

• 15P0102B100 •

SINUS PENTA PENTA MARINE

MULTIFUNCTION AC DRIVE

USER MANUAL - Installation Guide -

Issued on 03/06/2019
R.01

English

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REVISION INDEX

The following subjects covered in this Installation Guide (ID Number **15P0102B100** revision R.01) have been added, changed or suppressed in respect to the previous Installation Guide (ID Number **15P0102B100** revision R.00).

ENERTRONICA GROUP logo added.

Parallel-connected models added to tables related to Standard AC Power Supply, Standard DC Power Supply, 12-pulse AC Power Supply, 18-pulse AC Power Supply.

Product nameplate updated (TUV logo added for STO; fields required by UL added).

References have been added to Degree of Protection IP00 and IP20 / UL Open Type Equipment and Degree of Protection IP21 / UL Type 1 with NEMA 1 Kit GLANDKIT UL Category number NMMS/NMMS7.

References have been added to UL Category Codes ZMVF and ZMVF2 (Lugs), YDPU2 (Extruded Tubings), UZCW2 (Sleeving), VZCA2/VZCA8 (Surge-protective Devices), JFHR2/JFHR8 (Fuses) and XGPU2/XGPU8 (Thermistor Type Devices).

Nominal current of models 0030/0086/0260 fixed in the Cross-sections of the Power Cables and Sizes of the Protective Devices section.

Some Cable Cross-sections to Mains and Motor Side fixed in the Cross-sections of the Power Cables and Sizes of the Protective Devices section.

Figure Connection to +48 Vdc Power Supply Units for S60P added.

Calculation formula added to the Maximum allowable Operating Temperature without Derating section.

Note about Carrier Frequency used with FOC and SYN control algorithms removed.

Carrier frequency for S60 4T fixed.

Values fixed in the Short-circuit Currents according to UL table.

SANTERNO USER MANUALS MENTIONED IN THIS GUIDE

The following Santerno User Manuals are mentioned throughout this Installation Guide:

- **15R0102B1** Sinus Penta - Programming Guide
- **15N0102B200** SINUS PENTA - Spare Control Board User Manual
- **15Q0102B00** Sinus Penta - Guide to the Regenerative Application
- **15Q0102B200** Sinus Penta - Guide to the Synchronous Motor Application
- **15P0101B1** Sinus Penta - Assembly Instructions for Modular Inverters
- **15G0010B1** PROFIdrive Communications Board - Installation and Programming Instructions
- **15J0901B100** Remote Drive DRIVE REMOTE CONTROL - User Manual
- **15M0102B10** Sinus Penta - Guide for Capacitor Reforming
- **15N0040B100** Sine Filters - User Manual
- **15W0102B100** Sinus Penta - Assembly Instructions for Through-panel Kit S22
- **15W0102B200** Sinus Penta - Assembly Instructions for Through-panel Kit S32
- **15W0102B300** Safe Torque Off Function - Application Manual
- **15W0102B500** Motor Drives Accessories - User Manual
- **15P0102B200** SINUS PENTA - Parallel-connected Models S41..S52
- **15P0102B300** AC/DC Units

TABLE OF CONTENTS

REVISION INDEX.....	2
SANTERNO USER MANUALS MENTIONED IN THIS GUIDE	2
1. GENERAL DESCRIPTION	8
1.1. FEATURE LIST	9
1.2. SPECIAL APPLICATIONS AVAILABLE FOR THE SINUS PENTA.....	10
2. SAFETY STATEMENTS.....	11
2.1. INSTALLING AND OPERATING THE EQUIPMENT.....	11
2.2. PERMANENT MAGNET MOTORS.....	14
3. EQUIPMENT DESCRIPTION AND INSTALLATION	15
3.1. PRODUCTS COVERED IN THIS MANUAL	15
3.2. DELIVERY CHECK	16
3.2.1. Nameplate.....	17
3.2.2. Transport and Handling	19
3.2.3. Unpacking	19
3.3. INSTALLING THE EQUIPMENT	21
3.3.1. Environmental Requirements for the Equipment Installation, Storage and Transport	21
3.3.2. Air Cooling.....	22
3.3.2.1. STAND-ALONE Models - IP20 and IP00 (S05–S60P)	22
3.3.2.2. STAND-ALONE Models - IP54 (S05–S32)	23
3.3.2.3. STAND-ALONE Modular Inverters - IP00 (S64–S90).....	24
3.3.2.4. Dimensioning the Cooling System	24
3.3.3. Inverter Scheduled Maintenance	26
3.3.4. Air Filters	26
3.3.5. Heat Sink and Ambient Temperature Check	28
3.3.5.1. Control Board	28
3.3.5.2. Cleaning the Heat Sink.....	28
3.3.6. Cooling Fans.....	28
3.3.6.1. Replacing the Cooling Fans	28
3.3.7. Capacitors.....	28
3.3.7.1. Capacitor Reforming	28
3.3.7.2. Replacing a Capacitor	28
3.3.8. Bypass Contactor.....	29
3.3.8.1. Replacing the Bypass Contactor	29
3.3.9. Size, Weight, Efficiency, Noise Level	29
3.3.9.1. IP20 and IP00 STAND-ALONE Models (S05–S60) Class 2T.....	30
3.3.9.2. IP20 and IP00 STAND-ALONE Models (S05–S60P) Class 4T	31
3.3.9.3. IP20 and IP00 STAND-ALONE Models (S12–S52) Class 5T-6T	32
3.3.9.4. Modular IP00 STAND-ALONE Models (S64–S90)	33
3.3.9.5. IP54 STAND-ALONE Models (S05–S30) Class 2T	38
3.3.9.6. IP54 STAND-ALONE Models (S05–S30) Class 4T	39
3.3.9.7. IP54 STAND-ALONE Models (S12–S32) Class 5T-6T	40
3.3.9.8. IP54 BOX Models (S05–S20) Class 2T	41
3.3.9.9. IP54 BOX Models (S05–S20) Class 4T	42
3.3.9.10. IP42 and IP54 Cabinet Models (S15–S90).....	43
3.3.10. Standard Mounting and Piercing Templates (IP20 and IP00 Stand-Alone Models S05–S60P)	45
3.3.11. Through-Panel Assembly and Piercing Templates (IP20 and IP00 Stand-Alone Models S05–S52)	47
3.3.11.1. Sinus Penta S05.....	47
3.3.11.2. Sinus Penta S12.....	48

3.3.11.3.	Sinus Penta S14	49
3.3.11.4.	Sinus Penta S15–S20–S30	50
3.3.11.5.	Sinus Penta S22–S32	51
3.3.11.6.	Sinus Penta S41–S42–S51–S52	53
3.3.12.	<i>Standard Mounting and Piercing Templates (IP00 Modular Models S64–S90)</i>	55
3.3.12.1.	Installation and Lay-out of the Connections of a Modular Inverter (S65)	57
3.3.13.	<i>Standard Mounting and Piercing Templates (IP54 Stand-Alone Models S05–S32)</i>	58
3.4.	POWER CONNECTIONS	59
3.4.1.	<i>Wiring Diagram for inverters S05–S60P</i>	61
3.4.2.	<i>Wiring Diagram for Modular Inverters S64–S90</i>	63
3.4.2.1.	External Connections for Modular Inverters S65 and S70	63
3.4.2.2.	External Connections for Modular Inverters S64	64
3.4.2.3.	External Connections for Modular Inverters S74, S75 and S80	65
3.4.2.4.	External Connections for Modular inverters S84 and S90	65
3.4.2.5.	Internal Connections for Modular Inverters S65 and S70	65
3.4.2.6.	Internal Connections for Modular Inverters S64	72
3.4.2.7.	Internal Connections for Modular Inverters S74, S75 and S80	76
3.4.2.8.	Internal Connections for Modular Inverters S84 and S90	76
3.4.3.	<i>12-pulse Connection for Modular Inverters</i>	76
3.4.3.1.	Standard AC Power Supply, Standard DC Power Supply, 12-pulse AC Power Supply, 18-pulse AC Power Supply	78
3.4.4.	<i>Power Terminals for S05–S52</i>	79
3.4.5.	<i>Power Terminals Modified for a DC Inductor</i>	82
3.4.6.	<i>Connection Bars for S60P Inverters</i>	83
3.4.7.	<i>Connection Bars for Modular Inverters S64–S70</i>	84
3.4.8.	<i>Connection Bars for Modular Inverters S74–S80</i>	85
3.4.9.	<i>Connection Bars for Modular Inverters S84–S90</i>	86
3.4.10.	<i>Auxiliary Power Supply Terminals</i>	87
3.4.11.	<i>Cross-sections of the Power Cables and Sizes of the Protective Devices</i>	87
3.4.11.1.	2T Voltage Class	88
3.4.11.2.	UL-approved Fuses - 2T Voltage Class	89
3.4.11.3.	UL-approved Surge Protective Devices (SPDs) - 2T Voltage Class	90
3.4.11.4.	4T Voltage Class	91
3.4.11.5.	UL-approved Fuses - 4T Voltage Class	94
3.4.11.6.	5T and 6T Voltage Classes	95
3.4.11.7.	UL-approved Fuses - 5T and 6T Voltage Classes	97
3.4.12.	<i>Inverter and Motor Ground Connection</i>	98
3.5.	CONTROL TERMINALS	99
3.5.1.	<i>Main Features</i>	100
3.5.2.	<i>Gaining Access to Control Terminals and Power Terminals</i>	103
3.5.2.1.	IP20 and IP00 Models	103
3.5.2.2.	IP54 Models	104
3.5.3.	<i>Control Board Signals and Programming</i>	105
3.5.3.1.	Display and Indicator LEDs	106
3.5.3.2.	DIP-switches	110
3.5.3.3.	Configuration Jumpers	112
3.5.4.	<i>Digital Inputs (Terminals 14..21 and Terminal S)</i>	113
3.5.4.1.	START (Terminal 14)	113
3.5.4.2.	ENABLE-A (Terminal 15) and ENABLE-B (Terminal S)	114
3.5.4.3.	RESET (Terminal 16)	114
3.5.4.4.	Connecting the Encoder and Frequency Input (Terminals 19 to 21)	115
3.5.4.5.	Technical Sheet for Digital Inputs	116
3.5.5.	<i>Analog Inputs (Terminals 1 to 9)</i>	117
3.5.5.1.	REF Single-ended Reference Input (Terminal 2)	118
3.5.5.2.	Differential Auxiliary Inputs (Terminals 5–8)	119
3.5.5.3.	Motor Thermal Protection Input (PTC, Terminals 7-8)	121
3.5.5.4.	Technical Sheet for Analog Inputs	122
3.5.6.	<i>Digital Outputs (Terminals 24 to 34)</i>	123
3.5.6.1.	Push-Pull Output MDO1 and Wiring Diagrams (Terminals 24 to 26)	123
3.5.6.2.	Open-collector MDO2 Output and Wiring Diagrams (Terminals 27-28)	126

3.5.6.3. Relay Outputs (Terminals 29..34)	128
3.5.6.4. Technical Sheet for Digital Outputs	129
3.5.7. <i>Analog Outputs (Terminals 10 to 13)</i>	130
3.5.7.1. Technical Sheet for Analog Outputs	130
3.6. OPERATING AND REMOTING THE KEYPAD	131
3.6.1. <i>Indicator LEDs on the Display/Keypad</i>	131
3.6.2. <i>Function Keys</i>	132
3.6.3. <i>Setting the Operating Mode</i>	133
3.6.3.1. Adjusting the Display Contrast	133
3.6.3.2. Adjusting the Display Contrast, Back-light and Buzzer	133
3.6.4. <i>Remoting the Display/Keypad</i>	134
3.6.5. <i>Using the Display/Keypad for Parameter Transfer</i>	137
3.7. SERIAL COMMUNICATIONS	138
3.7.1. <i>General Features</i>	138
3.7.2. <i>Direct Connection</i>	139
3.7.3. <i>Multidrop Network Connection</i>	139
3.7.3.1. Connection	139
3.7.3.2. Line Terminators	141
3.7.4. <i>How to Use Isolated Serial Board ES822 (Optional)</i>	142
3.7.5. <i>The Software</i>	142
3.7.6. <i>Serial Communications Ratings</i>	142
3.8. AUXILIARY POWER SUPPLY	143
4. START UP	144
5. TECHNICAL SPECIFICATIONS	145
5.1. CHOOSING THE PRODUCT	148
5.1.1. <i>LIGHT Applications: Overload up to 120% (60/120s) or up to 144% (3s)</i>	151
5.1.1.1. Technical Sheet for 2T and 4T Voltage Classes	151
5.1.1.2. Technical Sheet for 2T and 4T Voltage Classes – Parallel-connected Models	152
5.1.1.3. Technical Sheet for 5T and 6T Voltage Classes	153
5.1.1.4. Technical Sheet for 5T and 6T Voltage Classes – Parallel-connected Models	154
5.1.2. <i>STANDARD Applications: Overload up to 140% (60/120s) or up to 168% (3s)</i>	155
5.1.2.1. Technical Sheet for 2T and 4T Voltage Classes	155
5.1.2.2. Technical Sheet for 2T and 4T Voltage Classes – Parallel-connected Models	156
5.1.2.3. Technical Sheet for 5T and 6T Voltage Classes	157
5.1.2.4. Technical Sheet for 5T and 6T Voltage Classes – Parallel-connected Models	158
5.1.3. <i>HEAVY Applications: Overload up to 175% (60/120s) or up to 210% (3s)</i>	159
5.1.3.1. Technical Sheet for 2T and 4T Voltage Classes	159
5.1.3.2. Technical Sheet for Voltage Classes 2T and 4T – Parallel-connected Models	160
5.1.3.3. Technical Sheet for 5T and 6T Voltage Classes	161
5.1.3.4. Technical Sheet for Voltage Classes 5T and 6T – Parallel-connected Models	162
5.1.4. <i>STRONG Applications: Overload up to 200% (60/120s) or up to 240% (3s)</i>	163
5.1.4.1. Technical Sheet for 2T and 4T Voltage Classes	163
5.1.4.2. Technical Sheet for Voltage Classes 2T and 4T – Parallel-connected Models	164
5.1.4.3. Technical Sheet for 5T and 6T Voltage Classes	165
5.1.4.4. Technical Sheet for Voltage Classes 5T and 6T – Parallel-connected Models	166
5.2. CARRIER FREQUENCY SETTING	167
5.2.1. <i>IP20 and IP00 Models – 2T-4T Voltage Classes</i>	167
5.2.2. <i>IP20 and IP00 Models – 5T-6T Voltage Classes</i>	169
5.2.3. <i>IP54 Models – 2T-4T Voltage Classes</i>	171
5.2.4. <i>IP54 Models – 5T-6T Voltage Classes</i>	172
5.3. MAXIMUM ALLOWABLE OPERATING TEMPERATURE WITHOUT DERATING	173
5.3.1. <i>2T-4T Voltage Classes</i>	173
5.3.2. <i>5T-6T Voltage Classes</i>	175
5.4. SHORT-CIRCUIT CURRENTS	177
6. NORMATIVE REFERENCES	178
6.1. ELECTROMAGNETIC COMPATIBILITY DIRECTIVE	178
6.1.1. <i>Radiofrequency Disturbance</i>	181

6.1.2. The Power Supply Mains	182
6.1.2.1. Output Toroid Filters	182
6.1.2.2. The Cabinet	182
6.1.2.3. Input and Output Filters	185
6.2. LOW VOLTAGE DIRECTIVE	185
7. INDEX	186

Index of Figures

Figure 1: All Sinus Penta models	8
Figure 2: Packaging of the Sinus Penta	16
Figure 3: Example of a nameplate affixed on the drive metal enclosure	17
Figure 4: Example of a nameplate	17
Figure 5: Lifting the packing from underneath	19
Figure 6: How to open the packing	19
Figure 7: "This side up" pictogram	20
Figure 8: The Sinus Penta is unpacked	20
Figure 9: Sinus Penta packing box with the internal protective elements	20
Figure 10: Clearance to be observed between two inverters	23
Figure 11: Clearance to allow when installing the Inverter/Power supply unit modules	24
Figure 12: Piercing template for STAND-ALONE models from S05 to S52 included	45
Figure 13: Piercing template for models S60 and S60P	46
Figure 14: Fittings for through-panel assembly for Sinus Penta S05	47
Figure 15: Piercing templates for through-panel assembly for Sinus Penta S05	48
Figure 16: Fittings for through-panel assembly for Sinus Penta S12	48
Figure 17: Piercing template for through-panel assembly for Sinus Penta S12	49
Figure 18: Fittings for through-panel assembly for Sinus Penta S14	49
Figure 19: Piercing template for through-panel assembly for Sinus Penta S14	50
Figure 20: Through-panel assembly and piercing template for Sinus Penta S15, S20 and S30	51
Figure 21: Fittings for through-panel assembly for Sinus Penta S22 and S32	51
Figure 22: Piercing template for through-panel assembly for Sinus Penta S22 and S32	52
Figure 23: Mechanical parts for the through-panel assembly for Sinus Penta S41, S42, S51 and S52	53
Figure 24: Piercing templates for the through-panel assembly for Sinus Penta S41, S42, S51 and S52	54
Figure 25: Piercing templates for modular units	56
Figure 26: Piercing templates for control unit (stand-alone model)	56
Figure 27: Installation example for Sinus Penta S65 (in cabinet)	57
Figure 28: Piercing template for IP54 inverter	58
Figure 29: Wiring diagram	61
Figure 30: External connections for modular inverters S65-S70	63
Figure 31: External connections for modular inverters S64	64
Figure 32: Single optical fibre connector	65
Figure 33: Double optical fibre connector	66
Figure 34: Internal wiring for Sinus Penta S65-S70	68
Figure 35: ES840 Supply Board	69
Figure 36: ES841 Inverter Module Gate Unit Board	69
Figure 37: ES843 Bus-bar Voltage Acquisition Board	70
Figure 38: Position of the fastening screws in the terminal board cover and the control unit	70
Figure 39: ES842 Control Unit	71
Figure 40: Single optical-fibre connector	72
Figure 41: Double optical-fibre connector	73
Figure 42: Internal wiring for inverters S64	75
Figure 43: Amplitude of current harmonics in 6-pulse configuration	76
Figure 44: Amplitude of current harmonics in 12-pulse configuration	76
Figure 45: Layout of 12-pulse connection for inverters S41..S52	77

Figure 46: Layout of a 12-pulse connection for modular inverters	77
Figure 47: Connection bars in S41–S42–S51–S52.....	81
Figure 48: S60 and S60P Connection bars	83
Figure 49: Connection to +48 Vdc Power Supply Units for S60P	83
Figure 50: Connection bars for S64–S70	84
Figure 51: Connection bars for S74–S80	85
Figure 52: Connection bars for S84–S90	86
Figure 53: Control terminals	99
Figure 54: Tightening a screened signal cable.....	102
Figure 55: Gaining access to the control terminals	103
Figure 56: Gaining access to terminal boards in models IP54	104
Figure 57: Control board: signals and programming	105
Figure 58: Control board LEDs	106
Figure 59: Gaining access to DIP-switches SW1 and SW2.....	110
Figure 60: Gaining access to DIP-switch SW3 and connector RS485 (Sinus Penta S05 to S22).....	110
Figure 61: Position of DIP-switch SW3 and connector RS485 (Sinus Penta S30 to S60P)	111
Figure 62: PNP command (active to +24V)	113
Figure 63: Power section PWM enable circuit.....	114
Figure 64: Connecting an incremental encoder	115
Figure 65: Signal sent from a push-pull, +24V output	116
Figure 66: Potentiometer linked to the REF Input	118
Figure 67: Wiring of a PLC analog output, axis control board, etc.	119
Figure 68: Wiring of unipolar remote potentiometer 0 ÷ REF max.....	120
Figure 69: 4 ÷ 20 mA Sensor wiring	120
Figure 70: Standard pattern of the thermistor resistor for the motor thermal protection	121
Figure 71: MDO1 output wiring as PNP for relay control with internal power supply.....	123
Figure 72: MDO1 output wiring as PNP for relay control with external power supply.....	123
Figure 73: MDO1 output wiring as NPN for relay control with internal power supply	124
Figure 74: MDO1 output wiring as NPN for relay control with external power supply	124
Figure 75: Cascade connection: FOUT frequency output → FINA or FINB frequency input.....	125
Figure 76: MDO2 output wiring as PNP for relay control with internal power supply.....	126
Figure 77: MDO2 output wiring as PNP for relay control with external power supply.....	126
Figure 78: MDO2 output wiring as NPN for relay control with internal power supply	127
Figure 79: MDO2 output wiring as NPN for relay control with external power supply	127
Figure 80: Display/keypad	131
Figure 81: Removing the display/keypad module	135
Figure 82: Front/rear view of the display/keypad and its shell.	136
Figure 83: Example of multidrop and direct connection	138
Figure 84: Pin lay-out of serial link 1 connector	140
Figure 85: Recommended wiring diagram for “2-wire” MODBUS connection.....	140
Figure 86: Conducted emission limits.....	179
Figure 87: Disturbance sources in a power drive system equipped with an inverter	181
Figure 88: Example of correct wiring of an inverter inside a cabinet.....	184
Figure 89: Wiring the toroid filter for the inverters of the Sinus Penta series	185

1. GENERAL DESCRIPTION

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

The PENTA inverters provided with the standard firmware feature the control modes below:

- **IFD** control mode: voltage / frequency scalar control for asynchronous motors,
- **VTC** control mode: sensorless vector control for asynchronous motors.
- **FOC** control mode: vector control with encoder feedback for asynchronous motors,

The following applications are also available by re-programming the firmware (this can be done by the user as well):

- **SYN** control mode: sensorless vector control and with encoder feedback for PMSM synchronous motors;
- **RGN** control mode: two-way interface capable of delivering power to the drives and injecting motor braking power into the mains.

See Special Applications Available for the Sinus Penta for more details.

Available Sinus Penta models range from 1.5kW to 3MW.

AVAILABLE Sinus Penta MODELS



Figure 1: All Sinus Penta models



NOTE

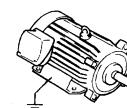
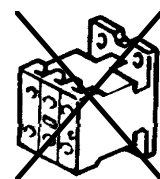
Products may have different ratings and/or appearance than the ones shown in the picture above. The proportion of one enclosure to the other is shown as an example and is not binding.

1.1. Feature List

- One product, multiple functions:
 - vector-modulation **IFD** function for general-purpose applications (V/f pattern);
 - sensorless, vector **VTC** function for high torque demanding performance (direct torque control);
 - vector **FOC** function with an encoder for accurate torque requirements and wide speed range;
 - **SYN** function for synchronous motors (see Special Applications Available for the Sinus Penta);
 - **RGN AFE** (Active Front End) function for power exchange with the mains, with unitary power factor and very low harmonic current (see Special Applications Available for the Sinus Penta);
- Wide range of supply voltage values (200 VAC ÷ 690 VAC) both for stand-alone models and cabinet models.
- Standard DC power supply, 280 to 970 VDC.
- Wide power range from 1.5kW a 3MW.
- Wide range of voltage values and power values for the electric motors to be connected to any inverter model. Example: 380-415Vac:

	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 EN 61800-3, issue 2 concerning emission limits.
- The new hardware configuration is standard supplied with a safety system including redundant circuitry for the inhibition of firing pulses in the power circuit: Safe Torque Off function, in compliance with EN 61800-5-2 (SIL3) and EN ISO 13849 (PL d). For the correct implementation of the STO functionality and the correct integration of the drive into the safety chain of your application, please refer to the application notice in the Safe Torque Off Function - Application Manual.
- Compact and light, the new series of Sinus Penta models may be installed in cabinets and offers a better price/performance ratio.
- Detection of the heat sink temperatures and control component temperatures.
- Automatic control of the cooling system. The ventilation system activates only when required. This ensures greater energy saving, minor wear of the cooling fans and reduced noise; In case of equipment failure, it is possible to adjust the system speed in order not to stop the equipment and to limit dissipated power.
- Built-in braking module up to Size S32 included.
- Noiseless operation ensured by high modulation frequency programmable up to 16 kHz.
- Motor thermal protection to be integrated both through thermal relay function and PTC input (in compliance with DIN44081/2).
- Remotable control panel with a 12-key LCD display showing full words for easier managing and programming of the displayed measures. Five languages available.
- Function parameter saving to remotable display/keypad and possibility of data transfer to multiple inverters.
- Four access levels to the operation parameters and preset parameters for the most common applications.
- PC interface for WINDOWS environment with the RemoteDrive software available in six foreign languages.
- RS485 MODBUS RTU Serial communication for serial links to PCs, PLCs and control interfaces.
- Fieldbuses with internal optional interface boards.



1.2. Special Applications Available for the Sinus Penta

Beside basic parameterization, Sinus Penta drives also implement operating modes and optional functional modes named **APPLICATIONS**, which can be obtained through firmware updating and additional external components.

Optional operating modes available for the inverters of the PENTA series are the **regenerative drive control application** and the **synchronous motor control application**.

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



NOTE

In order to upload and install your application SW and update the firmware packets of your Sinus Penta, you can use our RemoteDrive software. Refer to the User Manual related to each individual application for detailed instructions.

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

The **Synchronous Motor application (SYN)** allows PENTA drives to control permanent magnet synchronous motors (PMSM).

Any detail concerning functionality is given in the User Manuals related to each individual application.

2. SAFETY 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 electric shock.



FIRE HAZARD

Indicates fire hazard also leading to explosion.



HOT SURFACE

Indicates the presence of hot surfaces. Burn risks.



CAUTION

Indicates operating procedures that, if not carried out, may cause serious equipment failure.



NOTE

Indicates important hints concerning the equipment operation.

2.1. Installing and Operating the Equipment



NOTE

Always read this instruction manual before starting the equipment.

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

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

If a differential relay against electric shocks is intended to be used, this must be a "B-type" differential relay.

The inverter (depending on the models) may generate an output frequency up to 1000 Hz (on demand); this may cause a motor rotation speed up to 20 (twenty) times the rated motor speed—for 50Hz motors: never use the motor at a higher speed than the max. allowable speed stated on the motor nameplate.



DANGER

ELECTRIC SHOCK HAZARD – Never touch the inverter electrical parts when the inverter is on; always wait at least 20 minutes after switching off the inverter before operating on the inverter.

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

Do not perform electrical connections on the motor or the inverter if the inverter is on. Electric shock hazard exists on output terminals (U, V, W) and resistive braking module terminals (+, –, B) even when the inverter is disabled. Wait at least 20 minutes after switching off the inverter before operating on the electrical connection of the motor or the inverter.

**FIRE
HAZARD**

MECHANICAL MOTION – The drive causes mechanical motion. It is the operator's responsibility to ensure that this does not give rise to any dangerous situation. The STO function may be used to prevent mechanical motion under certain operating conditions. It is the user's responsibility to ascertain the safety level and properly adopt this function without exposing the equipment operators to mechanical risks.

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

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

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

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

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

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

If a contactor is installed between the inverter and the motor, make sure that it is switched over only when the inverter is disabled. Do not connect any power factor correction capacitor to the motor.

Operate the inverter only if a proper grounding is provided.

If an alarm trips, a comprehensive review of the Diagnostic section in the Sinus Penta's Programming Guide is recommended; restart the equipment only after removing the cause responsible for the alarm trip.

**CAUTION**

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

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

Prior to install the product, check the tightening of the factory-made link between power terminals 47/D and 47/+ in the models where this link is provided.

Do not connect single-phase motors.

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

Respect the environmental requirements for the equipment installation.

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

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



ATTENTION
 Static Sensitive
 Devices.
 Handle Only at
 Static Safe Work
 Stations.

ATTENTION
 Circuits sensibles à
 l'électricité statique.
 Manipulation uniquement
 autorisée sur un poste de
 travail protégé.

ACHTUNG
 Elektrostatisch gefährdete
 Bauelemente.
 Handhabung daher nur an
 geschützten Arbeitsplätzen
 erlaubt.

Before programming and starting the drive, make sure that the connected motor and all the controlled devices can be used for the whole speed range allowed by the converter. The drive may be programmed to control the motor at higher or lower rpm in respect to the speed attained by connecting the motor directly to the power supply line.

For the correct implementation of the STO functionality and the correct integration of the drive into the safety chain of your application, please refer to the application notice in the Safe Torque Off Function - Application Manual.

Motor insulation and bearing protection – Regardless of the output frequency, the inverter output includes impulses of approx. 1.35 times the equivalent grid voltage with a very short rise time. This applies to all inverters based on IGBT technology.

The impulse voltage may be approx. twofold at the motor terminals, based on the reflection and attenuation of the terminals and motor cable. This may cause additional stress to the motor and the motor insulation cable.

The variable speed drives characterized by rapid rise voltage impulses and by high switching frequencies may cause current impulses through the motor bearings, that could gradually wear the housings of the bearings and the rolling parts.

**CAUTION**

The motor insulation stress may be avoided by adopting optional du/dt filters (see the Output Inductors (DU/DT Filters) section in the Motor Drives Accessories - User Manual). The du/dt filters also reduce the motor shaft currents.

Sensors integrated into the motor – For the electrical and insulation specifications, please refer to the Control Terminals section and/or to the option boards which those sensors are connected to.

Critical torsional speed – If required, set up the critical torsional speed of the connected motor (see Prohibit Speeds menu in the Sinus Penta's Programming Guide).

Transient torque analysis – If required, limit the transient torque of the connected motor (see Limits menu in the Sinus Penta's Programming Guide).

**NOTE**

Disposal Instructions – Equipment containing electrical components may not be disposed of together with domestic waste. It must be collected separately as electrical and electronic waste according to local and currently valid legislation.



2.2. Permanent Magnet Motors

This section covers additional safety statements concerning Sinus Penta drives used with permanent magnet motors. The non-observance of the safety instructions below may cause serious injuries or death and equipment failure.

**DANGER**

Do not operate on the converter when the permanent magnet motor is rotating. Even if the power supply is cut out and the inverter is stopped, the permanent magnet motor, when rotating, powers the DC-link of the converter, and voltage is applied to the power supply links.

Do the following prior to install and service the inverter:

- Stop the motor.
- Make sure that the motor cannot rotate when operating on the equipment.
- Make sure that no voltage is applied to the power terminals in the converter.

**DANGER**

Do not exceed the motor rated rpm. Exceeding the motor rpm may cause overvoltage leading to damage or explosion of the converter DC-Link.

The permanent magnet motor control is made possible only by using the application firmware "PS" of the Sinus Penta for permanent magnet synchronous motors.

**NOTE**

Possible rotation of permanent magnet motors in case of multiple breakdowns of power semiconductors in the converter.

Multiple breakdowns of the power semiconductors may generate output DC voltage. Under such fault conditions, even if the STO (Safe Torque OFF) function is activated, the permanent magnet motor may be subject to self-alignment torque causing motor rotation of maximum $180/p$ degrees (where p is the number of pole pairs).

3. EQUIPMENT DESCRIPTION AND INSTALLATION

The inverters of the Sinus Penta series are full digital inverters capable of controlling asynchronous and synchronous motors up to 3 MW.

Inverters of the Sinus Penta series are designed and manufactured in Italy by the technicians of Elettronica Santerno; they incorporate the most advanced features offered by the latest electronic technologies.

Sinus Penta inverters fit any application thanks to their advanced features, among which: 32-bit multiprocessor control board; vector modulation; power control with the latest IGBTs; high immunity to radio interference; high overload capability.

Any value of the quantities required for the equipment operation may be easily programmed through the keypad, the alphanumeric display and the parameter menus and submenus.

The inverters of the Sinus Penta series are provided with the following features:

- wide power supply voltage range: 380-500Vac (–15%, +10%) for voltage class 4T;
- four classes of power supply: 2T (200-240Vac), 4T (380-500Vac), 5T (500-600Vac), 6T (575-690Vac);
- built-in EMC filters available for industrial environment;
- built-in EMC filters available for domestic environment (Sizes S05 and S12);
- DC voltage power supply available;
- built-in braking module (up to Size S32; S12 5T excepted);
- RS485 serial interface with communications protocol according to the MODBUS RTU standard;
- degree of protection IP20 (up to Size S32; IP00 for greater sizes);
- possibility of providing IP54 (up to Size S32);
- 3 analog inputs, 0 ± 10 VDC, $0 (4) \div 20$ mA; one input may be configured as a motor PTC input;
- 8 opto-isolated digital inputs (PNP inputs);
- 3 configurable analog outputs $0 \div 10$ V, $4 \div 20$ mA, $0 \div 20$ mA;
- 1 opto-isolated, “open collector” static digital output;
- 1 opto-isolated, “push-pull”, high-speed static digital output at high switching ratio;
- 2 relay digital outputs with change-over contacts;
- fan control (Sizes S15, S20 and modular drives excepted).

A comprehensive set of diagnostic messages allows a quick fine-tuning of the parameters during the equipment starting and a quick resolution of any problem during the equipment operation.

The inverters of the Sinus Penta series have been designed and manufactured in compliance with the requirements of the “Low Voltage Directive”, the “Machine Directive”, and the “Electromagnetic Compatibility Directive”.

3.1. Products Covered in this Manual

This manual covers any inverter of the Sinus Penta, Sinus BOX Penta, Sinus CABINET Penta series.

Any detail concerning optional functionality is given in separate manuals covering Sinus Penta software applications.

3.2. Delivery Check

Make sure that the equipment is not damaged and that it complies with the equipment you ordered by referring to the nameplate located on the inverter front part. The inverter nameplate is described below. If the equipment is damaged, contact the supplier or the insurance company concerned. If the equipment does not comply with the one you ordered, please contact the supplier as soon as possible.

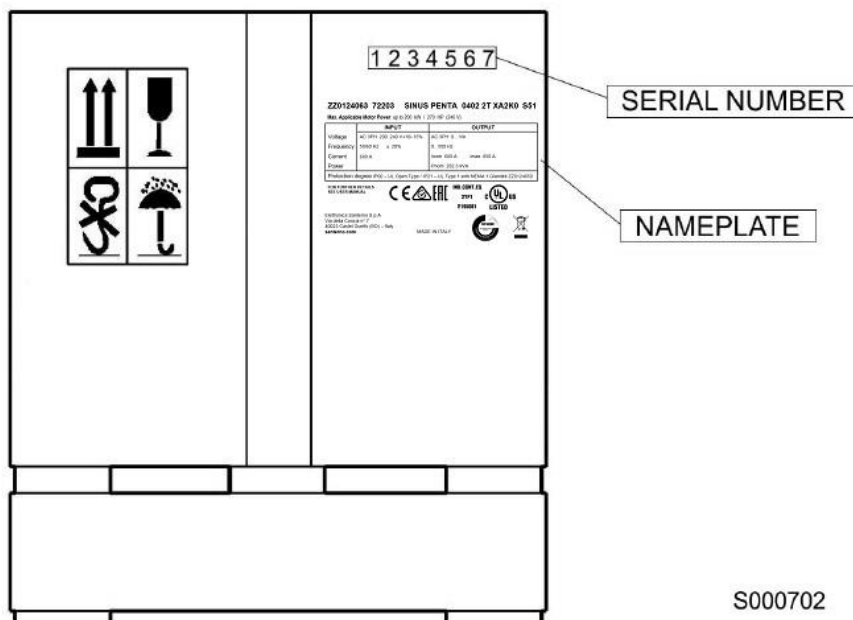


Figure 2: Packaging of the Sinus Penta

If the equipment is stored before being started, make sure that the ambient conditions do not exceed the ratings mentioned in Installing the Equipment section. The equipment guarantee covers any manufacturing defect. The manufacturer has no responsibility for possible damages occurred when shipping or unpacking the inverter. The manufacturer is not responsible for possible damages or faults caused by improper and irrational uses; wrong installation; improper conditions of temperature, humidity, or the use of corrosive substances. The manufacturer is not responsible for possible faults due to the inverter operation at values exceeding the inverter ratings and is not responsible for consequential and accidental damages. The equipment is covered by a 3-year guarantee starting from the date of delivery.

3.2.1. Nameplate

The product is identified by the nameplate affixed on the enclosure side.

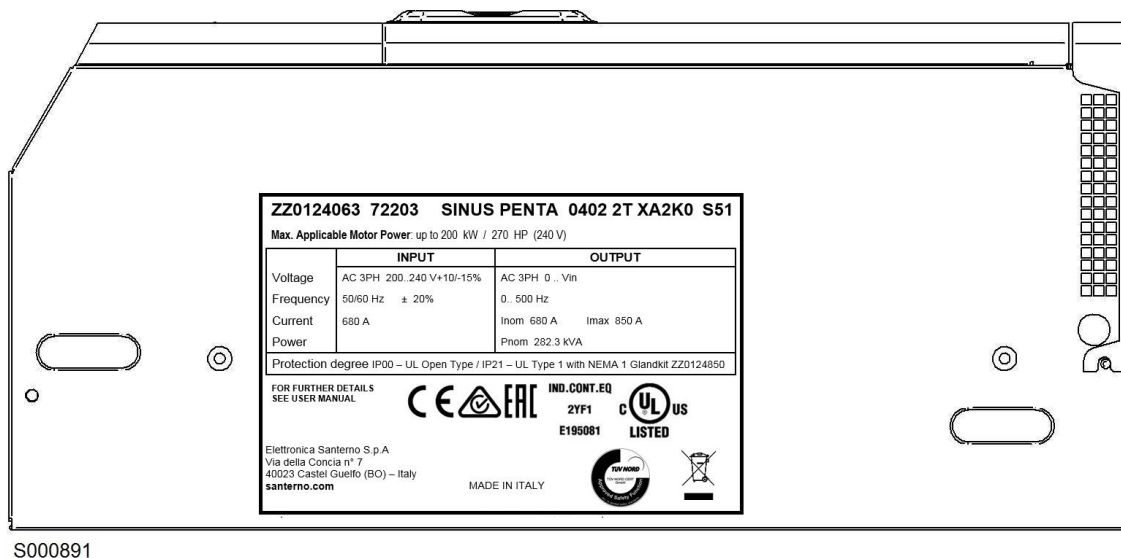


Figure 3: Example of a nameplate affixed on the drive metal enclosure

Example of a nameplate for Voltage Class 4T.

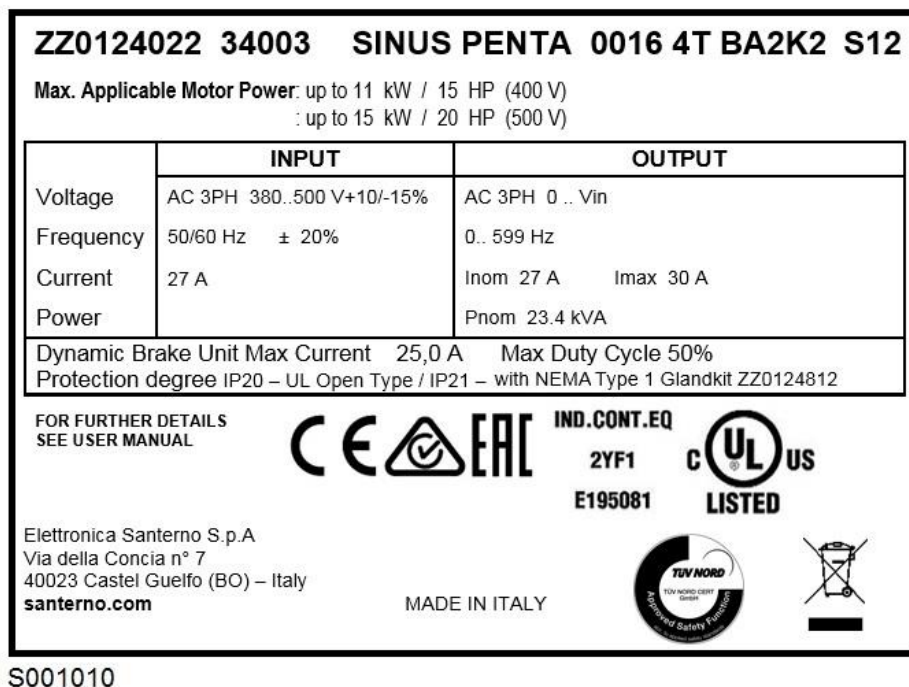


Figure 4: Example of a nameplate

Product Part Number:

SINUS	PENTA	0402	4	T	X	A2	K	0
1	2	3	4	5	6	7	8	9



NOTE Not all the combinations below are possible.

1	Product line: SINUS stand-alone inverter SINUS BOX inverter contained inside a box SINUS CABINET inverter contained inside a cabinet
2	PENTA control
3	Inverter Model
4	Supply voltage: 2 = Power supply 200÷240VAC; 280÷340VDC 4 = Power supply 380÷500VAC; 530÷705VDC 5 = Power supply 500÷600VAC; 705÷845VDC 6 = Power supply 575÷690VAC; 845÷970VDC
5	Type of power supply: T = AC three-phase voltage C = DC voltage
6	Braking module: X = no internal braking chopper B = built-in braking chopper
7	Type of EMC filter [*]: 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. A1 = integrated filter, EN 61800-3 issue 2 FIRST ENVIRONMENT Category C2, EN55011 gr.1 cl. A for industrial and domestic users. A2 = integrated filter, EN 61800-3 issue 2 SECOND ENVIRONMENT Category C3 for currents <400A; EN55011 gr.2 cl. A for industrial users, EN 61800-3 issue 2 SECOND ENVIRONMENT Category C4 for currents ≥400A I = no filter provided;
8	Control panel: X = no control panel provided (display/keypad) K = control panel and back-lit, 16 x 4 characters LCD display provided
9	Degree of protection of stand-alone inverters: 0 = IP00 (Sizes greater than S32) 2 = IP20 (up to Size S32) 5 = IP54 (possible up to Size S32)

**NOTE [*]**

Additional external EMC filters may be installed to bring emissions of devices of level **I** or **A2** to level **B** (part numbers AC171x, AC181x and AC182x).

**CAUTION**

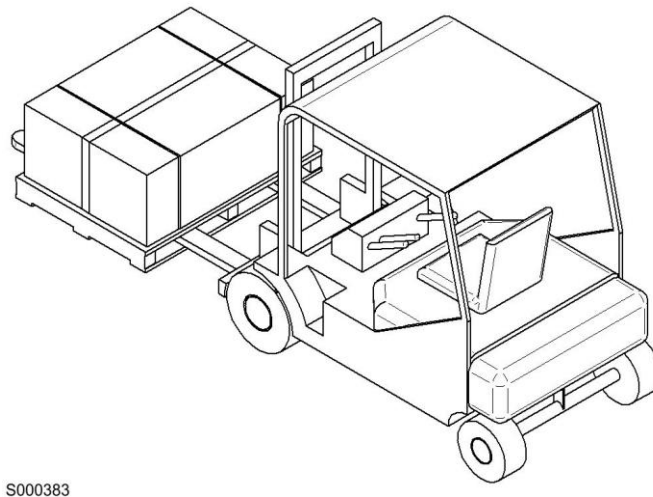
Standard EMC filters are designed for earthed networks (TN or TT). Filters for floating networks (IT) can be supplied on demand.

