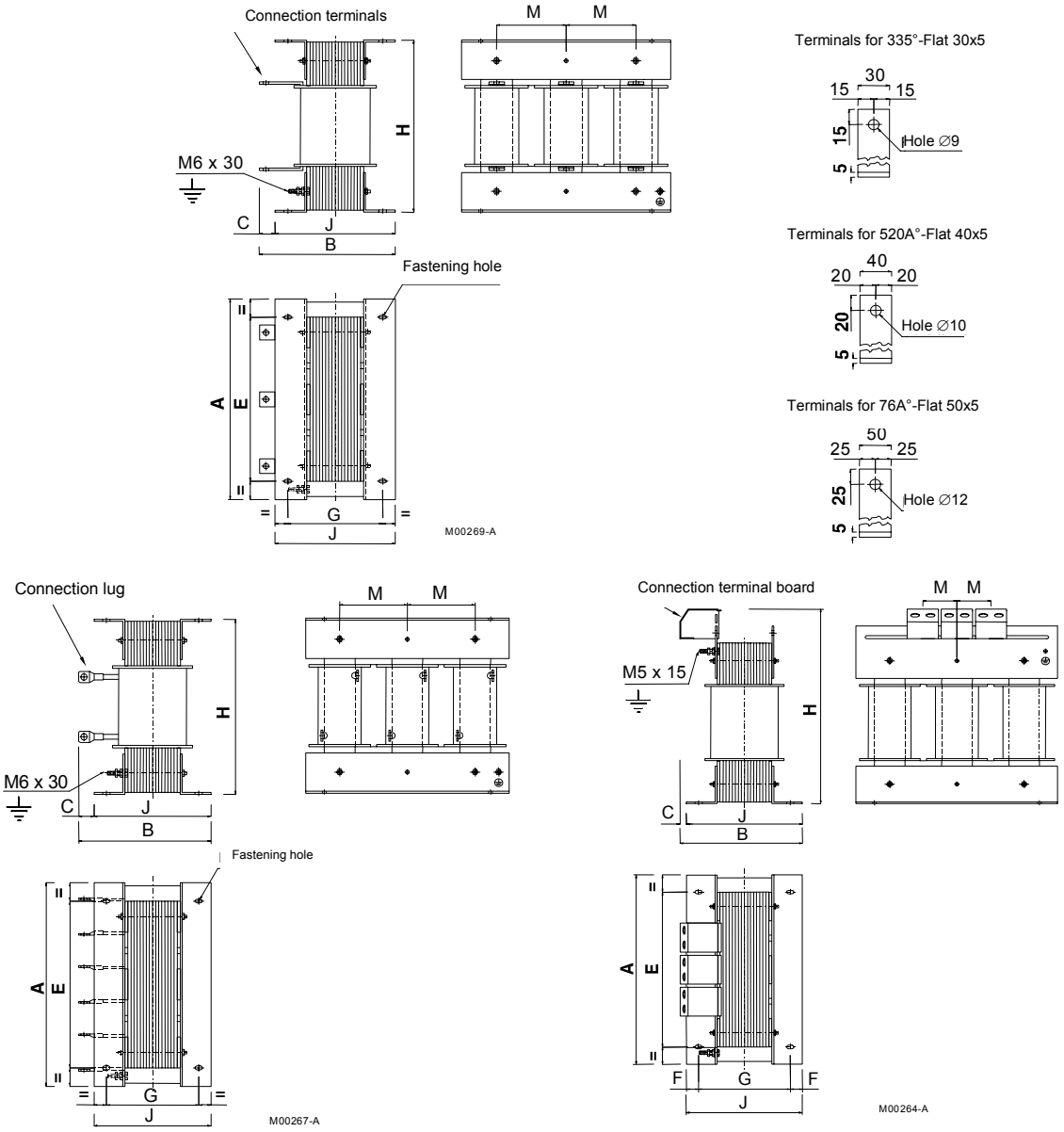


Fig.4.5: Overall dimensions of L2 reactance

4.4.2.2 L4 REACTANCE RATINGS

Code	Current	Induttance	Power loss	Size (mm)									Wgt	Fig
tipo L4	A	mH	Watt	A	B	C	E	G	H	J	M	foro	kg	
IM0122104	70	0.045	25	150	105	29	125	60	135	76	50	14x7	4	D
IM0122154	120	0.030	25	150	125	35	125	75	135	90	50	14x7	5	D
IM0122204	170	0.020	45	180	150	55	150	65	160	95	60	14x7	5,5	D
IM0122254	235	0.015	60	180	150	55	150	65	160	95	60	14x7	6	D
IM0122304	335	0.010	90	180	130	35	150	65	160	95	60	14x7	7,5	E
IM0122404	520	0.0062	180	240	200	60	200	110	250	140	80	18x7	22	E
IM0122504	780	0.0045	300	240	190	55	200	100	260	135	80	18x7	28	E

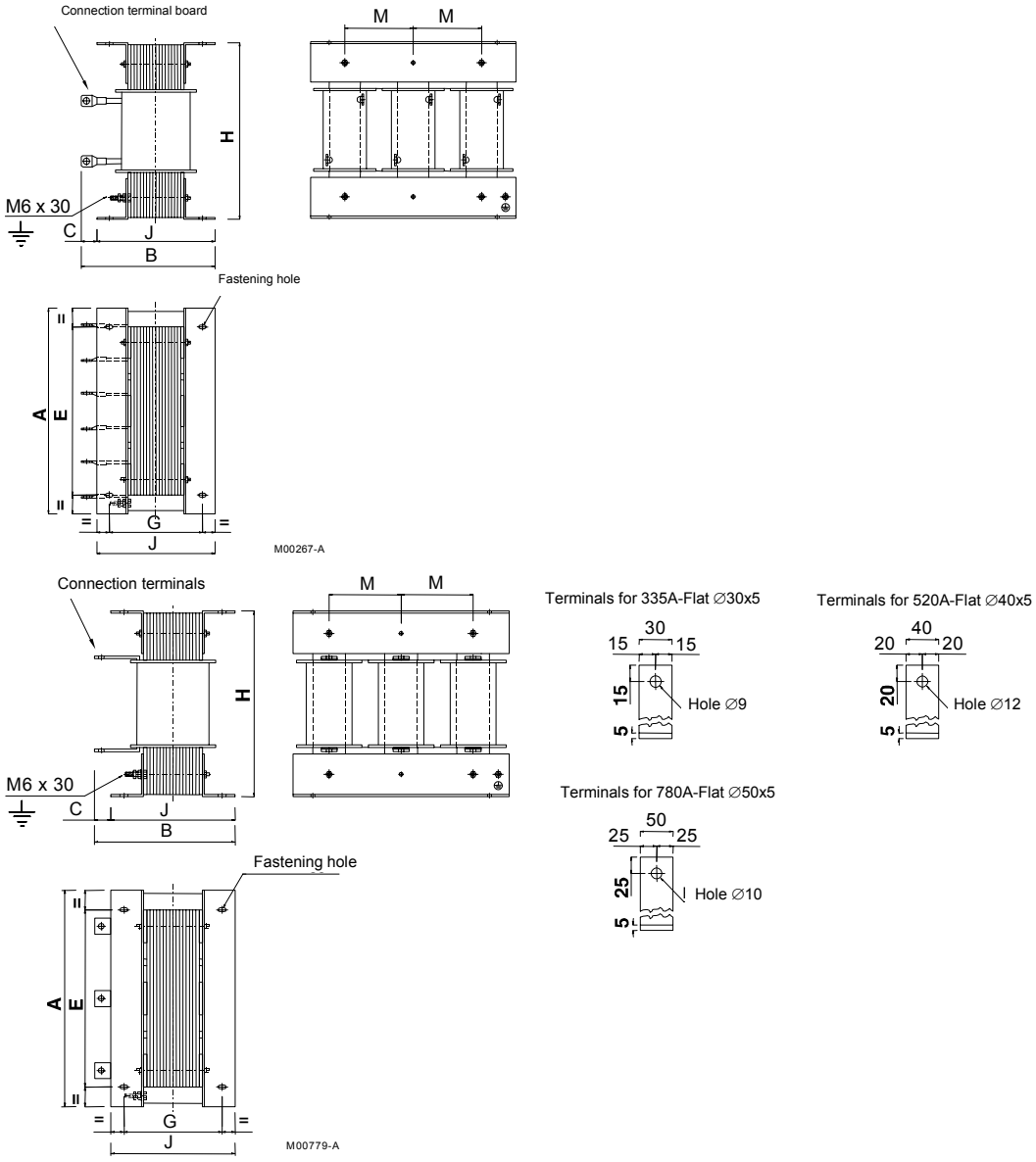


Fig.4.6 Overall dimensions of L4 reactance

4.4.2.3 L4 SINGLE-PHASE REACTANCE RATINGS

Code	Current	Inductance	Power loss	SIZE								Wgt
type L4	A	mH	Watt	A	B	C	E	H	W	J	Hole	kg
IM0100354	35	0.15	6	95	58	12	80	0	34	-	8x4	1

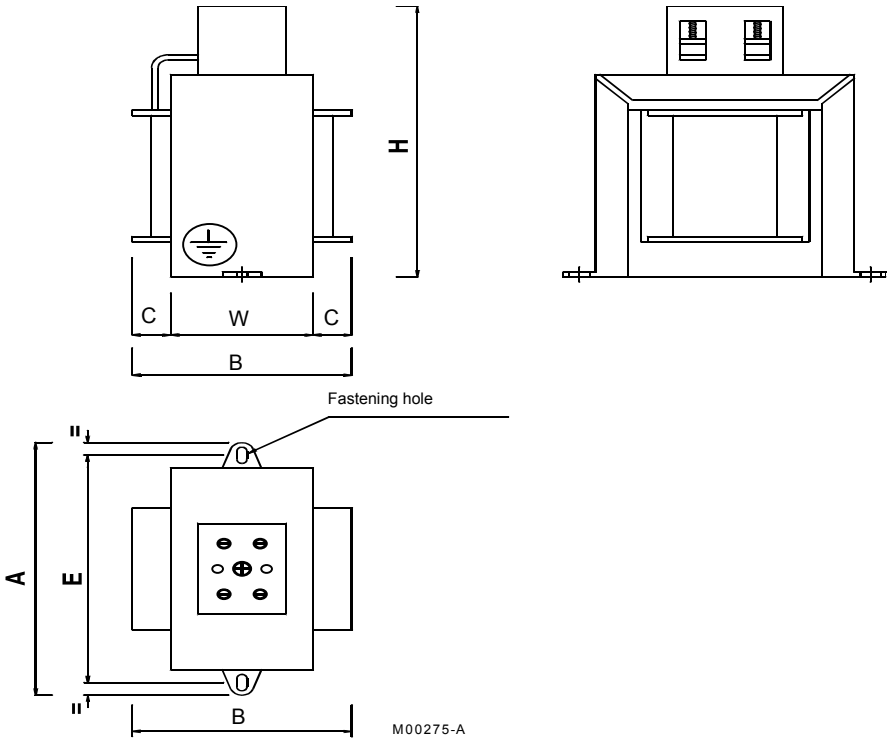


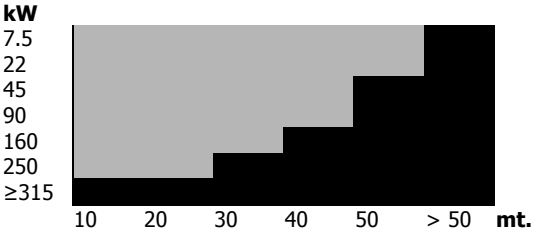
Fig.4.7: Overall dimensions of single-phase reactance L4

4.4.3 OUTPUT REACTANCE

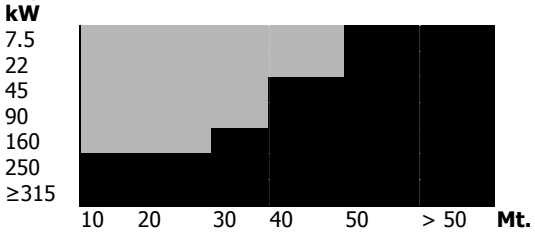
Installations requiring a longer distance between the inverter and the motor may cause overcurrent protections to frequently trip. This is due to the wire parasite capacity generating current pulses at the inverter output. This current peaks may be limited by an inductance installed on the inverter output. Screened cables even have a higher capacity and may have problems with a shorter length. L2 input inductance may also be installed on the inverter output (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 on the output of each inverter.