**CAUTION**

The drives of the Penta Marine series require the filters envisaged by the DNV Marine standard to suit the EMC profile requirements, which are strictest than the CE requirements.

3.2.2. Transport and Handling

The Sinus Penta packing ensures easy and safe handling. Handling shall be done using a transpallet or a lift truck with a carrying capacity of at least 100 kg, in order not to damage the product.



S000383

Figure 5: Lifting the packing from underneath

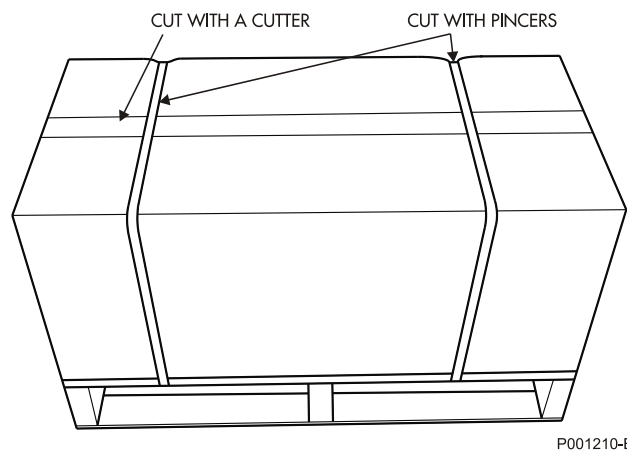
3.2.3. Unpacking

Get near the installation place, then unpack following the instructions provided below.



CAUTION The whole original packing is to be kept for the full duration of the warranty period.

1. Cut with pincers the plastic straps that fix the package of the Sinus Penta to the pallet.
2. Cut with a cutter the adhesive tape closing the box on the side where the package orientation symbol is reproduced (see Figure 7).



P001210-B

Figure 6: How to open the packing



Figure 7: “This side up” pictogram

3. Remove the Sinus Penta from its packing by lifting it from its sides. To avoid damaging the packing, lift the product keeping it horizontal to the floor (see Figure 8).

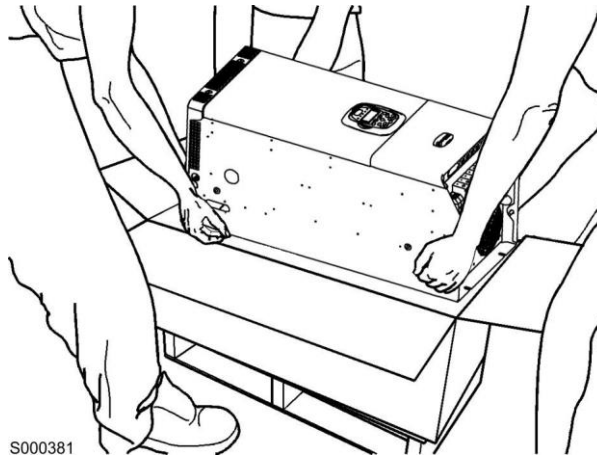


Figure 8: The Sinus Penta is unpacked

4. Put all the packing elements in the box and store it in a dry environment.

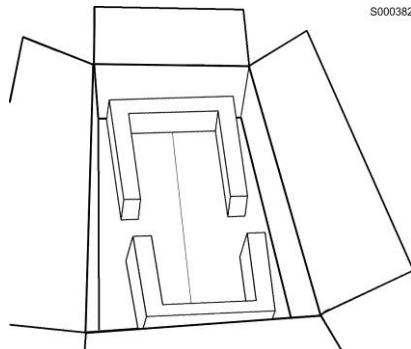


Figure 9: Sinus Penta packing box with the internal protective elements

3.3. Installing the Equipment

The inverters of the Sinus Penta series are Open Type Equipment – degree of protection IP00 and IP20 – that can be installed inside another enclosure featuring degree of protection IP3X as a minimum requirement. Only models featuring degree of protection IP54 may be wall-mounted.



NOTE 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. Install the inverter closed, without removing its covers; grab its side handles where fitted.



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




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



CAUTION The inverter must be installed on a stiff surface.

3.3.1. Environmental Requirements for the Equipment Installation, Storage and Transport

Any electronic board installed in the inverters manufactured by Elettronica Santerno is tropicalized. This enhances electrical insulation between the tracks having different voltage ratings and ensures longer life of the components. It is however recommended that the requirements below be met:

Maximum surrounding air temperature	<p>–10 °C to +55 °C</p> <p>Depending on the inverter model, it might be necessary to apply 2% derating of the rated current for every degree beyond the stated temperatures depending on the inverter model and the application category (see Maximum allowable Operating Temperature).</p> <div>  <p>NOTE For UL508C Open Type Equipment Maximum Surrounding Air Temperature is +40 °C.</p> </div>
Ambient temperatures for storage and transport	–25 °C to + 70 °C
Installation environment	<p>Pollution degree 2 or better (according to EN 61800-5-1 and UL508C Open Type Equipment).</p> <p>Do not install in direct sunlight and in places exposed to conductive dust, corrosive gases, vibrations, water sprinkling or dripping (except for IP54 models); do not install in salty environments.</p>
Altitude	<p>Max. altitude for installation 2000 m a.s.l. For installation above 2000 m and up to 4000 m, please contact Elettronica Santerno.</p> <p>Above 1000 m, derate the rated current by 1% every 100 m.</p>

Operating ambient humidity	From 5% to 95%, from 1 g/m ³ to 29 g/m ³ , non-condensing and non-freezing (extension to 95%, thus exceeding 85% required by class 3K3 according to EN 61800-5-1).
Storage ambient humidity	From 5% to 95%, from 1 g/m ³ to 29 g/m ³ , non-condensing and non-freezing (class 1K3 according to EN 61800-5-1).
Ambient humidity during transport	Max. 95%, up to 60 g/m ³ ; condensation may appear when the equipment is not running (class 2K3 according to EN 61800-5-1).
Storage and operating atmospheric pressure	From 86 to 106 kPa (classes 3K3 and 1K4 according to EN 61800-5-1).
Atmospheric pressure during transport	From 70 to 106 kPa (class 2K3 according to EN 61800-5-1).

**CAUTION**

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

**CAUTION**

Always transport the equipment within its original package.

3.3.2. Air Cooling

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

3.3.2.1. STAND-ALONE Models - IP20 and IP00 (S05–S60P)

Size	A – Side clearance (mm)	B – Side clearance between two drives (mm)	C – Bottom clearance (mm)	D – Top clearance (mm)
S05	20	40	50	100
S12	30	60	60	120
S14	30	60	80	150
S15	30	60	80	150
S20	50	100	100	200
S22	50	100	100	200
S30	100	200	200	200
S32	100	200	200	250
S41	50	50	200	300
S42	50	50	200	300
S51	50	50	200	300
S52	50	50	200	300
S60	150	300	500	300
S60P	150	150	500	300

3.3.2.2. STAND-ALONE Models - IP54 (S05–S32)

Size	A – Side clearance (mm)	B – Side clearance between two drives (mm)	C – Bottom clearance (mm)	D – Top clearance (mm)
S05	50	100	50	100
S12	60	120	60	120
S14	60	120	80	150
S15	30	60	80	150
S20	50	100	100	200
S22	50	100	100	200
S30	100	200	200	200
S32	100	200	200	250

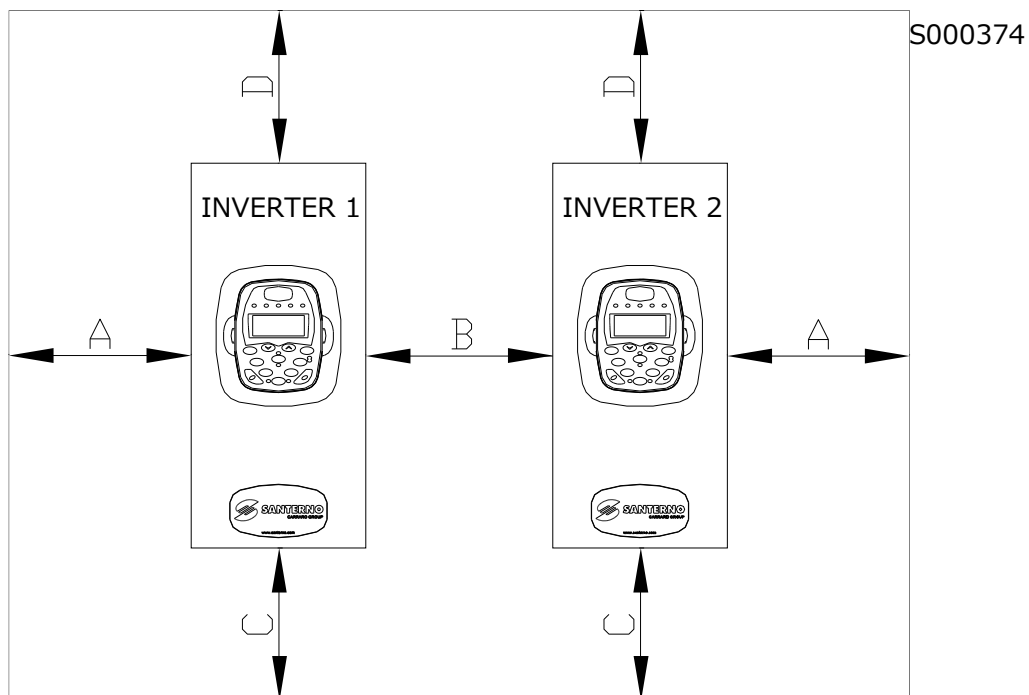


Figure 10: Clearance to be observed between two inverters

3.3.2.3. STAND-ALONE Modular Inverters - IP00 (S64–S90)

Size	Minimum side clearance b/w two inverter modules (mm)	Maximum side clearance b/w two inverter modules (mm)	Maximum side clearance b/w two supply modules (mm)	Maximum side clearance b/w inverter modules and supply modules (mm)	Top clearance (mm)	Bottom clearance (mm)	Clearance b/w two inverter units (mm)
S64-S90	20	50	50	400	100	See Figure 11	300

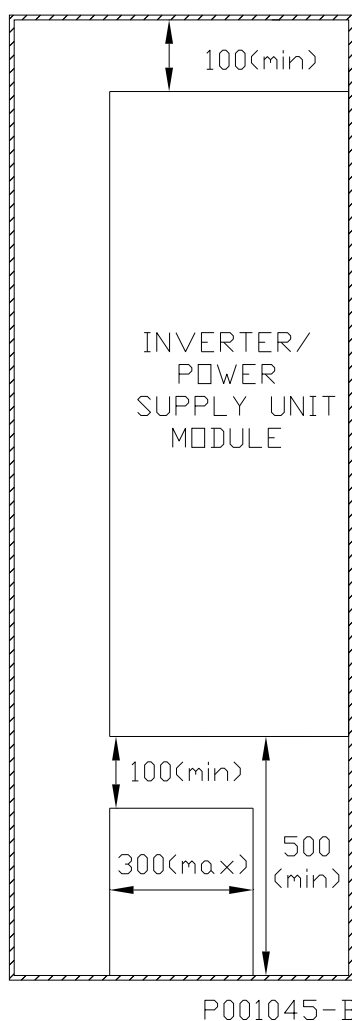


Figure 11: Clearance to allow when installing the Inverter/Power supply unit modules

3.3.2.4. Dimensioning the Cooling System

The air circulation through the enclosure must:

- avoid warm air intake;
- provide adequate air-cooling through the inverter.

The technical data related to dissipated power is shown in the ratings table in section Size, Weight, Efficiency, Noise Level.

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

The air delivery required is equal to $Q = (P_{ti} - P_{dsu}) / \Delta t \times 3.5$ [m³/h]:

P_{ti} is the overall thermal power dissipated inside the cabinet and expressed in W,

P_{dsu} is the thermal power dissipated from the cabinet surface,

Δt is the difference between the air temperature inside the cabinet and the air temperature outside the cabinet (temperatures are expressed in degrees centigrade, °C).

For sheet-steel enclosures, power dissipated from the cabinet walls (**P_{dsu}**) may be calculated as follows:

$$P_{dsu} = 5.5 \times \Delta t \times S$$

where **S** is equal to the enclosure overall surface in m².

Q is the air flow (expressed in m³ per hour) circulating through the ventilation slots and is the main dimensioning factor to be considered in order to choose the most suitable air-cooling systems.

Example:

Enclosure with a totally free external surface housing a **Sinus Penta 0113** and a 500 VA transformer dissipating 15 W.

Total power to be dissipated inside the enclosure (**P_{ti}**):

generated from the P_i	2150 W
inverter	
generated from other P_a	15 W
components	
P_{ti}	P_i + P_a 2165 W

Temperatures:

Max. inside temperature desired	T_i 40 °C
Max. outside temperature	T_e 35 °C
Difference between temp. T_i and T_e	Δt 5 °C

Size of the enclosure (metres):

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

Free external surface of the enclosure **S**:

$$S = (W \times H) + (W \times H) + (D \times H) + (D \times H) + (D \times W) = 4.68 \text{ m}^2$$

Thermal power dissipated outside the enclosure **P_{dsu}** (only for sheet-steel enclosures):

$$P_{dsu} = 5.5 \times \Delta t \times S = 128 \text{ W}$$

Remaining power to be dissipated:

$$P_{ti} - P_{dsu} = 2037 \text{ W}$$

To dissipate **P_{diss}**, left, provide a ventilation system with the following air delivery **Q**:

$$Q = (P_{ti} - P_{dsu}) / \Delta t \times 3.5 = 1426 \text{ m}^3/\text{h}$$

3.3.3. Inverter Scheduled Maintenance

If installed in an adequate place, the inverter scheduled maintenance is reduced to a minimum. The minimum maintenance intervals are indicated in the table below.

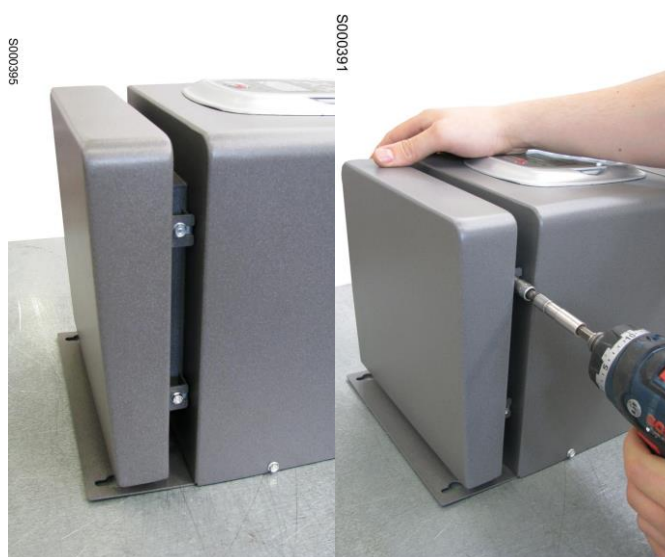
Maintenance tasks	Minimum frequency	What to do
Capacitor reforming	Every 12 months if the inverter is stored in a warehouse	See section Capacitor Reforming
Heat sink cleaning check, ambient temperature check	Depending on dust concentration (every 6...12 months)	See section Heat Sink and Ambient Temperature
Air filter cleaning (IP54 models only)	Depending on dust concentration (every 6...12 months)	See section Air Filters
Cooling fan check; replacement, if required	Depending on dust concentration (every 6...12 months)	See section Cooling Fans
Cooling fan replacement	Every 6 years	See section Cooling Fans
Capacitor replacement (if ambient temperature $\geq 35^{\circ}\text{C}$, but ranging within allowable rated values)	Every 10 years or 20,000 hours	See section Replacing a Capacitor
Capacitor replacement (if ambient temperature $< 35^{\circ}\text{C}$)	Every 12 years	See section Replacing a Capacitor
Bypass contactor	Every 10 years	See section Bypass Contactor

Please refer to the Programming Guide (Maintenance menu) for the creation of warnings as reminders of the scheduled maintenance activities.

3.3.4. Air Filters

The air filters are to be periodically cleaned in IP54 models only.

1. Remove voltage from the inverter.
2. Loosen the side screws on the cover.



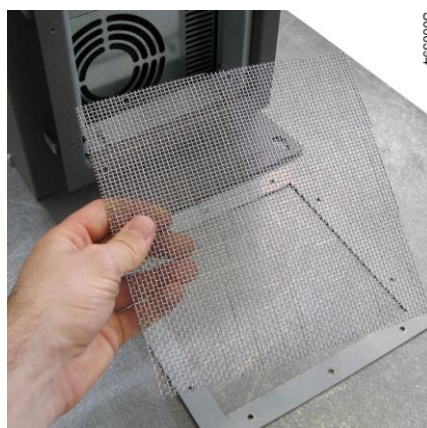
3. Pull out the cover in the direction of the arrow.



4. Loosen the fastening screws of the frame.



5. Clean the air filter and replace it, if required.



6. Close the inverter by refitting the air filter, then the cover.

7. Apply voltage to the inverter.

3.3.5. Heat Sink and Ambient Temperature Check

Dust builds up in the inverter cooling fans, as well as on the heat sink temperature sensors and the ambient temperature sensors. This may alter the readout values.

Periodically check the consistency of the temperature data. If required, clean the control board, (ambient temperature detection) and heat sink (heat sink temperature detection).

3.3.5.1. Control Board

- 1.Remove voltage from the inverter.
- 2.Remove the cover from the inverter.
- 3.Clean the control board with a soft brush.
- 4.Refit the inverter cover.
- 5.Apply voltage to the inverter.



CAUTION

It is forbidden to use compressed air, that contains humidity and impurity.
It is recommended that a vacuum cleaner be used along with the soft brush.

3.3.5.2. Cleaning the Heat Sink

Please contact Elettronica Santerno's Customer Service.

3.3.6. Cooling Fans

The minimum expected lifetime of the inverter cooling fans is approx. 50,000 hours. The actual lifetime depends on the operating mode of the inverter, the ambient temperature and the environmental pollution.

When the cooling fans are particularly noisy or the heat sink temperature rises, this means that an imminent fault is likely to occur, even if the fans have been regularly cleaned over time. If the inverter is used in a critical stage of a process, replace the fans as soon as those symptoms occur.

3.3.6.1. Replacing the Cooling Fans

Please contact Elettronica Santerno's Customer Service.

3.3.7. Capacitors

The DC-link of the inverter requires several electrolytic capacitors, whose expected lifetime is approx. 40,000 to 50,000 hours. The actual endurance depends on the inverter load and the ambient temperature. The capacitors lifetime may be increased by reducing the ambient temperature.

Capacitor faults cannot be predicted. Normally, when a capacitor fault occurs, the mains fuses blow or an alarm message appears. Please contact Elettronica Santerno's Customer Service if you suppose that a capacitor fault has occurred.

3.3.7.1. Capacitor Reforming

Reform the spare capacitors once a year as detailed in the Guide for Capacitor Reforming.

3.3.7.2. Replacing a Capacitor

Please contact Elettronica Santerno's Customer Service.

3.3.8. Bypass Contactor

Except for models S41/42/51/52 and \geq S64, the pre-charge circuit of the capacitors utilizes a bypass contactor whose expected lifetime is approx. 10 years. The actual duration of the bypass contactor depends on how many times the inverter is powered on and on the dust concentration in the installation environment. Normally, an alarm message is displayed when a bypass contactor fault occurs.

3.3.8.1. Replacing the Bypass Contactor

Please contact Elettronica Santerno's Customer Service.

3.3.9. Size, Weight, Efficiency, Noise Level

In general, efficiency of an inverter at rated current may be computed with the following formula:

$$\text{Efficiency} = P_{\text{out}} / P_{\text{in}} \times 100\% \quad (\text{eq. 1})$$

Input power can be written as a function of output power:

$$P_{\text{in}} = P_{\text{out}} + \text{losses} \quad (\text{eq. 2})$$

When replacing eq. 2 with eq. 1, we get:

$$\text{Efficiency} = P_{\text{out}} / (P_{\text{out}} + \text{losses}) \times 100\% \quad (\text{eq. 3})$$

Output power is calculated as follows:

$$P_{\text{out}} = \sqrt{3} \times V_{\text{out}} \times I_{\text{out}} \times \text{PF}_{\text{motor}} \quad (\text{eq. 4})$$

or (equivalent)

$$P_{\text{out}} = P_{\text{motor}} / \text{motor efficiency } (\eta) \quad (\text{eq. 5})$$

For example (200kW motor with Sinus Penta 0202), assuming motor efficiency (η) = 95.2%:

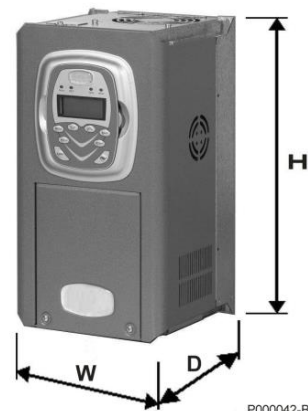
$$P_{\text{out}} = 200000 / 0.952 = 210084 \text{ kW}$$

$$\text{Efficiency} = 210084 / (210084 + 3200) \times 100\% = \mathbf{98.5\%}$$

where 3200W are the power losses at I_{nom} obtained from the tables in the sections below.

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

Size	Sinus Penta MODEL	W	H	D	Weight	Power dissipated at Inom	Noise level
		mm	mm	mm	kg	W	db(A)
S05	0007	170	340	175	7	160	46
	0008				7	170	
	0010				7	220	
	0013				7	220	
	0015				7	230	
	0016				7	290	
	0020				7	320	
S12	0023	215	401	225	11	390	57
	0033				12	500	
	0037				12	560	
S15	0040	225	466	331	22.5	820	48
	0049				22.5	950	
S20	0060	279	610	332	33.2	950	58
	0067				33.2	1250	
	0074				36	1350	
	0086				36	1550	
S30	0113	302	748	421	51	2150	61
	0129				51	2300	
	0150				51	2450	66
	0162				51	2700	
S41	0180	500	882	409	117	2550	64
	0202				117	3200	
	0217				121	3450	
	0260				121	4050	
S51	0313	578	882	409	141	4400	65
	0367				141	4900	
	0402				141	6300	
S60	0457	890	1310	530	260	7400	61
	0524				260	8400	

**NOTE**

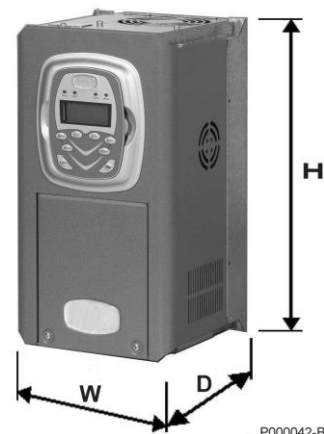
Degree of protection IP20 / UL Open Type Equipment up to Size S30; IP00 / UL Open Type Equipment for greater Sizes.

**NOTE**

Degree of protection IP21 / UL Type 1 up to Size S51 with NEMA 1 GLANDKIT kit UL Category number NMMS / NMMS7 by Elettronica Santerno.

3.3.9.2. IP20 and IP00 STAND-ALONE Models (S05–S60P) Class 4T

Size	Sinus Penta MODEL	W	H	D	Weight	Power Dissipated at Inom	Noise level
		mm	mm	mm	kg	W	db(A)
S05	0005	170	340	175	7	215	46
	0007				7	240	
	0009				7	315	
	0011				7	315	
	0014				7	315	
S12	0016	215	401	225	10.5	430	42
	0017				10.5	490	
	0020				10.5	490	
	0025				11.5	520	
	0030				11.5	550	53
	0034				12.5	680	
	0036				12.5	710	
S15	0040	225	466	331	22.5	820	48
	0049				22.5	950	
S20	0060	279	610	332	33.2	950	57
	0067				33.2	1250	
	0074				36	1350	
	0086				36	1550	
S30	0113	302	748	421	51	2150	61
	0129				51	2300	
	0150				51	2450	66
	0162				51	2700	
S41	0180	500	882	409	117	2550	63
	0202				117	3200	
	0217				121	3450	
	0260				121	4050	
S51	0313	578	882	409	141	4400	65
	0367				141	4900	
	0402				141	6300	
S60	0457	890	1310	530	260	7400	61
	0524				260	8400	
S60P	0598P	890	1310	530	255	6950	83



NOTE

Degree of protection IP20 / UL Open Type Equipment up to Size S30; IP00 / UL Open Type Equipment for greater Sizes.

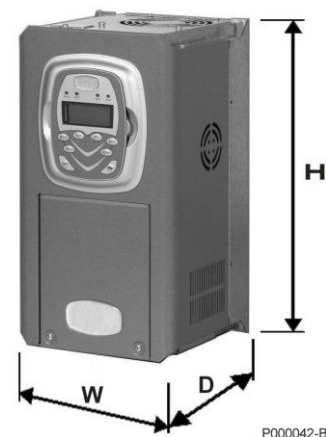


NOTE

Degree of protection IP21 / UL Type 1 up to Size S51 with NEMA 1 GLANDKIT kit UL Category number NMMS / NMMS7 by Elettronica Santerno.

3.3.9.3. IP20 and IP00 STAND-ALONE Models (S12–S52) Class 5T-6T

Size	Sinus Penta MODEL	W	H	D	Weight	Power dissipated at Inom	Noise Level
		mm	mm	mm	kg	W	db(A)
S12 5T	0003	215	401	225	10	160	50
	0004				10	180	
	0006				10.5	205	
	0012				10.5	230	
	0018				10.5	270	
S14	0003	270	527	240	17.5	170	49
	0004				17.5	190	
	0006				17.5	210	
	0012				17.5	240	
	0018				17.5	280	
	0019				17.5	320	
	0021				17.5	370	
	0022				18	470	
	0024				18	550	
	0032				18.5	670	
S22	0042	283	833	353	51	750	68
	0051				51	950	
	0062				54	1000	
	0069				54	1200	
	0076				80	1400	
S32	0088	367	880	400	80	1700	63
	0131				84	2100	
	0164				84	2500	
	0181				128	3450	
	0201				128	3900	
S42	0218	500	968	409	136	4550	63
	0259				136	4950	
	0290				160	5950	
	0314				160	6400	
	0368				160	7000	
S52	0401	578	968	409	160	7650	69

**NOTE**

Degree of protection IP20 / UL Open Type Equipment up to Size S32; IP00 / UL Open Type Equipment for greater Sizes.

**NOTE**

Degree of protection IP21 / UL Type 1 for all Sizes with NEMA 1 GLANDKIT kit UL Category number NMMS / NMMS7 by Elettronica Santerno.

3.3.9.4. Modular IP00 STAND-ALONE Models (S64–S90)

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

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

Four types of inverter modules are available:

- basic version
- version with integrated control unit
- version with integrated auxiliary supply unit (to be used for those models which are not equipped with the power supply module – sizes S64, S74, and S84);
- version with integrated splitter unit (to be used for the Penta sizes where parallel-connected inverter modules are installed – sizes S74, S75, S80, S84 and S90).

Match the modules above to obtain the proper inverter dimensioning for your application:

		Number of power supply modules			
		0	1	2	3
Number of IGBT modules	3	S64	S65	S70	–
	6	S74	–	S75	S80
	9	S84	–	–	S90



CAUTION

The busbars connecting the different modules are not supplied by Elettronica Santerno.



CAUTION

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

a) control unit

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

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



NOTE

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

b) Inverter modules and power supply unit

Configuration: power supply delivered from the mains

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

Size	Sinus Penta Model	Voltage class	Modules		Overall Dimensions	Overall Weight	Overall Power dissipated at Inom	Noise Level
			Power Supply Modules	Inverter Modules	WxHxD	kg	kW	db(A)
S65	0598	4T	1	3	980x1400x560	440	9.75	71
	0748	4T	1	3			10.75	
	0831	4T	1	3			12.90	
	0457	5T-6T	1	3			9.15	
	0524	5T-6T	1	3			9.80	
	0598	5T-6T	1	3			11.25	
	0748	5T-6T	1	3			12.45	
S70	0831	5T-6T	2	3	1230x1400x560	550	14.90	72

Models including parallel-connected inverter modules (S75, S80 and S90)

Size	Sinus Penta Model	Voltage Class	Modules		Overall Dimensions	Overall Weight	Overall Power dissipated at Inom	Noise Level
			Power Supply Modules	Inverter Modules (*)	WxHxD	kg	kW	db(A)
S75	0964	4T	2	6	1980x1400x560	880	17.20	73
	1130	4T	2	6			18.90	
	1296	4T	2	6			21.10	
	0964	5T-6T	2	6			18.40	
	1130	5T-6T	2	6			22.80	
S80	1296	5T-6T	3	6	2230x1400x560	990	24.90	74
S90	1800	4T	3	9	2980x1400x560	1320	29.25	75
	2076	4T	3	9			32.25	
	1800	5T-6T	3	9			33.75	
	2076	5T-6T	3	9			37.35	

(*): Three inverter modules are to be provided with an integrated splitter unit.

c) Inverter modules, power supply unit and braking unit

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

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

Size	Sinus Penta Model	Voltage class	Modules			Overall Dimensions	Overall Weight	Power Dissipated with 50% Braking Duty Cycle	Noise Level
			Power Supply Modules	Inverter Modules	Braking Modules				
						WxHxD	kg	kW	db(A)
S65	0598	4T	1	3	1	1230x1400x560	550	10.55	71
	0748	4T	1	3	1			11.65	
	0831	4T	1	3	1			13.90	
	0457	5T-6T	1	3	1			10.05	
	0524	5T-6T	1	3	1			10.80	
	0598	5T-6T	1	3	1			12.45	
	0748	5T-6T	1	3	1			13.75	
S70	0831	5T-6T	2	3	1	1480x1400x560	660	14.90	72

Models including parallel-connected inverter modules (S75, S80 and S90)

Size	Sinus Penta Model	Voltage class	Modules			Overall Dimensions	Overall Weight	Power Dissipated with 50% Braking Duty Cycle	Noise Level
			Power Supply Modules	Inverter Modules (*)	Braking Modules (**)				
						WxHxD	kg	kW	db(A)
S75	0964	4T	2	6	1	2230x1400x560	990	18.50	74
	1130	4T	2	6	1			20.40	
	1296	4T	2	6	2	2480x1400x560	1100	22.90	
	0964	5T-6T	2	6	1	2230x1400x560	990	20.30	
	1130	5T-6T	2	6	2	2480x1400x560	1100	25.00	
S80	1296	5T-6T	3	6	2	2730x1400x560	1210	27.30	75
S90	1800	4T	3	9	2	3480x1400x560	1540	31.25	76
	2076	4T	3	9	2			34.85	
	1800	5T-6T	3	9	2			36.75	
	2076	5T-6T	3	9	2			41.15	

(*): Three inverter modules are to be provided with an integrated splitter unit.

(**): When using two braking modules, one braking module is to be provided with an integrated splitter unit.

d) Inverter modules only

Configuration:

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

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

Size	Sinus Penta Model	Voltage Class	Modules	Overall Dimensions	Overall Weight	Overall Power dissipated at Inom	Noise Level
			Inverter modules				
				WxHxD	kg	kW	db(A)
S64	0598	4C	3	730x1400x560	338	7.50	69
	0748	4C	3			8.25	
	0831	4C	3			9.90	
	0457	5C-6C	3			7.20	
	0524	5C-6C	3			7.80	
	0598	5C-6C	3			8.85	
	0748	5C-6C	3			9.75	
	0831	5C-6C	3			11.70	

Models including parallel-connected inverter modules (S74 and S84)

Size	Sinus Penta Model	Voltage Class	Modules	Overall Dimensions	Overall Weight	Overall Power dissipated at Inom	Noise Level
			Inverter modules (*)				
				WxHxD	kg	kW	db(A)
S74	0964	4C	6	1480x1400 x560	676	13.20	72
	1130	4C	6			14.40	
	1296	4C	6			15.60	
	0964	5C-6C	6			14.40	
	1130	5C-6C	6			18.00	
	1296	5C-6C	6			19.20	
S84	1800	4C	9	2230x1400x560	1014	22.50	74
	2076	4C	9			24.75	
	1800	5C-6C	9			26.55	
	2076	5C-6C	9			29.25	

(*): Three inverter modules are to be provided with an integrated splitter unit.

e) Inverter modules and braking module only

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

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

Size	Sinus Penta Model	Voltage Class	Modules		Overall Dimensions	Overall Weight	Overall Power Dissipated with 50% Braking Duty Cycle	Noise Level
			Inverter Modules	Braking Module				
					WxHxD	kg	kW	db(A)
S64	0598	4C	3	1	980x1400x560	448	8.30	71
	0748	4C	3	1			9.15	
	0831	4C	3	1			10.90	
	0457	5C-6C	3	1			8.10	
	0524	5C-6C	3	1			8.80	
	0598	5C-6C	3	1			10.05	
	0748	5C-6C	3	1			11.05	
	0831	5C-6C	3	1			13.20	

Models including parallel-connected inverter modules (S74 and S84)

Size	Sinus Penta Model	Voltage Class	Modules		Overall Dimensions	Overall Weight	Overall Power Dissipated with 50% Braking Duty Cycle	Noise Level
			Inverter Modules (*)	Braking Modules (**)				
					WxHxD	kg	kW	db(A)
S74	0964	4C	6	1	1730x1400x560	786	14.50	74
	1130	4C	6	1			15.90	
	1296	4C	6	2	1980x1400x560	896	17.40	
	0964	5C-6C	6	1	1730x1400x560	786	16.30	
	1130	5C-6C	6	2	1980x1400x560	896	20.20	
	1296	5C-6C	6	2			21.60	
S84	1800	4C	9	2	2730x1400x560	1234	24.50	75
	2076	4C	9	2			27.35	
	1800	5C-6C	9	2			29.55	
	2076	5C-6C	9	2			33.05	

(*): Three inverter modules are to be provided with an integrated splitter unit.

(*): When using two braking modules, one braking module is to be provided with an integrated splitter unit.

3.3.9.5. IP54 STAND-ALONE Models (S05–S30) Class 2T

Size	Sinus Penta Model	W	H	D	Weight	Power Dissipated at Inom.	Noise Level
		mm	mm	mm	kg	W	db(A)
S05	0007	214	577	227	15.7	160	46
	0008					170	
	0010					220	
	0013					220	
	0015					230	
	0016					290	
	0020	Unavailable model as IP54					
S12	0023	250	622	268	23.8	390	65
	0033					500	
	0037					560	
S15	0040	288	715	366	40	820	47
	0049					950	
S20	0060	339	842	366	54.2	1050	59
	0067					1250	
	0074				57	1350	
	0086					1550	
S30	0113	359	1008	460	76	2150	61
	0129					2300	
	0150					2450	66
	0162					2700	

OPTIONAL FEATURES:

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

**NOTE**

When housing optional features,
 depth increases by 40mm.



3.3.9.6. IP54 STAND-ALONE Models (S05–S30) Class 4T

Size	Sinus Penta Model	W	H	D	Weight	Power Dissipated at Inom.	Noise Level
		mm	mm	mm	kg	W	db(A)
S05	0005	214	577	227	15.7	215	46
	0007					240	
	0009					315	
	0011					315	
	0014					315	
S12	0016	250	622	268	22.3	430	57
	0017					490	
	0020					490	
	0025				23.3	520	
	0030					550	
	0034				24.3	680	
	0036					710	
S15	0040	288	715	366	40	820	47
	0049					950	
S20	0060	339	842	366	54.2	1050	59
	0067					1250	
	0074					1350	
	0086				57	1550	
	0113					2150	
S30	0129	359	1008	406	76	2300	61
	0150					2450	66
	0162					2700	

OPTIONAL FEATURES:

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



NOTE

When housing optional features, depth increases by 40mm.



3.3.9.7. IP54 STAND-ALONE Models (S12–S32) Class 5T-6T

Size	Sinus Penta Model	W	H	D	Weight	Power dissipated at Inom	Noise Level
		mm	mm	mm	kg	W	db(A)
S12 5T	0003	250	622	268	22.5	160	50
	0004					180	
	0006				23	205	
	0012					230	
	0018					270	
S14	0003	305	751	290	30	170	49
	0004					190	
	0006					210	
	0012					240	
	0018					280	
	0019					320	
	0021					370	
	0022				30.5	480	52
	0024					560	
	0032	Unavailable model as IP54					
S22	0042	349	1095	393	80	750	68
	0051					950	
	0062				83	1000	
	0069					1200	
S32	0076	431	1160	471	118	1400	63
	0088					1700	
	0131				122	2100	
	0164					2500	

OPTIONAL FEATURES:

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

**NOTE**

When housing optional features, depth increases by 40mm.

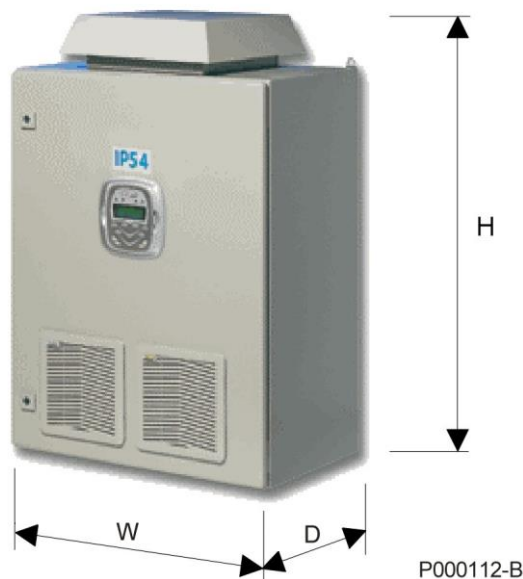


3.3.9.8. IP54 BOX Models (S05–S20) Class 2T

Size	Sinus Penta Model		W	H	D	Weight	Power dissipated at Inom.
			mm	mm	mm	kg	W
S05B	Sinus Penta BOX	0007	400	600	250	27.9	160
	Sinus Penta BOX	0008				27.9	170
	Sinus Penta BOX	0010				27.9	220
	Sinus Penta BOX	0013				27.9	220
	Sinus Penta BOX	0015				27.9	230
	Sinus Penta BOX	0016				27.9	290
	Sinus Penta BOX	0020				27.9	320
S12B	Sinus Penta BOX	0023	500	700	300	48.5	390
	Sinus Penta BOX	0033				49.5	500
	Sinus Penta BOX	0037				49.5	560
S15B	Sinus Penta BOX	0040	600	1000	400	78.2	820
	Sinus Penta BOX	0049				78.2	950
S20B	Sinus Penta BOX	0060	600	1200	400	109.5	1050
	Sinus Penta BOX	0067				109.5	1250
	Sinus Penta BOX	0074				112.3	1350
	Sinus Penta BOX	0086				112.3	1550

OPTIONAL FEATURES:

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

**NOTE**

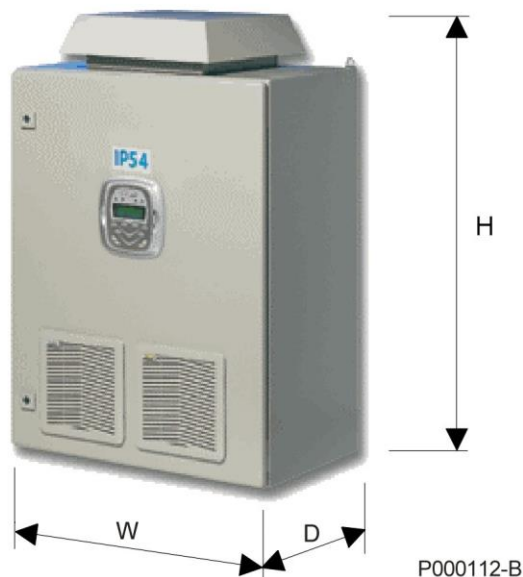
Dimensions and weights may vary depending on optional components required.

3.3.9.9. IP54 BOX Models (S05–S20) Class 4T

Size	Sinus Penta Model		W	H	D	Weight	Power dissipated at Inom.
			mm	mm	mm	kg	W
S05B	Sinus Penta BOX	0005	400	600	250	27.9	215
	Sinus Penta BOX	0007				27.9	240
	Sinus Penta BOX	0009				27.9	315
	Sinus Penta BOX	0011				27.9	315
	Sinus Penta BOX	0014				27.9	315
S12B	Sinus Penta BOX	0016	500	700	300	48.5	430
	Sinus Penta BOX	0017				48.5	490
	Sinus Penta BOX	0020				48.5	490
	Sinus Penta BOX	0025				49.5	520
	Sinus Penta BOX	0030				49.5	550
	Sinus Penta BOX	0034				50.5	680
	Sinus Penta BOX	0036				50.5	710
S15B	Sinus Penta BOX	0040	600	1000	400	78.2	820
	Sinus Penta BOX	0049				78.2	950
S20B	Sinus Penta BOX	0060	600	1200	400	109.5	1050
	Sinus Penta BOX	0067				109.5	1250
	Sinus Penta BOX	0074				112.3	1350
	Sinus Penta BOX	0086				112.3	1550

OPTIONAL FEATURES:

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

**NOTE**

Dimensions and weights may vary depending on optional components required.
 The dissipated power value does not include the optional components required.

3.3.9.10. IP42 and IP54 Cabinet Models (S15–S90)

Size	Sinus CABINET Penta Model	Voltage Class	W	H	D	Weight	Power dissipated at Inom	
			mm	mm	mm	kg	W	
S15C	0040	2T-4T	600	2000	500	130	820	
	0049						950	
S20C	0060					140	1050	
	0067						1250	
	0074					143	1350	
	0086						1550	
S22C	0042	5T-6T				158	750	
	0051						950	
	0062					161	1000	
	0069						1200	
S30C	0113	2T-4T				600	162	2150
	0129							2300
	0150				2450			
	0162				2700			
S32C	0076	5T-6T			191		1400	
	0088						1700	
	0131						195	2100
	0164							2500
S41C	0180	2T-4T	1000		280		2550	
	0202						3200	
	0217						3450	
	0260						4050	
S42C	0181	5T-6T			300	3450		
	0201					3900		
	0218					4550		
	0259					4950		
S51C	0313	2T-4T	1200		350	4400		
	0367					4900		
	0402					6300		
S52C	0290	5T-6T			370	5950		
	0314					6400		
	0368					7000		
	0401					7650		

(continued)

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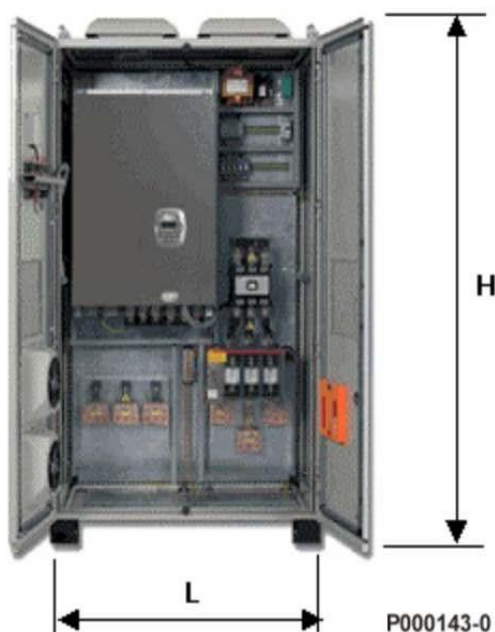
Size	Sinus CABINET Penta Model	Voltage Class	W	H	D	Weight	Power dissipated at Inom	
			mm	mm	mm	kg	W	
S60C	0457	2T-4T 5T-6T	1600	2350	800	586	7400	
	0524						8400	
S65C	0598	4T	2200			854	9750	
	0748						10750	
	0831						12900	
	0457	5T-6T					9150	
	0524						9800	
	0598						11250	
	0748						12450	
	0831						14900	
S70C	0831	2600	1007			17200		
S75C	0964	4T	3600			1468	18900	
	1130						21100	
	1296						18400	
	0964	5T-6T					22800	
	1130						24900	
	1296						4000	1700
S80C	1296	4T	4600			2300	32250	
	1800						33750	
	2076						5T-6T	37350
	1800							2076

**NOTE**

Dimensions and weights are approximate and related to the minimum layout. They may vary depending on optional components required.
 The dissipated power does not include the optional components required.
 The models related to Size S64C, S74C e S84C are not indicated.

AVAILABLE OPTIONAL COMPONENTS:

- Disconnecting switch with line fast fuses.
- Line magnetic circuit breaker with release coil.
- AC1/AC3 Line contactor.
- Front key-operated selector switch for **LOCAL/REMOTE** control and **EMERGENCY** pushbutton.
- Supply line input impedance.
- DC impedance.
- Additional terminal board for input/output wires.
- Output toroid filter. Motor forced-cooling circuit.
- Braking unit for size $\geq S41$.
- Anticondensation heater.
- PT100 instruments for motor temperature control.
- Network analyzer
- Optional features/components by request.

**NOTE**

The value "H" includes the fans and the cabinet base.

3.3.10. Standard Mounting and Piercing Templates (IP20 and IP00 Stand-Alone Models S05–S60P)

Sinus Penta Size	Piercing Templates (mm) (Standard Mounting)					
	X	X1	Y	D1	D2	Fastening screws
S05	156	-	321	4.5	-	M4
S12	192	-	377	6	12.5	M5
S14	247	-	506	6	13	M5
S15	185	-	449	7	15	M6
S20	175	-	593	7	15	M6
S22	175	-	800	7	15	M6
S30	213	-	725	9	20	M8
S32	213	-	847	9	20	M8
S41	380	190	845	12	24	M8-M10
S42	380	190	931	12	24	M8-M10
S51	440	220	845	12	24	M8-M10
S52	440	220	931	12	24	M10
S60	570	285	1238	13	28	M10-M12
S60P	570	285	1238	13	28	M10-M12



NOTE Degree of protection IP20 up to Size S32; IP00 for greater Sizes.

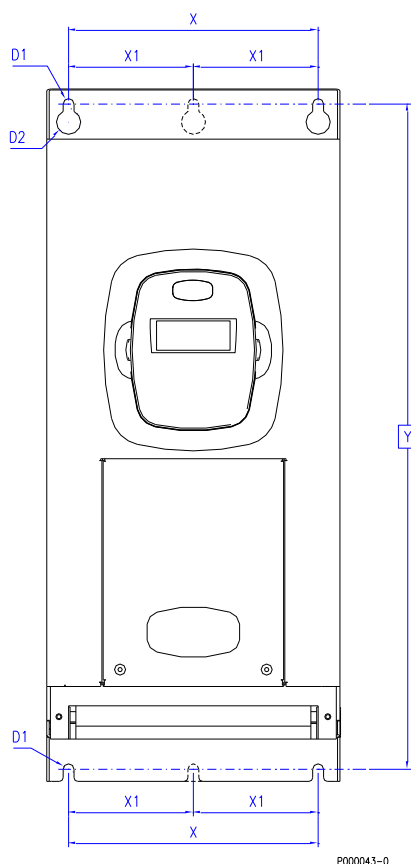


Figure 12: Piercing template for STAND-ALONE models from S05 to S52 included

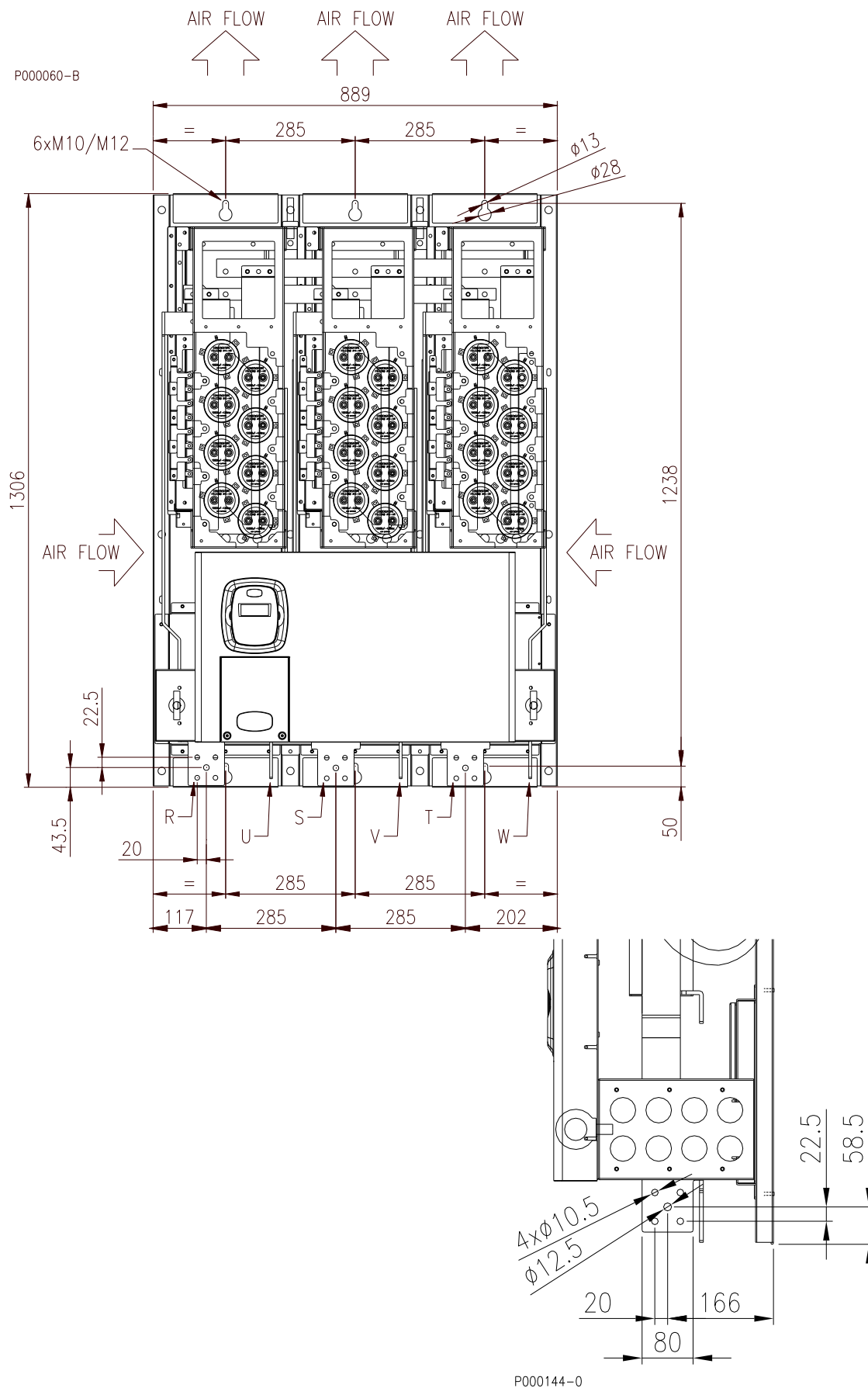


Figure 13: Piercing template for models S60 and S60P

3.3.11. Through-Panel Assembly and Piercing Templates (IP20 and IP00 Stand-Alone Models S05–S52)

The through-panel assembly allows segregating the air flow cooling the power section in order to avoid dissipating power related to inverter loss inside the inverter case. The inverters available for through-panel assembly are from size S05 to S52, both IP20 and IP00, also by way of an additional kit if required.

Drive Size	P/N of additional kit
S05	ZZ0095210
S12	ZZ0121920
S14	ZZ0124930
S15	Not required
S20	Not required
S22	ZZ0124931
S30	Not required
S32	ZZ0124932
S41	ZZ0123901
S42	ZZ0123902
S51	ZZ0123903
S52	ZZ0123904

The resulting degree of protection is IP40 for an IP44 cabinet, unless additional adjustments are implemented.

3.3.11.1. Sinus Penta S05

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

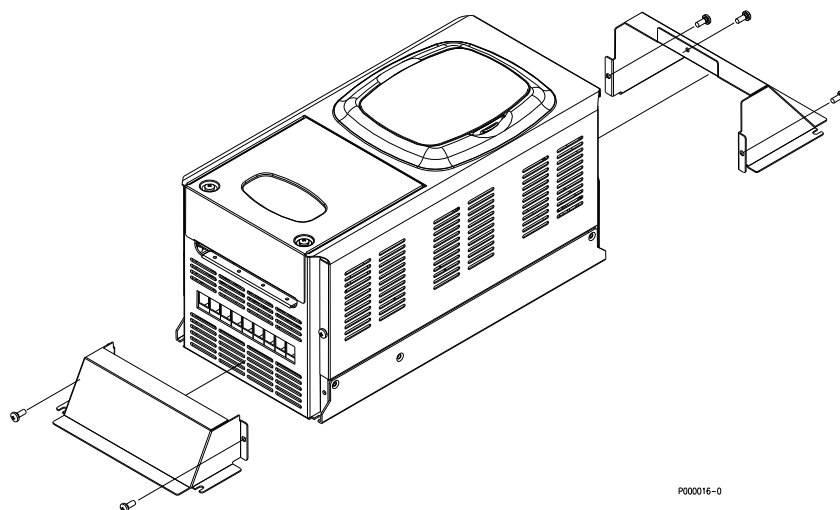


Figure 14: Fittings for through-panel assembly for Sinus Penta S05

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

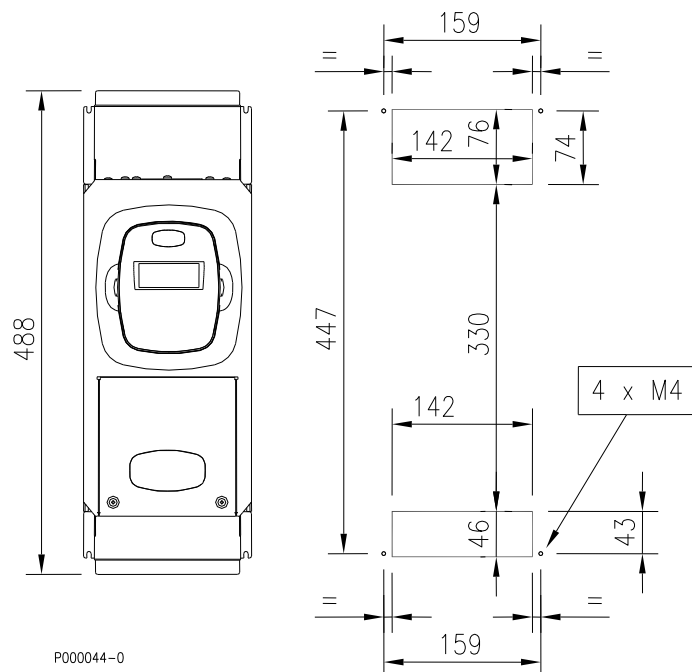


Figure 15: Piercing templates for through-panel assembly for Sinus Penta S05

3.3.11.2. Sinus Penta S12

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

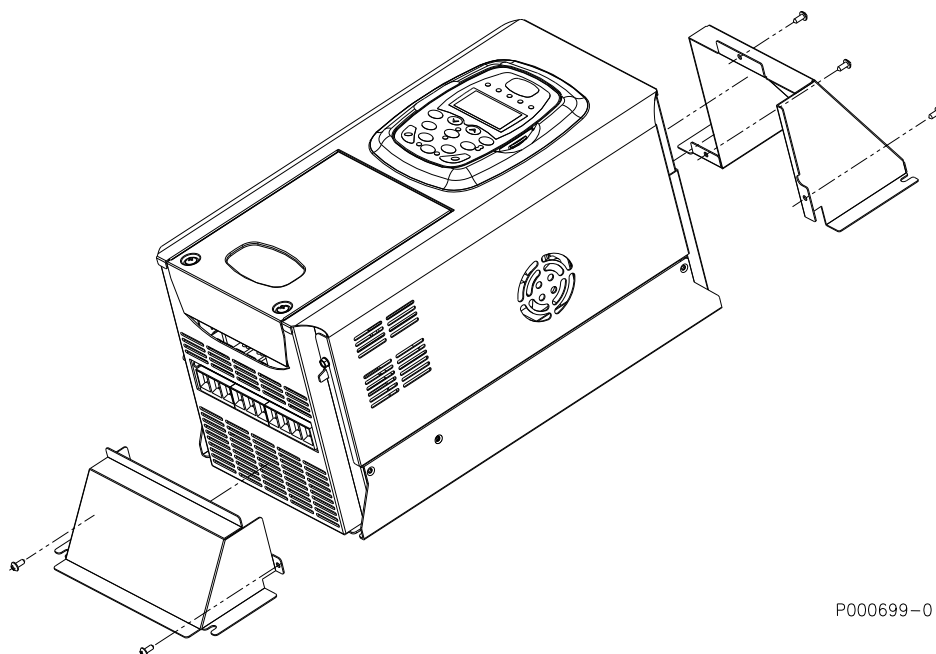


Figure 16: Fittings for through-panel assembly for Sinus Penta S12

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

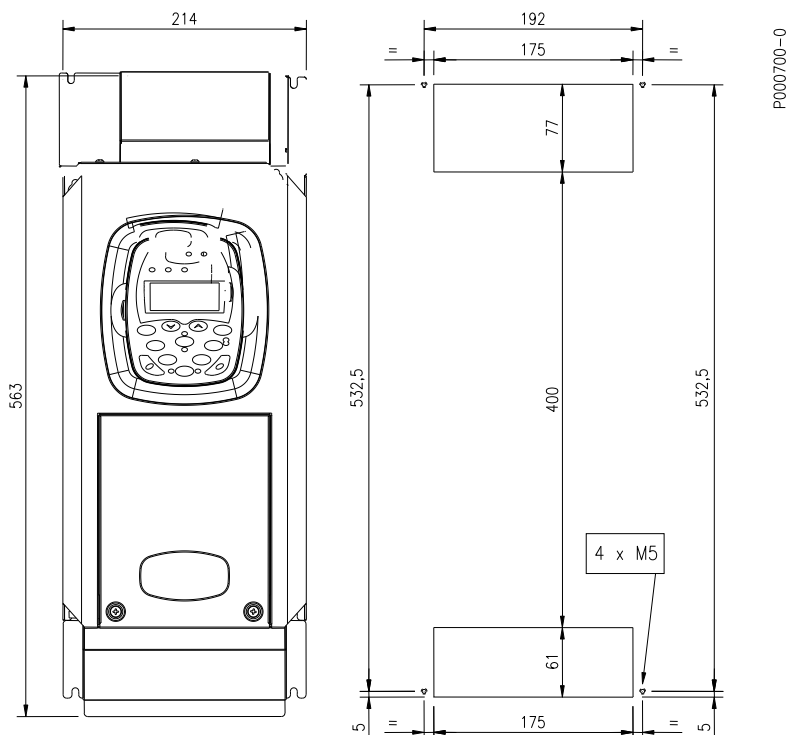


Figure 17: Piercing template for through-panel assembly for Sinus Penta S12

3.3.11.3. Sinus Penta S14

For this inverter size, no actual through-panel assembly is used, but the air flow of the power section is segregated from the air flow of the control section by installing two optional mechanical parts to be assembled with four (4) M4 self-forming screws (see figure below).

S000268

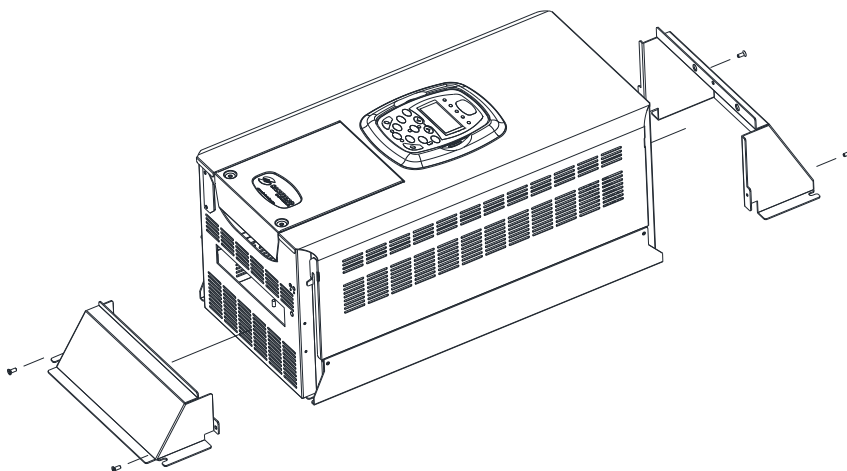


Figure 18: Fittings for through-panel assembly for Sinus Penta S14

The equipment height becomes 690 mm with the two additional components (see figure on the left below). The same figure below also shows the piercing template of the mounting panel, including four M4 holes for the inverter mounting and two slots (232 x 81 mm both) for the air-cooling of the power section.

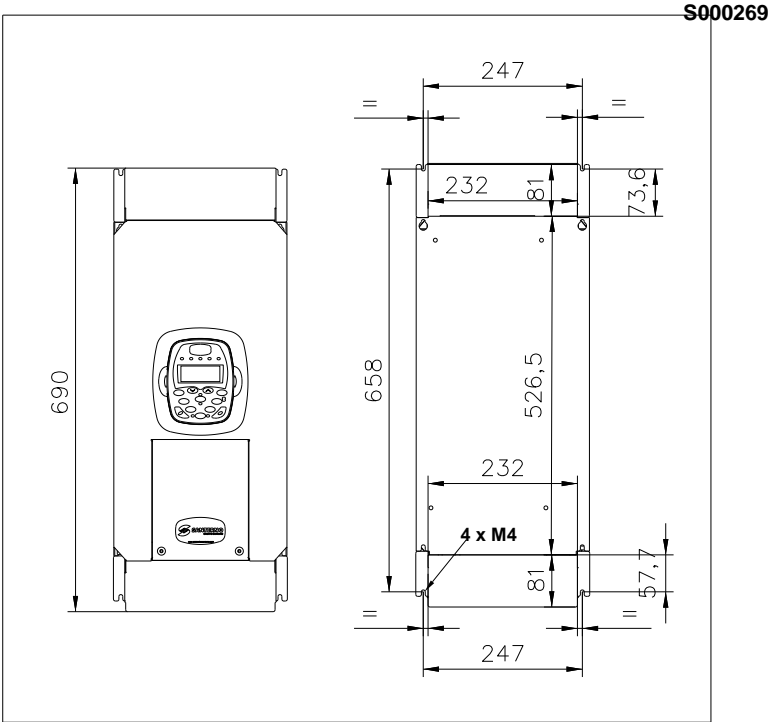


Figure 19: Piercing template for through-panel assembly for Sinus Penta S14

3.3.11.4. Sinus Penta S15–S20–S30



NOTE

Sizes S15-S20-S30 are ready for through-panel assembly with no need to use any additional mechanical components.

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

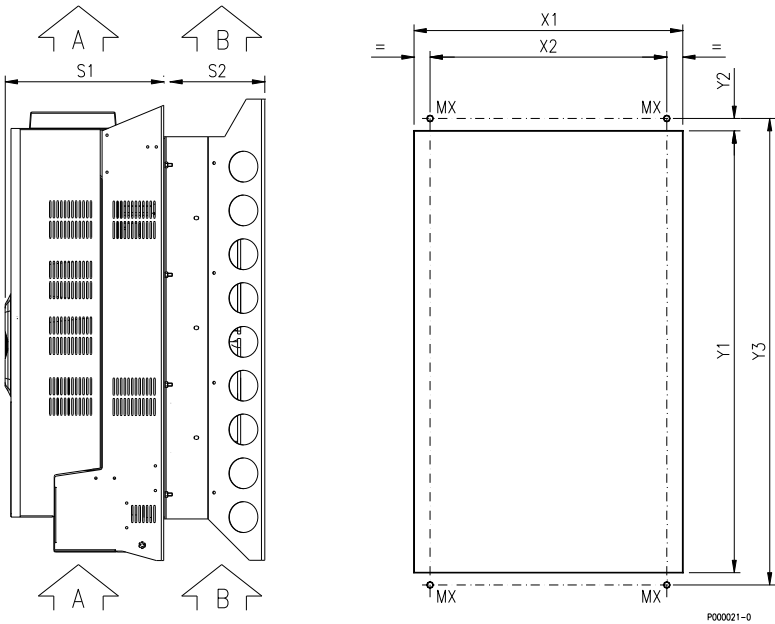


Figure 20: Through-panel assembly and piercing template for Sinus Penta S15, S20 and S30

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	
S15	256	75	207	420	185	18	449	4 x M6
S20	256	76	207	558	250	15	593	4 x M6
S30	257	164	270	665	266	35	715	4 x M8

3.3.11.5. Sinus Penta S22–S32

For these inverter sizes, no actual through-panel assembly is used, but the air flow of the power section is segregated from the air flow of the control section by installing two optional mechanical parts to be assembled as shown below. The screws are included in the mounting kit.

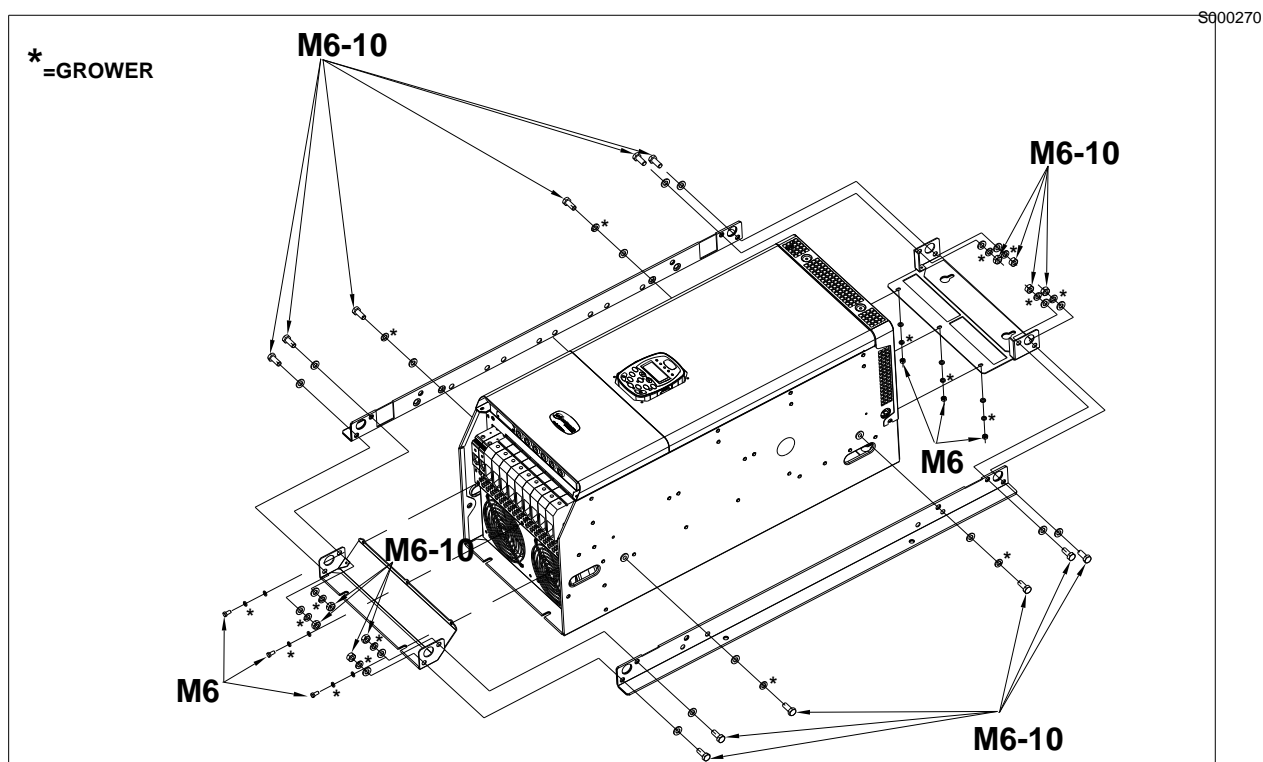
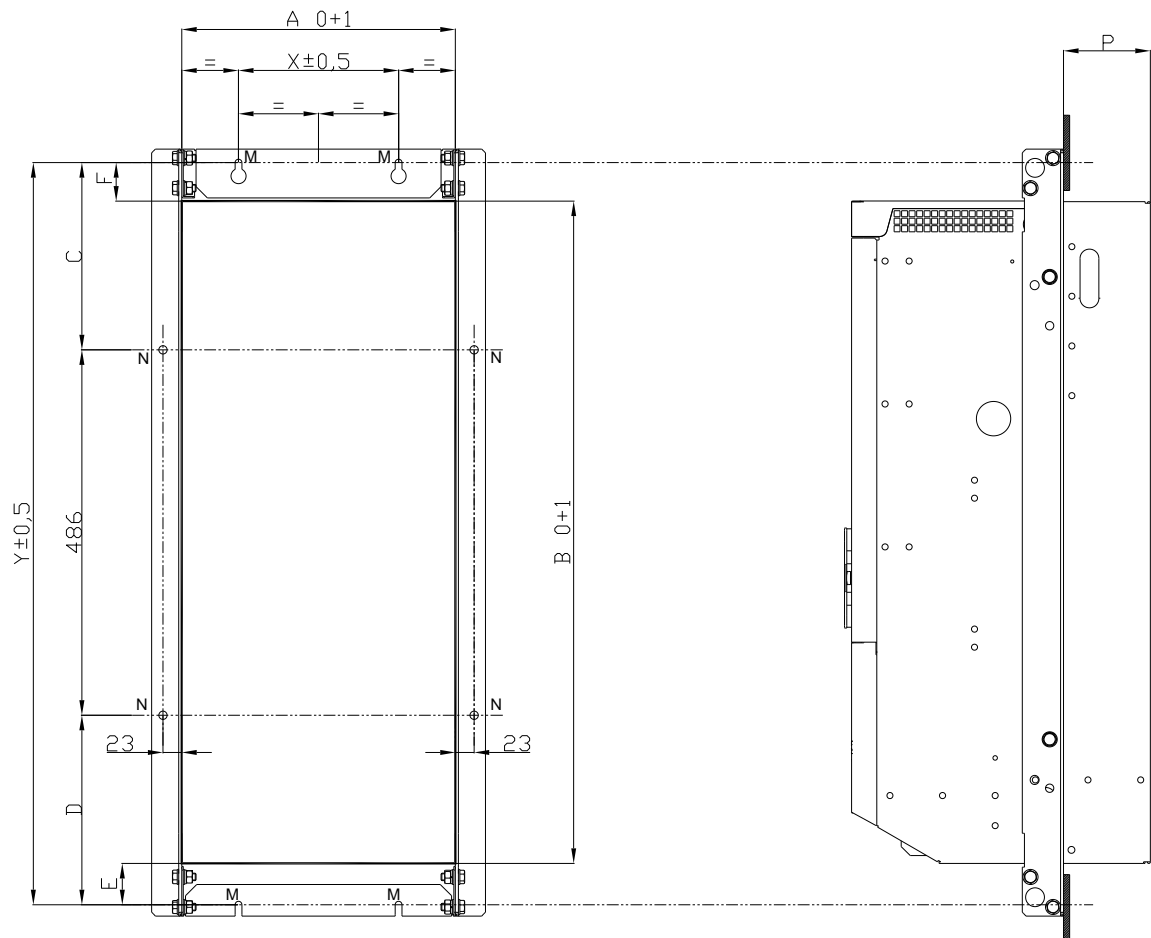


Figure 21: Fittings for through-panel assembly for Sinus Penta S22 and S32

The figure below shows the piercing templates of the mounting panel, including the inverter fixing holes and the hole for the power section air cooling flow.

S000271



		MEASUREMENT (mm)										
		A	B	C	D	E	F	X	Y	M	N	P
SIZE	S22	284	860	228	229	54	39	175	943	M6	M6	67
	S32	368	901	249	252	52	34	213	987	M8	M6	115.5

Figure 22: Piercing template for through-panel assembly for Sinus Penta S22 and S32



NOTE

For more details please refer to Assembly Instructions for Through-panel Kit S22 and Assembly Instructions for Through-panel Kit S32.

3.3.11.6. Sinus Penta S41–S42–S51–S52

For this inverter size, no actual through-panel assembly is used, but the air flow of the power section is segregated from the air flow of the control section. This application requires mounting some additional mechanical parts as shown below (the screws are included in the mounting kit).

* =GROWER

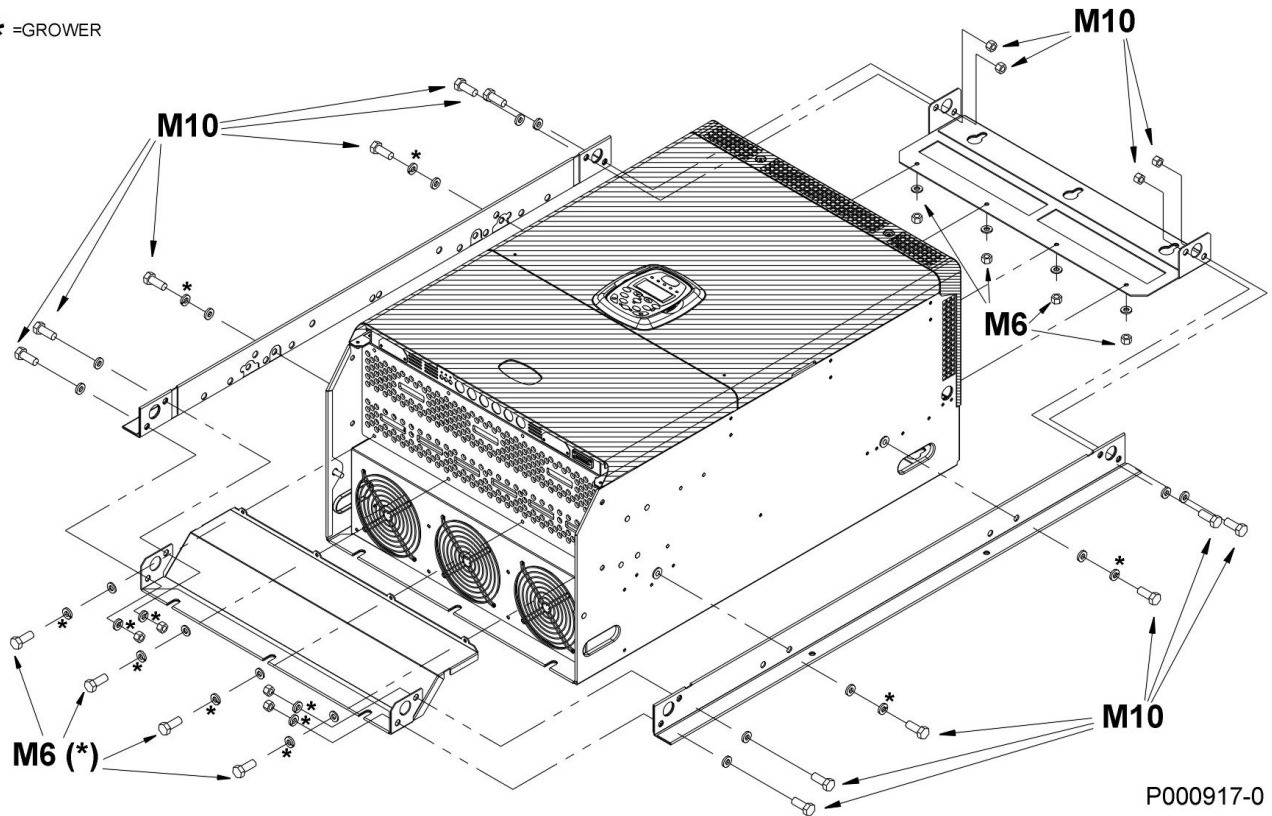


Figure 23: Mechanical parts for the through-panel assembly for Sinus Penta S41, S42, S51 and S52

The figure below shows the piercing templates for the through-panel assembly of the inverter, including six M8 holes and the hole for the air-cooling of the power section.

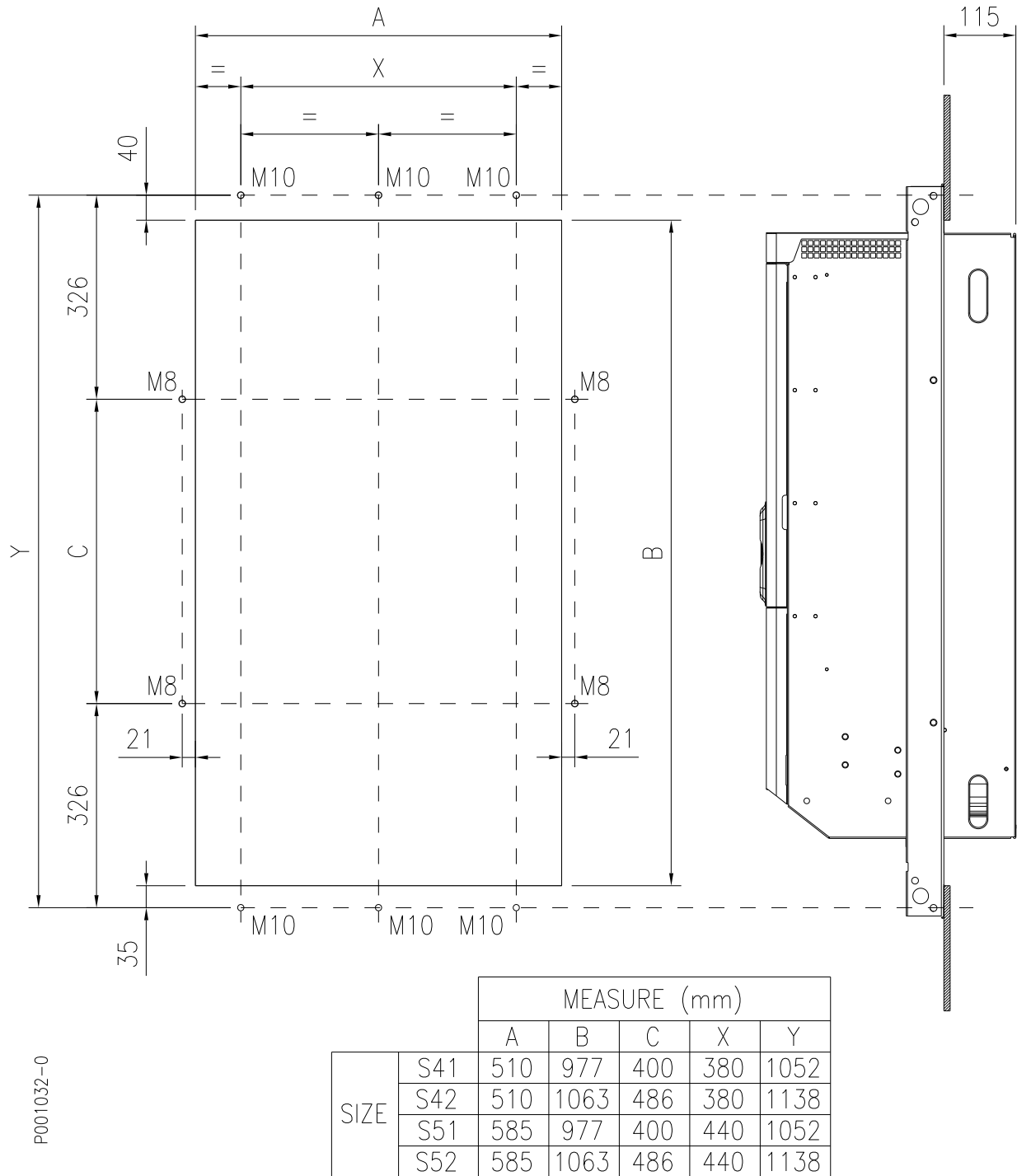


Figure 24: Piercing templates for the through-panel assembly for Sinus Penta S41, S42, S51 and S52

3.3.12. Standard Mounting and Piercing Templates (IP00 Modular Models S64–S90)

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

- **Control unit integrated into the inverter**

MODULE	Piercing Templates (mm) (Single Module)					Modules Fitted							
	X	Y	D1	D2	Fastening screws	Inverter Size							
						S64	S65	S70	S74	S75	S80	S84	S90
POWER SUPPLY UNIT	178	1350	11	25	M10	-	1	2	-	2	3	-	3
INVERTER	178	1350	11	25	M10	1	2	2	-	2	2	2	5
INVERTER WITH INTEGRATED CONTROL UNIT	178	1350	11	25	M10	1	1	1	1	1	1	1	1
INVERTER WITH INTEGRATED AUXILIARY POWER SUPPLY UNIT	178	1350	11	25	M10	1	-	-	2	-	-	3	-
INVERTER WITH INTEGRATED SPLITTER UNIT	178	1350	11	25	M10	-	-	-	3	3	3	3	3

- **Control unit separate from the inverter module**

MODULE	Fixing Templates (mm) (Single Module)					Modules Fitted							
	X	Y	D1	D2	Fastening screws	Inverter Size							
						S64	S65	S70	S74	S75	S80	S84	S90
POWER SUPPLY UNIT	178	1350	11	25	M10	-	1	2	-	2	3	-	3
INVERTER	178	1350	11	25	M10	2	3	3	1	3	3	3	6
INVERTER WITH INTEGRATED CONTROL UNIT	178	1350	11	25	M10	1	-	-	2	-	-	3	-
INVERTER WITH INTEGRATED AUXILIARY POWER SUPPLY UNIT	178	1350	11	25	M10	-	-	-	3	3	3	3	3
INVERTER WITH INTEGRATED SPLITTER UNIT	184	396	6	14	M5	1	1	1	1	1	1	1	1