Motor wiring with unscreened cables

2-4-6-pole MOTORS

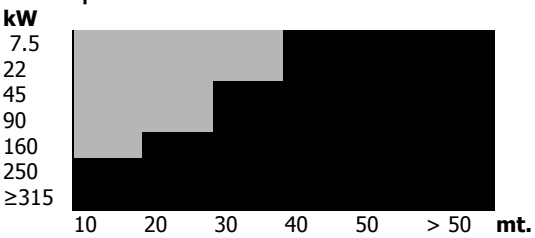


8-pole MOTORS

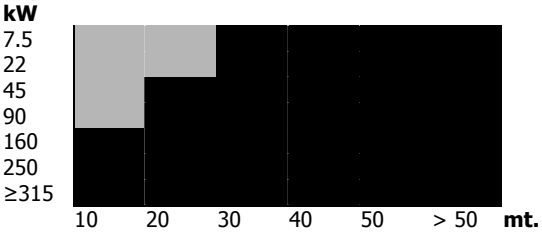


Motor wiring with screened cables

2-4-6-pole MOTORS

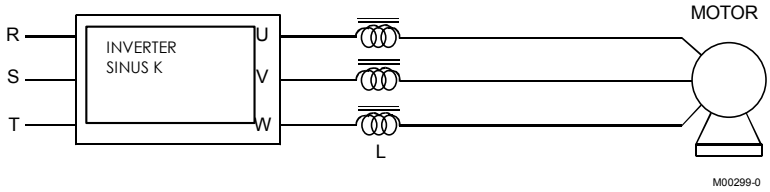


8-pole MOTORS



Always use an output inductance for >= 10-pole motors or parallel-connected motors controlled by a single inverter

Output inductance NOT required
Output inductance REQUIRED



Output inductance wiring

:

CAUTION

L2 inductance 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.

NOTA:

When using 10-pole motors, >10-pole motors or parallel-connected motors controlled by one inverter, the output inductance is always required.

4.5 ENCODER BOARD ES836

Board for incremental, bidirectional encoder to be used as a speed feedback for inverters of the SINUS PENTA series.

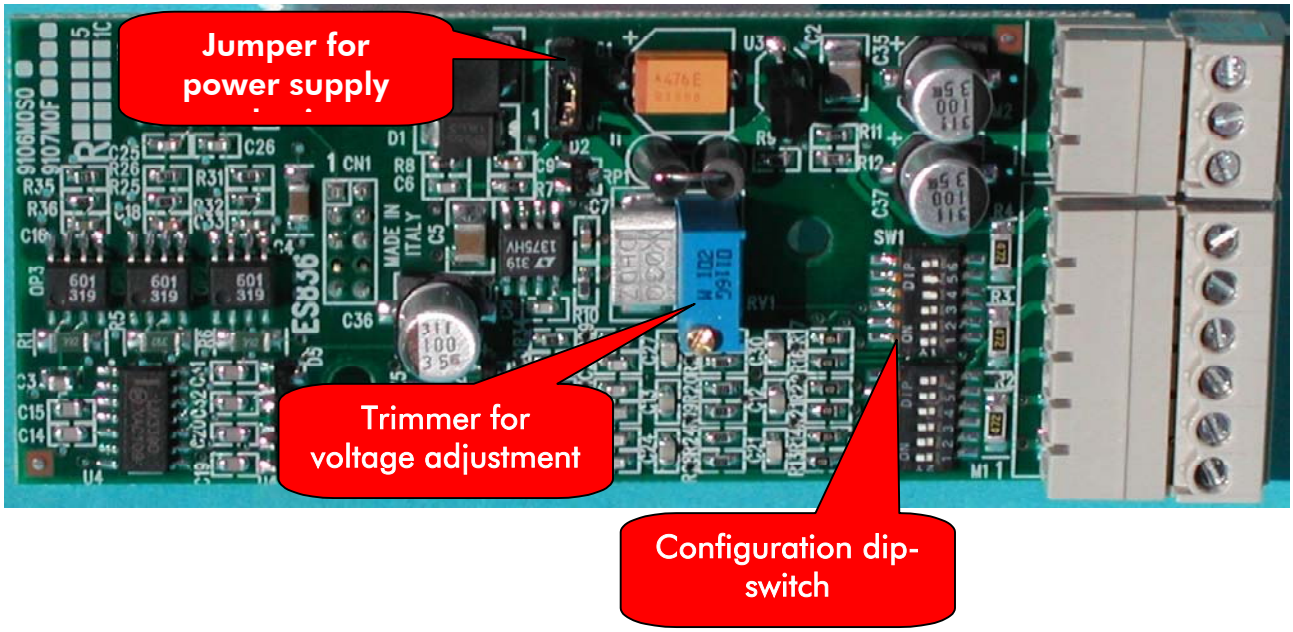


Fig.4.11. Encoder board ES836

DESCRIPTION	ID NUMBER	COMPATIBLE ENCODERS	
		POWER SUPPLY	OUTPUT
Encoder board ES836	ZZ0095832	5V, 12V or 24V	LINE DRIVER, PNP, NPN, PUSH-PULL

4.5.1 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 (a.s.l.)

4.5.2 ELECTRICAL FEATURES

Connection to encoder	*Value*			
	Min	*Typ*	*Max*	*Unit of m.*
Encoder supply current, +24V, protected with self-resetting 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	Differential or single-ended			
Voltage range for encoder input signals	4		24	V
Pulse max. frequency with noise filter setting on	77kHz (1024imp @ 4500rpm)			
Pulse max. frequency with noise filter setting off	155kHz (1024imp @ 9000rpm)			
Input impedance in NPN or PNP mode (auxiliary pullup or pulldown resistors required)		15k		Ω
Input impedance in line driver mode or push-pull mode		3600		Ω

ISOLATION:

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

4.5.3 INSTALLING THE ENCODER BOARD ON THE INVERTER

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 left.

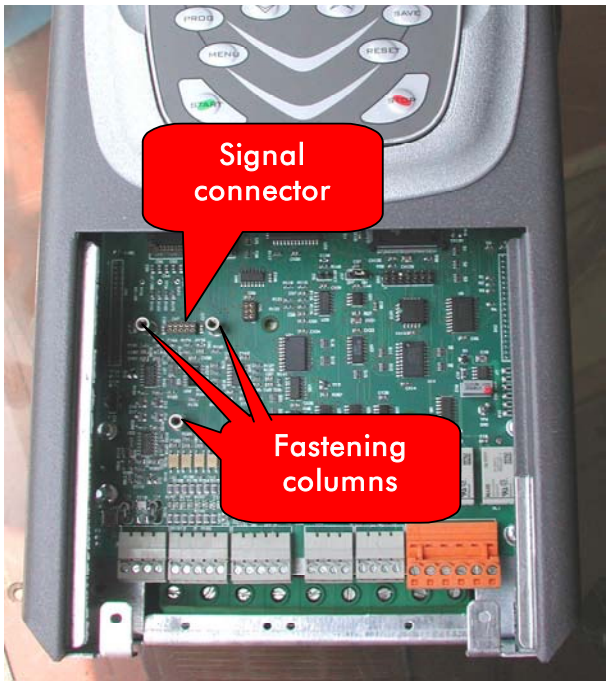


Fig.4.12. Position of the slot for the encoder board installation

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 metal columns using the screws supplied.
4) Configure 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) Turn on the inverter and set the parameters relating to the encoder feedback (see Programming Manual).

Fig.4.13. Encoder board fastened to its slot

4.5.4 ENCODER BOARD TERMINALS

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

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	~~CHA~~	Encoder input channel A inverse polarity
3	CHB	Encoder input channel B true polarity
4	~~CHB~~	Encoder input channel B inverse polarity
5	CHZ	Encoder input channel Z (zero notch) true polarity
6	~~CHZ~~	Encoder input channel Z (zero notch) inverse polarity
7	+VE	Encoder supply output 5V/12V/24V
8	GNDE	Encoder supply grounding
9	GNDE	Encoder supply grounding

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

4.5.5 DIP-SWITCHES

Encoder board ES836 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 and are adjusted as shown in the figure below:

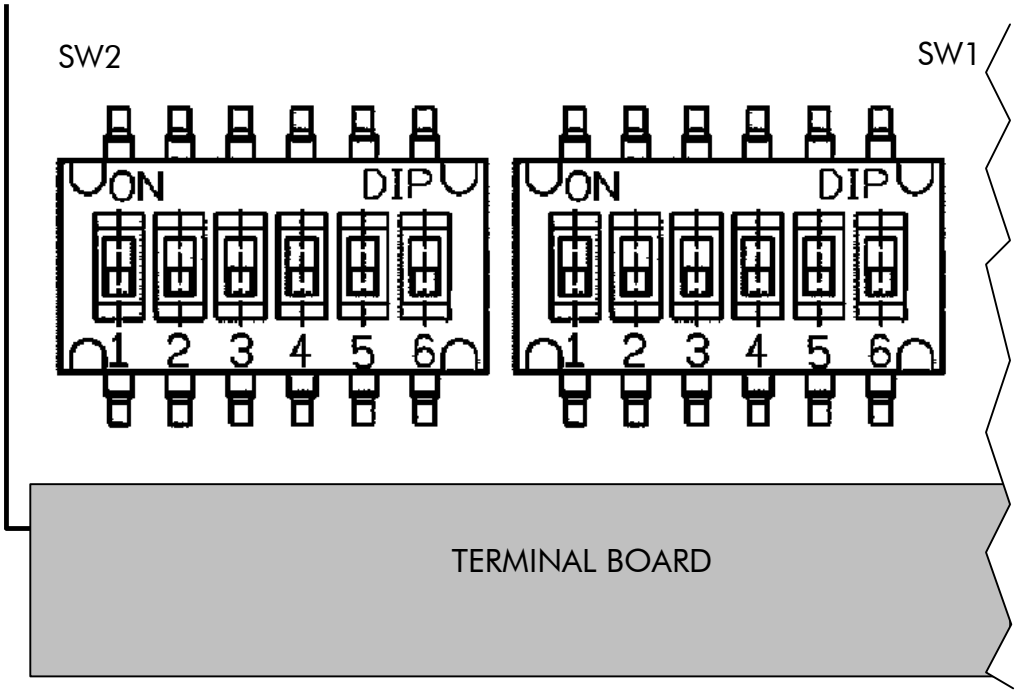


Fig.4.14. Position of dip-switches

Dip-switch functionality is detailed in the table below:

Switch	*OFF - open*	*ON - closed*
SW2 – 1	Channel Z, with no band limit	Channel Z, with band limit
SW2 – 2	Channel Z, differential Line driver	Channel Z, single-ended
SW2 – 3	Channel Z, type NPN or PNP	Channel Z, Line driver or Push Pull
SW2 – 4	Channel B, with no band limit	Channel B, with band limit
SW2 – 5	Channel B, differential Line driver	Channel B, single-ended
SW2 – 6	Channel B, type NPN or PNP	Channel B, Line driver or Push Pull
SW1 – 1	Channel A, with no band limit	Channel A, with band limit
SW1 – 2	Channel A, differential Line driver	Channel A, type single-ended
SW1 – 3	Channel A, type NPN or PNP	Channel A, type Line driver or Push Pull
SW1 – 4	Not used	Not used
SW1 – 5	Not used	Not used
SW1 – 6	Supply voltage: 12V	Supply voltage: 5V

4.5.6 JUMPER SELECTING THE TYPE OF ENCODER SUPPLY

Two-position jumper J1 installed on control board ES836 allows to set the encoder supply voltage. 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 SW1-6 (see table above).

4.5.7 TRIMMER

Trimmer RV1 installed on board ES836 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.

Adjustment procedure:

1. put a tester on the encoder supply connector (encoder side of the connecting cable); make sure the encoder is on.

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 if 24V power supply of is delivered.

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.

4.5.8 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 SW2-1, SW2-4, and SW1-1 are in position ON, i.e. 77kHz 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 SW1-6 is not shown in the figures because its setting depends on the supply voltage required by the encoder. See previous sections of this manual.

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 any detail.

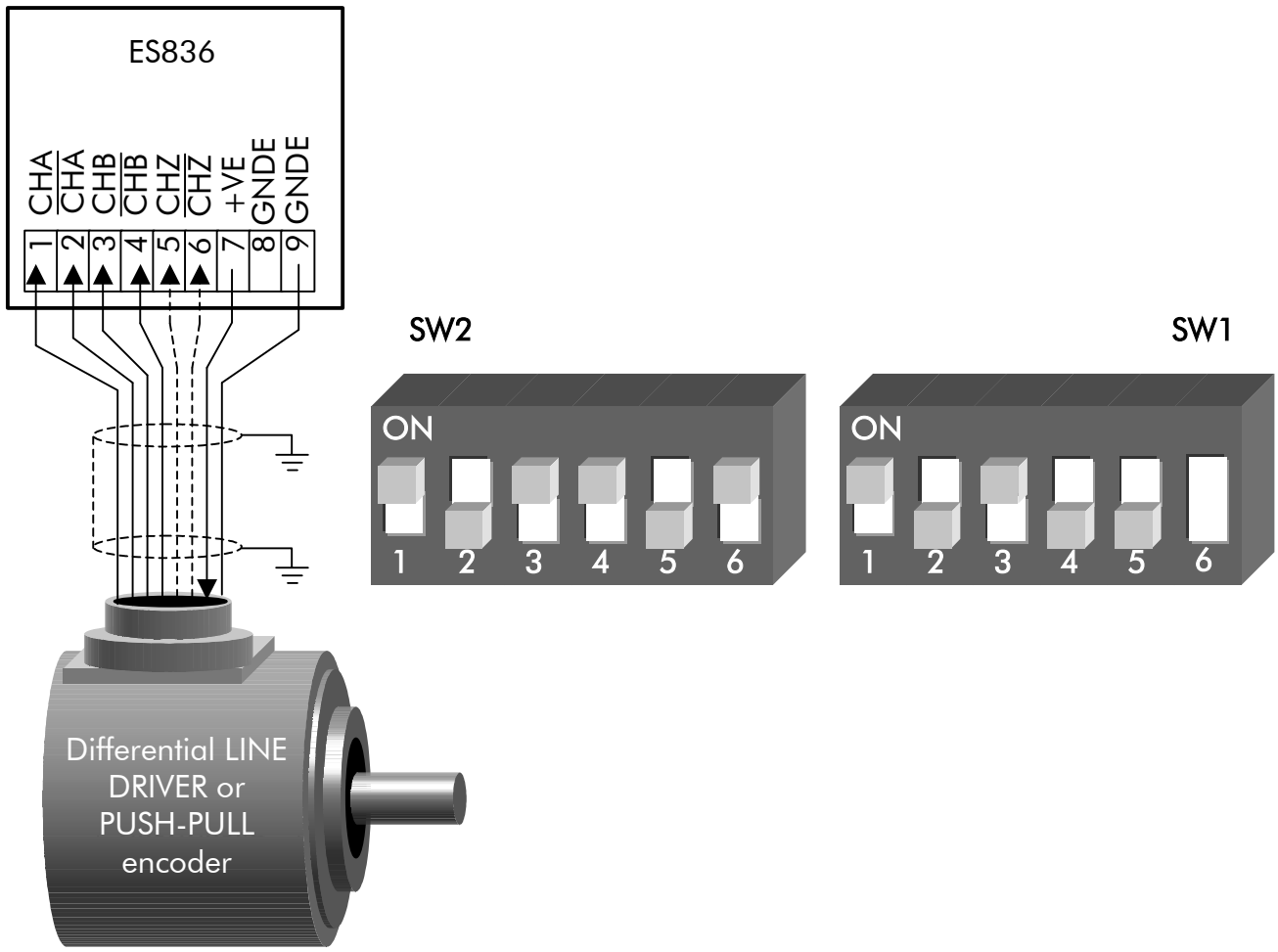


Fig.4.15) LINE DRIVER or PUSH-PULL encoder with complementary outputs

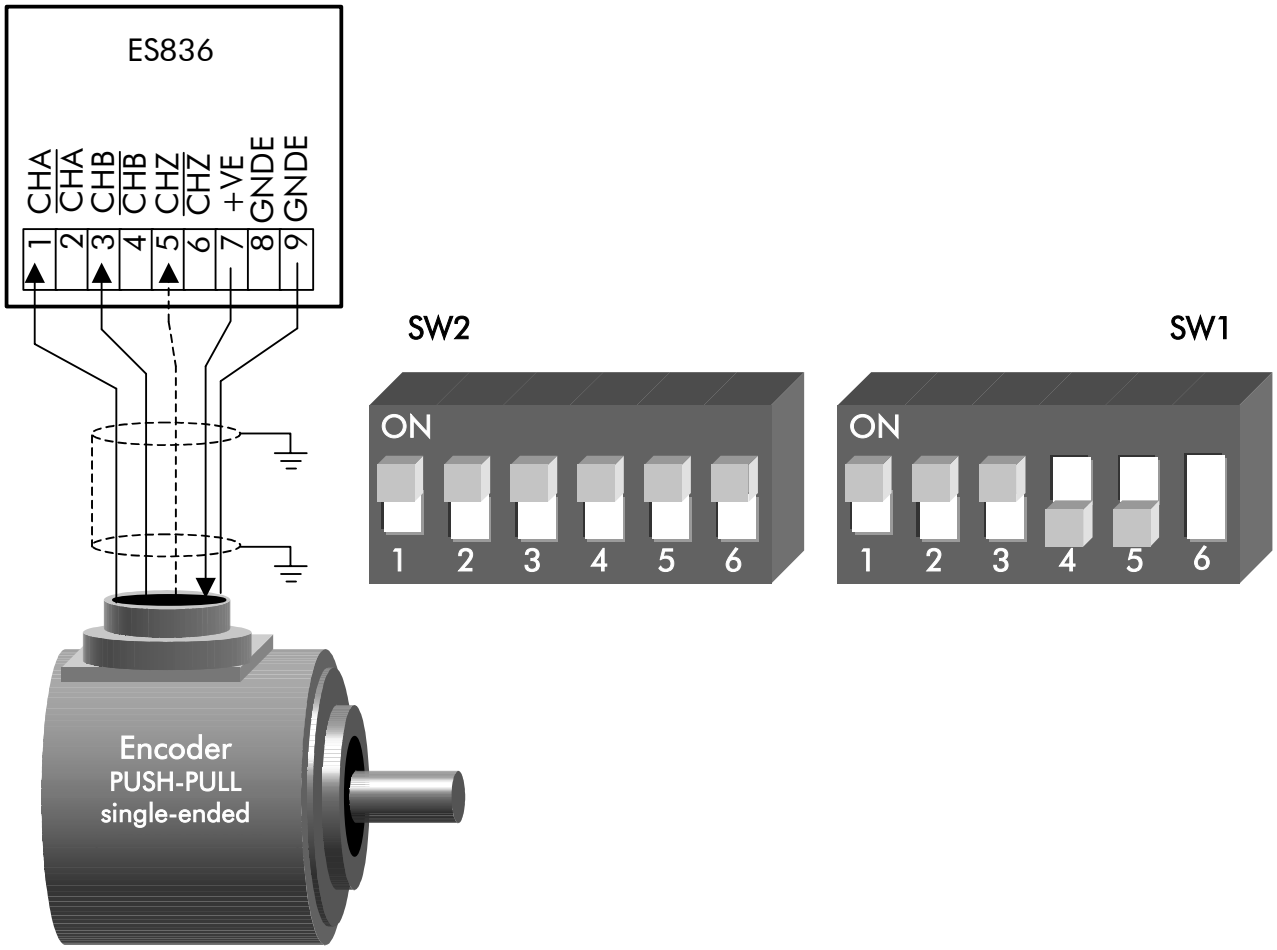


Fig.4.16) PUSH-PULL encoder with single-ended outputs

CAUTION: Because settings required for a single-ended encoder (dip-switches SW2-1, SW2-5, SW1-2 closed) 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.