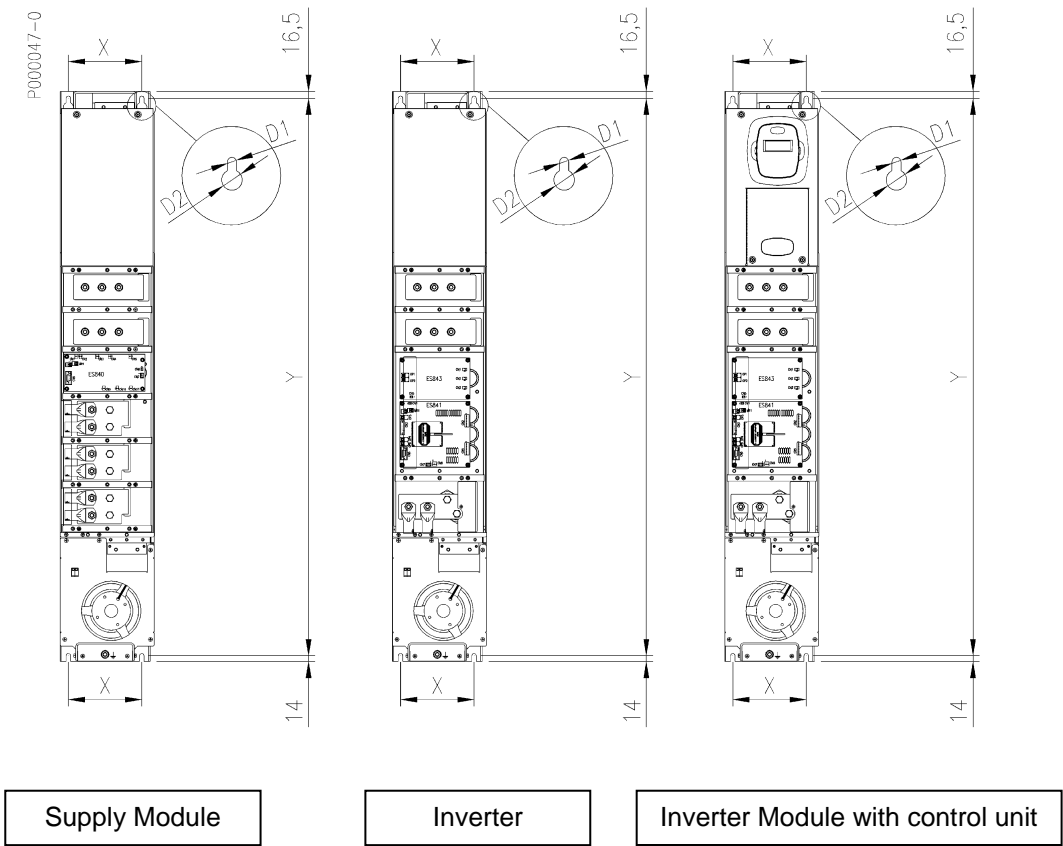


Figure 25: Piercing templates for modular units

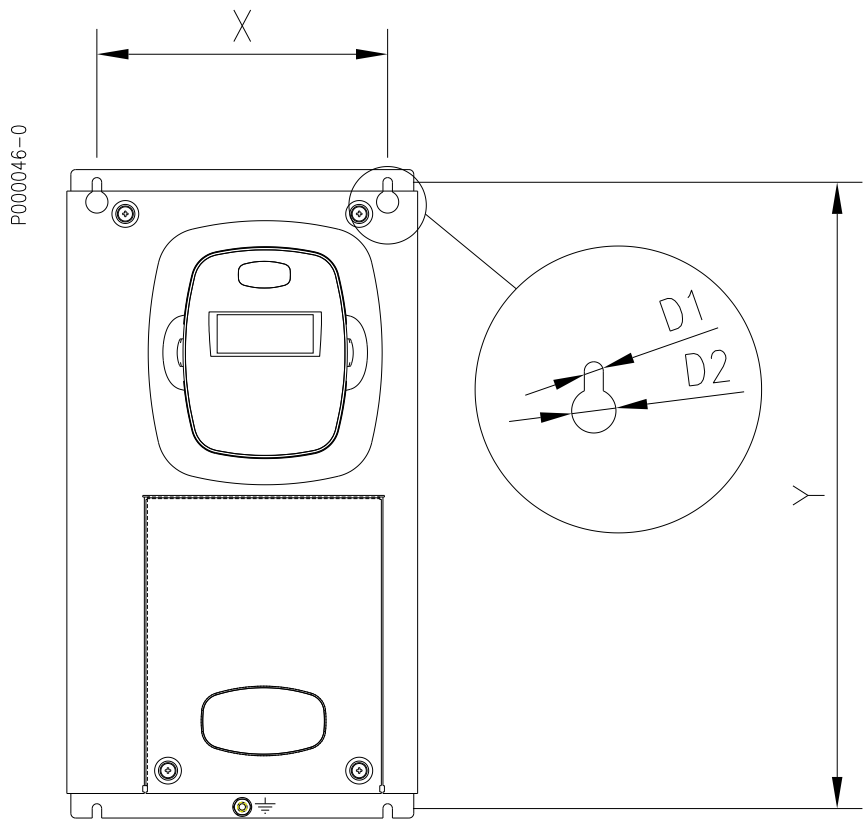
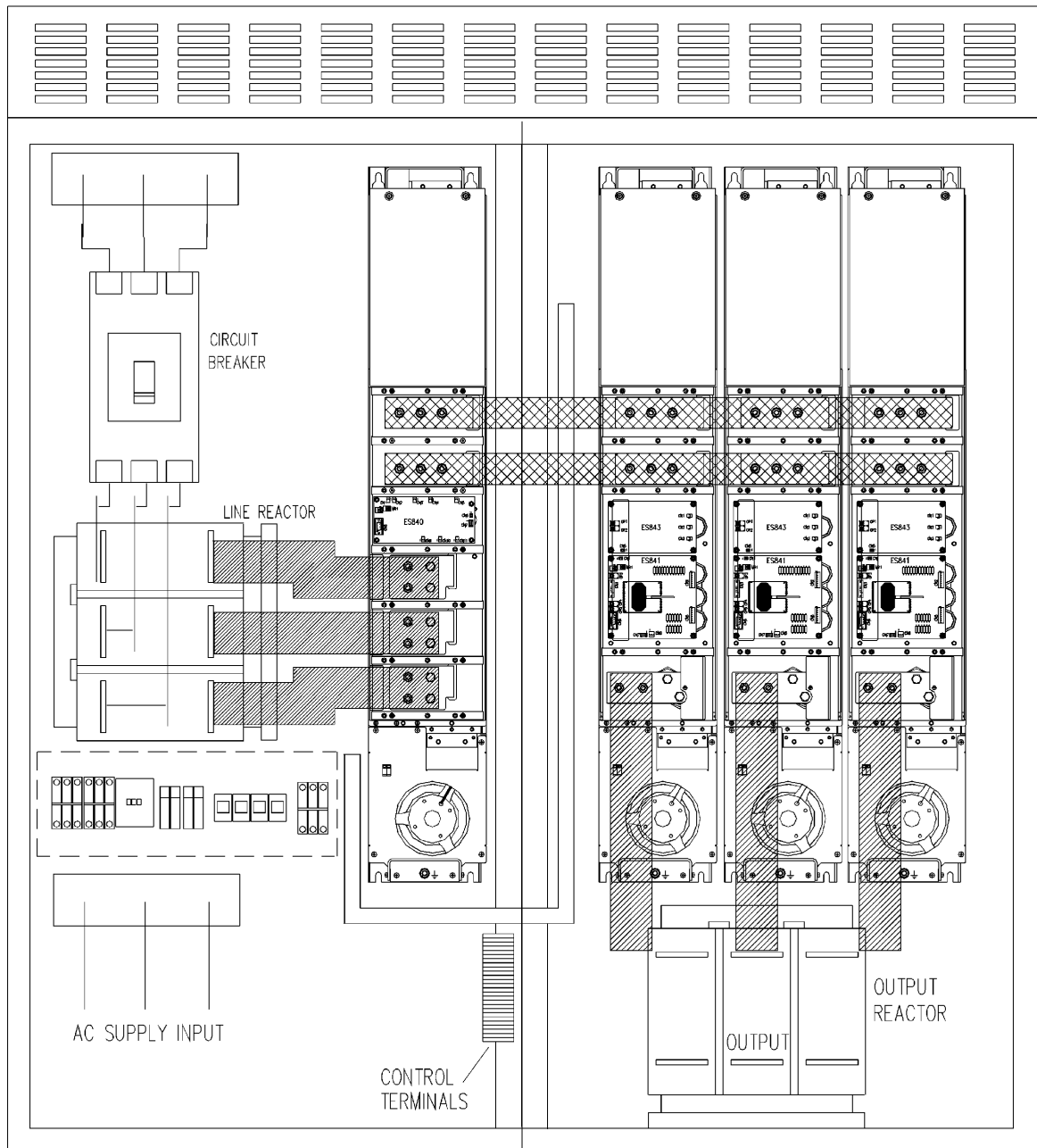


Figure 26: Piercing templates for control unit (stand-alone model)

3.3.12.1. *Installation and Lay-out of the Connections of a Modular Inverter (S65)*



P000011-B

Figure 27: Installation example for Sinus Penta S65 (in cabinet)

3.3.13. Standard Mounting and Piercing Templates (IP54 Stand-Alone Models S05–S32)

Sinus Penta IP54 Size	Fixing templates (mm) (standard mounting)				Fastening screws
	X	Y	D1	D2	
S05	177	558	7	15	M6
S12	213	602.5	7	15	M6
S14	260	732	7	15	M6
S15	223	695	10	20	M8
S20	274	821	10	20	M8
S22	250	1050	10	20	M8
S30	296	987	10	20	M8
S32	300	1130	9	20	M8

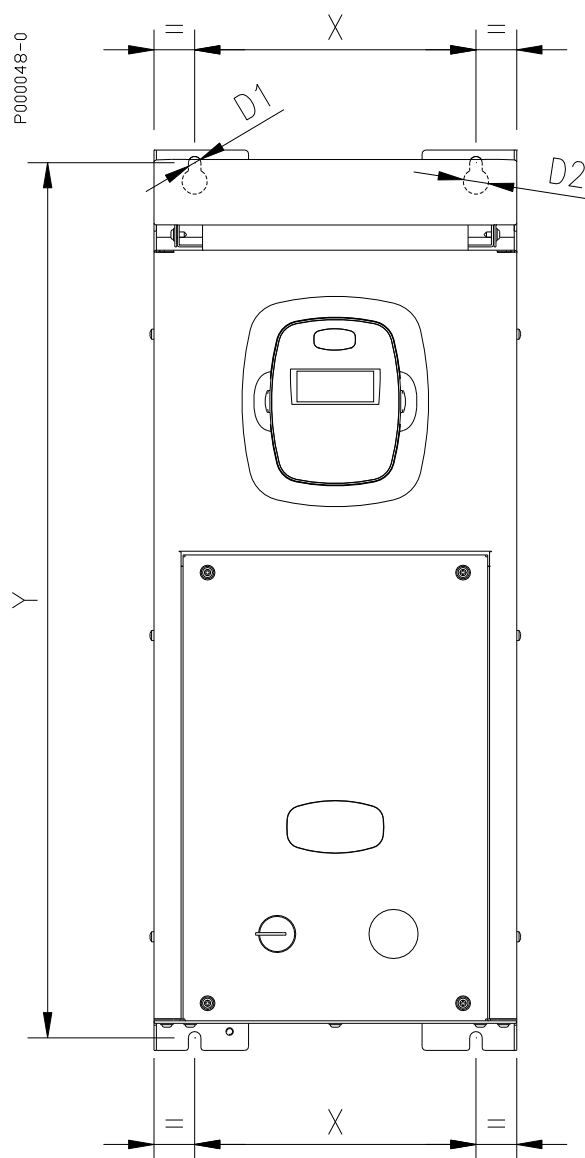


Figure 28: Piercing template for IP54 inverter

3.4. Power Connections

The inverters of the Sinus Penta series are designed both for DC and AC power supply.

The wiring diagrams below show the inverter connection to a LV three-phase AC mains.

12-pulse or 18-pulse connections are also possible for modular and parallel inverters. In that case, a dedicated transformer and a suitable number of power supply modules are required (see 12-pulse Connection for Modular Inverters).

For certain sizes, VDC direct connection is also available with no need to change the inverter layout; only, a safety fuse is to be installed in the VDC supply line—please refer to Cross-sections of the Power Cables and Sizes of the Protective Devices for the safety fuses to be installed.

**CAUTION**

For sizes S41, S42, S51, S52, S60, S60P an external precharge system is required, because the precharge circuit is located upstream of the DC voltage power supply terminals.

**CAUTION**

For sizes S64, S74, S84 an external precharge system is required, because the precharge circuit is not fitted inside the inverter.

DC voltage power supply is normally used for the parallel connection of multiple inverters inside the same cubicle. Output DC power supply units (both uni-directional and bi-directional, with power ratings ranging from 5 kW to 2000 kW for 200 Vac to 690 Vac rated voltage) can be supplied by Elettronica Santerno.

To access the power terminals, please refer to sections Gaining Access to Control Terminals and Power Terminals and IP54 Models.

**DANGER**

Before changing the equipment connections, shut off the inverter and wait at least 20 minutes to allow for the discharge of the heat sinks in the DC-link.

Use only B-type differential circuit breakers.

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

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

Always connect the ground terminal to avoid electric shock hazard and to limit disturbance. Always provide a grounding connection to the motor; if possible, ground the motor directly to the inverter.

The user has the responsibility to provide a grounding system in compliance with the regulations in force.

After connecting the equipment, check the following:

- all wires must be properly connected;
- no link is missing;
- no short-circuit is occurring between the terminals and between the terminals and the ground.

To perform UL compliant installation, the Wire Connectors shall be any UL Category Code (ZMVV) or R/C Wire Connectors and Soldering Lugs UL Category Code (ZMVV2), used with 60°C/75°C copper (Cu) conductors only, within electrical ratings and used with their properly evaluated crimping tool.

The Wire Terminals may be sleeved with Fiber Glass or R/C Extruded Tubing UL Category Code (YDPU2) or R/C Sleeving UL Category Code (UZCW2), min. rated 105 °C, VW-1, 600 V.

**CAUTION**

The Field Wiring Terminals shall be used with the tightening torque values specified in the Table of the corresponding section in this Manual.

The Auxiliary Wiring Terminal Blocks, provided for end-use installation connection with external devices, shall be used within the ratings specified. Refer to Cross-sections of the Power Cables and Sizes of the Protective Devices.

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

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

Do not apply single-phase voltage.

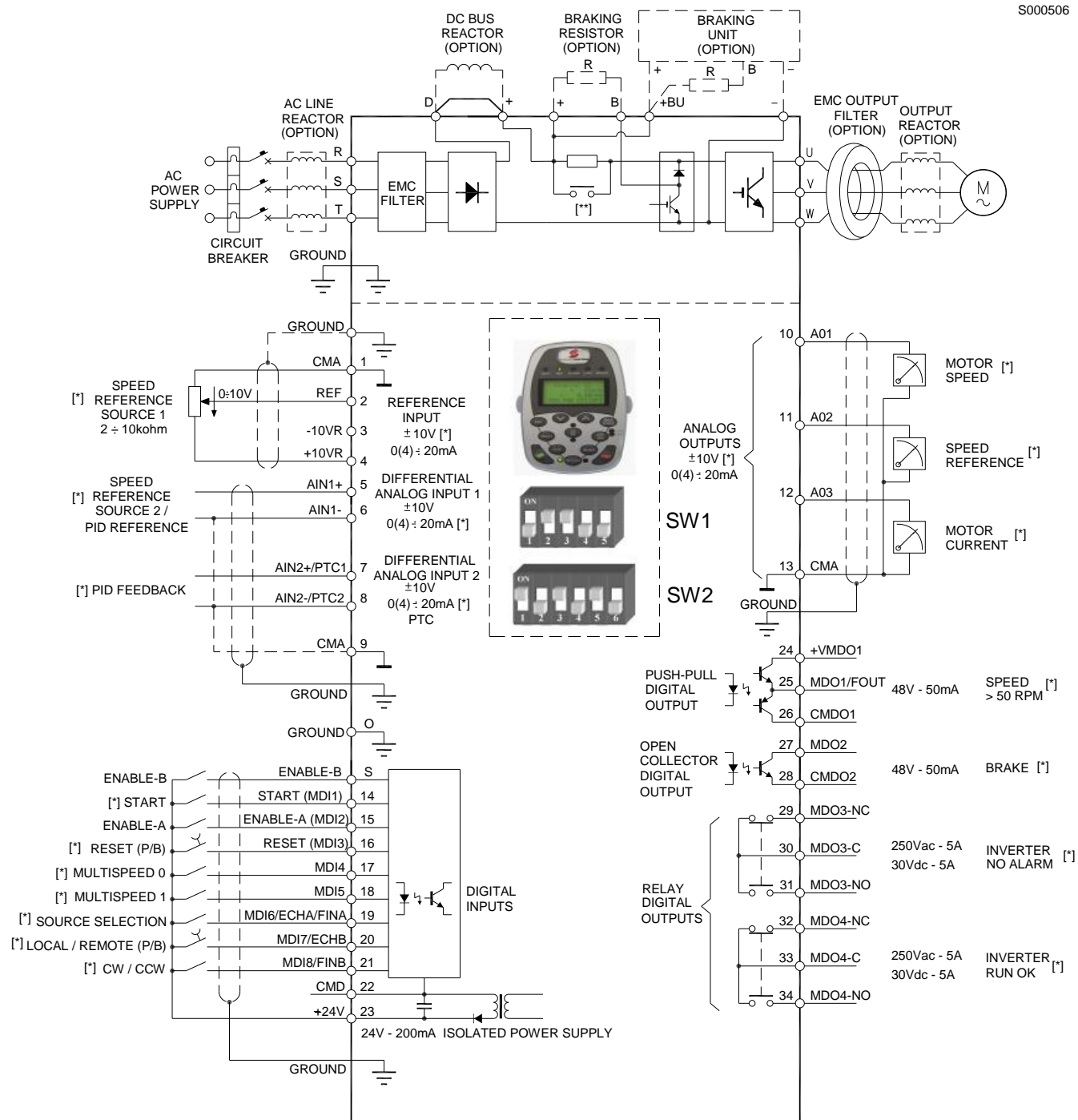
Always mount antidisturbance filters on the contactor coils and the solenoid valve coils.

At power on, if the inverter commands **ENABLE-A** (terminal 15) and **ENABLE-B** (terminal S) and **START** (terminal 14) are active and the main reference is other than zero, the motor will immediately start.

To prevent the motor from accidentally starting, refer to the Programming Guide to set configuration parameters accordingly. In that case, the motor will start only after opening and closing the command contacts on terminals 15 and terminal S.

3.4.1. Wiring Diagram for inverters S05–S60P

S000506



[*] FACTORY DEFAULTS

[**] PRECHARGE CIRCUIT (SEE BELOW)

Figure 29: Wiring diagram

**CAUTION**

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

**NOTE**

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

**NOTE**

Please refer to the Inductors section in the Motor Drives Accessories - User Manual for the applicable input and output inductors.

**NOTE**

The **ENABLE-A** and **ENABLE-B** inputs are allocated to the STO function. The control mode and control circuit of these signals must be accomplished according to the instructions given in the Safe Torque Off Function - Application Manual. That manual also includes a detailed validation procedure for the STO control configuration to be performed upon first start up of the equipment and also periodically at given time intervals.

**CAUTION**

Inverter sizes S15, S20 and S30 and modular inverters S65 to S90 require hardware adjustment in order to install DC inductors. This adjustment must be specified when ordering the equipment.



[*]

NOTE

Factory settings can be changed by changing the configuration of the DIP-switches and/or by changing the parameters pertaining to the terminals concerned (see Sinus Penta's Programming Guide).

**CAUTION**

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



[**]

CAUTION

Please contact Elettronica Santerno if DC voltage power supply is to be supplied to Sinus Penta S41, S42, S51, S52, S60 and S60P, as the precharge circuit in the DC-bus capacitors is installed upstream of the DC voltage power supply terminals.



[**]

CAUTION

Please contact Elettronica Santerno if DC voltage power supply is to be supplied to Sinus Penta S64, S74, S84, as no precharge circuit for the DC-bus capacitors is provided.

**CAUTION**

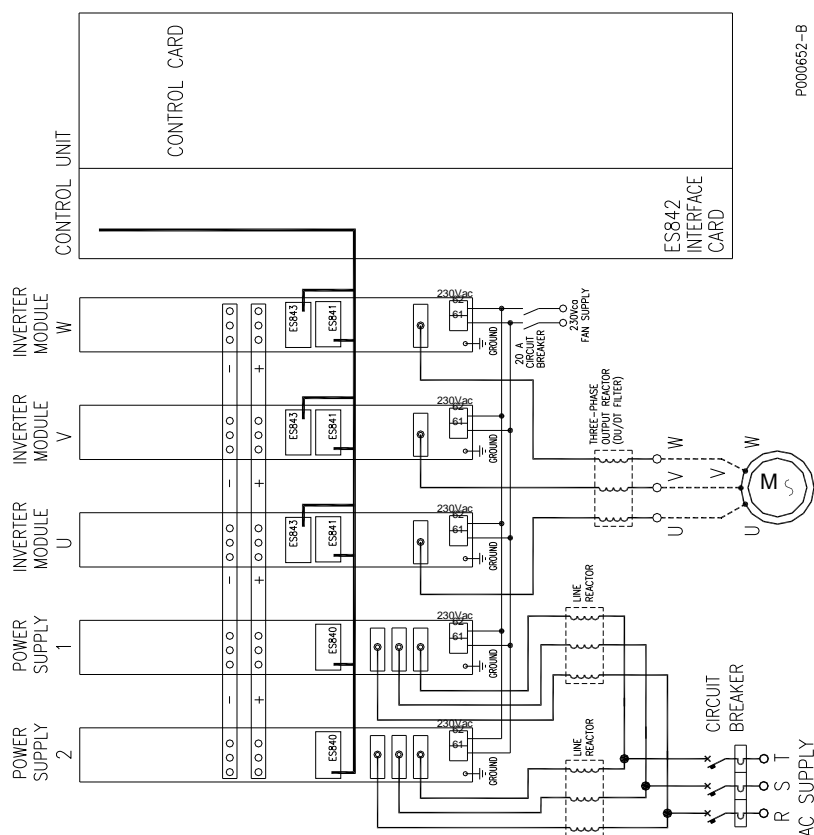
For S60 and S60P inverters only: if the supply voltage is other than 500 Vac, the wiring of the internal auxiliary transformer must be changed accordingly (see Figure 48).

**CAUTION**

For Sinus Penta S60P only, +48 Vdc 16 A auxiliary power supply is required (see Figure 48).

3.4.2. Wiring Diagram for Modular Inverters S64–S90

3.4.2.1. External Connections for Modular Inverters S65 and S70



PD00652-B

Figure 30: External connections for modular inverters S65-S70



NOTE Power supply unit 2 is available for size S70 only.



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

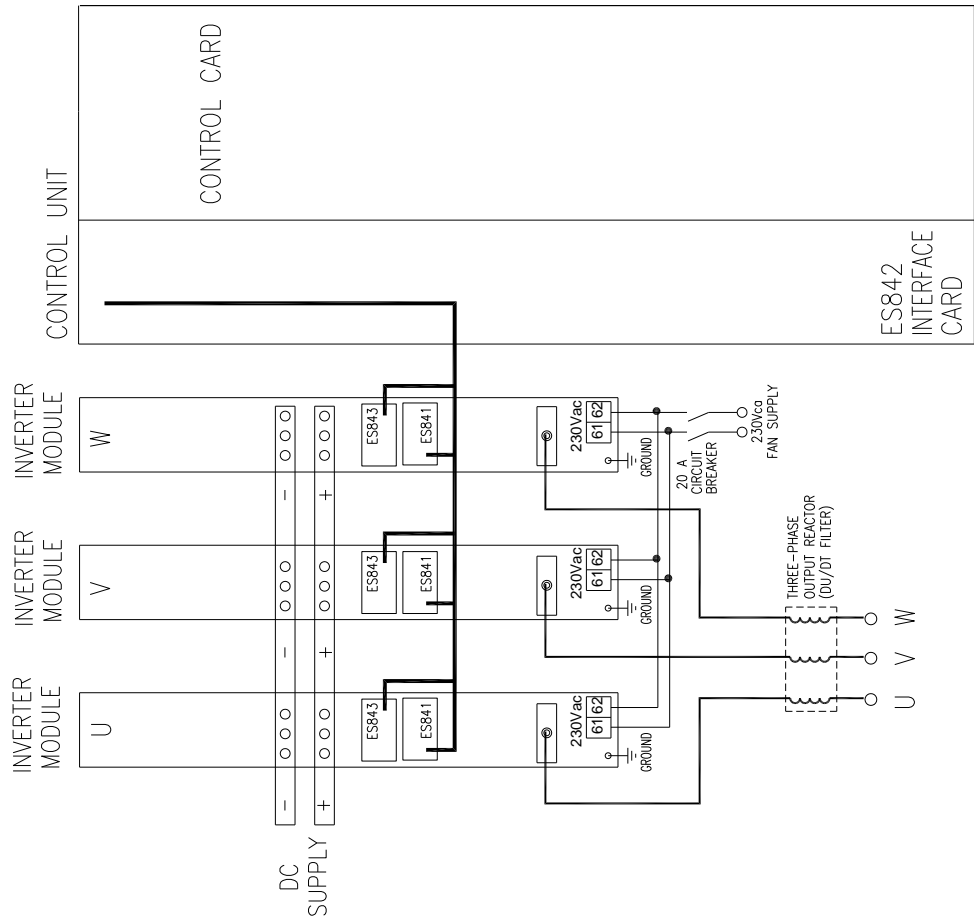


CAUTION In the event of fuse line protection, always install the fuse failure detection device. If a fuse blows, this must disable the inverter to avoid single-phase operation of the equipment.



NOTE Please refer to the Inductors section in the Motor Drives Accessories - User Manual for the inductors to be used.

3.4.2.2. External Connections for Modular Inverters S64



P000654-B

Figure 31: External connections for modular inverters S64



CAUTION

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



NOTE

Please refer to the Inductors section in the Motor Drives Accessories - User Manual for the inductors to be used.

3.4.2.3. External Connections for Modular Inverters S74, S75 and S80

Please refer to the Assembly Instructions for Modular Inverters.

3.4.2.4. External Connections for Modular inverters S84 and S90

Please refer to the Assembly Instructions for Modular Inverters.

3.4.2.5. Internal Connections for Modular Inverters S65 and S70

The following connections are needed:

N. 2 copper bar 60*10mm power connections between power supply and inverter arms for DC voltage supply.

N. 5 connections with 9-pole shielded cable (S70) or N. 4 connections with 9-pole shielded cable (S65) for analog measures.

Type of cable: shielded cable

n. of wires: 9

diameter of each wire: AWG20÷24 (0.6÷0.22mm²)

connectors: 9-pole female SUB-D connectors;

Connections inside the cable:

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

The following connections are required:

- from control unit to supply 1 (supply 1 control signals)
- from control unit to supply 2 (size S70 only) (supply 2 control signals)
- from control unit to inverter arm U (phase U control signals)
- from control unit to inverter arm V (phase V control signals)
- from control unit to inverter arm W (phase W control signals)

N. 4 connections with unipolar cable pairs, type AWG17-18 (1mm²), for AC, low voltage supply.

- from supply 1 to control unit (power supply + 24 V control unit)
- from supply 1 to driver boards of each power arm (supply line can run from supply to one driver board—e.g. arm U—to arm V, then to arm W) (24 V supply for IGBT driver boards)

N. 7 optical fibre connections, 1mm, standard single plastic material (typical damping: 0.22dB/m), with connectors type Agilent HFBR-4503/4513.

HFBR-4503/4513 — Simplex Latching

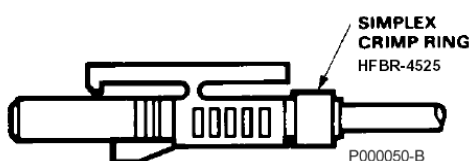


Figure 32: Single optical fibre connector

Connections required:

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

N.3 optical fibre connections, 1mm, standard double plastic material (typical damping 0.22dB/m), with connectors type Agilent HFBR-4516.

HFBR-4516 — Duplex Latching

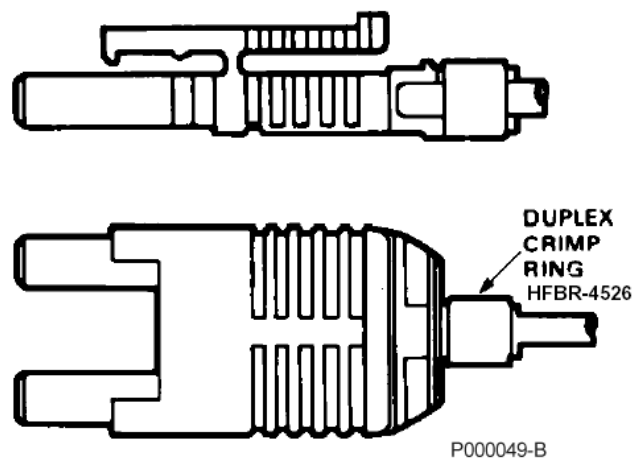


Figure 33: Double optical fibre connector

Connections required:

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

INTERNAL CONNECTIONS (S65-S70)
WIRE CONNECTIONS

Signal	Type of connection	Cable marking	Component	Board	Connector	Component	Board	Connector
control signals, supply 1	9-pole shielded cable	C-PS1	control unit	ES842	CN4	supply 1	ES840	CN8
control signals, supply 2 (*)	9-pole shielded cable	C-PS2	control unit	ES842	CN3	supply 2	ES840	CN8
control signals, phase U	9-pole shielded cable	C-U	control unit	ES842	CN14	phase U	ES841	CN6
control signals, phase V	9-pole shielded cable	C-V	control unit	ES842	CN11	phase V	ES841	CN6
control signals, phase W	9-pole shielded cable	C-W	control unit	ES842	CN8	phase W	ES841	CN6

+24V Power supply, control unit	unipolar cable, 1mm ²	24V-CU	supply 1	ES840	MR1-1	control unit	ES842	MR1-1
0VD Power supply, control unit	unipolar cable, 1mm ²		supply 1	ES840	MR1-2	control unit	ES842	MR1-2
+24VD Power supply, driver boards ES841	unipolar cable, 1mm ²	24V-GU	supply 1	ES840	MR1-3	phase U	ES841	MR1-1
0VD Power supply, driver boards ES841	unipolar cable, 1mm ²		supply 1	ES840	MR1-4	phase U	ES841	MR1-2
+24VD Power supply, driver boards ES841	unipolar cable, 1mm ²	24V-GV	phase U	ES841	MR1-3	phase V	ES841	MR1-1
0VD Power supply, driver boards ES841	unipolar cable, 1mm ²		phase U	ES841	MR1-4	phase V	ES841	MR1-2
+24VD Power supply, driver boards ES841	unipolar cable, 1mm ²	24V-GW	phase V	ES841	MR1-3	phase W	ES841	MR1-1
0VD Power supply, driver boards ES841	unipolar cable, 1mm ²		phase V	ES841	MR1-4	phase W	ES841	MR1-2

OPTICAL FIBRE CONNECTIONS

IGBT command, phase U	double optical fibre	G-U	control unit	ES842	OP19-OP20	phase U	ES841	OP4-OP5
IGBT command, phase V	double optical fibre	G-V	control unit	ES842	OP13-OP14	phase V	ES841	OP4-OP5
IGBT command, phase W	double optical fibre	G-W	control unit	ES842	OP8-OP9	phase W	ES841	OP4-OP5

IGBT fault, phase U	single optical fibre	FA-U	control unit	ES842	OP15	phase U	ES841	OP3
IGBT fault, phase V	single optical fibre	FA-V	control unit	ES842	OP10	phase V	ES841	OP3
IGBT fault, phase W	single optical fibre	FA-W	control unit	ES842	OP5	phase W	ES841	OP3
bus bar voltage reading	single optical fibre	VB	control unit	ES842	OP2	one phase	ES843	OP2
IGBT status, phase U	single optical fibre	ST-U	control unit	ES842	OP16	phase U	ES843	OP1
IGBT status, phase V	single optical fibre	ST-V	control unit	ES842	OP11	phase V	ES843	OP1
IGBT status, phase W	single optical fibre	ST-W	control unit	ES842	OP6	phase W	ES843	OP1

(*) Available for S70 only



CAUTION

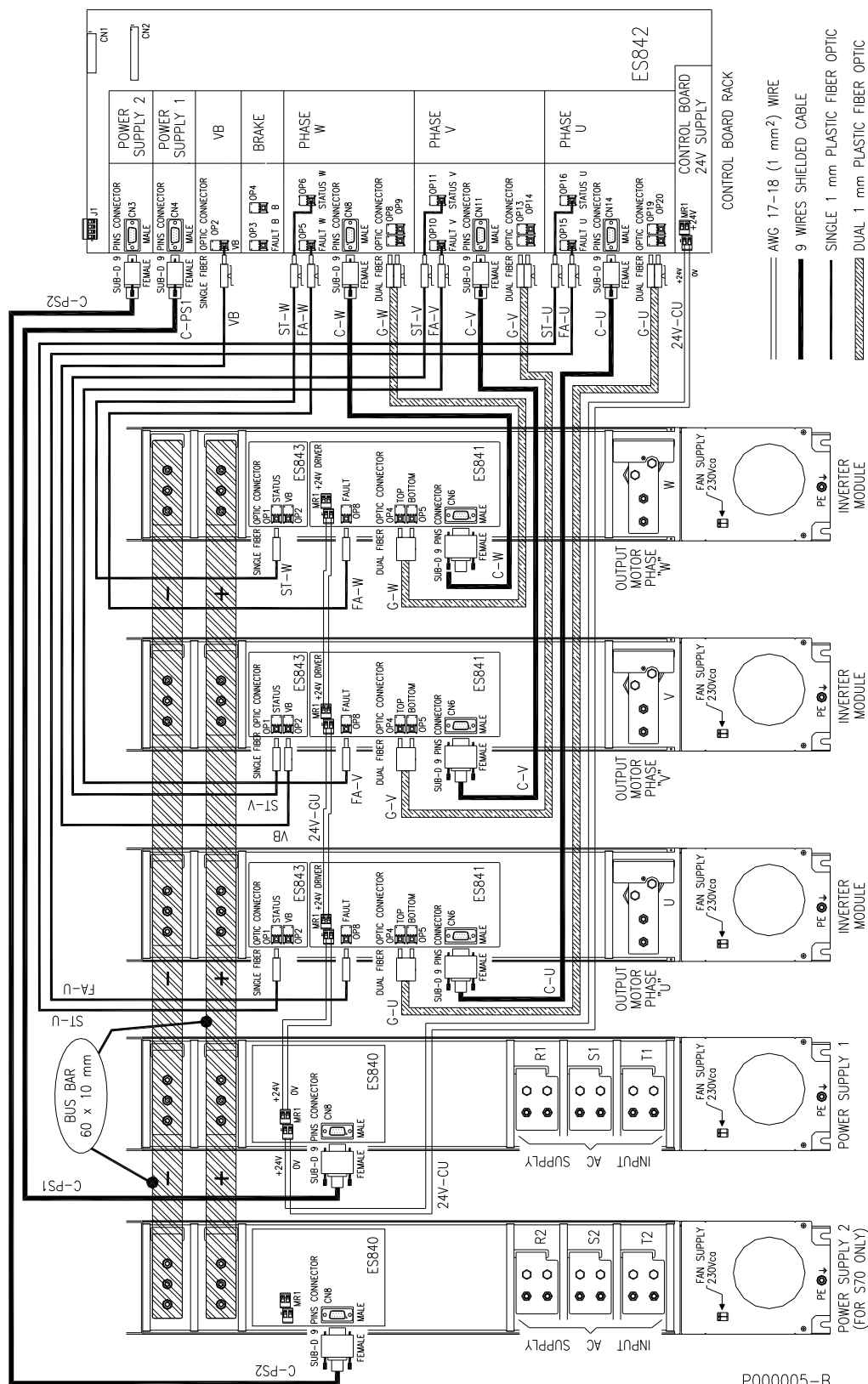
Carefully check that connections are correct. Wrong connections can adversely affect the equipment operation.



CAUTION

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

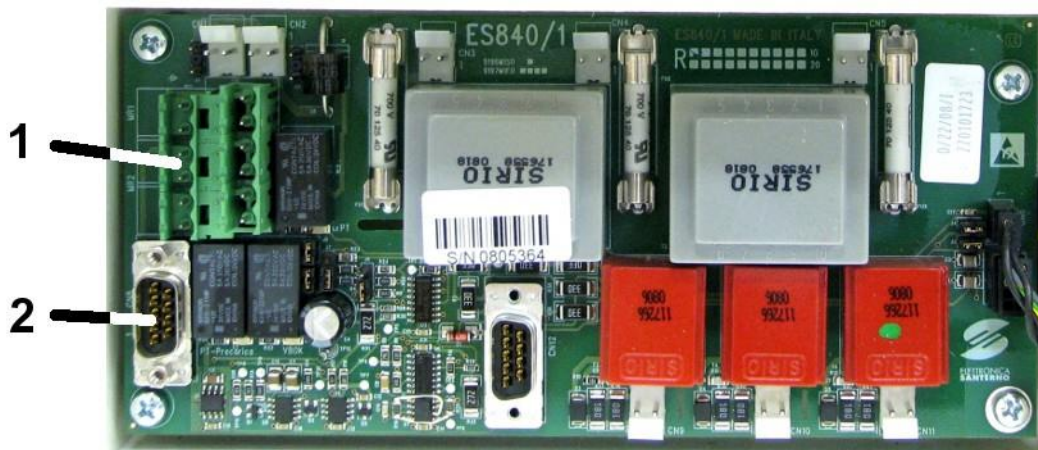
The diagram below illustrates the connections required for the components of the modular inverter model.



P000005-B

Do the following to obtain internal wiring:

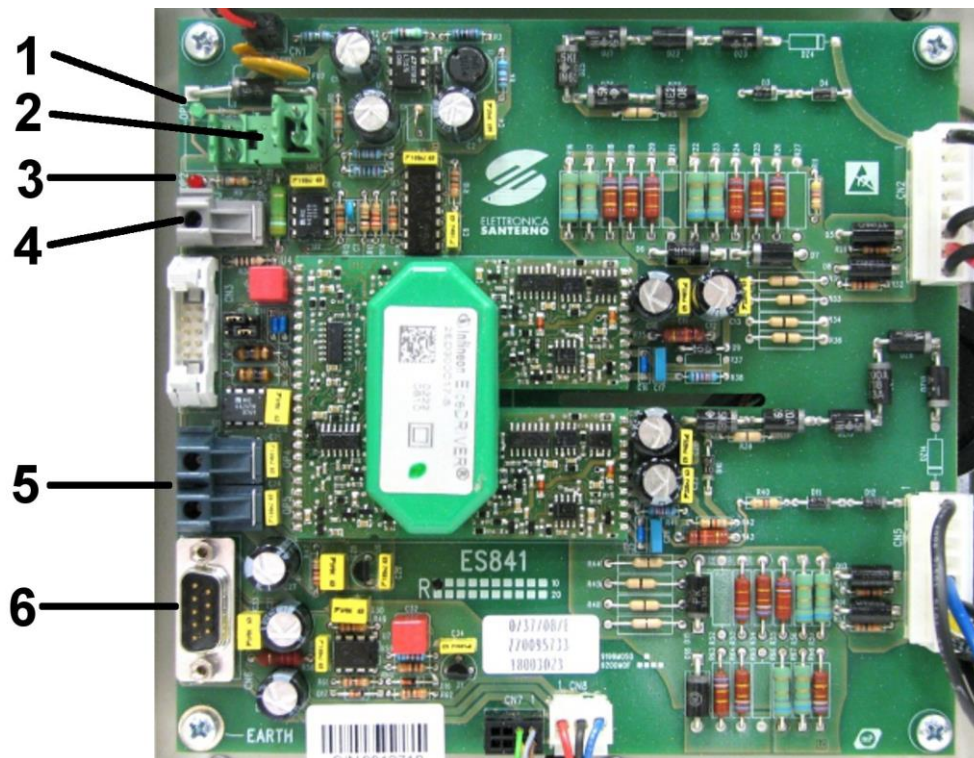
- 1) Gain access to boards ES840, ES841 and ES843. The first board is located on the front part of the supply module; the remaining two boards are located on the front part of each inverter module. Remove the front covers made of Lexan by loosening the cover fastening screws;



S000119

Figure 35: ES840 Supply Board

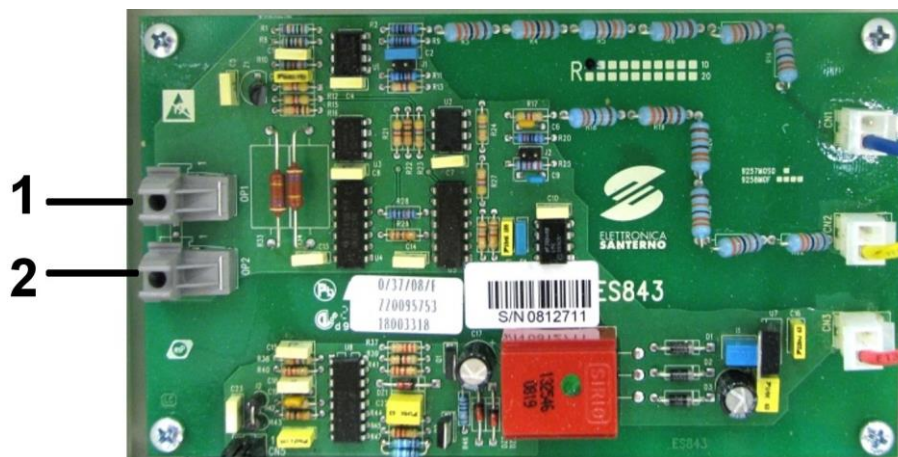
- 1 – MR1: +24V Control Unit and Gate Unit supply
2 – CN8: Power Supply control signal connector



S000118

Figure 36: ES841 Inverter Module Gate Unit Board

- 1 – OP1: Board OK
2 – MR1: 24V gate unit supply
3 – OP2: Board Fault
4 – OP3: IGBT Fault
5 – OP4, OP5: IGBT gate commands
6 – CN3: Inverter module signal connector



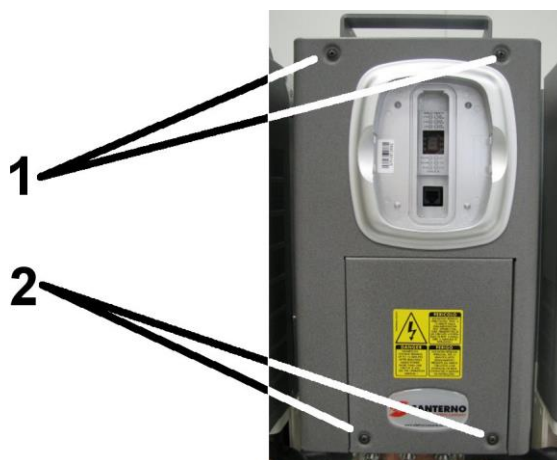
S000120

Figure 37: ES843 Bus-bar Voltage Acquisition Board

1 – OP1: IGBT status

2 – OP2: Bus bar voltage reading

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



S000132

Figure 38: Position of the fastening screws in the terminal board cover and the control unit

1 – Control unit cover fixing screws

2 – Control terminal cover screws

3) You can then access connectors on the ES842 control board.

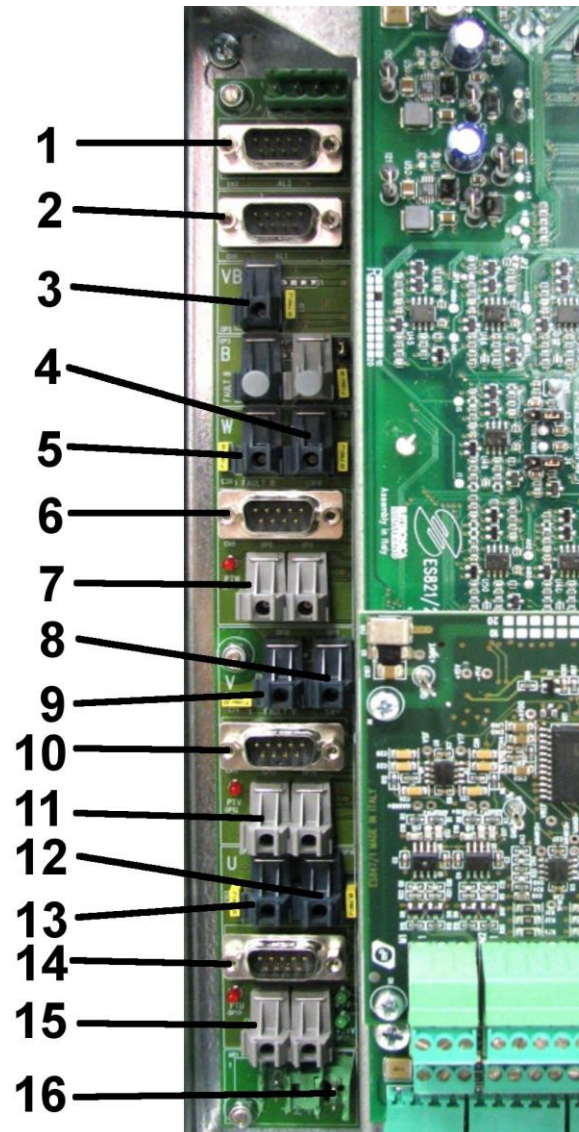


Figure 39: ES842 Control Unit

- 1 – CN3: Power Supply 2 Signal Connector
- 2 – CN2: Power Supply 1 Signal Connector
- 3 – OP2: VB
- 4 – OP6: Status IGBT W
- 5 – OP5: Fault IGBT W
- 6 – CN8: Inverter Module W Signal Connector
- 7 – OP8, OP9: Gate W
- 8 – OP11: Status IGBT V
- 9 – OP10: Fault IGBT V
- 10 – CN11: Inverter Module V Signal Connector
- 11 – OP13, OP14: Gate V
- 12 – OP16: Status IGBT U
- 13 – OP15: Fault IGBT U
- 14 – CN14: Inverter Module U Signal Connector
- 15 – OP19, OP20: Gate U
- 16 – MR1: 24V Control Unit Supply

S000133

- 4) Use the connection cable kit to connect the inverter components to each other. Make sure that the tab of the optical fibre connectors is turned outwards to the connector fixed in the control board.
- 5) Reassemble the covers made of Lexan and the covering of the control unit, making sure not to flatten any cable/optical fibre.

3.4.2.6. Internal Connections for Modular Inverters S64

The following links are required:

N. 2 power connections with 60*10mm copper bar between the inverter arms in order to deliver DC voltage.

N. 4 connections with 9-pole shielded cable.

Type of cable: shielded cable

N. of conductors: 9

Diameter of each conductor: AWG20÷24 (0.6÷0.22mm²)

Connectors: 9-pole SUB-D female connectors

Connections within the cable:

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

The following links are required:

- from control unit to inverter arm with auxiliary power supply unit (control signals for auxiliary power supply)
- from control unit to inverter arm U (phase U control signals)
- from control unit to inverter arm V (phase V control signals)
- from control unit to inverter arm W (phase W control signals)

N. 4 connections with AWG17-18 (1mm²) unipolar cable pairs delivering low-voltage DC power supply.

- from inverter arm with auxiliary power supply unit to control unit (control unit +24V voltage supply)
- from inverter arm with auxiliary power supply unit to driver boards of each power arm of the inverter (the power supply can be transferred from the supply unit to a driver board, in arm U for instance, then to arm V, finally to arm W). (IGBT driver board 24V power supply.)

N. 7 optical-fibre connections, 1mm, single standard plastics (0.22dB/m typical attenuation) with Agilent HFBR-4503/4513 connectors.

HFBR-4503/4513 — Simplex Latching

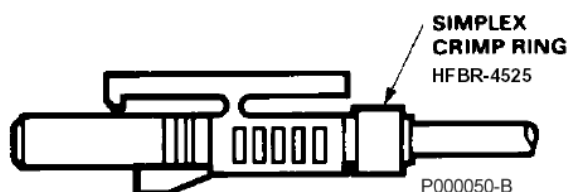


Figure 40: Single optical-fibre connector

The following links are required:

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

N.3 optical-fibre connections, 1mm, double standard plastics (0.22dB/m typical attenuation) with Agilent HFBR-4516 connectors.

HFBR-4516 — Duplex Latching

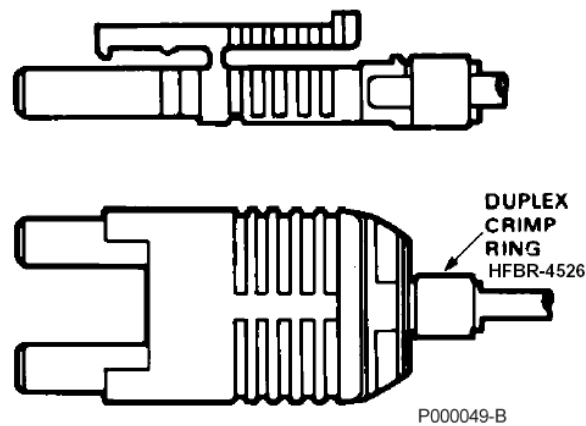


Figure 41: Double optical-fibre connector

The following links are required:

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

**INTERNAL CONNECTIONS FOR S64
WIRE CONNECTIONS**

Signal	Type of Connection	Cable Marking	Component	Board	Connector	Component	Board	Connector
control signals for phase U	9-pole shielded cable	C-U	control unit	ES842	CN14	phase U	ES841	CN6
control signals for phase V	9-pole shielded cable	C-V	control unit	ES842	CN11	phase V	ES841	CN6
control signals for phase W	9-pole shielded cable	C-W	control unit	ES842	CN8	phase W	ES841	CN6

+24V control unit power supply	unipolar cable, 1mm ²	24V-CU	inverter arm with auxiliary power supply unit	auxiliary power supply unit	MR1-1	control unit	ES842	MR1-1
0V control unit power supply	unipolar cable, 1mm ²		inverter arm with auxiliary power supply unit	auxiliary power supply unit	MR1-2	control unit	ES842	MR1-2
ES841 driver board +24VD power supply	unipolar cable, 1mm ² (*)	24V-GU	inverter arm with auxiliary power supply unit	auxiliary power supply unit	MR2-1	phase U	ES841	MR1-1
ES841 driver board +0VD power supply	unipolar cable, 1mm ² (*)		inverter arm with auxiliary power supply unit	auxiliary power supply unit	MR2-1	phase U	ES841	MR1-2
ES841 driver board +24VD power supply	unipolar cable, 1mm ²	24V-GV	phase U	ES841	MR1-3	phase V	ES841	MR1-1
ES841 driver board +0VD power supply	unipolar cable, 1mm ²		phase U	ES841	MR1-4	phase V	ES841	MR1-2
ES841 driver board +24VD power supply	unipolar cable, 1mm ²	24V-GW	phase V	ES841	MR1-3	phase W	ES841	MR1-1
ES841 driver board +0VD power supply	unipolar cable, 1mm ²		phase V	ES841	MR1-4	phase W	ES841	MR1-2

OPTICAL FIBRE CONNECTIONS

IGBT command, phase U	double optical fibre	G-U	control unit	ES842	OP19-OP20	phase U	ES841	OP4-OP5
IGBT command, phase V	double optical fibre	G-V	control unit	ES842	OP13-OP14	phase V	ES841	OP4-OP5
IGBT command, phase W	double optical fibre	G-W	control unit	ES842	OP8-OP9	phase W	ES841	OP4-OP5

IGBT fault, phase U	single optical fibre	FA-U	control unit	ES842	OP15	phase U	ES841	OP3
IGBT fault, phase V	single optical fibre	FA-V	control unit	ES842	OP10	phase V	ES841	OP3
IGBT fault, phase W	single optical fibre	FA-W	control unit	ES842	OP5	phase W	ES841	OP3
bus bar voltage reading	single optical fibre	VB	control unit	ES842	OP2	one phase	ES843	OP2
IGBT status, phase U	single optical fibre	ST-U	control unit	ES842	OP16	phase U	ES843	OP1
IGBT status, phase V	single optical fibre	ST-V	control unit	ES842	OP11	phase V	ES843	OP1
IGBT status, phase W	single optical fibre	ST-W	control unit	ES842	OP6	phase W	ES843	OP1

(*): Factory-set connection provided



CAUTION

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



CAUTION

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

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

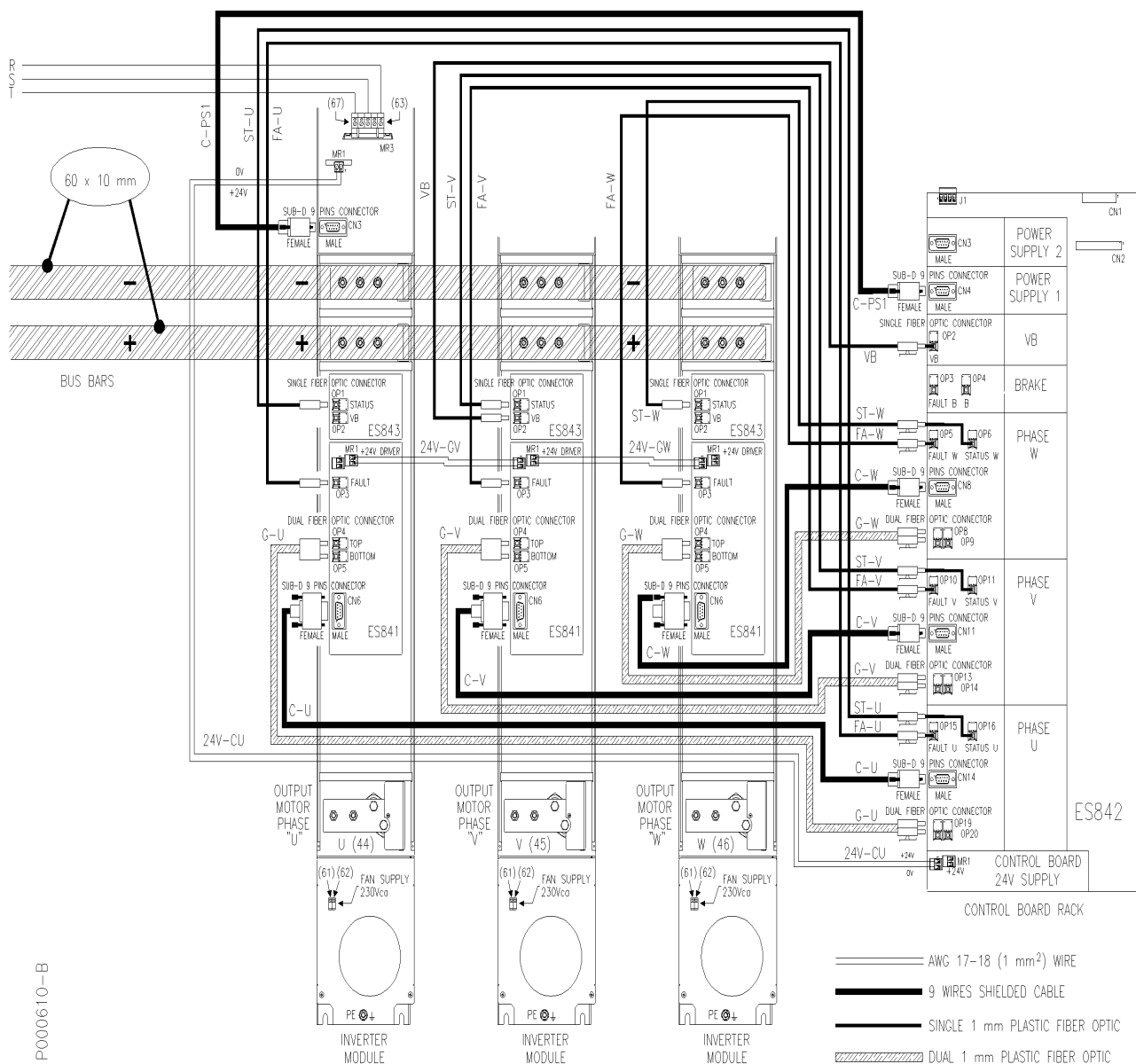


Figure 42: Internal wiring for inverters S64

3.4.2.7. Internal Connections for Modular Inverters S74, S75 and S80

Please refer to the Assembly Instructions for Modular Inverters.

3.4.2.8. Internal Connections for Modular Inverters S84 and S90

Please refer to the Assembly Instructions for Modular Inverters.

3.4.3. 12-pulse Connection for Modular Inverters

12-pulse connection allows reducing current harmonics in the inverter supply line. This solution reduces power supply harmonics by suppressing the lowest harmonics.

The classic power supply design for AC 3-phase inverters provides for a 3-phase diode bridge rectifier directly connected to the DC bus, thus obtaining the diagram of a 6-pulse rectifier. As it is known from the theory, the harmonic spectrum of current drawn by non-linear load, e.g. an adjustable speed drive (inverter), from the mains, depends on the type of input rectifier used in the drive structure. Only harmonics of certain orders appear in the harmonic spectrum, satisfying an equation as follows:

$$h = k \cdot p \pm 1,$$

where h = harmonic order, k = integral number, p = pulse number of the rectifier.

In case of a 6-pulse rectifier, only harmonics of order: $h = 1, 5, 7, 11, 13, 17, 19, 23, 25, 29, 31, \dots$ are present.

Example: THDI=68%

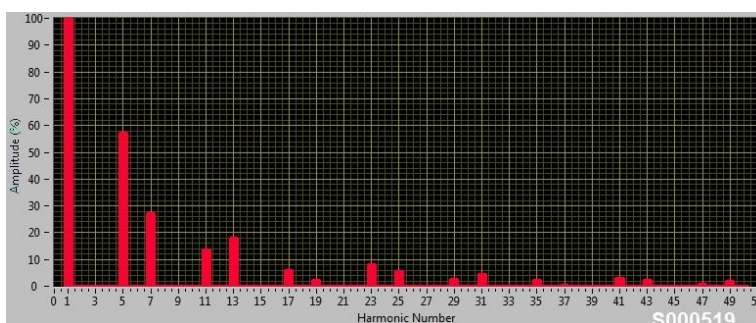


Figure 43: Amplitude of current harmonics in 6-pulse configuration

In order to obtain a 12-pulse rectifier, two AC 3-phase supplies must be available, where each phase in the first supply is 30° shifted against the corresponding one in the second supply (a Dy11d0 or Dy5d0 transformer is required). Each supply feeds a 3-phase diode rectifier and the outputs are put in common on the DC bus. Proper sized input reactors are required between supplies and rectifiers.

According to the above equation, only harmonics of order: $h = 1, 11, 13, 23, 24, 35, 37, \dots$ are present.

Example: THDI=11%

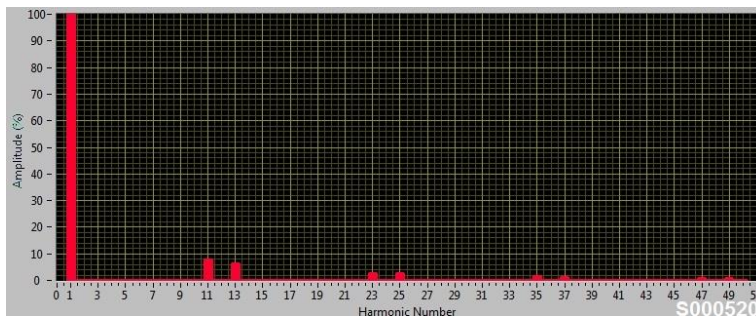


Figure 44: Amplitude of current harmonics in 12-pulse configuration

The basic wiring diagram of the 12-pulse connection for S41..52 is shown below (see Supply Unit for Drives S41..S52 (SU465) in the Motor Drives Accessories - User Manual):

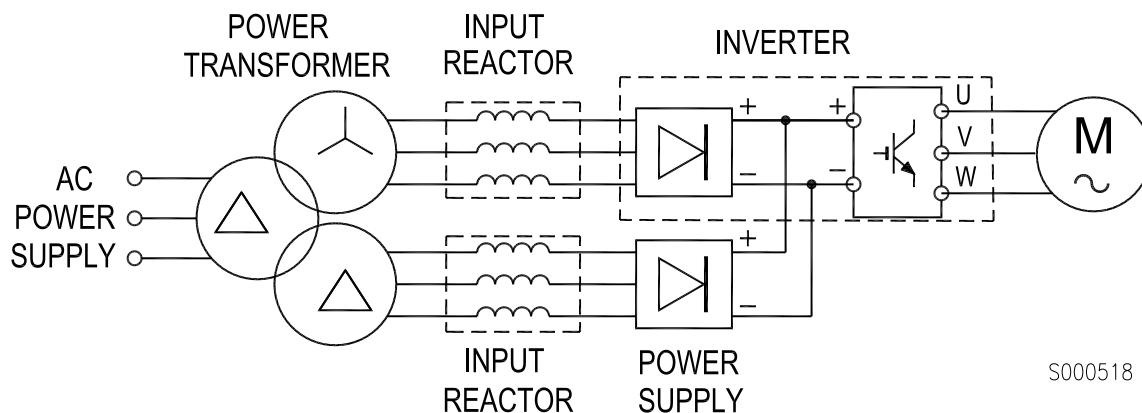


Figure 45: Layout of 12-pulse connection for inverters S41..S52

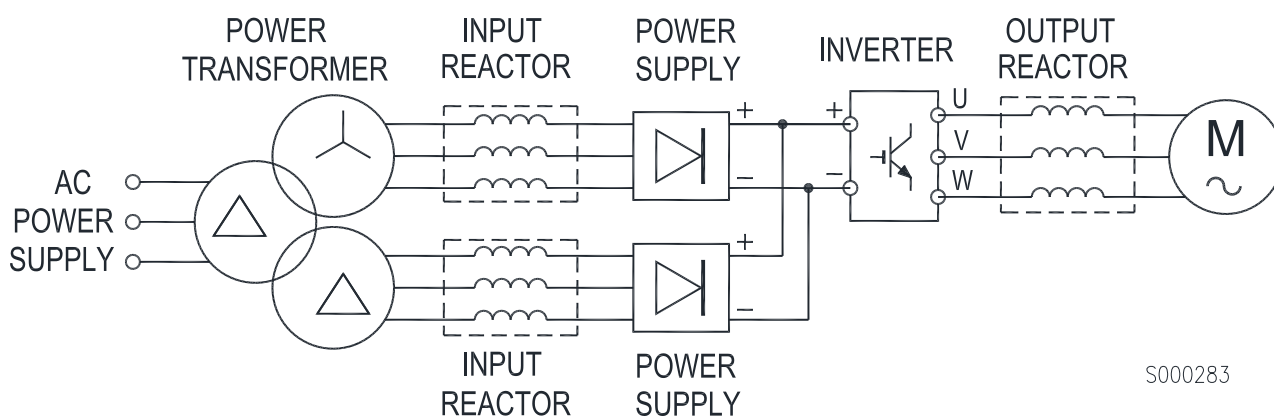


Figure 46: Layout of a 12-pulse connection for modular inverters

An 18-pulse connection may be obtained with configurations similar to the configuration above. The 18-pulse connection requires a transformer with three secondary windings shifted by 20° (Dd0⁺²⁰d0d0⁻²⁰ transformer) and three power supply units.

3.4.3.1. Standard AC Power Supply, Standard DC Power Supply, 12-pulse AC Power Supply, 18-pulse AC Power Supply

The tables below summarise the possible power supply modes for inverters from S41 to S90 and for parallel-connected models. The standard configurations described in the sections above are

- on green shading (in particular, see the Modular IP00 STAND-ALONE Models (S64–S90));
- otherwise, if a different number of modules is required, this is marked on yellow shading.

Inverters power supplied

- through AC 380-500Vac or DC voltage (4C):

Model	Standard AC (4T)	DC Voltage (4C)	AC 12-pulse	AC 18-pulse
0180, 0202, 0217, 0260	S41	S41	S41 + 1 SU465	S41 + 2 SU465 [*]
0313, 0367, 0402	S51	S51	S51 + 1 SU465	S51 + 2 SU465 [*]
0598, 0748, 0831	S65	S64	S70	S65 + 2 Power Supplies
0964, 1130, 1296	S75	S74	S75	S80
1800, 2076	S90	S84	S90 + 1 Power Supply	S90
0523	2xS41	2xS41	2xS41	2xS41 + 1 SU465
0599, 0749, 0832	2xS51	2xS51	2xS51	2xS51 + 1 SU465
0850, 0965, 1129	3xS51	3xS51	3xS51 + 1 SU465	3xS51

Modular inverters power supplied

- through AC 500-600Vac voltage or DC voltage (5C);

- through AC 575-690Vac or DC voltage (6C):

Model	Standard AC (5T/6T)	DC Voltage (5C/6C)	AC 12-pulse	AC 18-pulse
0181, 0201, 0218, 0259	S42	S42	S42 + 1 SU465	S42 + 2 SU465 [*]
0290, 0314, 0368, 0401	S52	S52	S52 + 1 SU465	S52 + 2 SU465 [*]
0457, 0524, 0598, 0748	S65	S64	S70	S65 + 2 Power Supplies
0831	S70	S64	S70	S65 + 2 Power Supplies
0964, 1130	S75	S74	S75	S80
1296	S80	S74	S80 + 1 Power Supply	S90
1800, 2076	S90	S84	S90 + 1 Power Supply	S90
0459	2xS42	2xS42	2xS42	2xS42 + 1 SU465
0526, 0600, 0750, 0828	2xS52	2xS52	2xS52	2xS52 + 1 SU465
0960, 1128	3xS52	3xS52	3xS52 + 1 SU465	3xS52



[*] NOTE

When using the 18-pulse connection, a 24 Vdc external supply unit with power ratings equal to or higher than 20 W is required.

3.4.4. Power Terminals for S05–S52

Decisive voltage class C according to EN 61800-5-1

DESCRIPTION	
41/R – 42/S – 43/T	Inputs for three-phase supply (the phase sequence is not important).
44/U – 45/V – 46/W	Three-phase motor outputs.
47/+	Link to the DC voltage positive pole. It can be used for <ul style="list-style-type: none"> - DC voltage supply; - DC inductors; - the external braking resistor and the external braking unit (for the drive models which are NOT provided with terminal 50/+ dedicated to the external braking resistor) - the external braking unit.
47/D	When fitted, link to the positive pole of the continuous AC rectified voltage. It can be used for the inductor; if no DC inductor is used, terminal 47/D must be short-circuited to terminal 47/+ using a cable/bar having the same cross-section as the cables used for power supply – factory setting).
48/B	When available, it can be used to connect the IGBT brake for braking resistors.
49/–	Link to the negative pole of the DC voltage. It can be used for <ul style="list-style-type: none"> - DC voltage power supply; - the external braking unit
50/+	When available, it can be used to connect the positive pole of the DC voltage to be used for the external braking resistor only.

S05 (4T)–S15–S20 Terminal board:

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

S05 (2T) Terminal board:

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



CAUTION

Connection bars **47D** and **47+** are short-circuited as a factory setting. The DC inductor, if any, shall be linked between bars **47D** and **47+** after removing the short-circuit.



CAUTION

If DC voltage power supply is required and if an external braking resistor is to be installed, remove the short-circuit between **47/D** and **47/+** and use terminal **47/+**.



CAUTION

Use terminals **47/+** and **48/B** if an external braking resistor is to be installed.

S12 Terminal board (2T-4T)–S14:

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

**CAUTION**

Connection bars **47/D** and **47/+** are short-circuited as a factory setting. The DC inductor, if any, shall be linked between bars **47/D** and **47/+** after removing the short-circuit.

**CAUTION**

If DC voltage power supply is required and if an external braking resistor is to be installed, remove the short-circuit between **47/D** and **47/+** and use terminal **47/+**.

**CAUTION**

Use terminals **47/+** and **48/B** if an external braking resistor is to be installed.

S12 Terminal board (5T):

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

S22-32 Terminal board:

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

**CAUTION**

Connection bars **47/D** and **47/+** are short-circuited as a factory setting. The DC inductor, if any, shall be linked between bars **47/D** and **47/+** after removing the short-circuit.

**CAUTION**

If DC voltage power supply is required and if an external braking resistor is to be installed, remove the short-circuit between **47/D** and **47/+** and use terminal **47/+**.

**NOTE**

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

S30 Terminal board:

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

**NOTE**

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

Connection bars for S41–S42–S51–S52:



CAUTION

Connection bars **47/D** and **47/+** are short-circuited as a factory setting. The DC inductor, if any, shall be linked between bars **47/D** and **47/+** after removing the short-circuit.



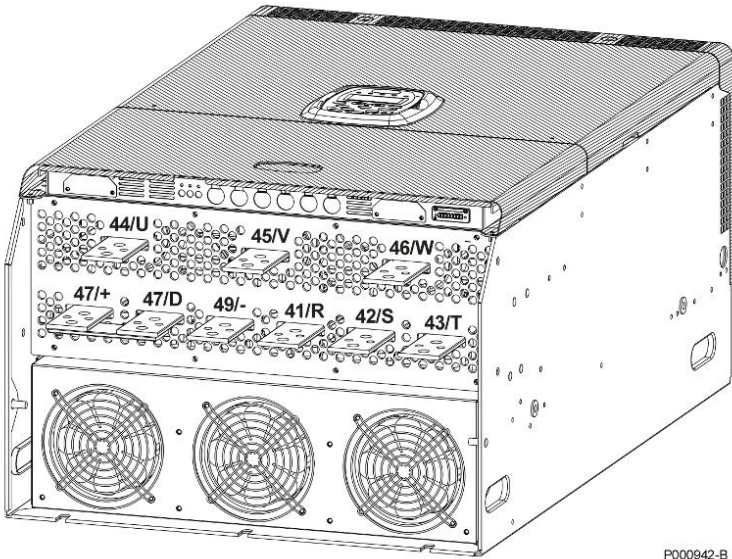
CAUTION

Please contact Elettronica Santerno if DC voltage power supply is to be applied to Sinus Penta S41, S42, S51, S52 (precharge circuit for the DC-bus capacitor upstream of the DC voltage power supply terminals).



NOTE

Use terminals **47/+** and **49/-** if the external braking unit is to be installed.



P000942-B

Figure 47: Connection bars in S41–S42–S51–S52

3.4.5. Power Terminals Modified for a DC Inductor

When a DC inductor is required for Sinus Penta S15-20-30, this must be specified when ordering the equipment.



CAUTION

Inverter sizes S15, S20 and S30 and modular inverters S65 to S90 require hardware adjustment in order to install DC inductors. This adjustment must be specified when ordering the equipment.



NOTE

The terminals changed for the connection of a DC inductor are **red on grey shading**.



CAUTION

Models S05(4T) cannot be changed for the connection of a DC inductor.

S15-S20 Terminal board:

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



NOTE

Use terminals **47/+** and **48/B** if an external braking resistor is to be installed.

S30 Terminal board:

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



NOTE

Use terminals **47/+** and **48/B** if an external braking resistor is to be installed.

3.4.6. Connection Bars for S60P Inverters

S000531

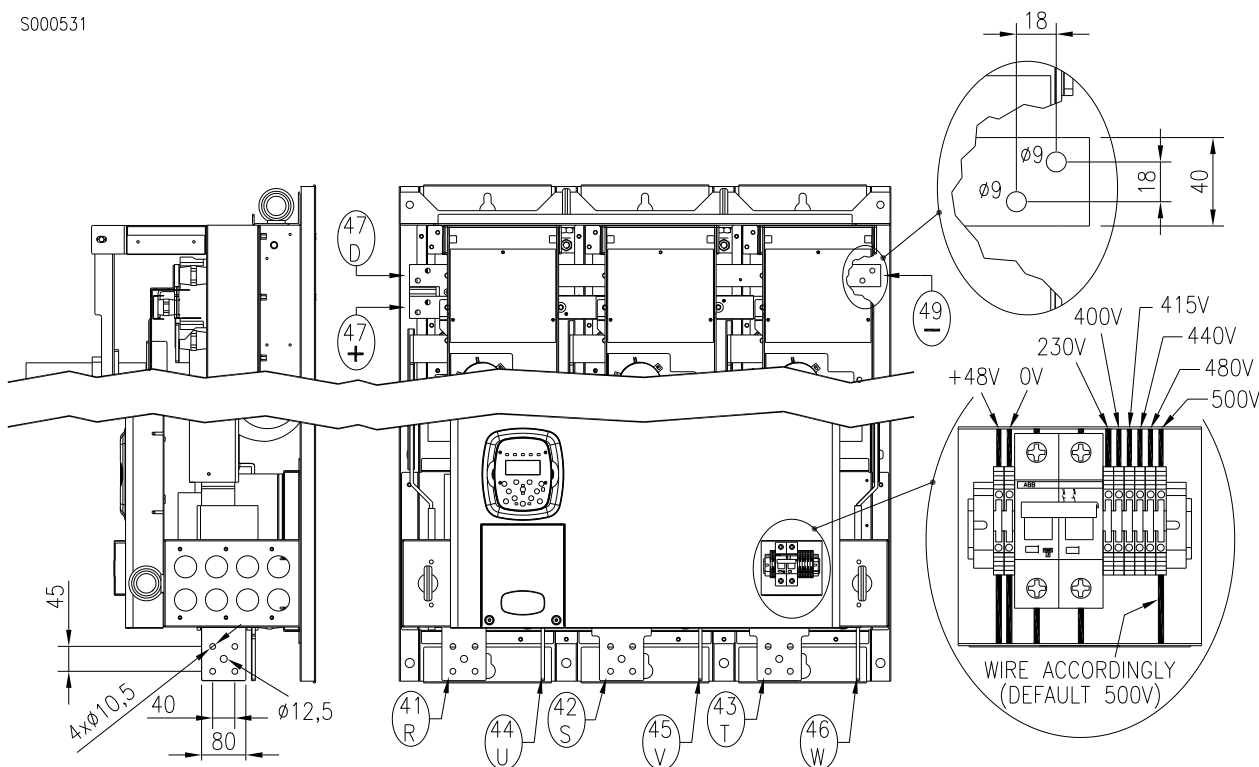


Figure 48: S60 and S60P Connection bars

Figure 48 shows the location and dimension of the bars connecting Sinus Penta drives S60 and S60P to the mains and the motor. The figure also shows the position and the wiring instructions for the built-in power supply transformer. The transformer must be wired based on the rated supply voltage being used.



CAUTION

Connection bars **47/D** and **47/+** are short-circuited as a factory setting. The DC inductor, if any, shall be linked between bars **47/D** and **47/+** after removing the short-circuit.



CAUTION

Please contact Elettronica Santerno if DC voltage power supply is to be applied to Sinus Penta S60 and S60P (precharge circuit for the DC-bus capacitor upstream of the DC voltage power supply terminals).



CAUTION

48 Vdc 16 A power supply is required for Sinus Penta drives S60P (see Figure 48). However, 230 V power supply for the bypass contactor is still required.

When using power supply unit **WW0001330**, N. 2 power supply units are to be connected in parallel:

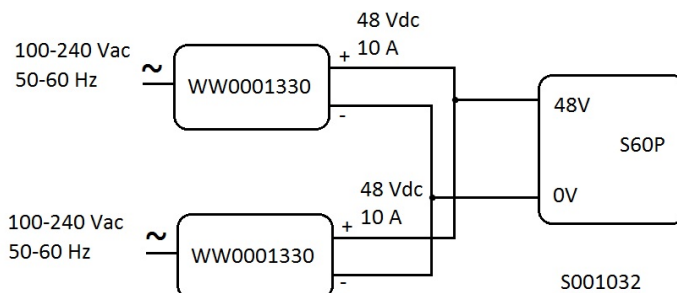
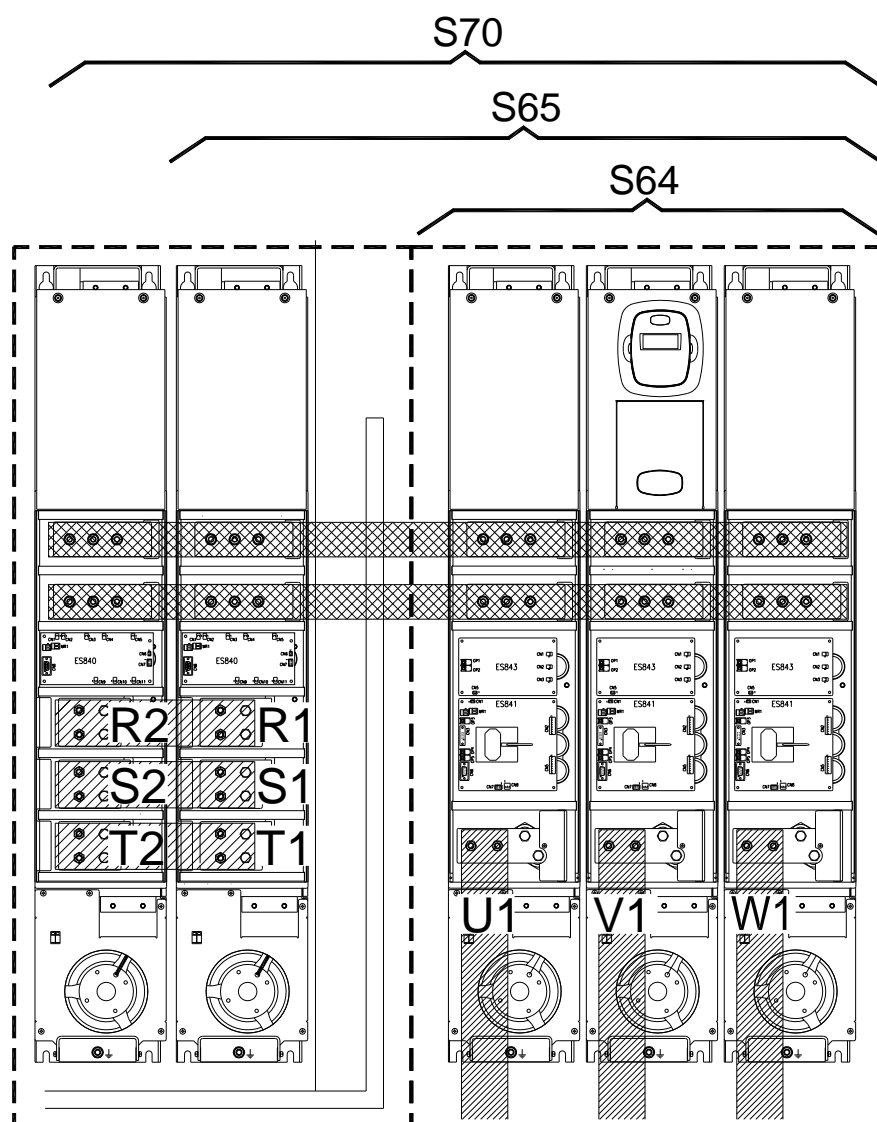


Figure 49: Connection to +48 Vdc Power Supply Units for S60P

3.4.7. Connection Bars for Modular Inverters S64–S70



P000650-B

Figure 50: Connection bars for S64-S70



CAUTION

Inverter sizes S65 and S70 require hardware adjustment in order to install DC inductors. This adjustment must be specified when ordering the equipment.



CAUTION

When a DC inductor is to be installed, special-purpose bars are required.

3.4.8. Connection Bars for Modular Inverters S74–S80

S000265

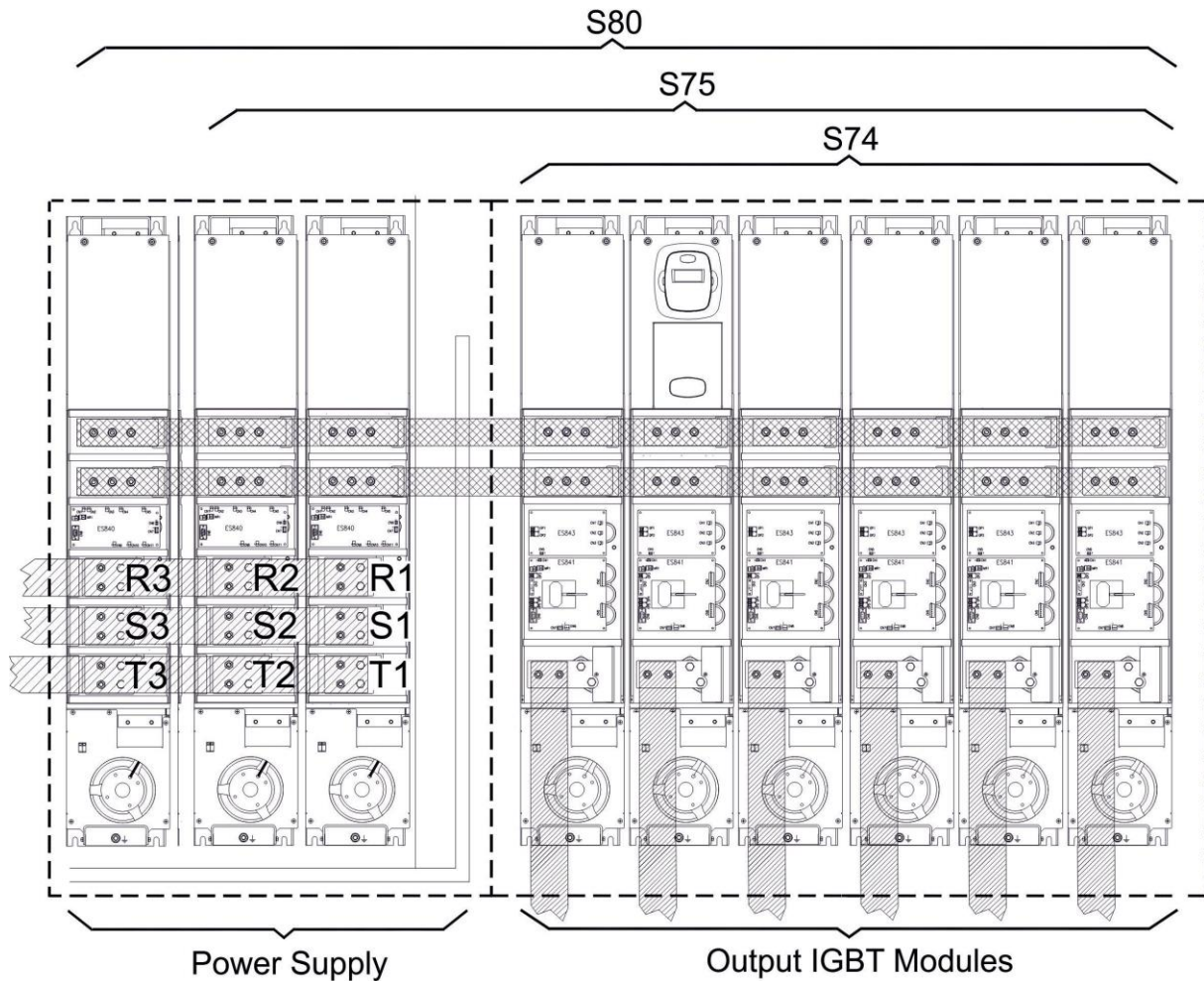


Figure 51: Connection bars for S74-S80



CAUTION

Inverter sizes S75 and S80 require hardware adjustment in order to install DC inductors. This adjustment must be specified when ordering the equipment.



CAUTION

When a DC inductor is to be installed, special-purpose bars are required.

3.4.9. Connection Bars for Modular Inverters S84–S90

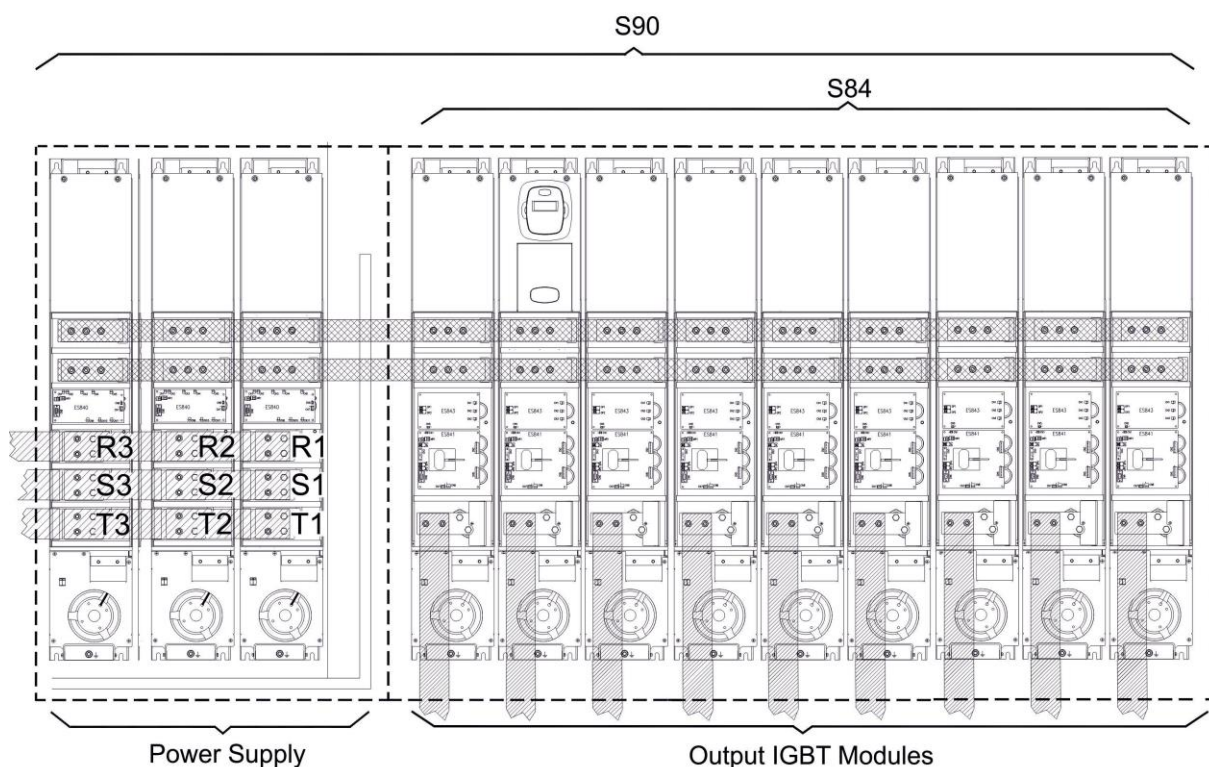


Figure 52: Connection bars for S84-S90



CAUTION

Inverter size S90 require hardware adjustment in order to install DC inductors. This adjustment must be specified when ordering the equipment.



CAUTION

When a DC inductor is to be installed, special-purpose bars are required.



CAUTION

Please contact Elettronica Santerno if DC supply is to be applied to Sinus Penta S64 to S84 (the precharge circuit of DC-bus capacitors is not present).



CAUTION

The mounting layout in the figures above may vary based on the accessories being used (input and output inductors, sine filters, harmonic filters).

3.4.10. Auxiliary Power Supply Terminals

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

Decisive voltage class A according to EN 61800-5-1.

Inverter	Terminal	Description	Ratings
S65–S64– S70–S74–S75– S80–S84–S90	61–62	Inputs for fan power supply	230 Vac / 2 A

3.4.11. Cross-sections of the Power Cables and Sizes of the Protective Devices

The minimum requirements of the inverter cables and the protective devices needed to protect the system against short-circuits are given in the tables below. It is however recommended that the applicable regulations in force be observed; also check if voltage drops occur for cable links longer than 100 m.