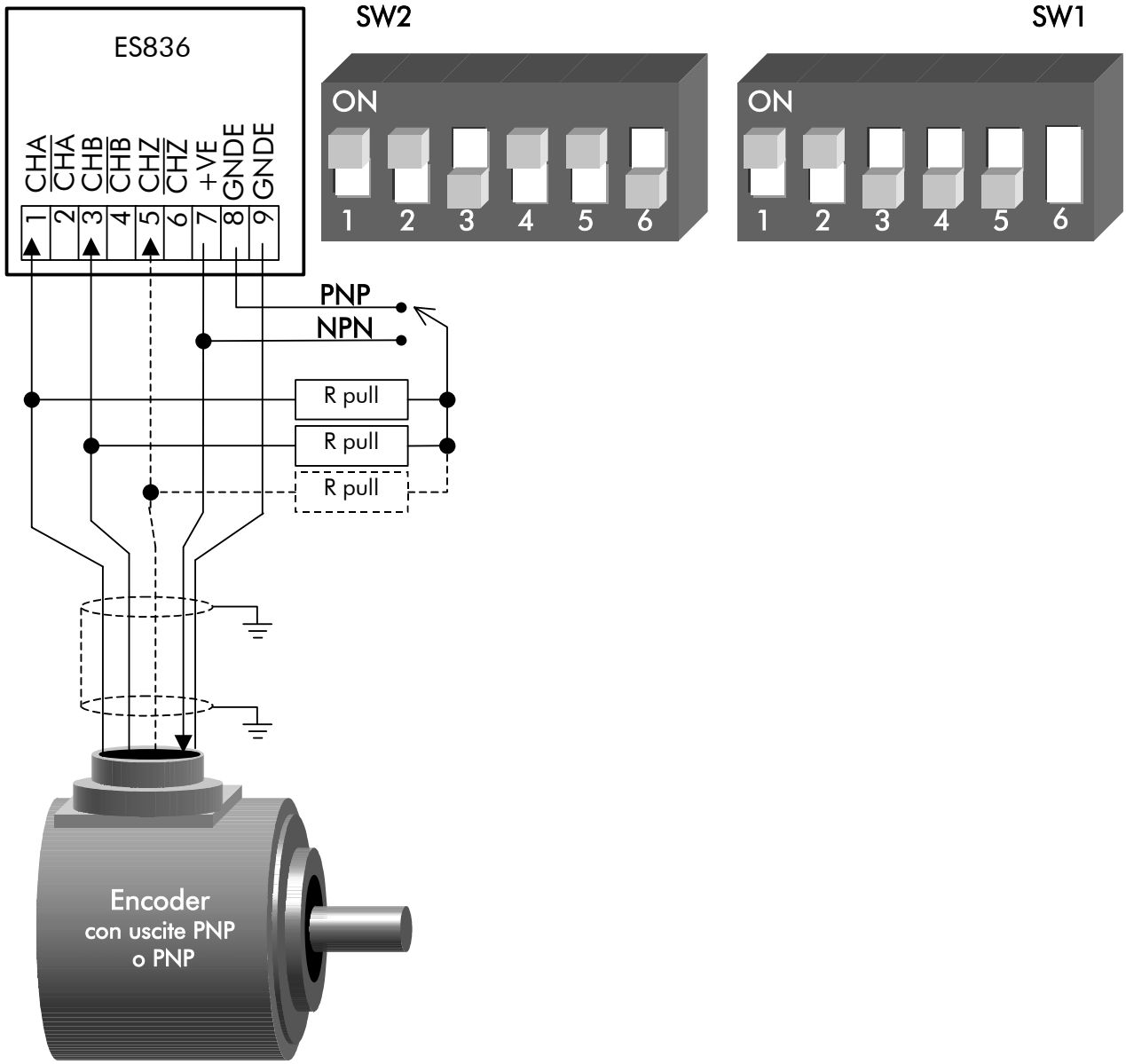


Fig.4.17) PNP or NPN encoder with single-ended outputs and load resistors with external wiring

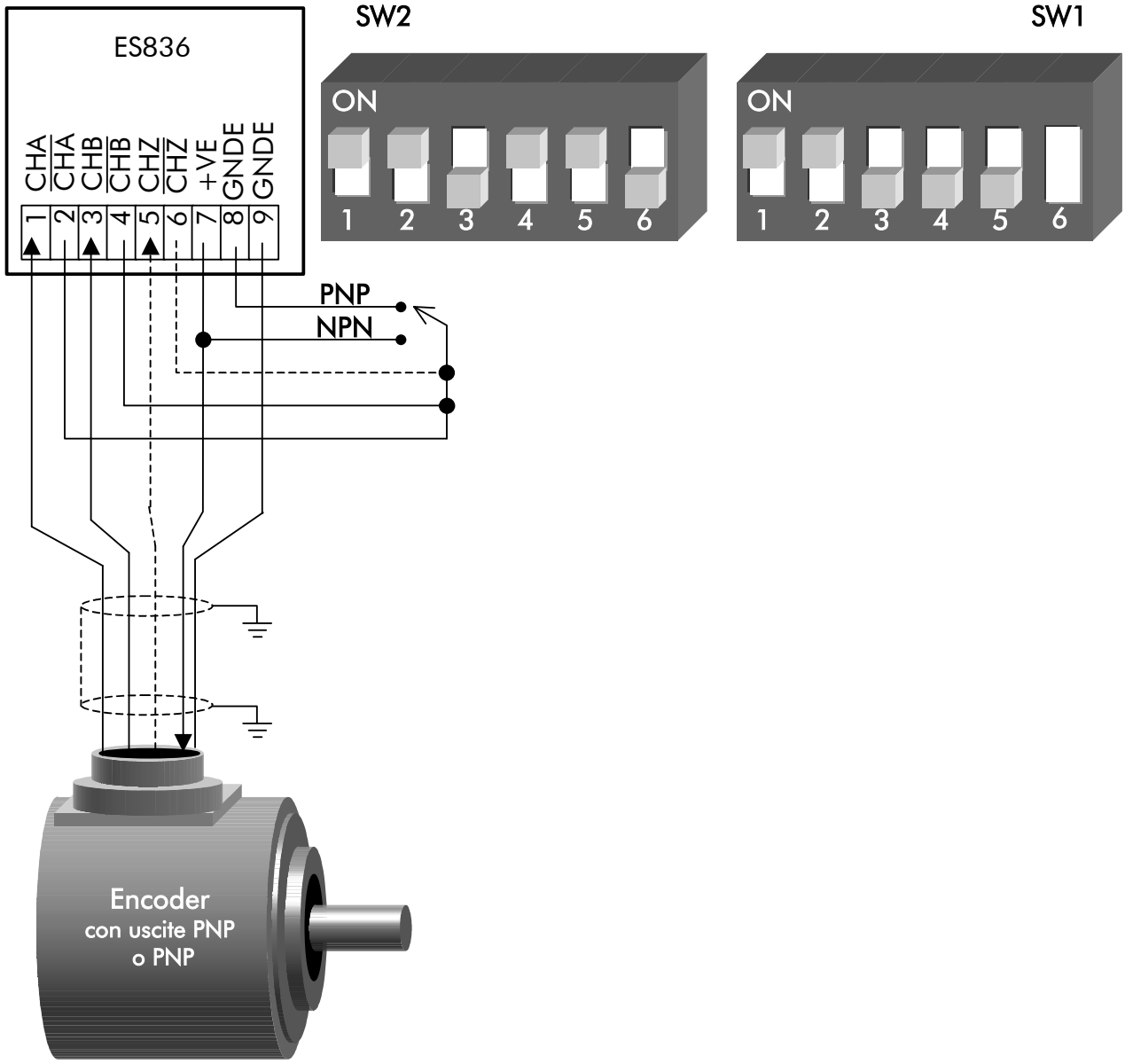


Fig.4.18) PNP or NPN encoder with single-ended outputs and incorporated load resistors (4700Ω)

NOTE:

NPN or PNP encoders are provided with outputs requiring a resistive, pull-up or pull-down load towards the power supply or the common. Load resistors are to be externally connected because their ratings are defined by the encoder manufacturer. Connect the resistor common to the mains for a NPN encoder or to the common for a PNP encoder.
Incorporated load resistors may be used only if the encoder can operate with 4700Ω resistors. Their wiring is shown in Figure 4.18.

NOTE:

NPN or PNP encoders cause pulse distortions because ramps up and ramps down are different. Distortion depends on the load resistors 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.

4.5.9 WIRING

Use a screened cable to connect the encoder to the 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.

Fig.4.18 – 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 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 a difficult speed adjustment or uneven operation of the inverter; in the worst cases, it can lead to the inverter stop due to overcurrent conditions.

4.6 ISOLATED SERIAL BOARD ES822

Isolated serial board RS 232/485 controlling SINUS PENTA and SINUS K inverters. Allows to connect a computer through interface RS232 or allows a multidrop connection of modbus devices through interface RS485. Provides galvanic isolation of interface signals relating to both the control board ground and the terminal board common of the control board.

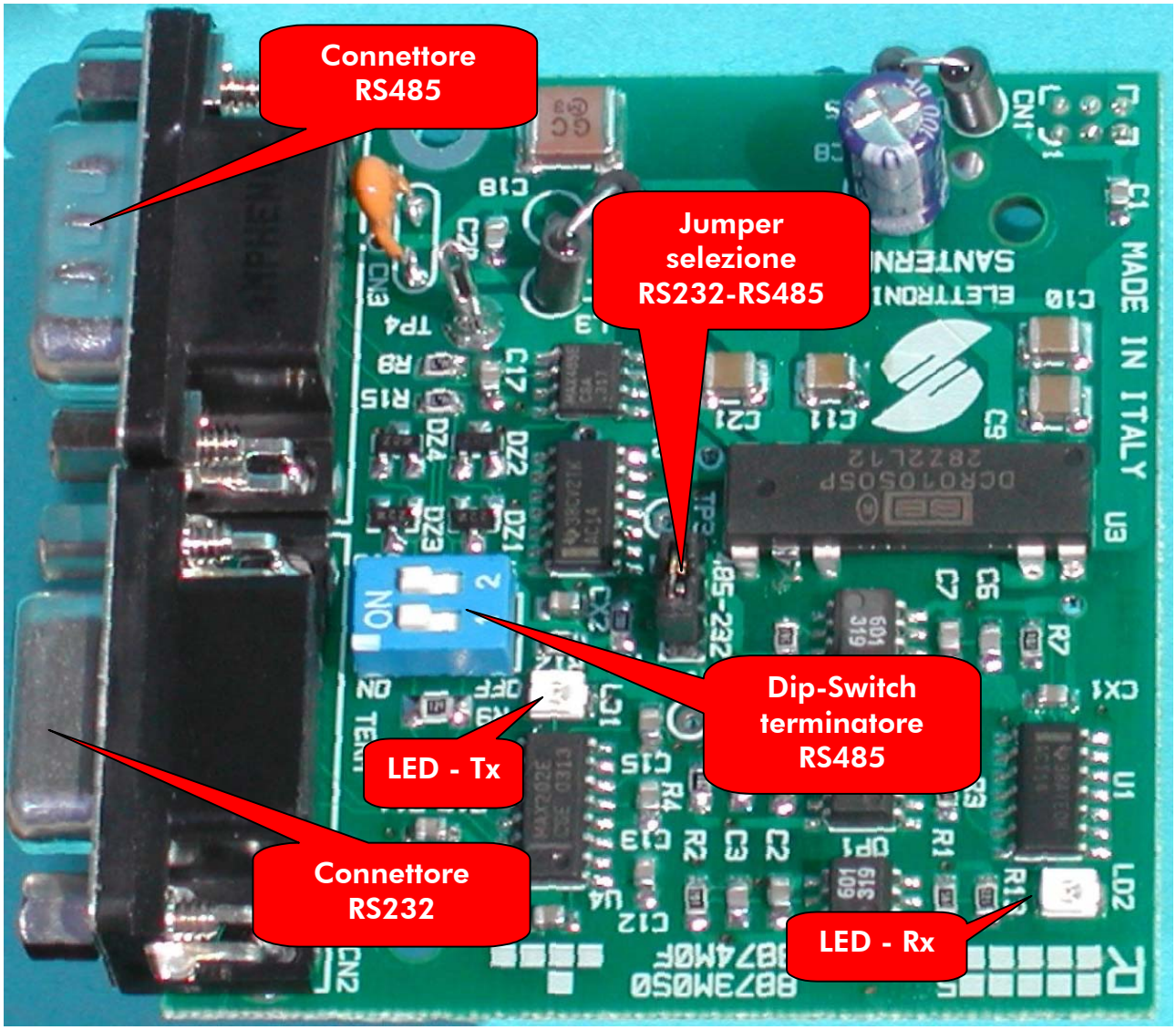


Fig. 4.19 – Board ES822

DESCRIPTION	ID NUMBER
Isolated serial board RS 232/485	ZZ0095850

4.6.1 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 (a.s.l.)