For the largest inverter sizes, special links with multiple conductors are provided for each phase. For example, 2x150 in the column relating to the cable cross-section means that two 150 mm² parallel conductors are required for each phase.

Multiple conductors shall have the same length and must run parallel to each other, thus ensuring even current delivery at any frequency value. Paths having the same length but a different shape deliver uneven current at high frequency.

Also, do not exceed the tightening torque for the terminals to the bar connections. For connections to bars, the tightening torque relates to the bolt tightening the cable lug to the copper bar. The cross-section values given in the tables below apply to copper cables.

The links between the motor and the Penta drive must have the same lengths and must follow the same paths. Use 3-phase cables where possible.



NOTE

The recommended cross-sections for the mains-side and motor-side cables are referred to the drive when powered at its rated current. Smaller cable cross-sections may be used with lower power supply ratings.

3.4.11.1. 2T Voltage Class

Size	Sinus Penta Model	Rated Inverter Current	Cable Cross-section Fitting the Terminal	Cable Stripping	Tightening Torque	Cable Cross-section to Mains and Motor Side	Fast Fuses (700V) + Disc. Switch	Magnetic Circuit Breaker	AC1 Contactor
		A	mm ² (AWG/kcmils)	mm	Nm	mm ² (AWG/kcmils)	A	A	A
S05	0007	12.5	0.5÷10 (20÷6AWG)	10	1.2-1.5	2.5 (14AWG)	16	16	25
	0008	15		10	1.2-1.5		16	16	25
	0010	17		10	1.2-1.5	4 (12AWG)	20	25	25
	0013	19		10	1.2-1.5		20	25	25
	0015	23		10	1.2-1.5	6 (10AWG)	25	25	25
	0016	27		10	1.2-1.5		32	32	45
	0020	30		10	1.2-1.5		50	50	45
S12	0023	38	0.5÷25 (20÷4AWG)	18	2.5	10 (8AWG)	63	63	60
	0033	51		18	2.5	16 (6AWG)	80	80	80
	0037	65		18	2.5	25 (4AWG)	80	80	80
S15	0040	72	4÷25 (12÷4AWG)	15	2.5		100	100	100
	0049	80		15	2.5		125	100	100
S20	0060	88	25÷70 (3÷2/0AWG)	24	6-8	35 (2AWG)	125	125	125
	0067	103		24	6-8		125	125	125
	0074	120		24	6-8	50 (1/0AWG)	160	160	145
	0086	145		24	6-8		200	160	160
S30	0113	180	35÷185 (2AWG÷350kcmils)	30	10	95 (4/0AWG)	250	200	250
	0129	195		30	10	120 (250kcmils)	250	250	250
	0150	215		30	10		315	400	275
	0162	240		30	10		400	400	275
S41 (**)	0180	300	Bus bar	-	M12: 30	185 (400kcmils)	350	400	400
	0202	345	Bus bar	-	M12: 30	240 (500kcmils)	500	400	450
	0217	375	Bus bar	-	M12: 30	2x120 (2x4/0AWG)	550	630	450
	0260	445	Bus bar	-	M12: 30	2x120 (2x250kcmils)	630	630	500
S51 (**)	0313	480	Bus bar	-	M12: 30	2x150 (2x300kcmils)	700	630	550
	0367	550	Bus bar	-	M12: 30	2x185 (2x350kcmils)	800	800	600
	0402	680	Bus bar	-	M12: 30	2x240 (2x500kcmils)	1000	800	700
S60	0457	720	Bus bar	-	M10: 20	3x150 (3x300kcmils)	1000	800	800
	0524	800	Bus bar	-	M10: 20	3x185 (3x350kcmils)	1000	1000	1000

**CAUTION**

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

**CAUTION (**)**

When applying 12-phase power supply, refer to the values given in Cross-sections of the Power Cables and Sizes of the Protective Devices when the SU465 is Installed in the Motor Drives Accessories - User Manual.

3.4.11.2. *UL-approved Fuses - 2T Voltage Class*

UL-approved semiconductor fuses, which are recommended for the Sinus Penta drives, are listed in the table below.

In multiple cable installations, install one fuse per phase (NOT one fuse per conductor).

Fuses suitable for the protection of semiconductors produced by other manufacturers may be used, provided that they have comparable ratings to those for UL-approved fuses (particularly, I^2t lower than or equal to the one for UL-approved fuses) and

- are Nonrenewable UL Listed Cartridge Fuses (UL Category code JFHR2), or UL Recognized External Semiconductor Fuses;
- are of the type specifically approved also with reference to the Canadian Standard (UL Category code JFHR8).

Size	Sinus Penta Model	UL-approved Fuses Manufactured by:							
		SIBA Sicherungen-Bau GmbH (200 kA _{RMS} Symmetrical A.I.C.)				Bussmann Div Cooper (UK) Ltd (200 kA _{RMS} Symmetrical A.I.C.)			
		Mod. No.	Ratings			Mod. No.	Ratings		
Current A _{RMS}	I ² t (230V) A ² s		Vac	Current A _{RMS}	I ² t (230V) A ² s		Vac		
S05	0007	60 033 05 16	16	48	600	170M1409	16	22	700
	0008								
	0010	60 033 05 20	20	80		170M1410	20	35	
	0013								
	0015	50 142 06 25	25	140		170M1411	25	58	
	0016	50 142 06 32	32	315		FWP-35B	35	40	
S12	0020	50 142 06 50	50	400	700	FWP-50B	50	150	
	0023								
	0033	20 412 20 80	80	1.12k		FWP-70B	70	500	
	0037					FWP-80B	80	600	
S15	0040	20 412 20 100	100	1.72k		FWP-100B	100	900	
	0049								
S20	0060	20 412 20 125	125	3.10k		FWP-125A	125	3.65k	
	0067					FWP-150A	150	5.85k	
	0074	20 412 20 160	160	6.70k		FWP-175A	175	8.40k	
S30	0086	20 412 20 200	200	12.0k					
	0113	20 412 20 250	250	20.1k		FWP-225A	225	15.7k	
	0129								
	0150	20 412 20 315	315	37.0k		FWP-250A	250	21.3k	
	0162	20 412 20 400	400	68.0k		FWP-350A	350	47.8k	
S41	0180	20 622 32 450	450	47.3k		FWP-450A	450	68.5k	
	0202	20 622 32 500	500	64.5k		FWP-500A	500	85.0k	
	0217	20 622 32 550	550	84.0k		FWP-600A	600	125k	
	0260	20 622 32 630	630	129k					
S51	0313	20 622 32 700	700	177k		FWP-700A	700	54.0k	
	0367	20 622 32 800	800	250k	FWP-800A	800	81.0k		
	0402	20 622 32 1000	1000	542k	FWP-1000A	1000	108k		
S60	0457								
	0524	20 632 32 1250	1250	924k	FWP-1200A	1200	198k		

3.4.11.3. UL-approved Surge Protective Devices (SPDs) - 2T Voltage Class

In accordance with **UL508C** for Sinus Penta 2T models Overvoltage Protection shall be externally provided in the end-use application by R/C Surge-protective Devices – Component (UL Category Code VZCA2/VZCA8).

UL-approved Surge Protective Devices (SPDs) which are recommended for Sinus Penta 2T models are listed in the table below.

Other devices or systems produced by different manufacturers may be used, provided that they

- are listed in UL Category Code VZCA2;
- are evaluated based on the requirements in Standard UL 1449;
- are evaluated also to withstand the available short circuit current when tested in accordance with UL 1449;
- are of the type specifically approved also with reference to the Canadian Standard (UL Category Code VZCA8);
- have Max Voltage Protective Rating of 1kV, non MOV type.

Size	SINUS PENTA Model	UL-approved SPDs by	Rated Drive Current	Part Number	Ratings			Intended End-Use SPD Type
			A		Short-circuit Current (kA)	Surge Level (kV)	Rated Voltage (V)	
S05	0007	Phoenix Contact	12.5	VAL-MS 230 ST (2798844)	5	<1	230	2
	0008		15					
	0010		17					
	0013		19					
	0015		23					
	0016		27					
	0020		30					
S12	0023		38					
	0033		51					
	0037		65					
S05	0007	Dehn	12.5	952 300	5	<1.8	230	2
	0008		15					
	0010		17					
	0013		19					
	0015		23					
	0016		27					
	0020		30					
S12	0023		38					
	0033		51					
	0037		65					
S05	0007	ERICO	12.5	TDS1501 SR240 (articolo N. 702406 per l'Europa)	5	<0.9	240	2
	0008		15					
	0010		17					
	0013		19					
	0015		23					
	0016		27					
	0020		30					
S12	0023		38					
	0033		51					
	0037		65					

3.4.11.4. 4T Voltage Class

Size	Sinus Penta Model	Rated Inverter Current	Cable Cross-section Fitting the Terminal	Cable Stripping	Tightening Torque	Cable Cross-section to Mains and Motor Side	Fast Fuses (700V) + Disc. Switch	Magnetic Circuit Breaker	AC1 Contactor
		A	mm ² (AWG/kcmils)	mm	Nm	mm ² (AWG/kcmils)	A	A	A
S05	0005	10.5	0.5÷10 (20÷6AWG)	10	1.2-1.5	2.5 (14AWG)	16	16	25
	0007	12.5		10	1.2-1.5	4 (12AWG)	16	16	25
	0009	16.5		10	1.2-1.5		25	25	25
	0011	16.5		10	1.2-1.5		25	25	25
	0014	27		10	1.2-1.5		32	32	30
S12	0016	26		10	1.2-1.5	6 (10AWG)	40	40	45
	0017	30		10	1.2-1.5		40	40	45
	0020	30		10	1.2-1.5		40	40	45
	0025	41		10	1.2-1.5	10 (8AWG)	63	63	55
	0030	45		10	1.2-1.5		63	63	60
	0034	57	0.5÷25 (20÷4AWG)	18	2.5	16 (6AWG)	100	100	100
	0036	60		18	2.5	25 (4AWG)	100	100	100
	0040	72		15	2.5		100	100	100
S15	0049	80	4÷25 (12÷4AWG)	15	2.5		125	100	100
S20	0060	88	25÷70 (3÷2/0 AWG)	24	6-8	35 (2AWG)	125	125	125
	0067	103		24	6-8	50 (1/0AWG)	125	125	125
	0074	120		24	6-8		160	160	145
	0086	145		24	6-8		200	160	160
S30	0113	180	35÷185 (2AWG÷350kcmils)	30	10	95 (4/0AWG)	250	200	250
	0129	195		30	10	120 (250kcmils)	250	250	250
	0150	215		30	10		315	400	275
	0162	240		30	10		350	400	275

(continued)

(continued)

Size	Sinus Penta Model	Rated Inverter Current	Cable Cross-section Fitting the Terminal	Cable Stripping	Tightening Torque	Cable Cross-section to Mains and Motor Side	Fast Fuses (700V) + Disc. Switch	Magnetic Circuit Breaker	AC1 Contactor
		A	mm ² (AWG/kcmils)	mm	Nm	mm ² (AWG/kcmils)	A	A	A
S41 (**)	0180	300	Bus bar	-	M12: 30	185 (400kcmils)	400	400	400
	0202	345	Bus bar	-	M12: 30	240 (500kcmils)	500	400	450
	0217	375	Bus bar	-	M12: 30	2x120 (2x250kcmils)	550	630	450
	0260	445	Bus bar	-	M12: 30	2x120 (2x250kcmils)	630	630	500
S51 (**)	0313	480	Bus bar	-	M12: 30	2x150 (2x300kcmils)	700	630	550
	0367	550	Bus bar	-	M12: 30	2x185 (2x350kcmils)	800	800	600
	0402	680	Bus bar	-	M12: 30	2x240 (2x500kcmils)	1000	800	700
S60	0457	720	Bus bar	-	M10: 20	3x150 (3x300kcmils)	1000	800	800
	0524	800	Bus bar	-	M10: 20	3x185 (3x350kcmils)	1000	1000	1000
S60P	0598P	900	Bus bar	-	M10: 20	3x240 (3x500kcmils)	1250	1250	1000
S65	0598	900	Bus bar	-	M10: 20 M12: 30	3x240 (3x500kcmils)	1250	1250	1000
	0748	1000	Bus bar	-	M10: 20 M12: 30	3x240 (3x500kcmils)	1250	1250	1200
	0831	1200	Bus bar	-	M10: 20 M12: 30	4x240 (4x500kcmils)	1600	1600	1600
S75	0964	1480	Bus bar	-	M10: 20 M12: 30	6x150 (6x300kcmils)	2x1000	2000	2x1000
	1130	1700	Bus bar	-	M10: 20 M12: 30	6x185 (6x350kcmils)	2x1250	2000	2x1200
	1296	2100	Bus bar	-	M10: 20 M12: 30	6x240 (6x500kcmils)	2x1250	2500	2x1200
S90	1800	2600	Bus bar	-	M10: 20 M12: 30	9x240 (9x500kcmils)	3x1250	4000	3x1000
	2076	3000	Bus bar	-	M10: 20 M12: 30	9x240 (9x500kcmils)	3x1250	4000	3x1200

**CAUTION**

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

**CAUTION (**)**

When applying 12-phase power supply, refer to the values given in section Cross-sections of the Power Cables and Sizes of the Protective Devices when the SU465 is Installed in the Motor Drives Accessories - User Manual.

Size	Sinus Penta Model	Rated Output Current	Rated Input Current	Cable Cross-section Fitting the Terminal	Tightening Torque	Motor Cable Cross-section
		A	Adc	mm ² (AWG/kcmils)	Nm	mm ² (AWG/kcmils)
S64	0598	900	1000	Bus bar	M10: 20 M12: 30	3x240 (3x500kcmils)
	0748	1000	1100	Bus bar	M10: 20 M12: 30	3x240 (3x500kcmils)
	0831	1200	1400	Bus bar	M10: 20 M12: 30	4x240 (4x500kcmils)
S74	0964	1480	1750	Bus bar	M10: 20 M12: 30	6x150 (6x300kcmils)
	1130	1700	2000	Bus bar	M10: 20 M12: 30	6x185 (6x350kcmils)
	1296	2100	2280	Bus bar	M10: 20 M12: 30	6x240 (6x500kcmils)
S84	1800	2600	2860	Bus bar	M10: 20 M12: 30	9x240 (9x500kcmils)
	2076	3000	3300	Bus bar	M10: 20 M12: 30	9x240 (9x500kcmils)

**CAUTION**

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

3.4.11.5. UL-approved Fuses - 4T Voltage Class

UL-approved semiconductor fuses, which are recommended for the Sinus Penta drives, are listed in the table below. In multiple cable installations, install one fuse per phase (NOT one fuse per conductor).

Fuses suitable for the protection of semiconductors produced by other manufacturers may be used, provided that they have comparable ratings to those for UL-approved fuses (particularly, I^2t lower than or equal to the one for UL-approved fuses) and:

- are Nonrenewable UL Listed Cartridge Fuses (UL Category code JFHR2), or UL Recognized External Semiconductor Fuses;
- are of the type specifically approved also with reference to the Canadian Standard (UL Category code JFHR8).

Size	Sinus Penta Model	UL-approved Fuses Manufactured by:										
		SIBA Sicherungen-Bau GmbH (200 kARMS Symmetrical A.I.C.)				Bussmann Div Cooper (UK) Ltd (100/200 kARMS Symmetrical A.I.C.)						
		Mod. No.	Ratings			Mod. No.	Ratings					
Current Arms	I²t (500V) A²s		Vac	Current Arms	I²t (500V) A²s		Vac					
S05	0005	50 142 06 16	16	40	700	170M1409	16	36	700			
	0007					170M1410	20	58				
	0009	50 142 06 25	25	105								
	0011					FWP-40B	40	160				
0014	50 142 06 40	40	430									
0016				FWP-60B		60	475					
0017												
S12	0020	20 412 20 63	63	980		FWP-80B	80	1.20k				
	0025					FWP-100B	100	1.75k				
	0030											
	0034											
0036	20 412 20 80	80	1.82k									
S15	0040	20 412 20 100	100	2.80k		FWP-125A	125	5.40k				
	0049					FWP-150A	150	8.70k				
S20	0060	20 412 20 125	125	5.04k		FWP-175A	175	12.3k				
	0067					FWP-225A	225	23.0k				
	0074	20 412 20 160	160	10.78k		FWP-250A	250	32.0k				
	0086	20 412 20 200	200	19.25k		FWP-350A	350	70.8k				
S30	0113	20 412 20 250	250	32.76k		FWP-450A	450	101.4k				
	0129					FWP-500A	500	125.8k				
	0150	20 412 20 315	315	60.20k		FWP-600A	600	185k				
	0162	20 412 20 400	400	109.2k		FWP-700A	700	129k				
S41	0180	20 622 32 450	450	77.0k		FWP-900A	900	228k				
	0202	20 622 32 500	500	105.0k		FWP-1000A	1000	258k				
	0217	20 622 32 550	550	136.5k		FWP-1200A	1200	473k				
	0260	20 622 32 630	630	210k		170M6067	1400	1700k				
S51	0313	20 622 32 700	700	287k		170M6069	1600	2700k				
	0367					2x20 622 32 800	2x800	2x406k		2xFWP-1000A	2x1000	2x258k
	0402					20 622 32 900	900	665k		2xFWP-1200A	2x1200	2x473k
S60	0457	20 632 32 1000	1000	602k		2x170M6067	2x1400	2x1700k				
	0524	20 632 32 1250	1250	1225k		3x170M6067	3x1400	3x1700k				
S60P	0598P	20 632 32 1400	1400	1540k								
S65	0598											
	0748											
	0831					2x20 622 32 800	2x800	2x406k				
S75	0964	2x20 632 32 1000	2x1000	2x602k								
	1130	2x20 622 32 1250	2x1250	2x1225k								
	1296	2x20 632 32 1400	2x1400	2x1540k								
S90	1800	3x20 632 32 1400	3x1400	3x1540k								
	2076											

**NOTE**

In modular sizes (S65–S90), each supply arm shall be protected by a separate fuse (see table above).

3.4.11.6. 5T and 6T Voltage Classes

Size	Sinus Penta Model	Rated Inverter Current	Terminal Cross-section	Cable Stripping	Tightening Torque	Cable Cross-section to Mains and Motor Side	Fast Fuses (700V) + Disc. Switch	Magnetic Circuit Breaker	AC1 Contactor
		A	mm ² (AWG/kcmils)	mm	Nm	mm ² (AWG/kcmils)	A	A	A
S12 5T S14 6T	0003	7	0.5÷16 (20÷5AWG)	10	1.2-1.5	2.5 (14AWG)	16	16	25
	0004	9		10	1.2-1.5		16	16	25
	0006	11		10	1.2-1.5	4 (12AWG)	32	32	30
	0012	13		10	1.2-1.5		32	32	30
	0018	17		10	1.2-1.5		32	32	30
S14	0019	21	0.5÷25 (20÷4 AWG)	18	2.5-4.5	6 (10AWG)	40	40	45
	0021	25		18	2.5-4.5		40	40	45
	0022	33		18	2.5-4.5	10 (8AWG)	63	63	60
	0024	40		18	2.5-4.5		63	63	60
	0032	52		18	2.5-4.5	16 (6AWG)	100	100	100
S22	0042	60	25÷50 (4÷1/0 AWG)	20	2.5-5	25 (4 AWG)	100	100	100
	0051	80		20	2.5-5		100	100	100
	0062	85		20	2.5-5	35 (2 AWG)	125	125	125
	0069	100		20	2.5-5		125	125	125
S32	0076	125	25÷95 (4÷4/0AWG)	30	15-20	50 (1/0AWG)	200	200	250
	0088	150		30	15-20	70 (2/0AWG)	200	200	250
	0131	190	35÷150 (2/0AWG÷300kcmils)	30	15-20	120 (250kcmils)	315	400	275
	0164	230		30	15-20		315	400	275
S42 (**)	0181	305	Bus bar	-	M12: 30	240 (500kcmils)	400	400	400
	0201	330	Bus bar	-	M12: 30		450	400	450
	0218	360	Bus bar	-	M12: 30	2x120 (2x250kcmils)	500	400	450
	0259	400	Bus bar	-	M12: 30		630	630	500
S52 (**)	0290	450	Bus bar	-	M12: 30	2x150 (2x300kcmils)	630	630	550
	0314	500	Bus bar	-	M12: 30		700	630	550
	0368	560	Bus bar	-	M12: 30	2x185 (2x350kcmils)	800	800	600
	0401	640	Bus bar	-	M10: 20 M12: 30	2x240 (2x500kcmils)	900	800	700
S65	0457	720	Bus bar	-	M10: 20 M12: 30	3x150 (3x300kcmils)	900	800	800
	0524	800	Bus bar	-	M10: 20 M12: 30	3x185 (3x350kcmils)	1000	1000	1000
	0598	900	Bus bar	-	M10: 20 M12: 30	3x240 (3x500kcmils)	1250	1250	1000
	0748	1000	Bus bar	-	M10: 20 M12: 30		1400	1250	1200
S70	0831	1200	Bus bar	-	M10: 20 M12: 30	4x240 (4x500kcmils)	2x800	1600	2x800
S75	0964	1480	Bus bar	-	M10: 20 M12: 30	6x150 (6x300kcmils)	2x1000	2000	2x1000
	1130	1700	Bus bar	-	M10: 20 M12: 30	6x185 (6x400kcmils)	2x1250	2000	2x1000
S80	1296	2100	Bus bar	-	M10: 20 M12: 30	6x240 (6x500kcmils)	3x1000	2500	3x1000
S90	1800	2600	Bus bar	-	M10: 20 M12: 30	9x240 (9x500kcmils)	3x1000	4000	3x1000
	2076	3000	Bus bar	-	M10: 20 M12: 30	9x240 (9x500kcmils)	3x1250	4000	3x1000

**CAUTION**

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

**CAUTION (**)**

When applying 12-phase power supply, refer to the values given in Cross-sections of the Power Cables and Sizes of the Protective Devices when the SU465 is Installed in the Motor Drives Accessories - User Manual.

Size	Sinus Penta Model	Rated Output Current	Rated Input Current	Cable Cross-section Fitting the Terminal	Tightening Torque	Motor Cable Cross-section
		A	Adc	mm ² (AWG/kcmils)	Nm	mm ² (AWG/kcmils)
S64	0457	720	750	Bus bar	M10: 20 M12: 30	3x150 (3x300kcmils)
	0524	800	840	Bus bar	M10: 20 M12: 30	3x185 (3x350kcmils)
	0598	900	950	Bus bar	M10: 20 M12: 30	3x240 (3x500kcmils)
	0748	1000	1070	Bus bar	M10: 20 M12: 30	3x240 (3x500kcmils)
	0831	1200	1190	Bus bar	M10: 20 M12: 30	4x240 (4x500kcmils)
S74	0964	1480	1500	Bus bar	M10: 20 M12: 30	6x150 (6x300kcmils)
	1130	1700	1730	Bus bar	M10: 20 M12: 30	6x185 (6x400kcmils)
	1296	2100	1980	Bus bar	M10: 20 M12: 30	6x240 (6x500kcmils)
S84	1800	2600	2860	Bus bar	M10: 20 M12: 30	9x240 (9x500kcmils)
	2076	3000	3300	Bus bar	M10: 20 M12: 30	9x240 (9x500kcmils)

**CAUTION**

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

3.4.11.7. *UL-approved Fuses - 5T and 6T Voltage Classes*

UL-approved semiconductor fuses, which are recommended for the Sinus Penta drives, are listed in the table below.

In multiple cable installations, install one fuse per phase (NOT one fuse per conductor).

Fuses suitable for the protection of semiconductors produced by other manufacturers may be used, provided that they have comparable ratings to those for UL-approved fuses (particularly, I^2t lower than or equal to the one for UL-approved fuses) and:

- are Nonrenewable UL Listed Cartridge Fuses (UL Category code JFHR2), or UL Recognized External Semiconductor Fuses;
- are of the type specifically approved also with reference to the Canadian Standard (UL Category code JFHR8).

Size	Sinus Penta Model	UL-approved Fuses Manufactured by:							
		SIBA Sicherungen-Bau GmbH (200 kARMS Symmetrical A.I.C.)				Bussmann Div Cooper (UK) Ltd (100/200 kARMS Symmetrical A.I.C.)			
		Mod. No.	Ratings			Mod. No.	Ratings		
Current Arms	I²t (600V) A²s		Vac	Current Arms	I²t (600V) A²s		Vac		
S12 5T S14 6T	0003	50 142 06 16	16	48 (40@575V)	700	170M1409	16	42.9	700
	0004					170M1410	20	75.1	
	0006					170M1411	25	117 (110@575V)	
	0012	50 142 06 20	20	90 (80@575V)		170M1411	25	117	
S14	0018	50 142 06 25	25	120 (115@575V)		170M1411	25	117	
	0019	50 142 06 25	25	120		170M1412	32	240	
	0021	50 142 06 32	32	310		FWP-40B	40	220	
	0022	20 412 20 40	40	430		FWP-50B	50	670	
	0024	20 412 20 50	50	660		FWP-70B	70	1.42k	
S22	0032	20 412 20 63	63	1.20k		FWP-80B	80	1.68k	
	0042	20 412 20 80	80	2.26k		FWP-100B	100	2.10k	
	0051	20 412 20 100	100	3.48k		FWP-125B	125	6.20k	
	0062	20 412 20 125	125	6.26k		FWP-150A	150	9.94k	
S32	0069	20 412 20 160	160	13.4k		FWP-175A	175	14.2k	
	0076	20 412 20 180	180	20.1k		FWP-200A	200	18.7k	
	0088	20 412 20 200	200	23.9k		FWP-250A	250	36.1k	
	0131	20 412 20 250	250	40.7k		FWP-300A	300	60.5k	
S42	0164	20 412 20 315	315	74.8k		FWP-400A	400	86.0k	
	0181	20 412 20 315	315	78.0k		FWP-450A	450	123k	
	0201	20 622 32 450	450	100k		FWP-500A	500	153k	
	0218	20 622 32 500	500	135k		FWP-600A	600	225k	
S52	0259	20 622 32 630	630	270k		FWP-600A	600	225k	
	0290	20 622 32 630	630	250k		FWP-700A	700	195k	
	0314	20 622 32 700	700	336k		FWP-800A	800	293k	
	0368	20 622 32 800	800	475k		FWP-900A	900	344k	
S65	0401	20 622 32 900	900	780k		FWP-900A	900	339k	
	0457	20 622 32 900	900	780k		FWP-1000A	1000	384k	
	0524	20 622 32 1000	1000	1008k		FWP-1200A	1200	704k	
	0598	20 622 32 1250	1250	1777k		FWJ-1400A	1400	1620k	
S70	0748	20 632 32 1400	1400	1827k		2xFWP-800A	2x800	2x293k	700
S75	0831	2x20 622 32 800	2x800	2x475k		2xFWP-1000A	2x1000	2x384k	
	0964	2x20 622 32 1000	2x1000	2x1008k		2xFWP-1200A	2x1200	2x704k	
S80	1130	2x20 632 32 1250	2x1250	2x1777k		3xFWP-1000A	3x1000	3x384k	1000
S90	1296	3x20 622 32 1000	3x1000	3x1008k		3xFWP-1200A	3x1200	3x704k	
	1800	3x20 632 32 1250	3x1250	3x1777k		3xFWJ-1400A	3x1400	3x1620k	1000
	2076	3x20 632 32 1400	3x1400	3x1827k					



NOTE

In modular sizes S65–S90, each supply arm shall be protected by a separate fuse (see table above).

3.4.12. Inverter and Motor Ground Connection

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



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



DANGER

Always connect the inverter grounding terminal to the grid grounding using a conductor complying with the safety regulations in force (see table below).

Always connect the motor casing to the inverter grounding to avoid dangerous voltage peaks and electric shock hazard.

Always provide a proper grounding of the inverter frame and the motor casing.



DANGER

The touch current in the ground protective conductor exceeds 3.5mAac/10 mAdc. Please refer to the table below for the dimensioning of the protective conductors.



NOTE

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

Protective earthing conductor cross-section (refer to EN 61800-5-1):

Cross-sectional area of phase conductors of the inverter (mm ²)	Minimum cross-sectional area of the corresponding protective earthing conductor (mm ²)
$S \leq 10$	10 (*)
$10 < S \leq 16$	S (*)
$16 < S \leq 35$	16
$35 < S$	$S/2$



NOTE

The values in the table above are valid only if the protective earthing conductor is made of the same metal as the phase conductors.

If this is not so, the cross-sectional area of the protective earthing conductor shall be determined in a manner which produces a conductance equivalent to that which results from the application of the table above.



NOTE (*)

In any case, a cross-section of the protective earthing conductor of at least 10 mm² Cu or 16 mm² Al is required to maintain safety in case of damage to or disconnection of the protective earthing conductor (refer to EN 61800-5-1 about Touch current).

3.5. Control Terminals

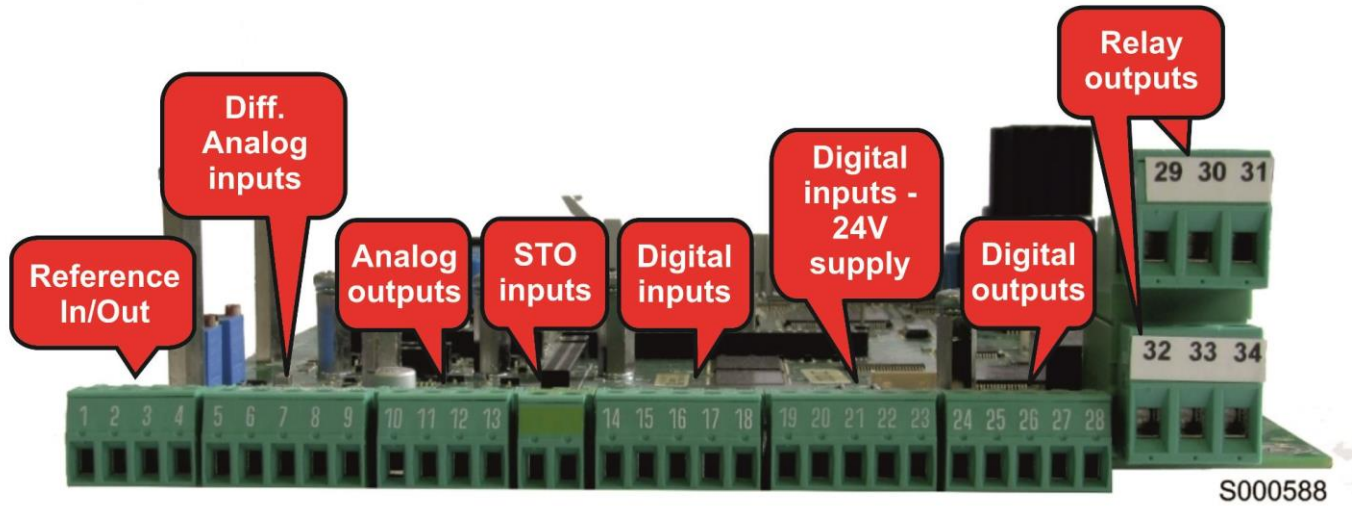


Figure 53: Control terminals

3.5.1. Main Features

Screwable terminal board in seven extractable sections suitable for cross-sections $0.08 \div 1.5\text{mm}^2$ (AWG 28-16).

Decisive voltage class A according to EN 61800-5-1.

No.	Name	Description	I/O Features	DIP-switch
1	CMA	0V for main reference (connected to control 0V)	Control board zero volt	
2	REF	Input for single-ended main reference to be configured either as a voltage input or as a current input	Vfs = $\pm 10\text{ V}$, Rin = $50\text{k}\Omega$; Resolution: 12 bits 0 (4) $\div 20\text{ mA}$, Rin = $250\ \Omega$; Resolution: 11 bits	SW1-1: Off (default) 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 = $\pm 10\text{ V}$, Rin = $50\text{k}\Omega$; Resolution: 12 bits	SW1-2: Off
6	AIN1-		0 (4) $\div 20\text{ mA}$, Rin = $250\ \Omega$; Resolution: 11 bits	SW1-2: On (default)
7	AIN2+/PTC1	Differential auxiliary analog input 2 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 = $\pm 10\text{ V}$, Rin = $50\text{k}\Omega$; Resolution: 12 bits	SW1-3: Off SW1-4,5: Off
8	AIN2-/ PTC2		0 (4) $\div 20\text{ mA}$, Rin = $250\ \Omega$; Resolution: 11 bits	SW1-3: On SW1-4,5: Off (default)
9	CMA		Motor protection PTC reading according to DIN44081/DIN44082	SW1-3: Off SW1-4,5: On
10	AO1	Analogue output 1 to be configured either as a voltage output or as a current output	Vout = $\pm 10\text{ V}$; Ioutmax = 5 mA ; Resolution: 11 bits 0 (4) $\div 20\text{ mA}$; Voutmax = 10 V Resolution: 10 bits	SW2-1: On; SW2-2: Off (default) SW2-1: Off; SW2-2: On
11	AO2	Analogue output 2 to be configured either as a voltage output or as a current output	Vout = $\pm 10\text{ V}$; Ioutmax = 5 mA Resolution: 11 bits 0 (4) $\div 20\text{ mA}$; Voutmax = 10 V Resolution: 10 bits	SW2-3: On; SW2-4: Off (default) SW2-3: Off; SW2-4: On
12	AO3	Analogue output 3 to be configured either as a voltage output or as a current output	Vout = $\pm 10\text{ V}$; Ioutmax = 5 mA Resolution: 11 bits 0 (4) $\div 20\text{ mA}$; Voutmax = 10 V Resolution: 10 bits	SW2-5: On; SW2-6: Off (default) SW2-5: Off; SW2-6: On
13	CMA	0V for main reference (connected to control 0V)	Control board zero volt	
S	ENABLE-B	Active input: inverter run enabled. Inactive input: freewheeling regardless of the control mode; converter not commutating. To be enabled/disabled in conjunction with ENABLE-A	24Vdc opto-isolated digital input; positive logic (PNP type): active with high signal in respect to CMD (terminal O). Compliant with EN 61131-2 as Type 1 digital inputs with 24Vdc nominal voltage. Max. response time to processor: $500\mu\text{s}$	
O	CMD		Control board zero volt	

(continued)



CAUTION (*)

The SINUS PENTA is intended to be used with motors that must have integral thermal protection, performed by R/C Thermistor type Devices - Component UL Category Code (XGPU2/XGPU8), PTC. The integral thermal protection terminals shall be connected to the converter on terminal (AIN2/PTC). The ultimate result of this signal is to switch the output Solid State Motor controller power to OFF.

(continued)

N.	Name	Description	I/O Features	DIP-switch
14	START (MDI1)	Active input: inverter running. Inactive input: main ref. is reset and the motor stops with a deceleration ramp Multifunction digital input 1	Opto-isolated digital inputs 24 VDC; positive logic (PNP): active with greater signal in respect to CMD (terminal 22). In compliance with EN 61131-2 as type-1 digital inputs with rated voltage equal to 24 VDC. Max. response time to processor: 500 μ s	
15	ENABLE-A (MDI2)	Active input: inverter running enabled Inactive input: motor idling regardless of control mode; inverter not switching To be enabled/disabled in conjunction with ENABLE-B Multifunction digital input 2		
16	RESET (MDI3)	Alarm reset function Multifunction digital input 3		
17	MDI4	Multifunction digital input 4		
18	MDI5	Multifunction digital input 5		

19	MDI6 / ECHA / FINA	Multifunction digital input 6; Encoder dedicated input, push-pull 24 V single-ended phase A, frequency input A	Opto-isolated digital inputs 24 VDC; positive logic (PNP): active with greater signal in respect to CMD (terminal 22). In compliance with EN 61131-2 as type-1 digital inputs with rated voltage equal to 24 VDC. Max. response time to processor: 600 μ s	
20	MDI7 / ECHB	Multifunction digital input 7; Encoder dedicated input, push-pull 24 V single-ended, phase B		
21	MDI8 / FINB	Multifunction digital input 8; Frequency input B		
22	CMD	0V digital input isolated to control 0V	Opto-isolated digital input zero volt	
23	+24V	Auxiliary supply output for opto-isolated multifunction digital inputs	+24V \pm 15% ; I _{max} : 200mA Protect with resettable fuse	
24	+VMDO1	Supply input for MDO1 output	20 \div 48 VDC; IDC = 10 mA + output current (max 60 mA)	

25	MDO1/ FOUT	Multifunction digital output 1; frequency output	Opto-isolated digital output (push-pull); I _{max} = 50 mA max; f _{out} max 100 kHz.	
26	CMDO1	0V Multifunction digital output 1	Common for supply and multifunction output 1	
27	MDO2	Multifunction digital output 2	Opto-isolated digital output (open collector); V _{omax} = 48 V; I _{omax} = 50mA	
28	CMDO2	Common for multifunction digital output 2	Common for multifunction output 2	

Screwable terminal board in two extractable sections suitable for cross-sections 0.2 \div 2.5 mm² (AWG 24-12).

Decisive voltage Class C according to EN 61800-5-1.

N.	Name	Description	I/O Features	DIP-switch
29	MDO3-NC	Multifunction, relay digital output 3 (NC contact)	Change-over contact: with low logic level, common terminal is closed with NC terminal; with high logic level, common terminal is open with NO terminal; V _{omax} = 250 Vac, I _{omax} = 5 A, Resistive Load; [*] V _{omax} = 250 Vac, I _{omax} = 3 A; [*] V _{omax} = 30 Vdc, I _{omax} = 5 A	
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 3 (NC contact)	Change-over contact: with low logic level, common terminal is closed with NC terminal; with high logic level, common terminal is open with NO terminal; V _{omax} = 250 Vac, I _{omax} = 5 A, Resistive Load; [*] V _{omax} = 250 Vac, I _{omax} = 3 A; [*] V _{omax} = 30 Vdc, I _{omax} = 5 A	
33	MDO4-C	Multifunction, relay digital output 4 (common)		
34	MDO4-NO	Multifunction, relay digital output 4 (NO contact).		

**CAUTION** [*]

Above 1000 m asl, relays may be used only with Vomax = 30 Vdc, *not* with Vomax = 250 Vac.

**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 Sinus Penta's Programming Guide)
- updating of the application firmware

Always consider those conditions when operating the inverter.

The firmware considers encoder inputs MDI6/ECHA, MDI7/ECHB as ENCODER A in the terminal board.

**NOTE**

Inserting an option board in slot C reallocates the digital inputs and only MDI6 and MDI7 functions are active, while the ENCODER A acquisition function is reallocated to the option board. For more details, see the ES836/2 Encoder Board (Slot A), ES913 Line Driver Encoder Board (Slot A) in the Motor Drives Accessories - User Manual and the Programming Guide.

The **ENABLE-A** and **ENABLE-B** inputs are allocated to the STO function. The control mode and control circuit of these signals must be accomplished according to the instructions given in the Safe Torque Off Function - Application Manual.

**NOTE**

That manual also includes a detailed validation procedure for the STO control configuration to be performed upon first start up of the equipment and also every 12 months.

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 shielded cables to be grounded. The figure shows how to wire a shielded cable.

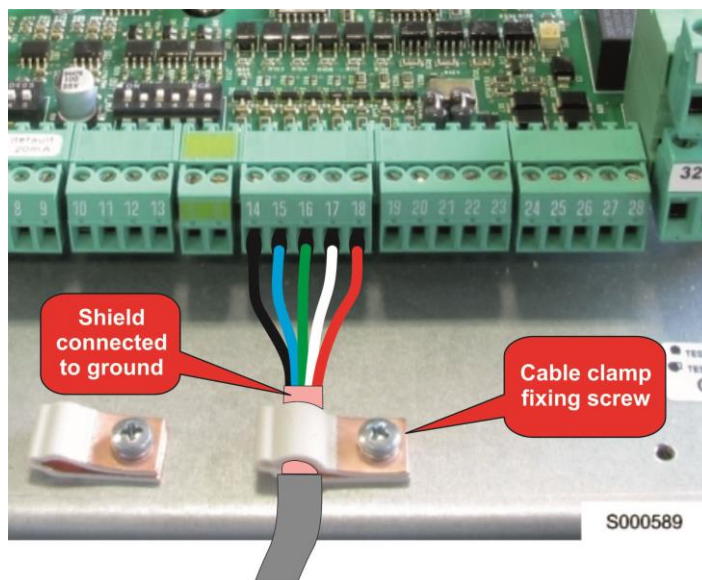


Figure 54: Tightening a screened signal cable

**CAUTION**

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

3.5.2. Gaining Access to Control Terminals and Power Terminals



DANGER

Before gaining access to the components inside the inverter, remove voltage from the inverter and wait at least 20 minutes. Wait for a complete discharge of the internal components to avoid any electric shock hazard.



DANGER

Do not connect or disconnect signal terminals or power terminals when the inverter is on to avoid electric shock hazard and to avoid damaging the inverter.



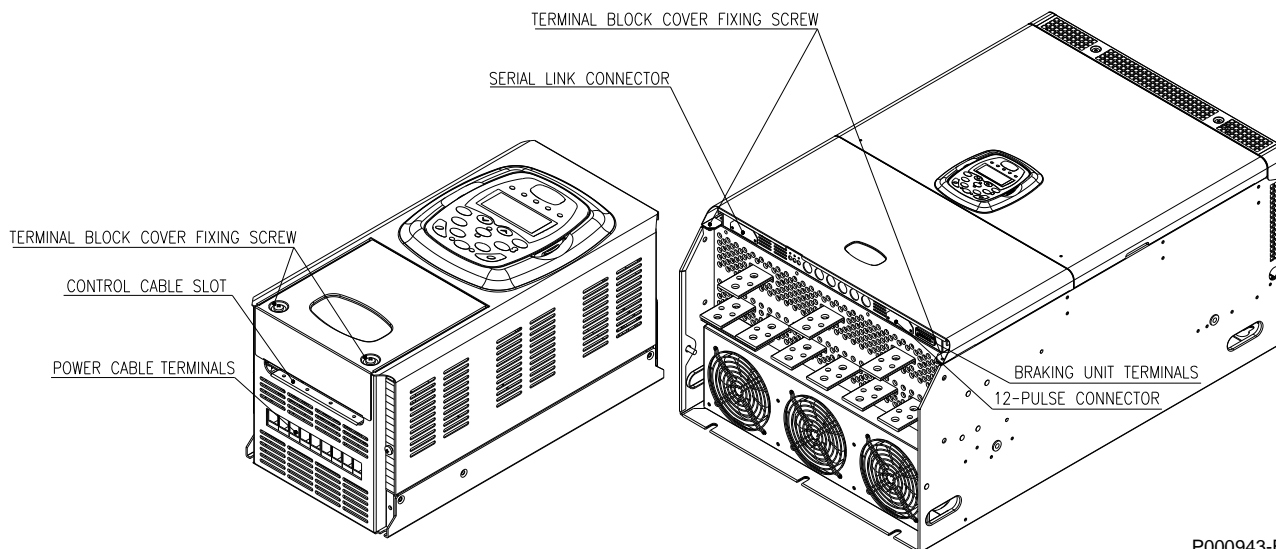
NOTE

The user is authorised to remove only the fixing elements of the parts mentioned in this section or in other sections in this manual (such as the terminals cover, the access to the serial interface connector, the cable raceway plates, and so on).

Removing fixing elements in order to access parts not mentioned in this manual will void the product warranty.

3.5.2.1. IP20 and IP00 Models

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



P000943-B

Figure 55: Gaining access to the control terminals

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

3.5.2.2. IP54 Models

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

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

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

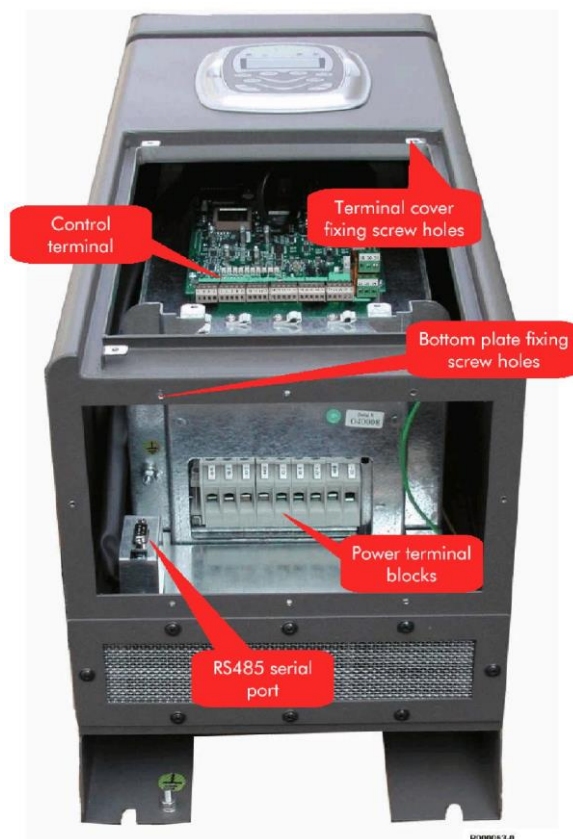


Figure 56: Gaining access to terminal boards in models IP54



CAUTION

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



CAUTION

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

3.5.3. Control Board Signals and Programming

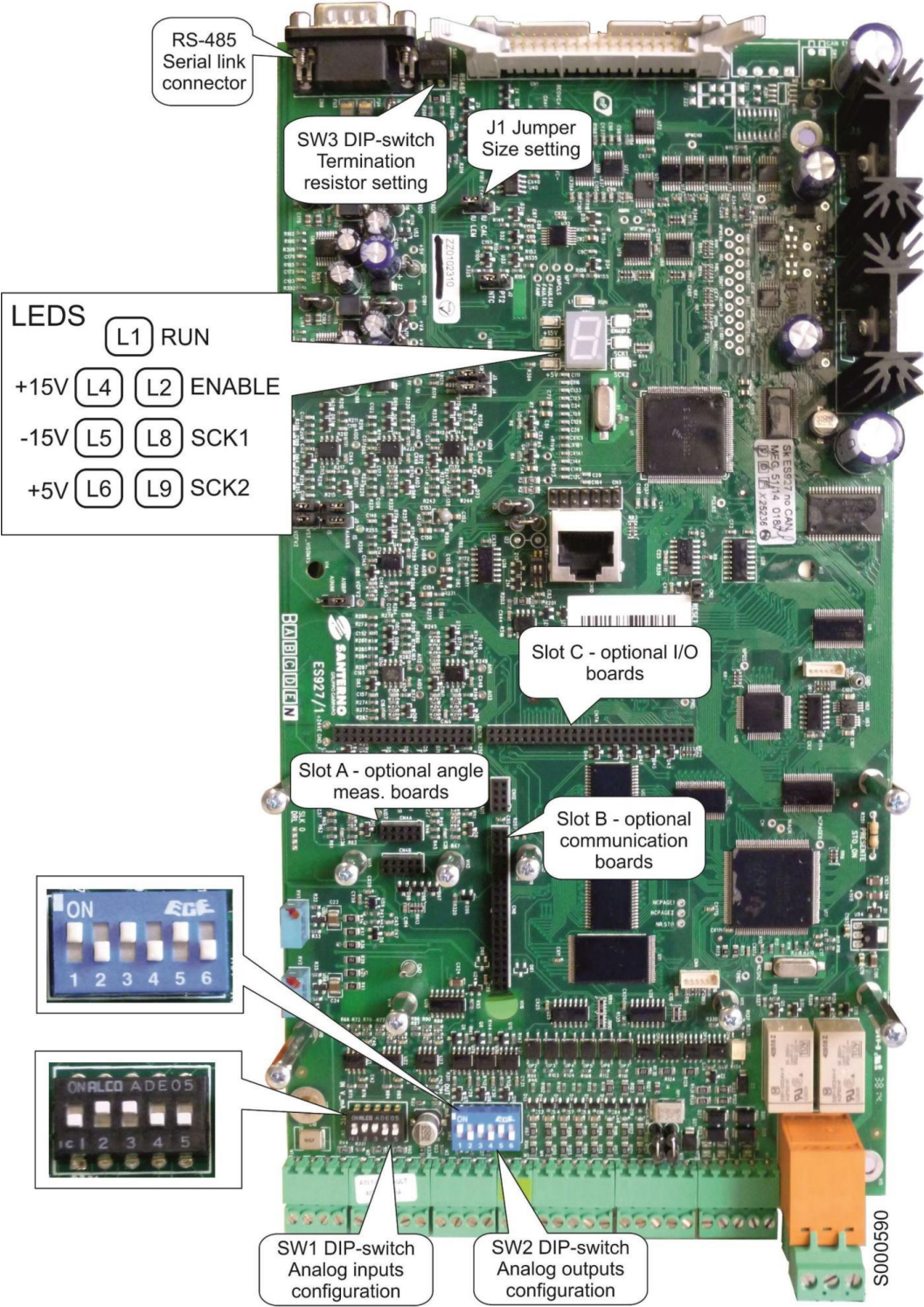


Figure 57: Control board: signals and programming

3.5.3.1. Display and Indicator LEDs

The board display and indicator LEDs allow viewing the inverter operating condition even if no user interface (display/keypad) is provided. The keypad housing allows displaying the indicator lights.

The indicator LEDs are the following:



Figure 58: Control board LEDs

- **Green LED L1 (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 power supply unit or the control board is faulty.
- **Yellow LED L2 (ENABLE):** If on, it indicates that the power converter is switching and is powering the connected load (terminals U, V, W). If off, all switching devices of the power converter are inactive and the connected load is not powered.



DANGER

Electric 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 20 minutes after switching off the inverter before operating on the electrical connection of the motor or the inverter.











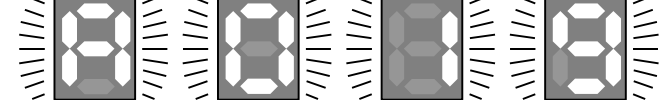
- **Green LED L4 (+15V OK):** It comes on when it detects positive analog power supply (+15V). If it does not turn on when the inverter is normally operating, this means that the power supply unit or the control board is faulty.
- **Green LED L5 (-15V OK):** It comes on when it detects negative power supply (-15V). If it does not turn on when the inverter is normally operating, this means that the power supply unit or the control board is faulty.
- **Green LED L6 (+5V OK):** It comes on when it detects I/O power supply (+5V). It turns off to indicate the following conditions:
 - o Short-circuit over the power supply delivered to connector RS485 output.
 - o Short-circuit over the power supply delivered to the connector output of the remotable keypad.
 - o Parameter quick storage and autoreset procedure due to "VDC undervoltage".
- **Yellow LED L8 (SCK1):** please refer to Safe Torque Off Function - Application Manual
- **Yellow LED L9 (SCK2):** please refer to Safe Torque Off Function - Application Manual








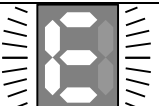
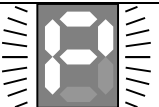
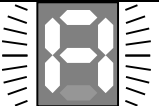
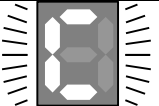
NOTE

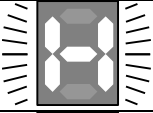
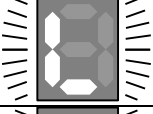
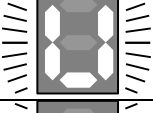

Yellow **LEDs L2, L8 and L9** are used when validating the product and when periodically checking the integrity of the Safe Torque Off Function - Application Manual STO function. The drive must be installed in such a way so as to allow the service technician to display the LED status, also by removing the display module, if required. Please refer to the instructions included in the Safe Torque Off Function - Application Manual for any details.

The messages appearing on the 7-segment display are the following:

Normal operation and alarms	
Symbol or sequence displayed	Inverter condition
	Inverter initialization stage.
	Inverter ready waiting for ENABLE-A and ENABLE-B .
	Inverter ready waiting for the ENABLE-A and ENABLE-B signals; see Sinus Penta's Programming Guide, parameter C181 .
	Inverter ready waiting for the START signal; see Sinus Penta's Programming Guide, Power Down and DC Braking menus.
	Motor not running because the PID value is disabled; see Sinus Penta's Programming Guide, parameters P254 and P255 .
	Motor not running because the PID value is disabled: number "4" fixed; see Sinus Penta's Programming Guide, parameters P065 and P066 .
	IFD enabled but waiting for the START signal.
	IFD enabled and START signal on but waiting for reference: the actual value of the reference is below the minimum value.
	Waiting for precharge; inverter is waiting for VDC voltage inside the capacitor to exceed the minimum operating value.
	Inverter enabled (power devices activated): a segment rotates to form an 8-shaped figure.
	Emergency condition: a 3-digit alarm code cyclically flashes on the display (the example shows alarm A019).

Hardware failure messages	
Symbol or sequence displayed	Inverter condition
	<p>Hardware Failure</p> <p>The self-diagnostics function integrated to the control board detected a hardware/software failure.</p> <p>Please contact ELETTRONICA SANTERNO's Customer Service.</p>
	
	
	
	

Operating firmware update (flash memory) messages	
Symbol or sequence displayed	Inverter condition
	Flash memory deletion: letter 'E' flashing.
	Flash memory programming: letter 'P' flashing.
	An alarm tripped while deleting or programming the software flash memory. Repeat programming: letter 'A' flashing.
	Autoreset: letter 'C' flashing.

Current limit and voltage limit while running	
Symbol or sequence displayed	Inverter condition
	<u>Current limit while accelerating or voltage limit due to overload conditions</u> ; letter 'H' flashing if the output current is limited to the values set in the operating parameters.
	<u>Output voltage limit</u> ; letter 'L' flashing if no voltage is delivered to the motor due to a V_{DC} too weak value.
	<u>Voltage limit when decelerating</u> ; letter U_ flashing if V_{DC} in the equipment exceeds the rated value by 20% during dynamic braking.
	<u>Braking function active</u> ; letter D flashing when the inverter is stopping the motor by applying DC voltage. See Sinus Penta's Programming Guide, DC Braking function.

**NOTE**

The display can be seen only after removing the remotable keypad. Please refer to the relevant section for more details.

3.5.3.2. 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 RS485

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

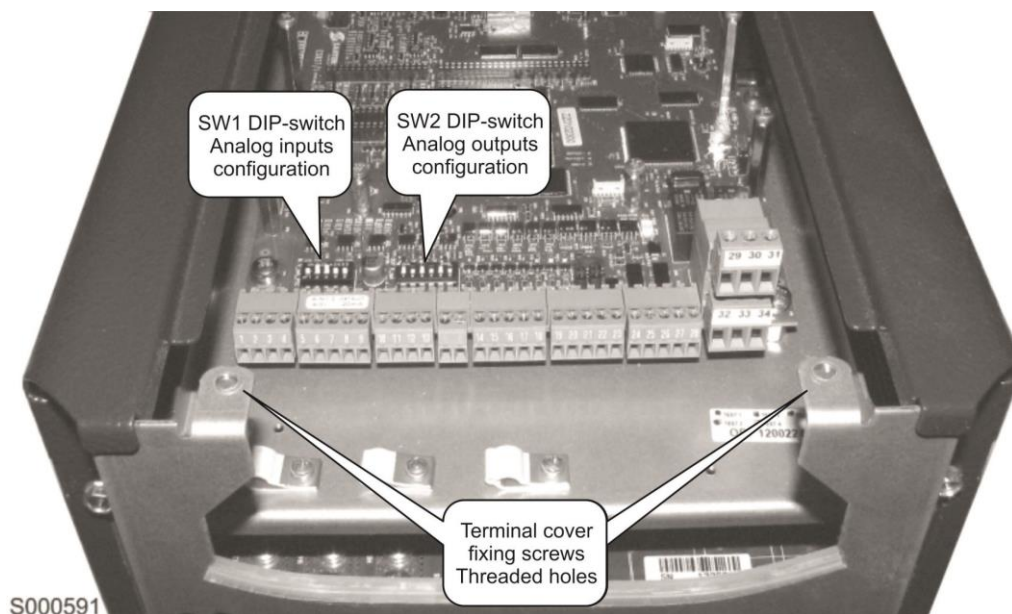


Figure 59: Gaining access to DIP-switches SW1 and SW2

To gain access to DIP-switch SW3, remove the protecting cover for connector RS485.

Sinus Penta S05 to S22: DIP-switch SW3 is located on the control board next to interface connector RS485; remove the inverter upper cover to gain access to DIP-switch SW3.

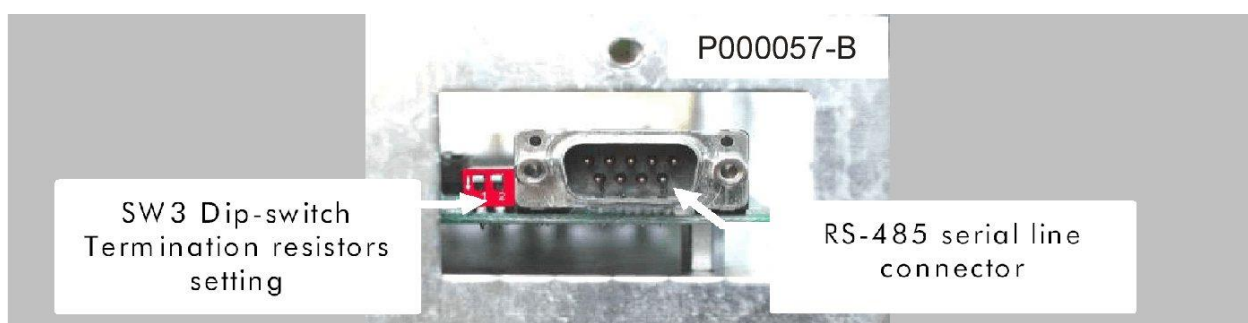


Figure 60: Gaining access to DIP-switch SW3 and connector RS485 (Sinus Penta S05 to S22)

Sinus Penta S30 to S60P: interface connector RS485 and DIP-switch SW3 are located next to the control terminal board cover.

Sinus Penta S65 and S70: to gain access to DIP-switch SW3, remove the cover located on the rear part of the control board.

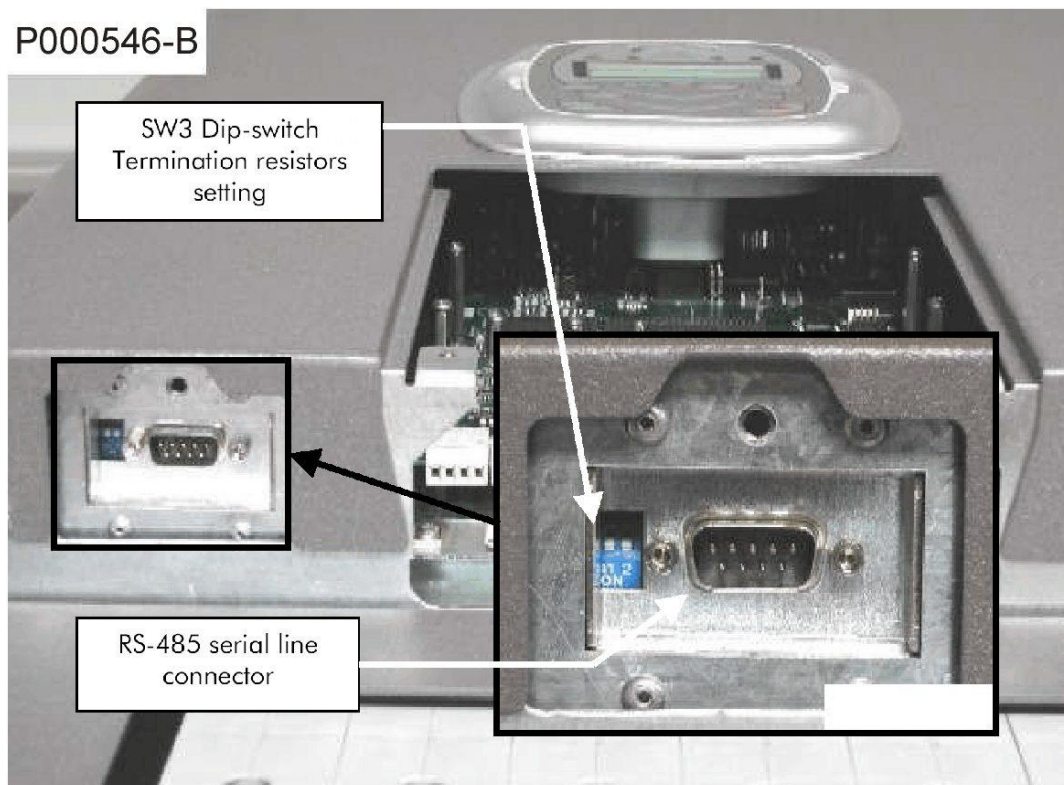


Figure 61: Position of DIP-switch SW3 and connector RS485 (Sinus Penta S30 to S60P)

For IP54 inverters, you can gain access to serial port connector RS485 and to dipswitch SW3 from the inside of the front door covering wires and cables.

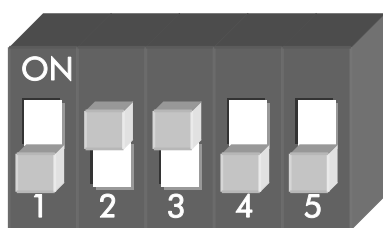
DIP-switch functionality is detailed in the tables below

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

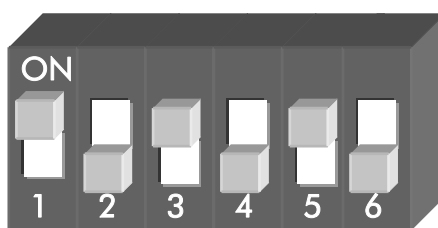
DIP-switch SW2: analog output configuration		
Switches	Functionality	
SW2-1, SW2-2	1=ON, 2=OFF: AO1 voltage output (DEFAULT)	1=OFF, 2=ON: AO1 current output
SW2-3, SW2-4	3=ON, 4=OFF: AO2 voltage output (DEFAULT)	3=OFF, 4=ON: AO2 current output
SW2-5, SW2-6	5=ON, 6=OFF: AO3 voltage output (DEFAULT)	5=OFF,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

DIP-switch SW3: interface RS485 terminator		
Switches	Functionality	
SW3-1, SW3-2	Both OFF: RS485 terminator disabled (DEFAULT)	Both ON: RS485 terminator enabled

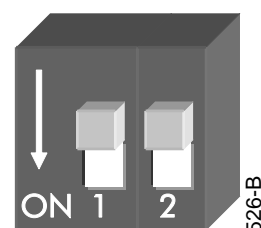
DIP-switch factory setting is as follows:



SW1 - All OFF except 2 and 3



SW2 – Odd numbers ON



SW3 - OFF

P000526-B

Factory setting provides the following operating modes:

- REF Analog input (voltage input) and two current analog inputs (AIN1, AIN2)
- Voltage analog outputs
- Terminator RS485 off

3.5.3.3. Configuration Jumpers

The inverter control board is provided with two configuration jumpers called J1 and J2 for the setup of the inverter size. These jumpers are factory-set based on the inverter size required and must not be tampered with.

When a spare control board is installed, jumper J1 only is to be set up accordingly. In that case, the spare control board is supplied in "Spare" mode.

Jumper	Position
J1	1-2 = IU CAL 2-3 = IU LEM - See Spare Control Board User Manual
J2	Leave position unchanged

3.5.4. Digital Inputs (Terminals 14..21 and Terminal S)

All digital inputs are galvanically isolated in 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 resettable fuse.

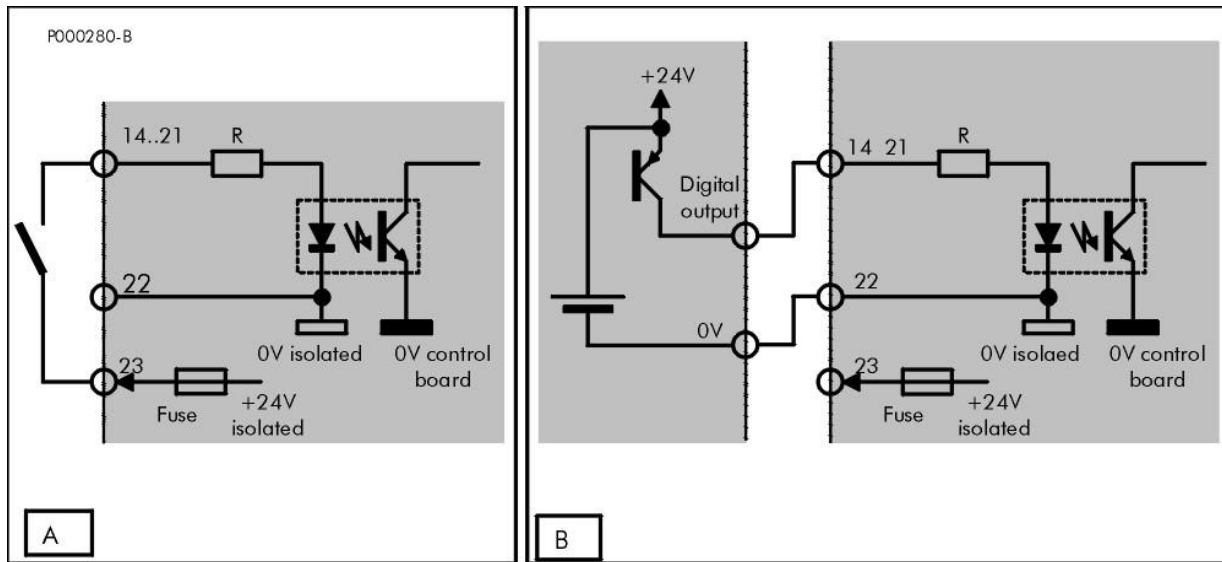


Figure 62: PNP command (active to +24V)

A) through a voltage-free contact

B) outcoming from a different device (PLC, digital output board, etc.)



NOTE

Terminal 22 (digital input zero volt) is galvanically isolated from terminals 1, 9, 13 (control board zero volt) and from terminals 26 and 28 (common terminals of the digital outputs).

The digital input condition is displayed on the inverter display/keypad in the Measures menu as measure **M033**. Logic levels are displayed as □ for the inactive input and as ■ for the active input.

The inverter firmware acknowledges all inputs as multifunction inputs. Dedicated functions assigned to terminals START (14), ENABLE-A (15), ENABLE-B (S), RESET (16), MDI6 / ECHA / FINA(19), MDI7 / ECHB (20), and MDI8 / FIN B(21) are also available.

3.5.4.1. 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 in respect to the preset deceleration ramp.

3.5.4.2. ENABLE-A (Terminal 15) and ENABLE-B (Terminal S)

The ENABLE-A and ENABLE-B inputs are always to be activated to enable the inverter operation regardless of the control mode.

If the ENABLE inputs are 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 switching signal to the three-phase converter. Certain applications allow getting rid of the contactor installed between the inverter and the motor. Always consider any specific standard for the inverter application and observe the safety regulations in force.

Please refer to the Safe Torque Off Function - Application Manual.

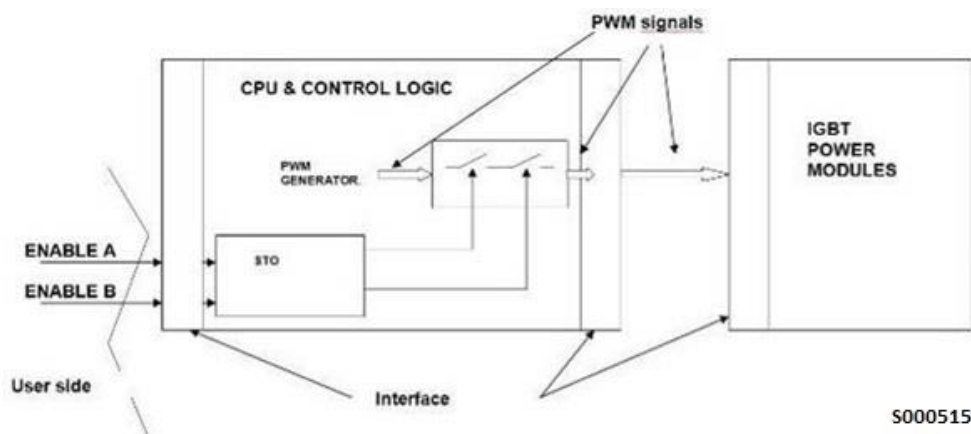


Figure 63: Power section PWM enable circuit

3.5.4.3. RESET (Terminal 16)

If an alarm trips:

- the inverter stops
- the motor is no longer powered and performs a coast to stop
- 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, once the inverter is unlocked, it is not necessary to activate and deactivate the ENABLE-A and ENABLE-B commands 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 Sinus Penta's Programming Guide and reset the equipment after detecting the cause responsible for the alarm.



DANGER

Electric 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-A and ENABLE-B inputs are inactive. In case a mechanical load with persistent resisting torque (e.g. lifting applications) is used, a motor coast to stop may cause the load to drop. In that case, always provide a mechanical locking device (brake) for the connected load.

3.5.4.4. Connecting the Encoder and Frequency Input (Terminals 19 to 21)

Functionality of the programmable digital inputs is given in the Programming Guide.

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

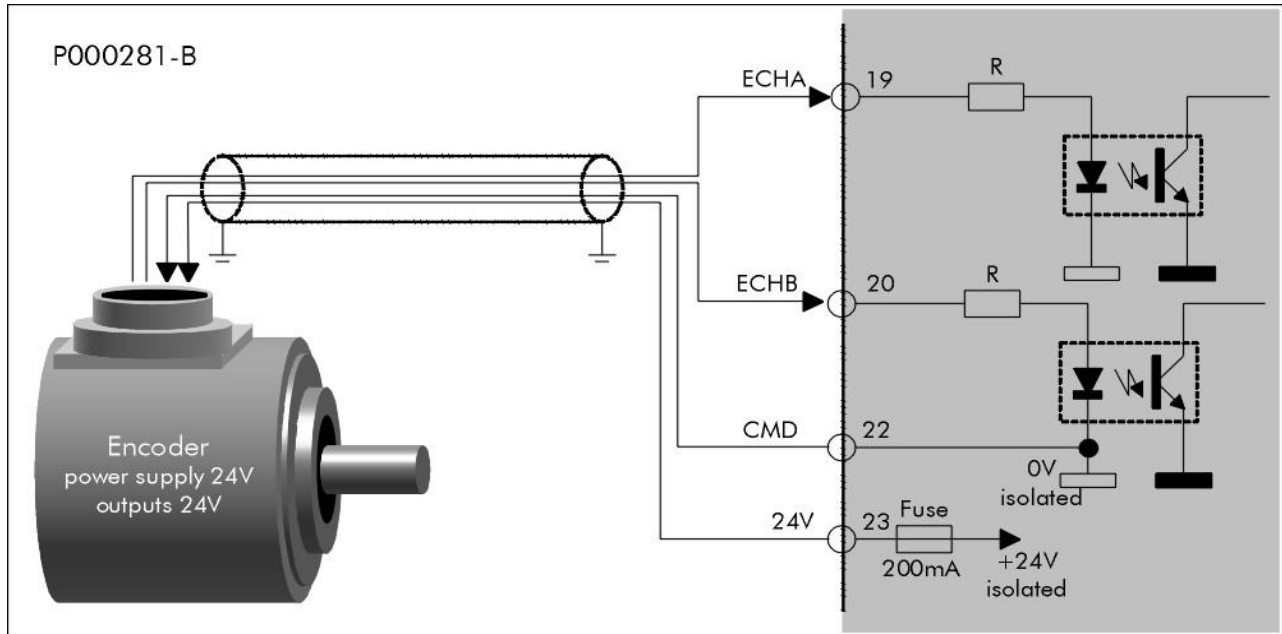


Figure 64: Connecting an incremental encoder

An incremental encoder must have PUSH-PULL outputs and must be powered at 24 V directly to the inverter isolated power supply delivered to terminals +24V (23) and CMD (22). Max. allowable feeding current is 200 mA and is protected by a resettable fuse.

Only encoders of that type may be connected to Sinus Penta's terminal board. Max. signal frequency is 155 kHz for 1024 pls/rev at 9000 rpm. To acquire different encoder types or to acquire an encoder without engaging any multifunction input, fit option board for encoder acquisition in SLOT A.

The encoder acquired via terminal board is indicated as ENCODER A by the inverter firmware, whereas the encoder acquired via option board is indicated as ENCODER B by the inverter firmware. Therefore, two encoders may be connected to the same inverter. (See the Encoder/Frequency Inputs menu in the Sinus Penta's Programming Guide.)

MDI6/ECHA/FINA and MDI8/FINB inputs allow acquiring a square-wave frequency signal from 10 kHz to 100 kHz. 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).



NOTE

MDI6/ECHA/FINA and MDI7/ECHB inputs are no longer active when ES847 or ES870 boards are fitted: their two terminals are automatically replaced with the corresponding XMDI6 and XMDI7 terminals. See the Motor Drives Accessories - User Manual.

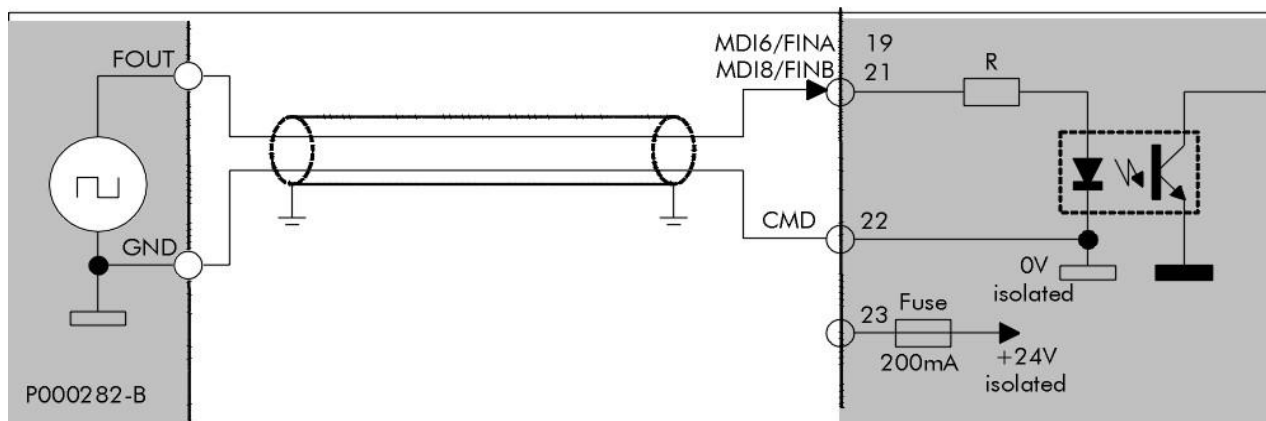


Figure 65: Signal sent from a push-pull, +24V output

3.5.4.5. Technical Sheet for Digital Inputs

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



CAUTION

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



NOTE

Isolated supply output is protected by a resettable fuse capable of preventing the inverter internal power supply unit from damaging due to a short-circuit. Nevertheless, if a short-circuit occurs, the inverter could lock and stop the motor.

3.5.5. Analog Inputs (Terminals 1 to 9)

The inverters of the Sinus Penta series are provided with three analog inputs, one single-ended input and two differential inputs. Analog inputs may be configured either as voltage inputs or as current inputs. AIN2 input may be used to acquire a PTC thermistor in compliance with DIN44081/DIN44082 for the motor thermal protection. In that case, up to 6 PTCs can be series-connected; functionality of the overtemperature alarm is not altered. Two reference outputs with rated values +10 V and -10 V are also available for the direct connection of a reference potentiometer.

Configuration as voltage input, current input or motor PTC input is done via the DIP-switches (see the DIP-switches section).

Five firmware acquisition modes are available (see Sinus Penta's Programming Guide) for three hardware settings as shown in the table:

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


NOTE

Firmware 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 Guide.

3.5.5.1. REF Single-ended Reference Input (Terminal 2)

Reference input REF (2) is assigned to the inverter speed reference (factory setting) and is a single-ended input related to terminal CMA (1).

The figure below shows wiring to a unipolar potentiometer, a bipolar potentiometer and a sensor with 4÷20mA current output. The REF input is factory-set as a $\pm 10V$ voltage input.

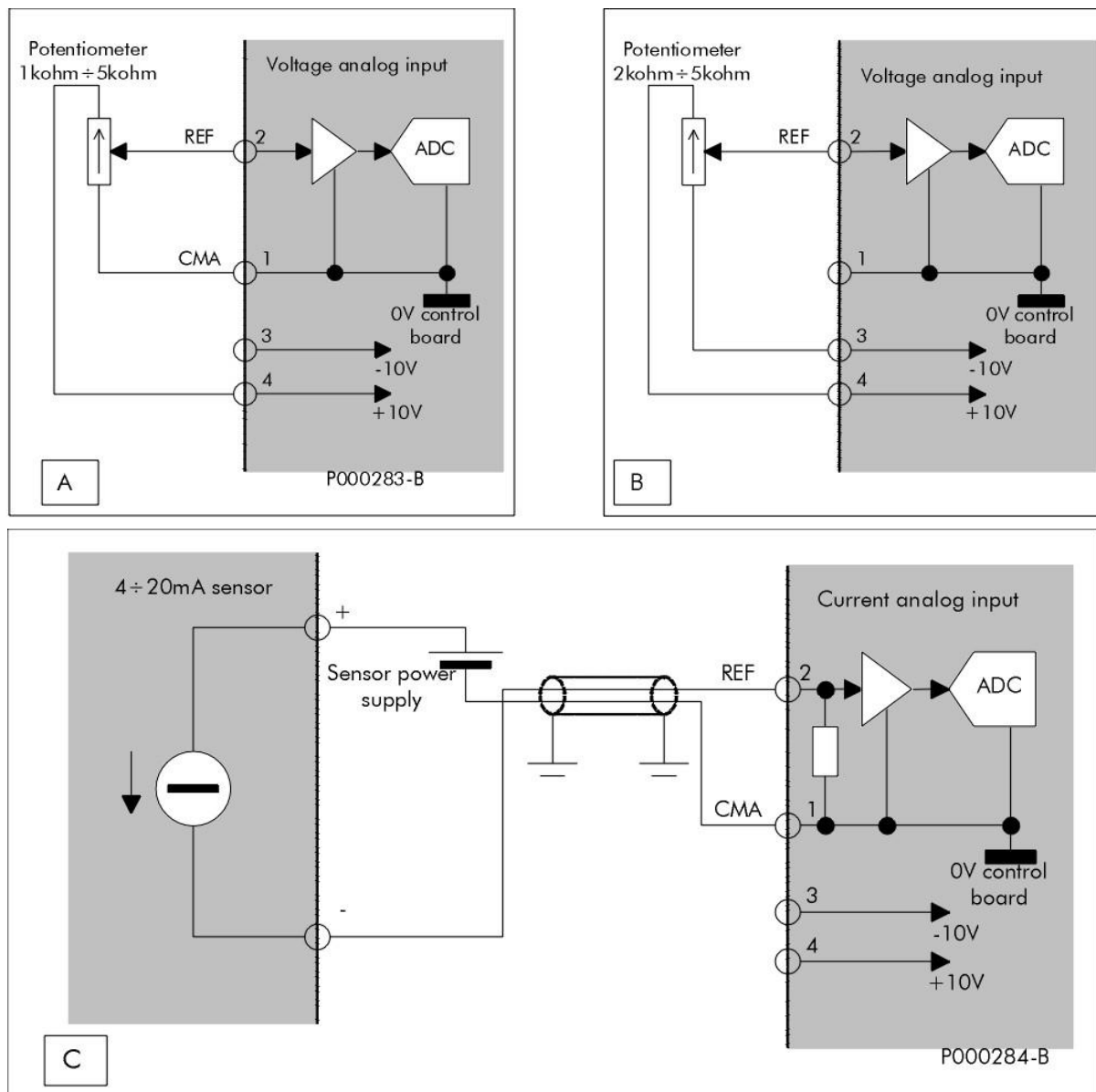


Figure 66: Potentiometer linked to the REF Input

A) For unipolar command $0 \div \text{REFMAX}$

B) Potentiometer wiring for bipolar command $-\text{REFmax} \div +\text{REFmax}$

C) 4÷20mA Sensor wiring



NOTE

Galvanic isolation exists between the common terminal of the digital inputs (CMD – terminal 22) and the common terminal of CMA analog inputs. Do not apply +24V voltage available on terminal 23 of the control board to supply 4÷20mA analog sensors if this isolation must be maintained for noise rejection or signal integrity.

3.5.5.2. Differential Auxiliary Inputs (Terminals 5–8)

Auxiliary inputs allow auxiliary voltage and current values for signals exceeding ground signals up to a preset maximum voltage value in common mode.

A differential input weakens disturbance due to “ground potentials” occurring when the signal is sent from a source that is located far from the inverter. Disturbance is weakened only if wiring is correct.

Each input is provided with a positive terminal and a negative terminal of the differential amplifier. Both terminals must be connected to the signal source and the signal grounding respectively. Make sure that the common mode voltage between the signal source grounding and the grounding of auxiliary inputs CMA (terminal 9) does not exceed the max. allowable voltage value in common mode.

When an input is used as a current input, the differential amplifier detects the voltage value in the terminals of a drop resistance (low ohm value). The max. voltage for the negative terminal of the differential input must not exceed the voltage value in common mode (see Technical Sheet for Analog Inputs). AIN1 and AIN2 inputs are factory-set as 4(0)...20mA current inputs.

Do the following to obtain noise rejection benefits:

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

The typical wiring is shown below:

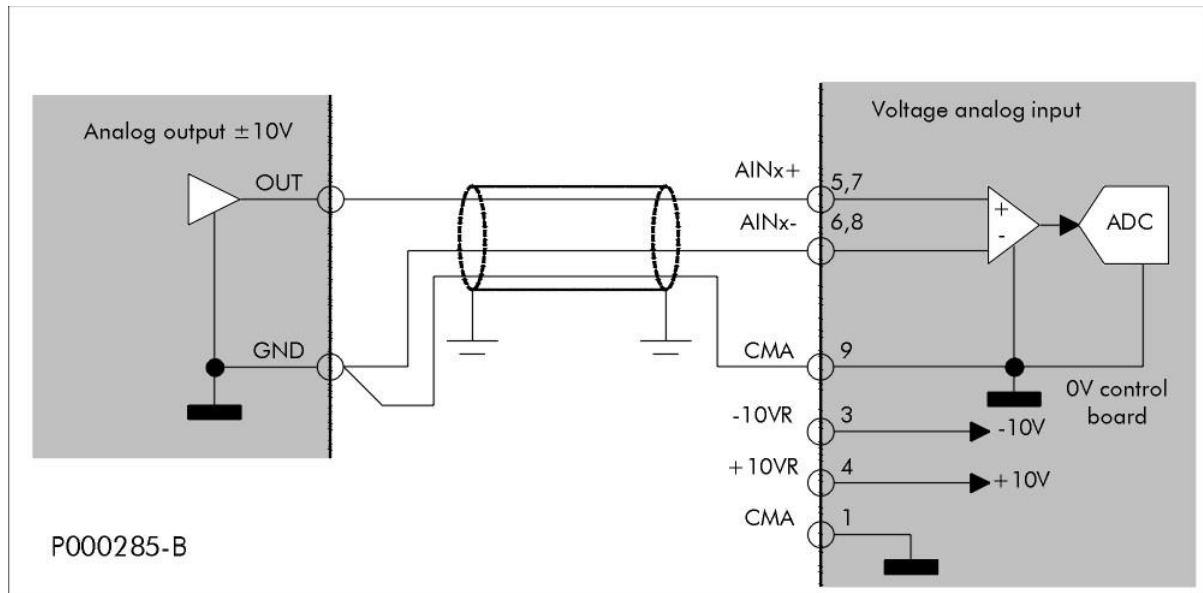


Figure 67: Wiring of a PLC analog output, axis control board, etc.