4.6.2 ELECTRICAL RATINGS

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) zero volt control Board
6 – 7	not connected
8	(GND) zero volt control Board
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	not connected
7-8	Non connesso

4.6.3 INSTALLING THE BOARD ON THE INVERTER

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.

Fig.4.20. Position of the slot for the board installation

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.

4.6.4 SETTING BOARD ES822

4.6.4.1 JUMPER FOR RS232 / RS485 SELECTION

Jumper J1 allows to set board ES822 to operate as interface RS-485 or as interface RS-232. On the board you can easly see the right position.
Jumper between pin1-2: CN3-(RS-485) is enabled
Jumper between pin2-3: CN2-(RS-232) is enabled

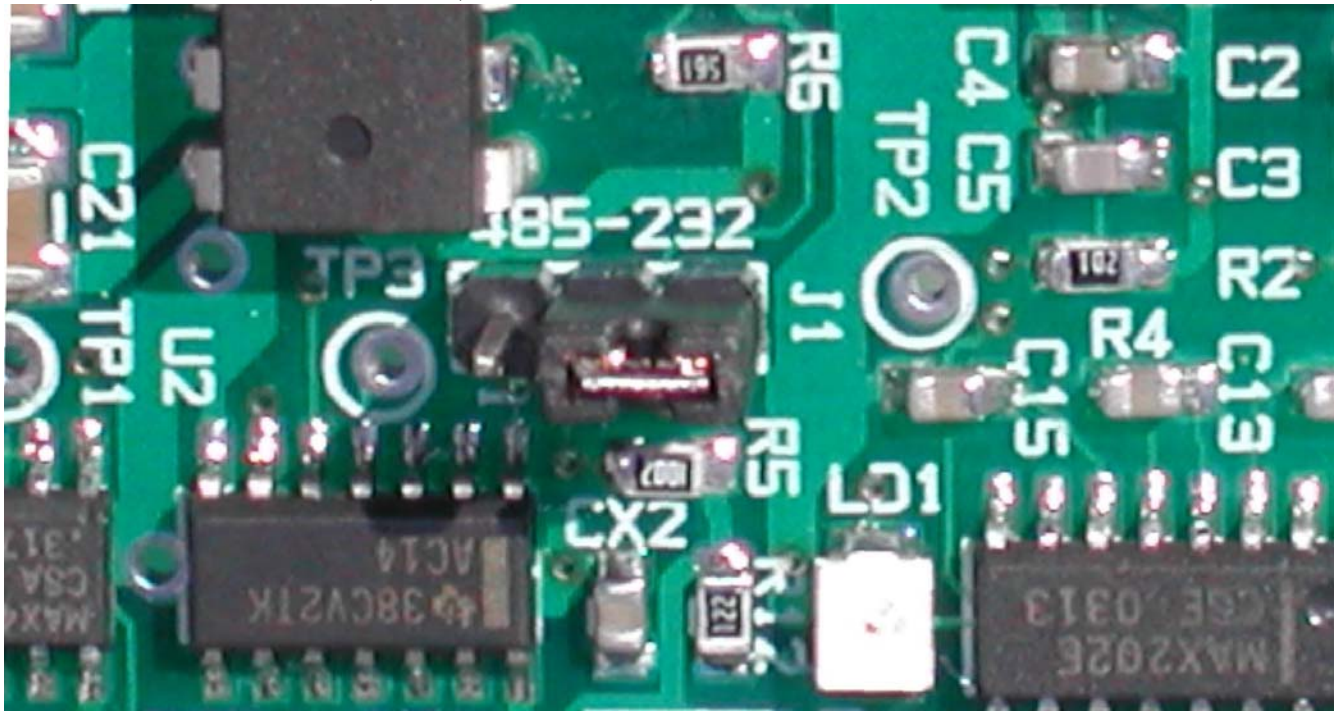


Fig. 4.21 – Jumper setting RS232/RS4

4.6.4.2 DIP-SWITCH FOR TERMINATOR RS-485

Please refer to section 1.6 (Serial Communication):
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.

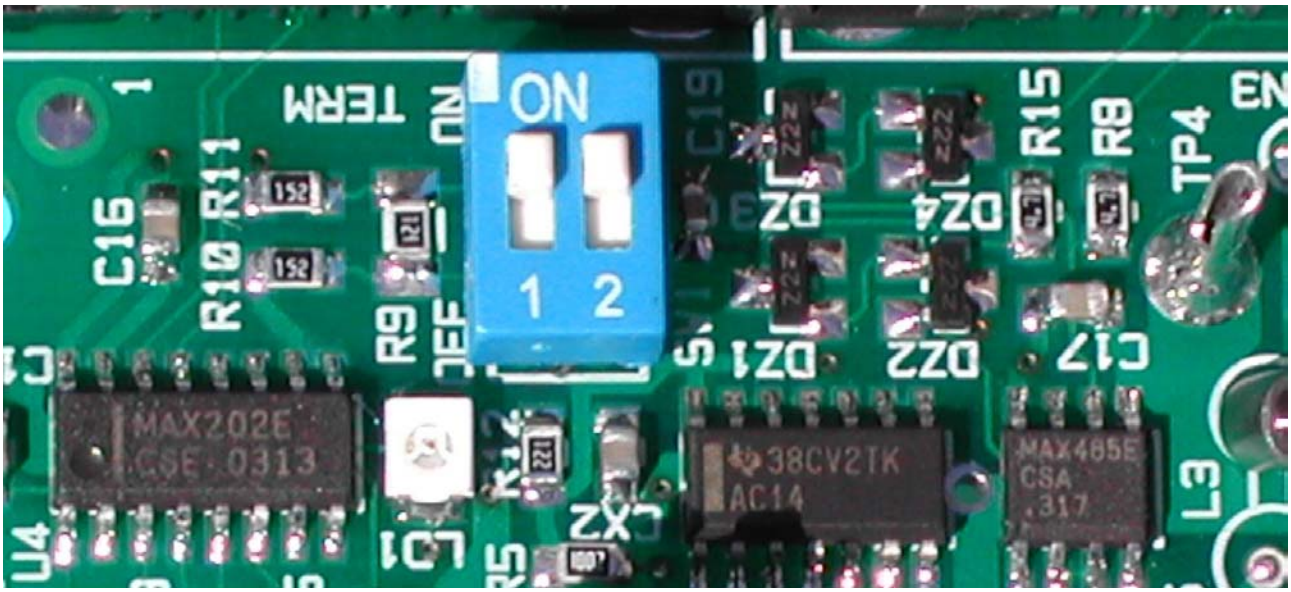


Fig. 4.22 –Dip switch line RS485

5 USING SINUS PENTA AS A REGENERATIVE FEEDER

5.1 OVERVIEW

Inverters of the SINUS PENTA series may be used as regenerative feeders, absorbing or delivering sinusoidal current to the mains with a unitary power factor. The power flow may be bidirectional. A regenerative feeder outputs a stabilized DC voltage for the power supply of one or multiple Elettronica Santerno inverters through DC bus terminals.
The figure shows a block diagram for the wiring of a SINUS PENTA inverter used as a regenerative feeder powering another SINUS PENTA controlling a connected motor.

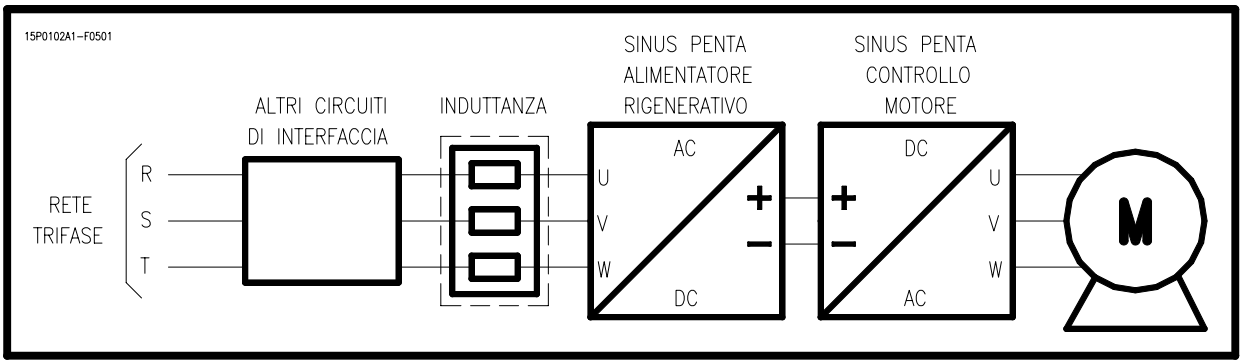


Fig 5.1. Block diagram of the inverter used as a regenerative feeder

An inductance is installed between the inverter and the mains to filter PWM voltage to the inverter output terminals and to produce sinusoidal current.
A regenerative feeder is particularly helpful when the connected motor often operates as a generator (e.g. in case of lifting applications, test benches, etc.). When this happens, energy is delivered to the mains with a sinusoidal waveform and a unitary power factor, thus allowing to save energy and avoiding installing cumbersome braking resistors.

NOTE

The equipment is designed to feed inverters manufactured by Elettronica Santerno. For different applications, please contact Elettronica Santerno.

5.2 DIMENSIONING THE REGENERATIVE INVERTER

The basic criterion for the dimensioning of a SINUS PENTA inverter used as a regenerative inverter consists in equalizing the power delivered by the inverter—used to control a connected motor—to the power that can be delivered by the regenerative inverter when operating in continuous mode and in overload mode, also considering the performance of the two inverters. Using two inverters of the same type does not always meet this requirement, as the continuous current delivered by the regenerative inverter is sometimes lower, because the minimum carrier frequency required for this application is 5kHz up to S30 included and 4kHz for the other inverter sizes.
Power of the applicable motor is given in the table below (supposing that a regenerative inverter feeds another inverter controlling a connected motor).

5.2.1 TECHNICAL SHEET FOR REGENERATIVE INVERTER

Size	REGENERATIVE INVERTER SINUS PENTA	CONNECTABLE MOTOR DEPENDING ON MAINS VOLTAGE				CURRENT DELIVERED BY THE REGENERATIVE INVERTER		REGENERATIVE INVERTER RATED POWER
		230VAC[1)]	400VAC	440VAC	480VAC	Inom	Imax	400VAC
		kW	kW	kW	kW	A	A	kW
S05	0005	2.8	5.0	5.5	6.0	10.5	11.5	6.3
	0007	3.4	6.2	6.8	7.5	12.5	13.5	7.5
	0009	4.6	8.3	9.1	10.0	16.5	17.5	10.0
	0011						21	
	0014						25	
S10	0017	9.0	16.1	17.7	19.4	30	32	18.2
	0020						36	
	0025	10.8	19.3	21.3	23.4	36	48	22.0
	0030						56	
	0035						72	
S15	0040	17.9	32.1	35.4	38.7	59	75	36.0
S20	0049	24.4	44.3	48.9	53.5	80	96	49.0
	0060	27.4	48.8	53.8	58.8	88	112	53.7
	0067	32.2	57.4	63.3	69.3	103	118	62.8
	0074	37.7	67.1	73.4	80.9	120	144	73.2
	0086	42.5	75.6	83.3	91.1	135	155	82.4
S30	0113	53.1	94.7	104	114	170	200	104
	0129	54.5	97.3	107	117	180	215	107
	0150	56.4	101	111	122	180	270	110
	0162	61.0	110	120	132	195	290	119
S40	0179	82.1	146	161	177	260	340	158
	0200	93.8	168	185	202	300	365	182
	0216						430	
	0250						480	
S50	0312	118	210	233	255	400	600	228
	0366	141	251	277	303	440	660	268
	0399	153	273	301	330	480	720	292
S60	0457	178	316	348	381	550	880	337
	0524	204	362	400	437	630	960	385
S70	0598	234	414	456	498	720	1100	441
	0748	292	517	570	623	900	1300	551
	0831	323	573	632	690	1000	1440	611

NOTA : (1) 200T type
(2) Water cooling

CABINET model available only

Legend:
Inom = continuous rated current of the regenerative inverter
Imax = max. current the inverter can deliver for 120 sec every 20 min up to S30, for 60 sec every 10 min for S40 and higher

NOTE: Power ratings of applicable motors are calculated based on 4-pole MA motors manufactured by Elettronica Santerno.

If different motors are connected, always check the dimensioning of the regenerative inverter.

Normally, power transferred by a regenerative inverter in permanent rpm mode is given by the following formula:

Preg=1.73*Vacmin* Inom

where Vacmin is the min. mains voltage

Power transferred by a regenerative inverter in overload mode is given by the following formula:

Pmaxreg=1.73*Vacmin* Imax

These values must be higher than the electrical power absorbed by the motor in the two operating modes, plus any loss of the two inverters. The electrical power in permanent rpm required by the motor is given by the following formula:

Pmot=1.73*Vmot*Imot*cosfimot

where Vmot, Imot and cosfimot are the rated voltage, rated current, and power factor of the connected motor.

The motor power in overload mode is given by the following formula:

Pmaxmot=1.73*Vmot*Ilim*cosfimot

where Ilim is the limit current of the inverter controlling the connected motor.

A regenerative inverter allows to feed multiple inverters controlling a connected motor, provided that the sum of the electrical power absorbed by each motor (both in permanent rpm and in overload mode) does not exceed the inverter power. Please contact Elettronica Santerno for this kind of applications.

5.3 WIRING

5.3.1 WIRING DIAGRAM OF THE POWER CONNECTIONS

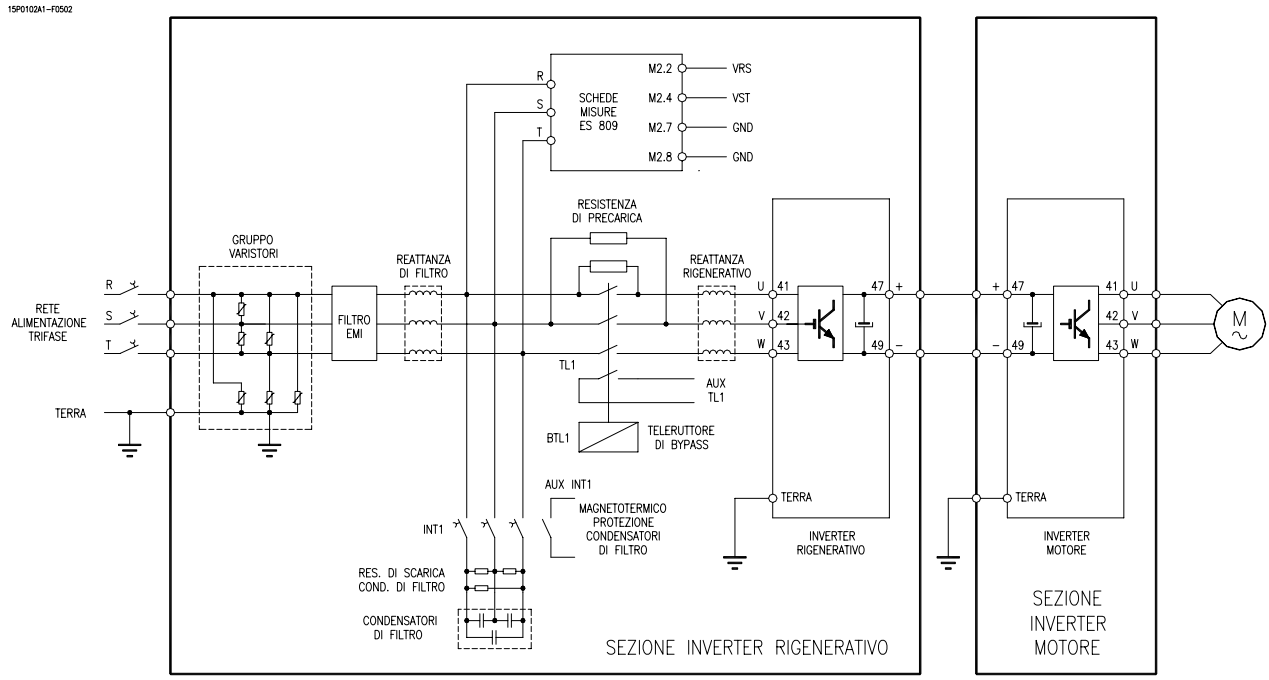


Fig.5.2 – Wiring diagram of the electromechanical fittings of a regenerative inverter

NOTE: Do not perform any phase reversal when connecting the different components. The equipment automatically acknowledges the phase sequence of the supply mains.

5.3.2 WIRING DIAGRAM OF THE SIGNAL CONNECTIONS

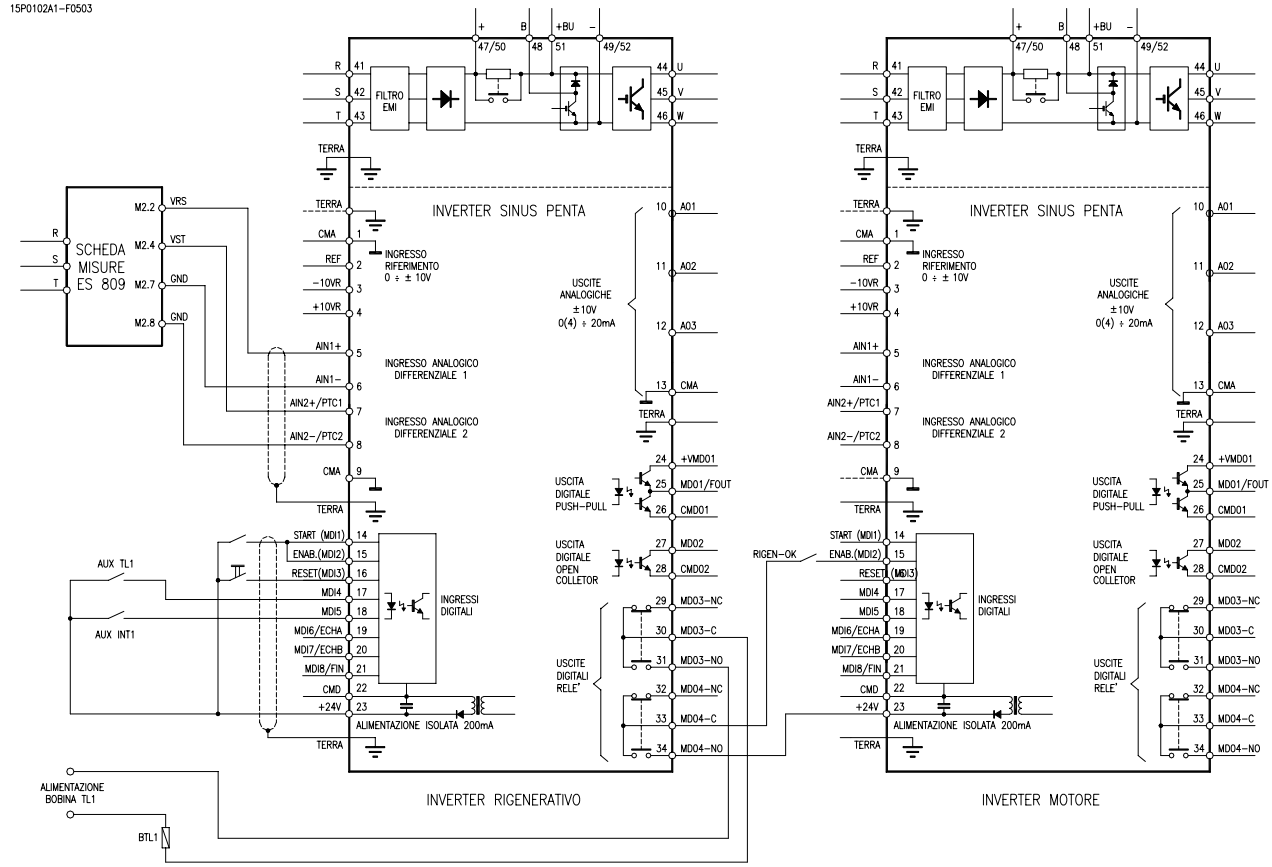


Fig. 5.3. Wiring diagram of the signal connections relating to a regenerative inverter

Only wiring required for the correct operation of a regenerative inverter is shown in the diagram. Wiring required for the motor control is not shown.

CAUTION: Make sure that voltage and current of coil BTL1 match with the ratings for contact MDO3-NO. Install an additional external relay with higher current ratings if required.

CAUTION: As shown in the wiring diagram, install contact MDO4-NO in the enabling sequence for the motor controlling inverter to prevent the motor from starting when the regenerative inverter is off.

5.4 COMPONENTS

5.4.1 REGENERATIVE REACTANCE

INVERTER SIZE	SINUS PENTA MODEL	Reactance Rating (mH)	Reactance Current (A)
05	0005	5.2	12.5
	0007		
	0009	3.9	16.5
	0011		
	0014		
S10	0017	2.2	30
	0020		
	0025	1.8	36
	0030		
	0035		
S15	0040	1.1	59
S20	0049	0.75	88
	0060		
	0067	0.5	135
	0074		
	0086		
S30	0113	0.35	195
	0129		
	0150		
	0162		
S40	0179	0.25	320
	0200		
	0216		
	0250		
S50	0312	0.2	400
	0366	0.15	550
	0399		
S60	0457	0.11	720
	0524		
	0598		
S70	0748	0.08	1000
	0831		

5.4.2 REACTANCE AND FILTER CAPACITORS

INVERTER SIZE	SINUS PENTA MODEL	Filter Reactance Rating	Filter Reactance Current	Filter Capacitance Rating	Filter Capacitance Voltage	Filter Capacitance Current
		(mH)	(A)	(uF)	(V)	Arms
05	0005	2.6	12.5	9.6	525	4
	0007					
	0009	2	16.5	11.5	525	5
	0011					
	0014					
S10	0017	1.1	30	24	525	10
	0020					
	0025	0.9	36	32	525	12
	0030					
	0035					
S15	0040	0.55	59	48	525	20
S20	0049	0.4	88	80	525	30
	0060					
	0067	0.25	135	80	525	6
	0074					
	0086					
S30	0113	0.18	195	2*80	525	60
	0129					
	0150					
	0162					
S40	0179	0.13	320	3*80	525	100
	0200					
	0216					
	0250					
S50	0312	0.1	400	3*80	525	110
	0366	0.08	550	4*80	525	132
	0399					
S60	0457					
	0524	0.06	720	5*80	525	180
S70	0598					
	0748	0.04	1000	6*80	525	240
	0831					

5.4.3 PRECHARGE RESISTANCE

INVERTER SIZE	SINUS PENTA MODEL	Resistance Rating (Ohm)	Resistance Power (W)
05	0005	10	600
	0007		
	0009	10	600
	0011		
	0014		
S10	0017	10	600
	0020		
	0025	10	600
	0030		
	0035		
S15	0040	10	600
S20	0049	10	600
	0060		
	0067	10	600
	0074		
	0086		
S30	0113	10	600
	0129		
	0150		
	0162		
S40	0179	10	600
	0200		
	0216		
	0250		
S50	0312	10	1300
	0366		
	0399		
S60	0457	10	1300
	0524		
S70	0598	2*10	1300
	0748		
	0831		

5.4.4 ADDITIONAL COMPONENTS

5.4.4.1 BY-PASS CONTACTOR

By-pass contactor is to be dimensioned in order to carry the inverter continuous current (Inom). Make sure that the coil ratings allow it to be driven on board of the inverter (250VAC-3A/30VDC-3A); otherwise, use an auxiliary relay. Always install an antidisturbance filter in parallel with the contactor coil.

5.4.4.2 THERMAL/MAGNETIC CIRCUIT BREAKER PROTECTING THE FILTER CAPACITORS

The thermal/magnetic circuit breaker is to be dimensioned for a continuous current at least equal to the current rating given in the table (Filter Capacitance Current column) and for a peak current equal to approx. 15 times the continuous current to prevent circuit breaker from opening during the supply transient.

5.4.4.3 VARISTORS

Use varistors with rated voltage 550V and min. energy 400J.

5.4.4.4 EMI FILTERS

EMI filters inside the inverter have no effect as they are connected to supply terminals R, S, T (41, 42, 43), which are not used for this application. Depending on the emission level allowed by the regulations in force, it can be necessary to install an adequate filter against radiofrequency interference (RFI). The table shows how to match a regenerative inverter to an EMI filter allowing not to exceed the range defined by EN61800-3 issue 2 SECOND ENVIRONMENT, category C3 EN55011 gr.2 cl.A for industrial users, EN50082-1,-2, EN61800-3-A11.

INVERTER SIZE	REGENERATIVE SINUS PENTA MODEL	EMI Filter Model	EMI Filter Current (A)
05	0005	FX.19	19
	0007		
	0009		
	0011		
	0014		
S10	0017	FX.36	36
	0020		
	0025		
	0030		
	0035		
S15	0040	FX65	65
S20	0049	FX120	120
	0060		
	0067		
	0074		
	0086	FX155	155
S30	0113	FX220	220
	0129		
	0150		
	0162		
S40	0179	FX280	280
	0200	FLTA-B360	375
	0216		
	0250		
S50	0312	FLTA-B500	480
	0366		
	0399		
S60	0457	FLTA-B750	750
	0524		
	0598		
S70	0748	FLTA-B1000	1000
	0831		
	0831		

6 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)

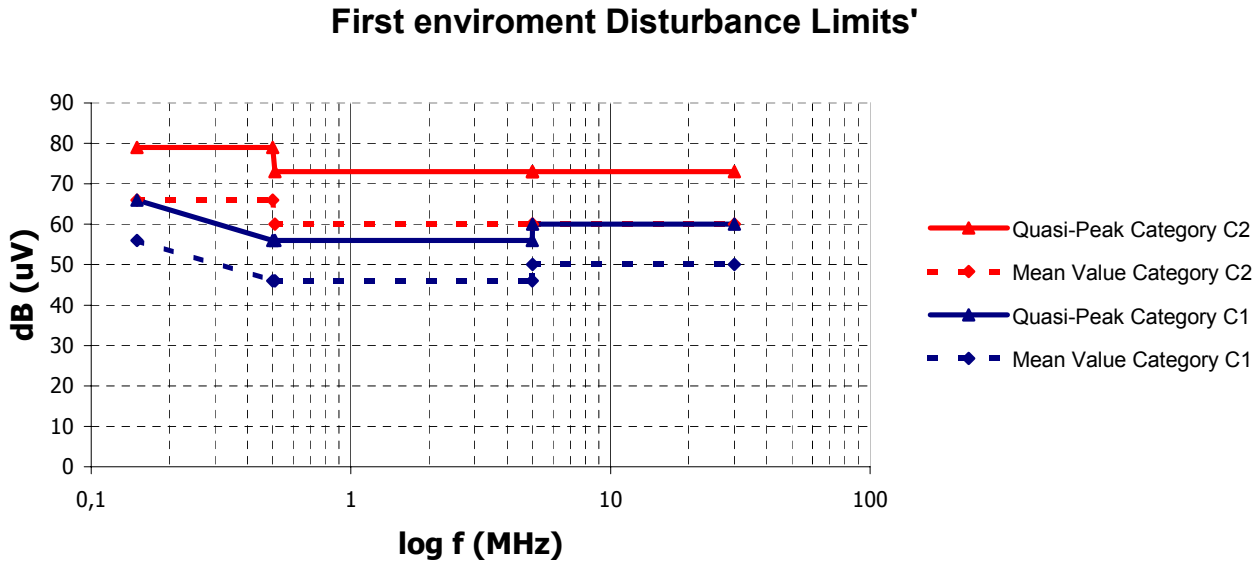
High frequency interference
High frequency interference is disturbance or radiated interference with >9kHz frequency. Critical values range from 150kHz to 1000MHz.
Interference is often caused by commutations to be found in any device, i.e. switching feeders and drive output modules. High frequency disturbance 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.

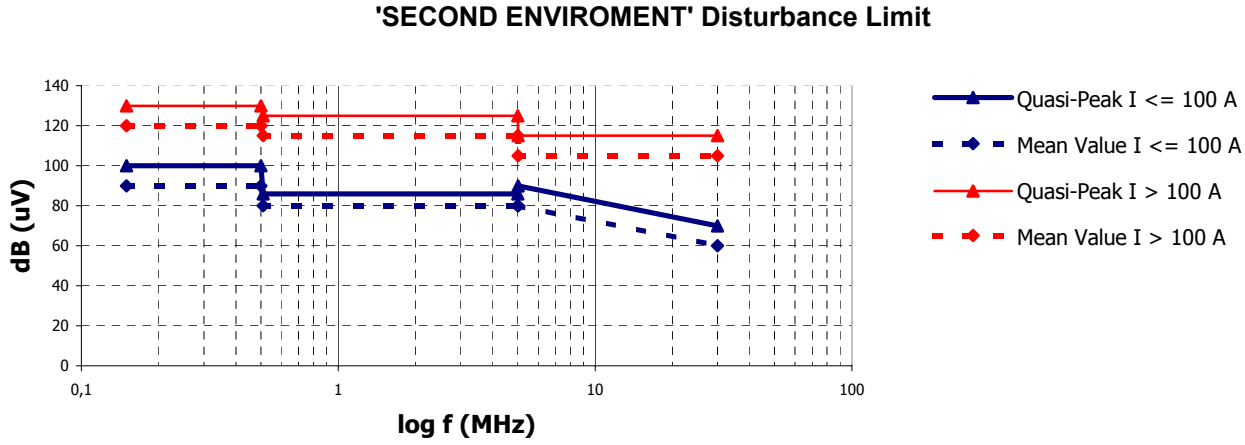
Emission Limits

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)



A1 = EN 61800-3 issue 2 FIRST ENVIRONMENT, Category C2, EN55011 gr.1 cl. A, EN50081-2, EN61800-3/A11.

B = EN 61800-3 issue 2 FIRST ENVIRONMENT, Category C1, EN55011 gr.1 cl. B, EN50081-1,-2, EN61800-3/A11.



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 emission suppression for PDS installed in the FIRST ENVIRONMENT, Category C2;
A2 emission suppression for PDS installed in the SECOND ENVIRONMENT, Category C3;
B emission suppression for PDS 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 25A and incorporated A2-type filters for currents over 25A.

Immunity

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:

Electromagnetic Compatibility (89/336/CEE 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: For 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: For 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.

Low Voltage Directive (73/23/CEE and following amendment 93/68/CEE)	IEC61800-5-1	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – Electrical, thermal and energy.
	IEC-22G/109/NP	Adjustable speed electrical power drive systems. Part 5-2: Safety requirements-Functional.
	EN60146-1-1/IEC146-1-1	Semiconductor convertors. General Requirements and line-commutated convertors. Part 1-1: Specifications of basic requirements
	EN60146-2/IEC1800-2	Adjustable speed electrical power drive systems. Part 2: General requirements – Rating specifications for low voltage adjustable frequency AC power drive systems.
	EN60204-1/IEC204-1	Safety of machinery. Electrical equipment of machines. Part 1: General requirements.
	EN60529/IEC529	Degrees of protection provided by enclosures (IP Code).
	EN50178 (1997-10)	Electronic equipment for power systems.

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).

6.1 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:

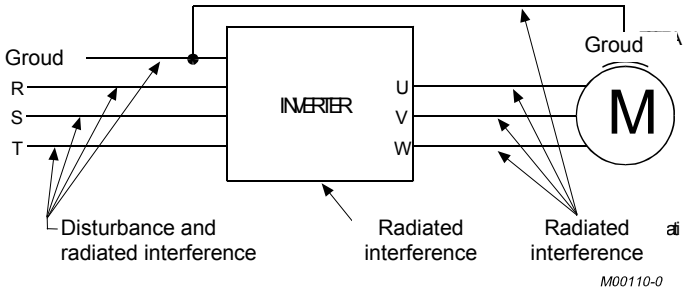


Fig.5.1 Disturbance sources in a power drive system equipped with an inverter

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 toroidal 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.

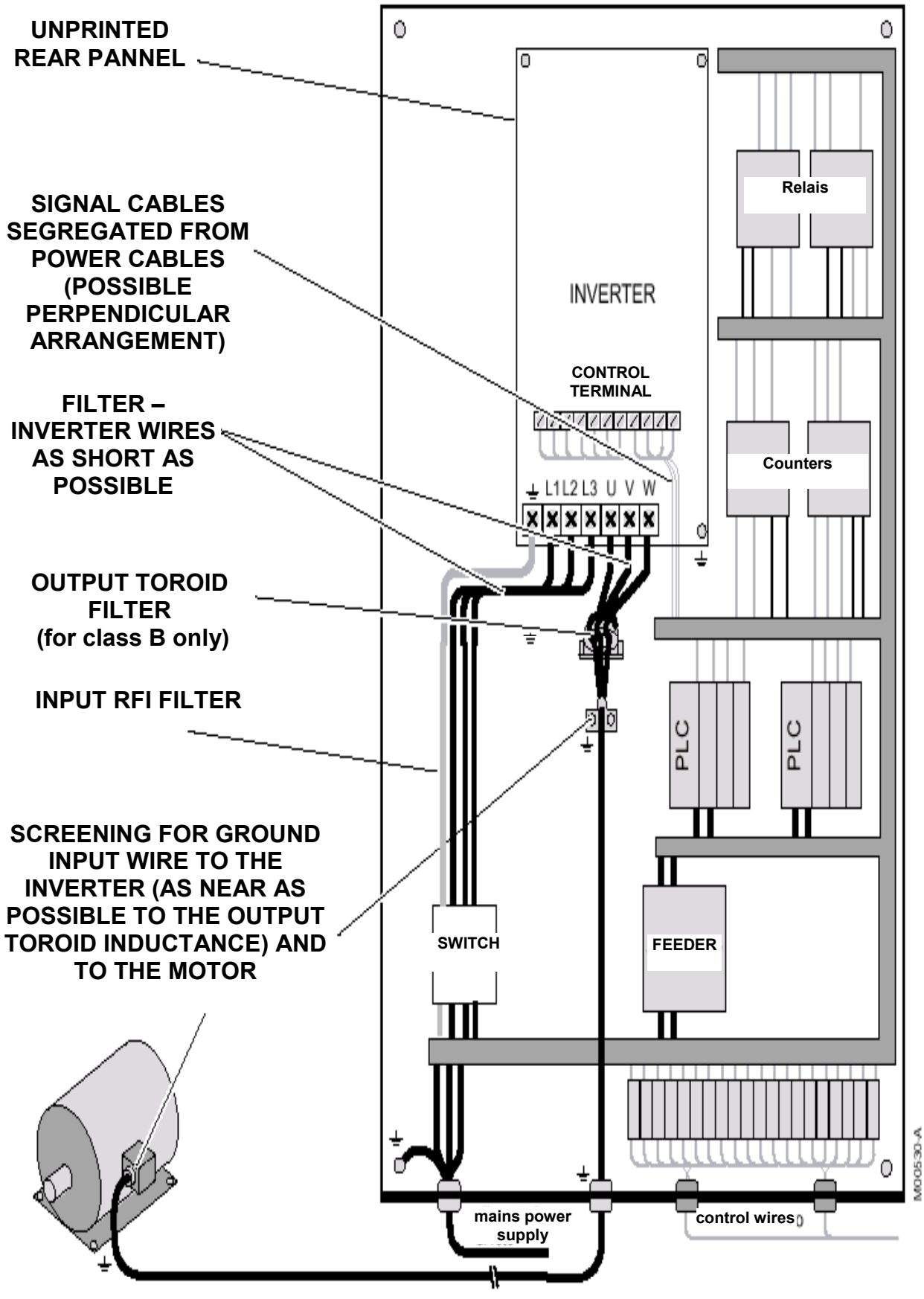
6.1.1 THE MAINS

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. Incorporated filters installed in the inverters are shown in section 5.2.4.


UNPRINTED REAR PANNEL
SIGNAL CABLES SEGREGATED FROM POWER CABLES (POSSIBLE PERPENDICULAR ARRANGEMENT)
FILTER – INVERTER WIRES AS SHORT AS POSSIBLE
OUTPUT TOROID FILTER (for class B only)
INPUT RFI FILTER
SCREENING FOR GROUND INPUT WIRE TO THE INVERTER (AS NEAR AS POSSIBLE TO THE OUTPUT TOROID INDUCTANCE) AND TO THE MOTOR
INVERTER
CONTROL TERMINAL
L1 L2 L3 U V W
Relais
Counters
PLC
PLC
SWITCH
FEEDER
mains power supply
control wires
M00530-A

6.1.2 OUTPUT TOROID FILTERS

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 ferrite;
- in case of single-phase conductors (or 2wire line) both phases must go through ferrite (incoming and outcoming conductor cables that are to be filtered must go through ferrite).

See section 5.2.4 for the selection of the output toroid filter to weaken radiofrequency interference.

6.1.3 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):

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.
- 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 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. 100μH) 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.

6.1.4 INPUT AND OUTPUT FILTERS

The inverters of the SINUS K 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 EN55011and 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.

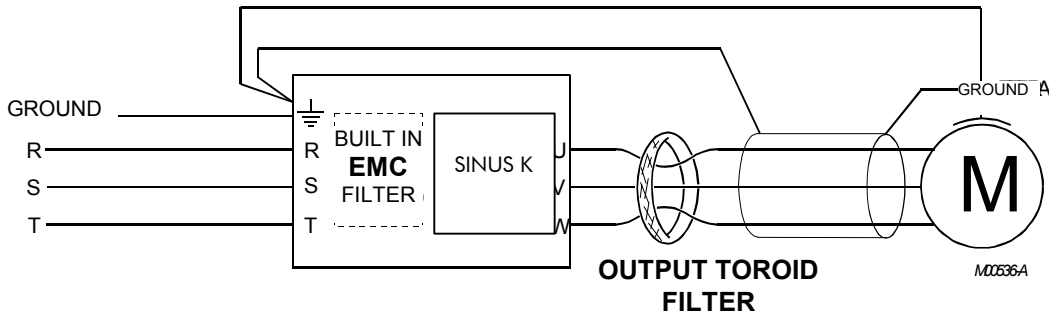


Fig. 5.2 Wiring the toroid filter for the inverter of the SINUS K series

NOTE: Install the output filter near the inverter to comply with the standards in force (leave a minimum clearance for the cable connections); follow the instructions given for the connection of the ground terminals and the terminals of the filter, the motor and the inverter (see section 5.2.1).

NOTE: Install the toroid filter by leading the connection cables between the motor and the inverter inside the toroid.

DECLARATION OF CONFORMITY

EC DECLARATION OF CONFORMITY

Elettronica Santerno S.p.A.

Via G. Di Vittorio, 3 - 40020 Casalfiumanese (BO) - Italia

AS MANUFACTURER

DECLARE

UNDER OUR SOLE RESPONSABILITY

THAT THE DIGITAL THREE-PHASE AC INVERTER OF **SINUS PENTA** TYPE,

AND RELATED ACCESSORIES,

TO WHICH THIS DECLARATION RELATES,

APPLIED UNDER CONDITIONS SUPPLIED IN THE USER'S MANUAL,

CONFORMS TO THE FOLLOWING STANDARDS OR NORMATIVE DOCUMENTS:

EN 61800-3:1996/A11:2000	Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods.
prEN 61800-3:2002	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods.
EN 61000-4-2 (1995-03)	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 2: Electrostatic discharge immunity test. Basic EMC Publication.
EN 61000-4-3 (1996-09)	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 3: Radiated, radio-frequency, electromagnetic field immunity test.
EN 61000-4-4 (1995-03)	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 4: Electrical fast transient/burst immunity test. Basic EMC Publication.
EN 61000-4-5 (1995-03)	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 5: Surge immunity test.
EN 61000-4-6 (1996-07)	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 6: Immunity to conducted disturbances, inducted by radio-frequency fields.

FOLLOWING THE PROVISIONS OF ELECTROMAGNETIC COMPATIBILITY DIRECTIVE 89/336/EEC

AND SUBSEQUENT AMENDMENTS 92/31/EEC, 93/68/EEC AND 93/97/EEC.

PLACE AND DATE OF ISSUE
Casalfiumanese, 09/09/2003

SIGNATURE
Executive V. President
Zanarini Ing. Sergio

EC DECLARATION OF CONFORMITY

Elettronica Santerno S.p.A.

Via G. Di Vittorio, 3 - 40020 Casalfiumanese (BO) - Italia

AS MANUFACTURER

DECLARE

UNDER OUR SOLE RESPONSABILITY

THAT THE DIGITAL THREE-PHASE AC INVERTER OF **SINUS PENTA** TYPE,

TO WHICH THIS DECLARATION RELATES,

CONFORMS TO THE FOLLOWING STANDARDS OR NORMATIVE DOCUMENTS:

IEC 61800-5-1: 2003	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – Electrical, thermal and energy.
IEC 22G/109/NP: 2002	Adjustable speed electrical power drive systems. Part 5-2: Safety requirements – Functional.
EN 60146-1-1 (1993-02)	Semiconductor convertors. General requirements and line commutated convertors. Part 1-1: Specifications of basic requirements.
EN 60146-2 (2000-02)	Semiconductor convertors. Part 2: Self-commutated semiconductor converters including direct d.c. converters.
EN 61800-2 (1998-04)	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 (1997-12)	Safety of machinery. Electrical equipment of machines. Part 1: General requirements.
EN 60204-1 Modifica 1 (1988-08)	Electrical equipment of industrial machines. Part 2: Item designation and examples of drawings, diagrams, tables and instructions.
EN 60529 (1991-10)	Degrees of protection provided by enclosures (IP Code).
EN 50178 (1997-10)	Electronic equipment for use in power installations.

FOLLOWING THE PROVISIONS OF LOW VOLTAGE DIRECTIVE 73/23/EEC AND SUBSEQUENT AMENDMENT 93/68/EEC.

LAST TWO DIGITS OF THE YEAR IN WHICH THE CE MARKING WAS AFFIXED: **03**

PLACE AND DATE OF ISSUE
Casalfiumanese, 09/09/2003

SIGNATURE
Executive V. President
Zanarini Ing. Sergio

MANUFACTURER'S DECLARATION

Elettronica Santerno S.p.A.

Via G. Di Vittorio, 3 - 40020 Casalfiumanese (BO) - Italia

AS MANUFACTURER

DECLARE

UNDER OUR SOLE RESPONSABILITY

THAT THE DIGITAL THREE-PHASE AC INVERTER OF **SINUS PENTA** TYPE,

TO WHICH THIS DECLARATION RELATES,

APPLIED UNDER CONDITIONS SUPPLIED IN THE USER'S MANUAL,

CONFORMS TO THE FOLLOWING STANDARDS OR NORMATIVE DOCUMENTS:

EN 60204-1 (1997-12)	Safety of machinery. Electrical equipment of machines. Part 1: General requirements.
EN 60204-1 Modifica 1 (1988-08)	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.

PLACE AND DATE OF ISSUE
Casalfiumanese, 09/09/2003

SIGNATURE
Executive V. President
Zanarini Ing. Sergio