NOTE

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

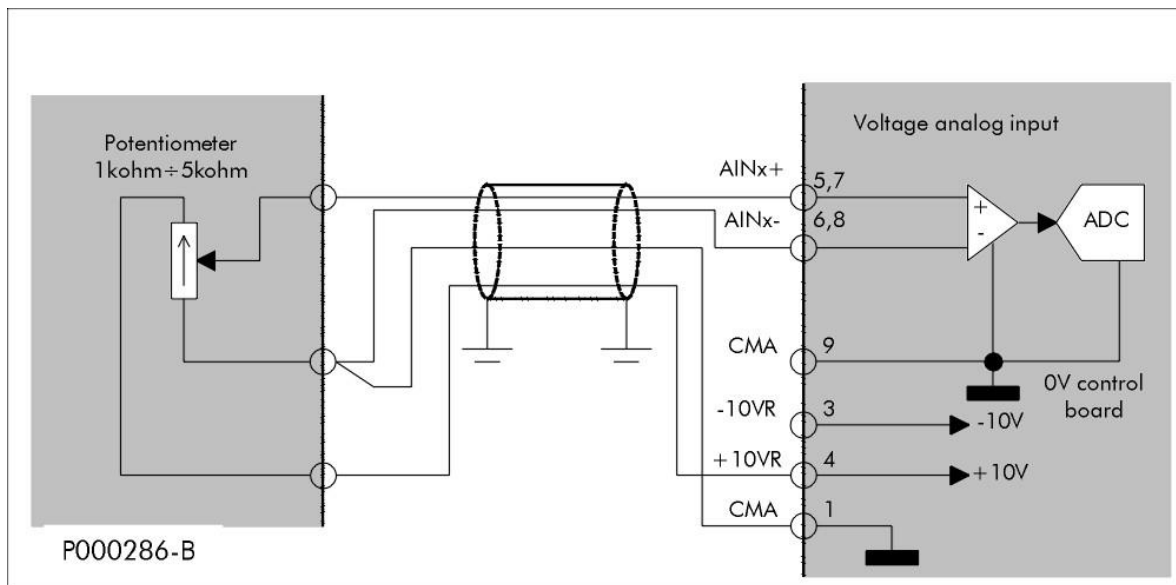


Figure 68: Wiring of unipolar remote potentiometer 0 ÷ REF max

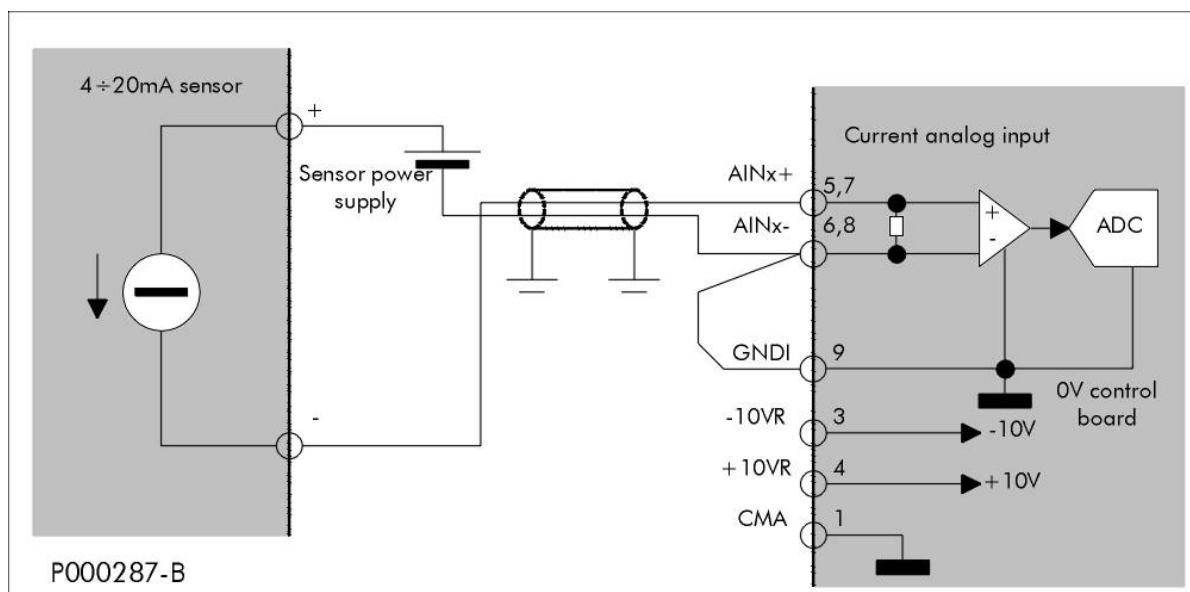


Figure 69: 4 ÷ 20 mA Sensor wiring

3.5.5.3. Motor Thermal Protection Input (PTC, Terminals 7-8)

The inverter manages the signal sent from one or more thermistors (up to 6 thermistors) incorporated in the motor windings to obtain a hardware thermal protection of the motor. The thermistor ratings must comply with IEC 34-11-2 (BS4999 Pt.111 - DIN44081/DIN44082) or to thermistors named "Mark A" in standard IEC 60947-8:

Resistor corresponding to Tnf temperature value: 1000 Ω (typical rating)

Resistor at Tnf -5°C : < 550 Ω

Resistor at Tnf $+5^{\circ}\text{C}$: > 1330 Ω

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

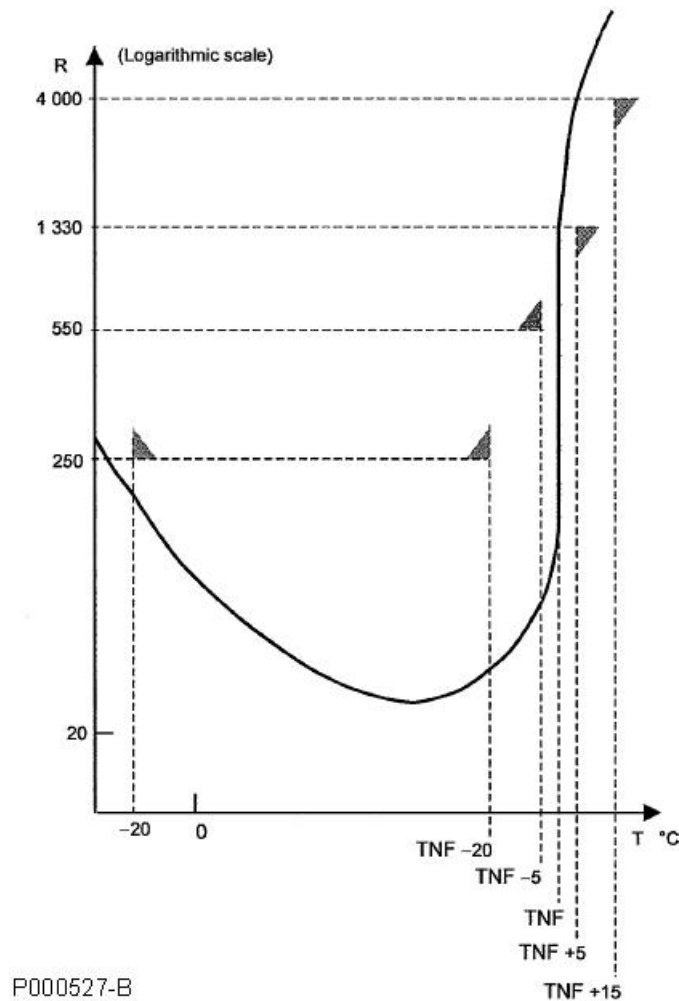


Figure 70: Standard pattern of the thermistor resistor for the motor thermal protection

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

The ultimate result of this signal is to switch the output Solid State Motor controller power OFF.

**NOTE**

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

Do the following to use the thermistor:

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

**CAUTION**

PTCs are located inside the motor winding coils. Make sure that their isolating features comply with the requirements for double insulation or reinforced insulation (SELV circuit).

**CAUTION**

For UL applications, the SINUS PENTA is intended to be used with motors that must have integral thermal protection, performed by R/C Thermistor type Devices - Component UL Category Code (XGPU2/XGPU8), PTC.

3.5.5.4. Technical Sheet for Analog Inputs

Specification	Min.	Type	Max.	Unit of m.
Input impedance in voltage configuration (REF input)	10k			Ω
Input impedance in voltage configuration (differential inputs AIN1, AIN2)		80k		Ω
Input impedance in current configuration		250		Ω
Offset cumulative error and gain in 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		μ A
Max. voltage of differential input common mode	-7		+7	V
Rejection ratio for differential input common mode at 50Hz	50			dB
Persistent overload with no damaging in voltage mode	-50		50	V
Persistent overload with no damaging in current mode	-23		23	mA
Input filter cut frequency (first prevailing order) over REF		230		Hz
Input filter cut frequency (first prevailing order) over AIN1, AIN2		500		Hz
Sampling time ⁽¹⁾	0.6		1.2	ms
Max. current of resistance measure in PTC acquisition mode			2.2	mA
Resistive trip threshold for PTC protection	3300	3600	3930	Ω
Resistive trip threshold for PTC protection deactivation	1390	1500	1620	Ω
Resistive trip threshold for PTC short-circuit		20		Ω
Tolerance of reference output voltage +10 VR, -10 VR			0.8	%
Current absorbed by reference outputs			10	mA

Note: (1) depending on the switching frequency set for the connected motor

**CAUTION**

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

**NOTE**

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

3.5.6. Digital Outputs (Terminals 24 to 34)

The Sinus Penta is provided with four digital outputs: one push-pull output, one open-collector output and two relay outputs. All outputs are opto-isolated; the push-pull output and the 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 connecting it to different devices without creating any ground loop.

3.5.6.1. Push-Pull Output MDO1 and Wiring Diagrams (Terminals 24 to 26)

Push-Pull MDO1 output (terminal 25) may also be used as a frequency output thanks to its powerful passband. Below you will find the wiring diagrams relating to the control of PNP/NPN loads and the cascade-connection of multiple inverters through frequency output and input.

The drive is provided with a +24V isolated internal power supply current limiting circuitry.

Because supply line and common terminal of output MDO1 are isolated, you can use both 24V supply and auxiliary supply (24V or 48V).

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 shielded cable to perform a star connection (a wire for each slave inverter will come from the output frequency).

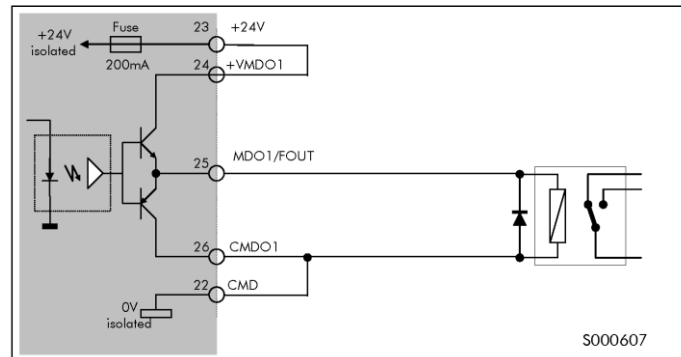


Figure 71: MDO1 output wiring as PNP for relay control with internal power supply

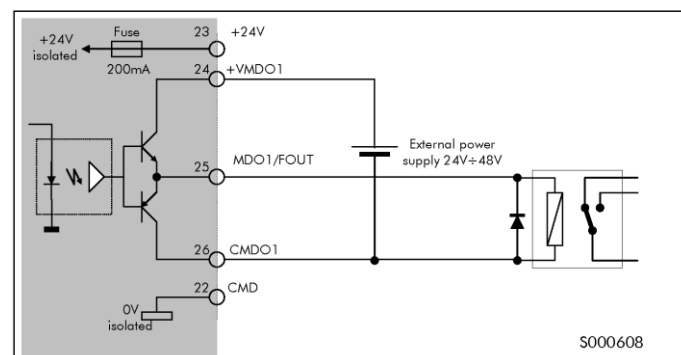


Figure 72: MDO1 output wiring as PNP for relay control with external power supply

**CAUTION**

Always use a freewheeling diode for inductive loads (e.g. relay coils). Diode wiring is shown in the figure.

**NOTE**

Connect *either* isolated inverter supply *or* auxiliary supply to power the output.

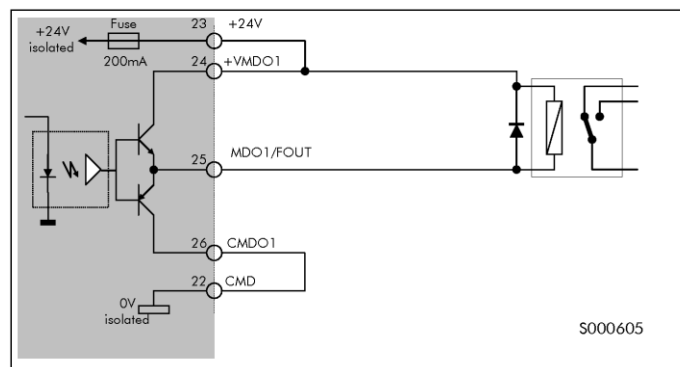


Figure 73: MDO1 output wiring as NPN for relay control with internal power supply

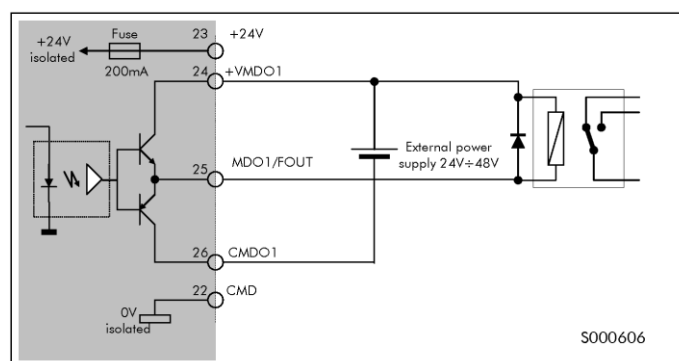


Figure 74: MDO1 output wiring as NPN for relay control with external power supply

**CAUTION**

Always use a freewheeling diode for inductive loads (e.g. relay coils). Diode wiring is shown in the figure.

**NOTE**

Connect *either* isolated inverter supply *or* auxiliary supply to power the output.

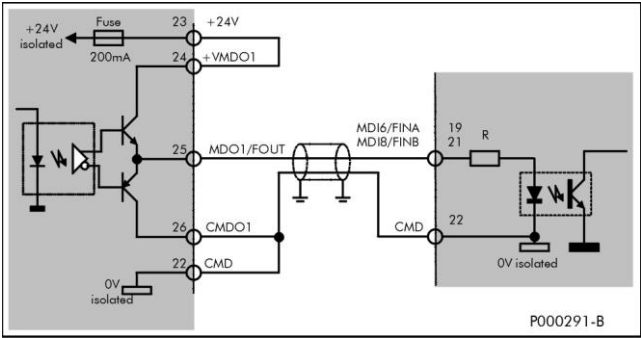


Figure 75: Cascade connection: FOUT frequency output → FINA or FINB frequency input

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

Multifunction output MDO2 (terminal 27) is provided with common terminal CMDO2 (terminal 28), which is galvanically isolated from the other outputs. Output MDO2 may be used for PNP and NPN connected loads (see wiring diagrams below).

Similarly to a closed contact, electrical conductivity 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.

The drive is provided with a +24V isolated internal power supply current limiting circuitry.

Power supply may result from the inverter isolated supply or from an auxiliary source (24V or 48V).

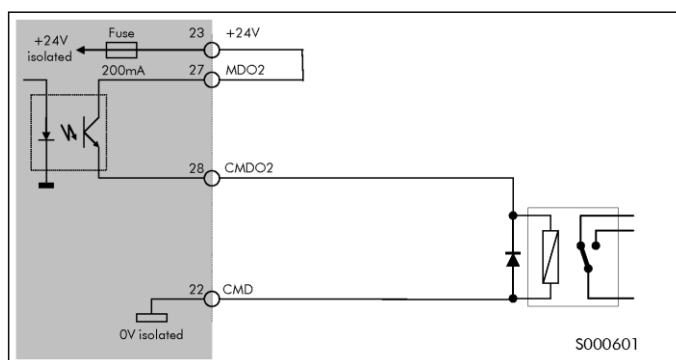


Figure 76: MDO2 output wiring as PNP for relay control with internal power supply

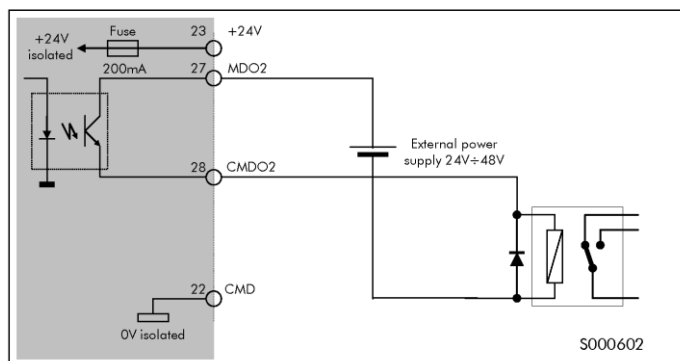


Figure 77: MDO2 output wiring as PNP for relay control with external power supply



CAUTION

Always use a freewheeling diode for inductive loads (e.g. relay coils). Diode wiring is shown in the figure.



NOTE

Connect *either* isolated inverter supply *or* auxiliary supply to feed the output.

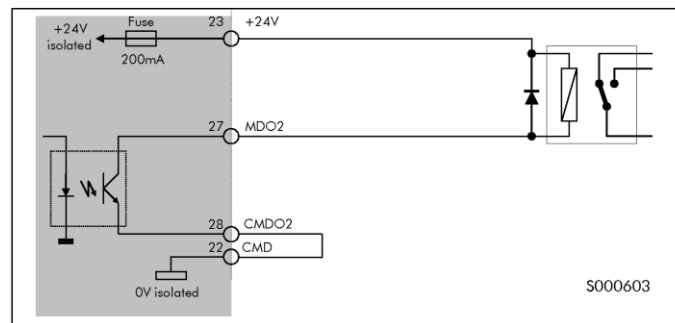


Figure 78: MDO2 output wiring as NPN for relay control with internal power supply

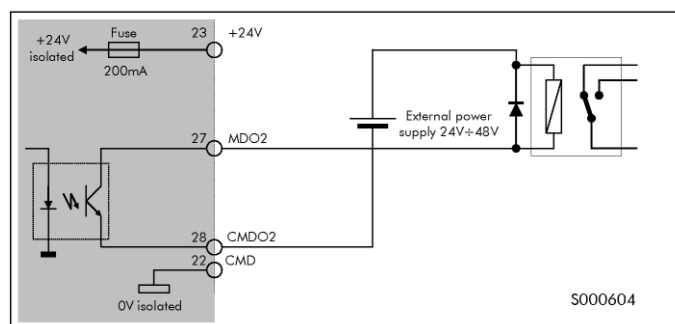


Figure 79: MDO2 output wiring as NPN for relay control with external power supply



CAUTION

Always use a freewheeling diode for inductive loads (e.g. relay coils). Diode wiring is shown in the figure.



NOTE

Connect *either* isolated inverter supply *or* auxiliary supply to feed the output.

3.5.6.3. Relay Outputs (Terminals 29..34)

Two relay outputs are available with potential-free change-over 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 electric 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 voltage 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 Sinus Penta's Programming Guide). In that case, particularly if enabling delay time is set to zero, relays will cyclically energize/de-energize and this will strongly affect their durability. We suggest that output MDO1 or MDO2 be used, which is not affected by repeated energizing/de-energizing.

3.5.6.4. Technical Sheet for Digital Outputs

Specification	Min.	Type	Max.	Unit of m.
Voltage range for MDO1 and MDO2 outputs	20	24	50	V
Max. current to be switched 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	5A, 250Vac 5A, 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 resettable 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 resettable fuse capable of preventing the inverter internal power supply unit from damaging due to a short-circuit. Nevertheless, if a short-circuit occurs, the inverter could lock and stop the motor.

3.5.7. Analog Outputs (Terminals 10 to 13)

Three analog outputs are available: AO1 (terminal 10), AO2 (terminal 11) and AO3 (terminal 12), related 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 Sinus Penta's Programming Guide).

The operating mode, gain, offset and filtering time constant (if any) may be defined by the user. The inverter firmware allows four operating modes that must match with the setup of the configuration DIP-switches (see Sinus Penta's Programming Guide).

Type of acquisition set for the inverter parameters	Hardware configuration for SW2	Full-scale value and notes
$\pm 10\text{ V}$	Voltage output	$-10\text{ V} \div +10\text{ V}$
$0 \div 10\text{ V}$	Voltage output	$0 \div 10\text{ V}$
$0 \div 20\text{ mA}$	Current output	$0\text{ mA} \div 20\text{ mA}$
$4 \div 20\text{ mA}$	Current output	$4\text{ mA} \div 20\text{ mA}$



CAUTION

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

3.5.7.1. Technical Sheet for Analog Outputs

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



NOTE

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

3.6. Operating and Remoting the Keypad

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



NOTE

UL Listed keypad to be used with A.C. Motor Drive SINUS PENTA Series.

3.6.1. Indicator LEDs on the Display/Keypad

Eleven LEDs are located on the keypad, along with a 4-line, 16-character LCD display, a buzzer and 12 function keys. The display shows parameter values, diagnostic messages and the quantities processed by the inverter.

For any detail concerning menus and submenus, parameter programming, measurement selection and messages displayed, please refer to the Sinus Penta's Programming Guide.

The figure below shows the location of the indicator LEDs and their functionality.

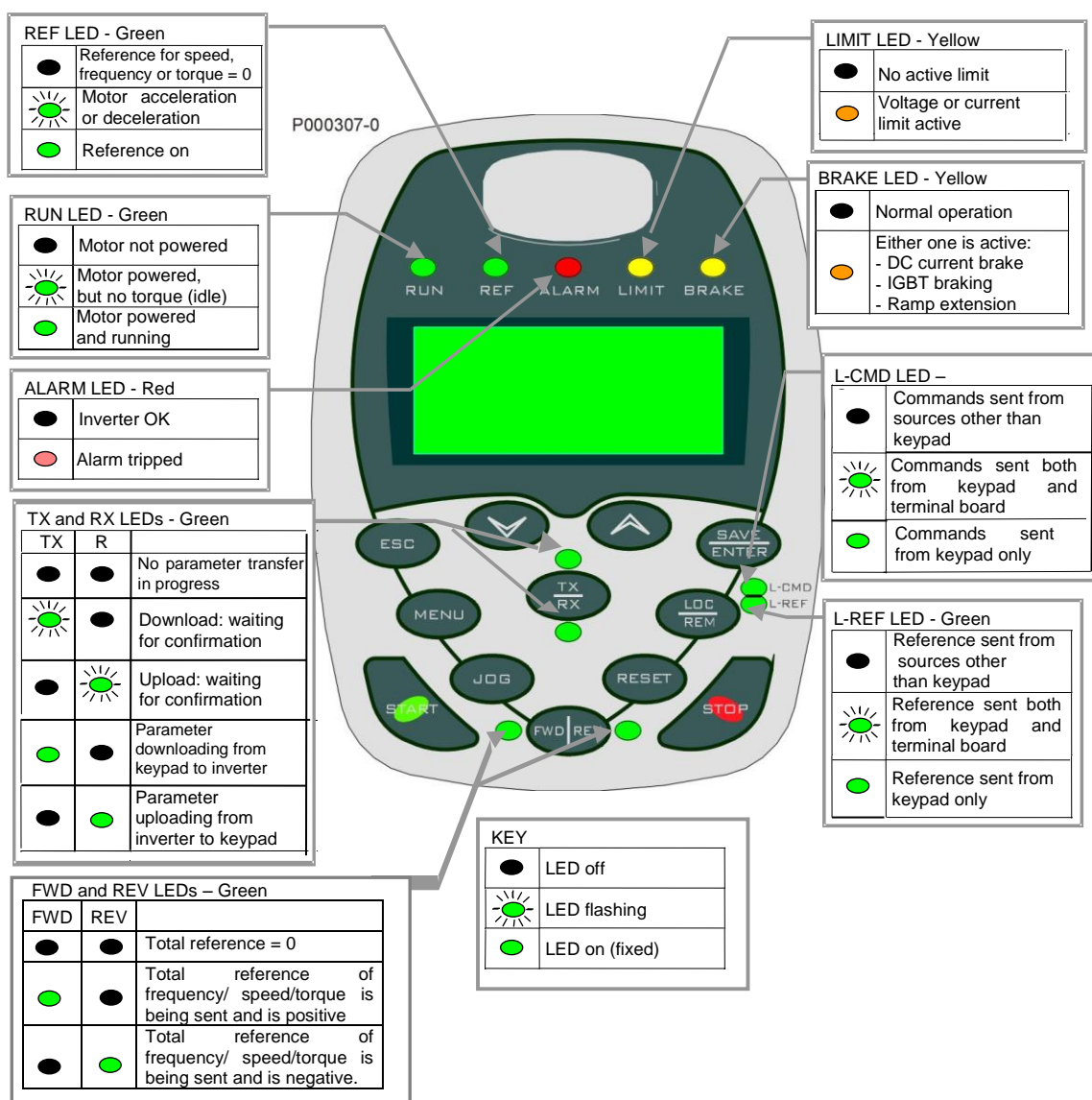















Figure 80: Display/keypad

3.6.2. Function Keys

The table below details the display/keypad function keys:

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



NOTE

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

3.6.3. Setting the Operating Mode

The display/keypad allows selecting two different configuration modes. To do so, press the SAVE | ENTER key for a few seconds, or press TX | RX + SAVE | ENTER for a few seconds.

If the SAVE key is pressed, only the LCD contrast may be adjusted; press TX | RX + SAVE to adjust the display contrast, enable or disable the buzzer and turn on/off the display backlight.

3.6.3.1. Adjusting the Display Contrast

Press the SAVE | ENTER 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 | ENTER for at least 2 seconds to store the new contrast setting.

3.6.3.2. Adjusting the Display Contrast, Back-light and Buzzer

Press TX | RX + SAVE | ENTER for more than 5 seconds. Press ▼ or ▲ to scroll through seven parameters relating to the display/keypad. Press ▼ or ▲ to decrement or increment the parameter value. Press SAVE | ENTER 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 Version	-	VERSION OF THE FIRMWARE IMPLEMENTED IN THE DISPLAY/KEYPAD (CANNOT BE MODIFIED)
Language		Inactive parameter (please refer to the Programming Guide to set a new dialog language)
Baudrate	4800 9600 19200 38400	Baudrate in bps between the Penta and the display/keypad
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 (Inactive function)
	OFF	Buzzer always off
Back-light	ON	LCD back-light always on
	REM	LCD back-light controlled by the inverter (Inactive function)
	OFF	LCD back-light always off
Address	0	Imposes scanning the addresses of multidrop inverters connected to the display/keypad
	1÷247	MODBUS address of the inverter: allows selecting an inverter among multidrop inverters connected to one display/keypad

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

3.6.4. Remoting the Display/Keypad

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

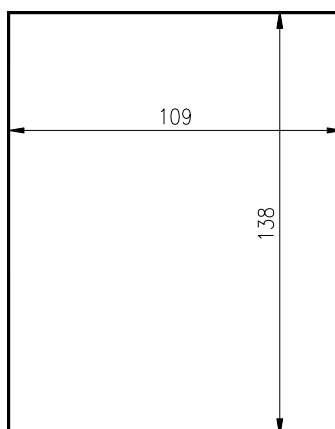
- Plastic shell
- Keypad mounting plate
- Fastening brackets
- Remoting wire (length: 5 m)

**NOTE**

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

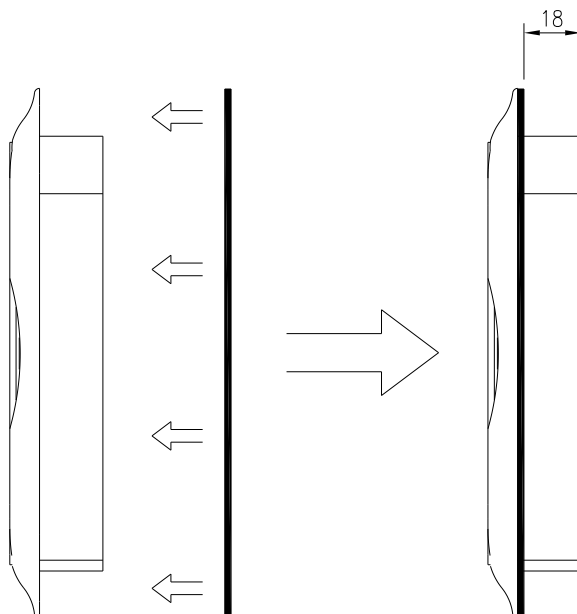
Do the following:

1 – Pierce the holes as shown in the figure (template 138 x109 mm).



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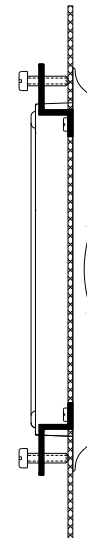
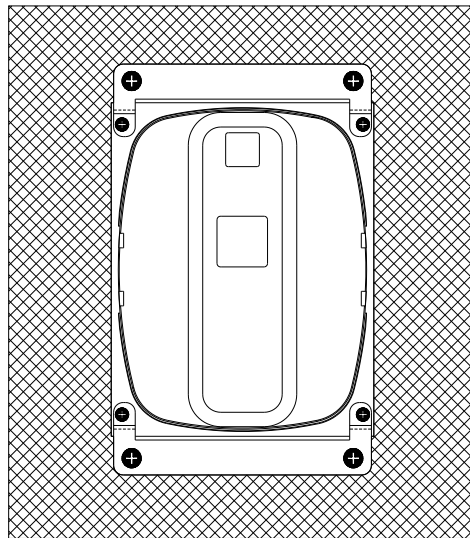
2 – Apply the self-adhesive mounting plate on the rear part of the plastic shell between the shell and the cabinet; make sure that holes coincide.



P000565-0

3 – Fit the plastic shell in the relevant slot.

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



P000563-0

5 – Remove the display/keypad from the inverter (Figure 81). A short wire with 8-pole telephone connectors is used to connect the display/keypad to the inverter. Press the cable tab to disconnect it.

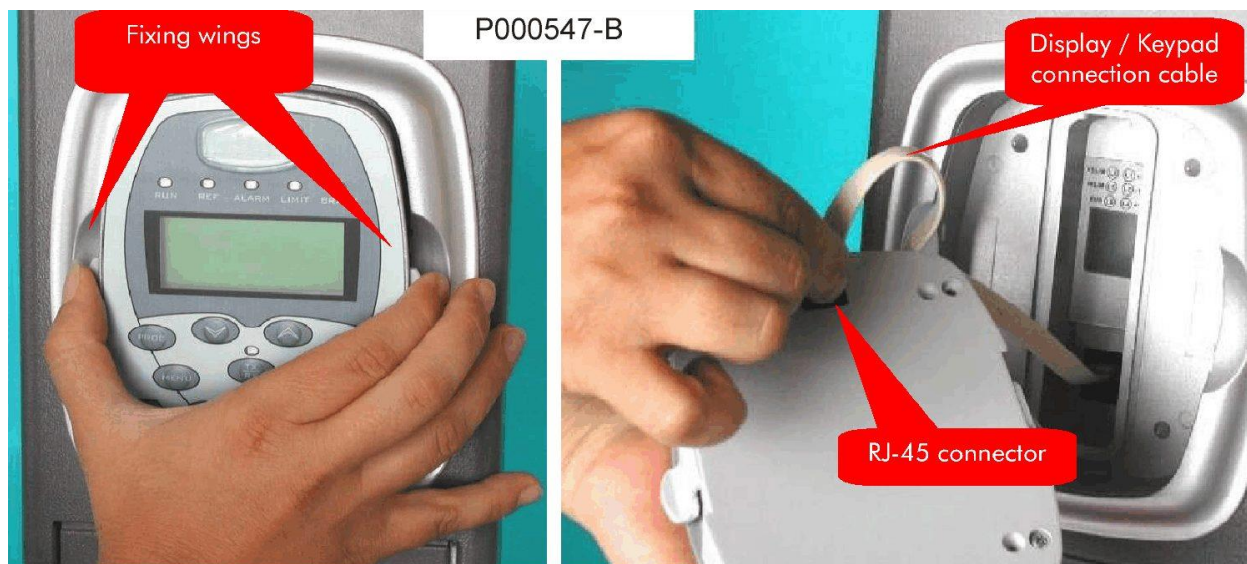


Figure 81: Removing the display/keypad module

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

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

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



Figure 82: Front/rear view of the display/keypad and its shell.



CAUTION

Never connect and disconnect the keypad when the inverter is on. Temporary overload may lock the inverter due to alarm trip.



CAUTION

Only use wires supplied by Elettronica Santerno for the keypad wiring. Wires with a different contactor arrangement will cause irreparable damages to the inverter and the display/keypad. A remoting wire with different specifications may cause disturbance and affect communications between the inverter and the display/keypad.



CAUTION

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

3.6.5. Using the Display/Keypad for Parameter Transfer

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

**CAUTION**

Never connect and disconnect the keypad when the inverter is on. Temporary overload may lock the inverter due to alarm trip.

**CAUTION**

Only use wires supplied by Elettronica Santerno for the keypad wiring. Wires with a different contactor arrangement will cause irreparable damages to the inverter and the display/keypad. A remoting wire with different specifications may cause disturbance and affect communications between the inverter and the display/keypad.

3.7. Serial Communications

3.7.1. General Features

The inverters of the Sinus Penta series may be connected to peripheral devices through a serial link; this enables both reading and writing of all parameters normally accessed through the display/keypad. Two-wire RS485 is used, which ensures a better immunity to disturbance even on long cable paths, thus limiting communication errors.

The inverter will typically behave as a slave device (i.e. it only answers to queries sent by another device); a master device (typically a computer) is then needed to start serial communication. The inverter may be connected directly to a computer or a multidrop network of inverters controlled by a master computer (see Figure 83 below).

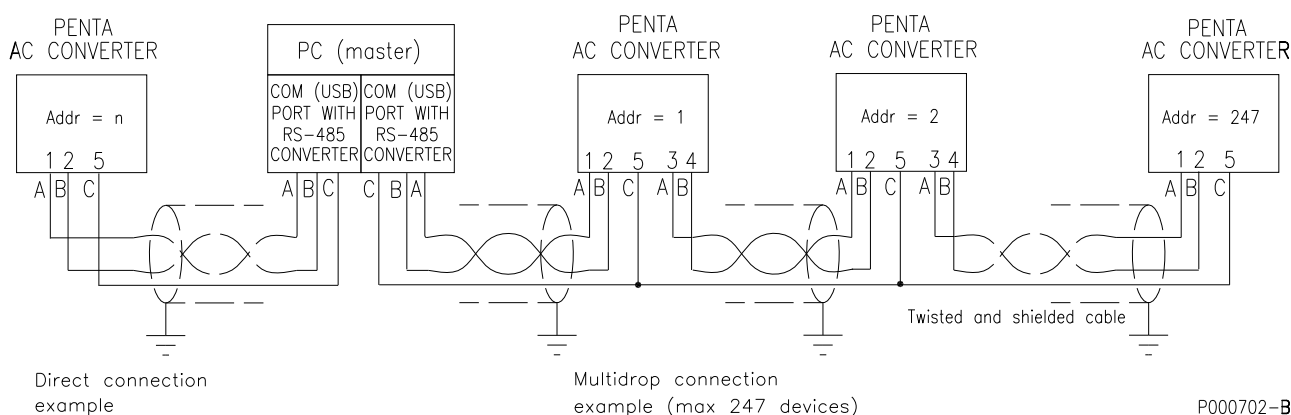


Figure 83: Example of multidrop and direct connection

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



Any information sent to/from the inverter through the display/keypad unit may be obtained also via serial link using the RemoteDrive software offered by Elettronica Santerno. The RemoteDrive allows the following functions: image acquisition, keypad simulation, oscilloscope functions and multifunction tester, table compiler including operation data log, parameter setup and data reception-transmission-storage from and to a computer, scan function for the automatic detection of the connected inverters (up to 247 inverters may be connected). Please refer to 15J0901B100 Remote Drive DRIVE REMOTE CONTROL - User Manual for the inverters of the Sinus PENTA series manufactured by Elettronica Santerno.

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

3.7.2. Direct Connection

Electrical standard RS485 may be connected directly to the computer if this is provided with a special port of this type. In case your computer is provided with a serial port RS232-C or a USB port, a RS232-C/ RS485 converter or a USB/RS485 converter is required.

Electronica Santerno may supply both converters as optional components.

Logic "1" (normally called a MARK) means that terminal TX/RX A is positive in respect to terminal TX/RX B (vice versa for logic "0", normally called a SPACE).

3.7.3. Multidrop Network Connection

Sinus Penta inverters may be connected to a network through electrical standard RS485, allowing a bus-type control of each device; up to 247 inverters may be interconnected depending on the link length and baud rate.

Each inverter has its own identification number, which can be set in the Serial Network menu as a unique code in the network connected to the PC.

3.7.3.1. Connection

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

The D connector pins are the following.

PIN	FUNCTION
1 – 3	(TX/RX A) Differential input/output A (bidirectional) according to standard RS485. Positive polarity in respect to pins 2 – 4 for one MARK. Signal D1 according to MODBUS-IDA association.
2 – 4	(TX/RX B) Differential input/output B (bidirectional) according to standard RS485. Negative polarity in respect to pins 1 – 3 for one MARK. Signal D0 according to MODBUS-IDA association.
5	(GND) control board zero volt. Common according to MODBUS-IDA association.
6	(VTEST) Auxiliary supply input – (see Auxiliary Power Supply)
7 – 8	not connected
9	+ 5 V, max 100 mA for power supply of optional RS485/RS232 converter

The D-connector metal frame is connected to the grounding. Wire duplex cable braiding to the metal frame of the female connector to be connected to the inverter. To avoid obtaining a too high common voltage for driver RS485 of the master or the multidrop-connected devices, connect together terminals GND (if any) for all devices. This ensures equipotentiality for all signal circuits, thus providing the best operating conditions for drivers RS485; however, if devices are connected to each other with analog interfaces, this can create ground loops. If disturbance occurs when communication interfaces and analog interface operate at a time, use optional, galvanically isolated RS485 communications interface.

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

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

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

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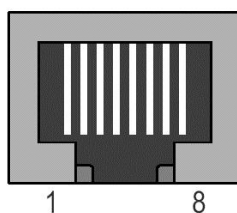


Figure 84: Pin lay-out of serial link 1 connector

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

Type of cable	Shielded cable composed of balanced D1/D0 pair + common conductor (“Common”)
Min. cross-section of conductors	AWG24 corresponding to 0.25mm ² . For long cable length, larger cross-sections up to 0.75mm ² are recommended.
Max. length	500 metres (based on the max. distance between two stations)
Characteristic impedance	Better if exceeding 100Ω (120Ω is typically recommended)
Standard colours	Yellow/brown for D1/D0 pair, grey for “Common” signal

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

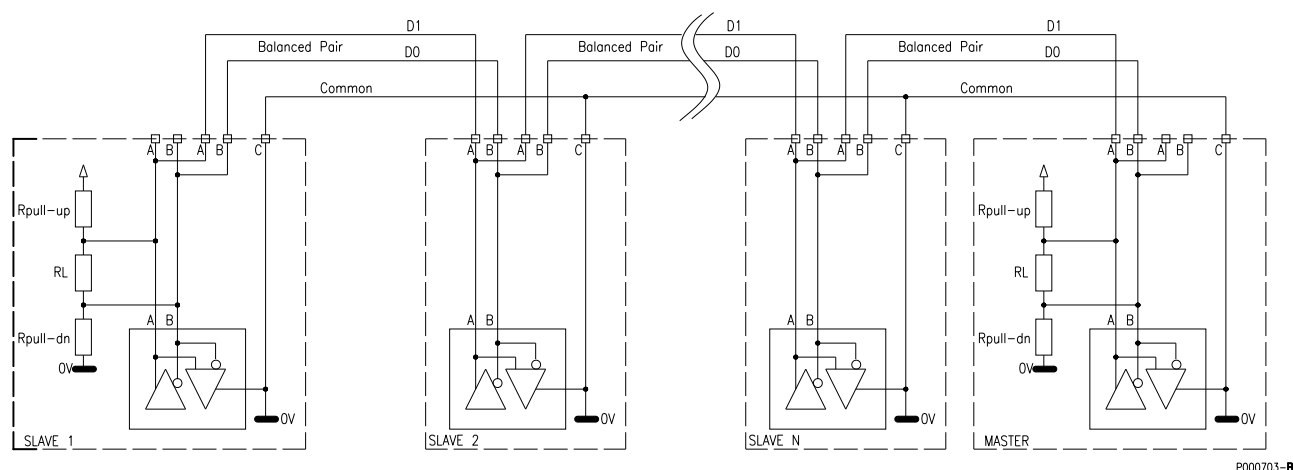


Figure 85: Recommended wiring diagram for “2-wire” MODBUS connection

Note that the network comprising the termination resistor and the polarization resistors is integrated into the inverter and can be activated via appropriate DIP-switches. Figure 85 shows the termination network in the devices at both ends of the chain. The terminator must be inserted in those devices only.



NOTE

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



NOTE

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



NOTE

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

If this happens, provide the communication device with a galvanically isolated interface, type RS485/RS232.

3.7.3.2. Line Terminators

Provide a linear wiring (not a star wiring) for multidrop line RS485. To do so, two pins for each line signal are provided on the inverter connector. The incoming line may be connected to pins 1 and 2, whereas the outgoing line may be connected to pins 3 and 4.

The first device in the multidrop connection will have only one outgoing line, while the last device will have only one incoming line. The line terminator is to be installed on the first device and the last device. In serial link 0, the terminator is selected through DIP-switch SW3 in the control board (see DIP-switches section) for Sinus Penta inverters.

The line master (computer) is typically placed at the beginning or at the end of a multidrop connection; in that case, the line terminator of the farthest inverter from the master computer (or the only inverter in case of direct connection to the master computer) shall be enabled: DIP-switch SW3, selector switches 1 and 2 in position ON.

The line terminator of the other inverters in intermediate positions shall be disabled: DIP-switch SW3, selector switches 1 and 2 in position OFF.



NOTE

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



CAUTION

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

3.7.4. How to Use Isolated Serial Board ES822 (Optional)

ES822 option board allows the connection to a serial link RS485 or RS232. ES822 board, to be installed inside the inverter, allows the inverter to be connected both to a computer through RS232—with no need to use additional devices—and to serial link RS485. Board ES822 also provides galvanic isolation between the serial link and the control board grounding of the inverter, thus avoiding ground loops and enhancing immunity to disturbance of the serial link. For more details, see ES822 Isolated Serial Board (Slot B) in the Motor Drives Accessories - User Manual.

The activation of ES822 results in the automatic switching of serial link 0, which is electrically suppressed from the standard serial connector of the inverter.

3.7.5. The Software

The serial communication protocol is MODBUS RTU standard.

Parameters are queried as they are read using the keys and the display. Parameter alteration is also managed along with the display/keypad. 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 via the terminal board or the serial link, depending on the condition of the relevant parameters (see Sinus Penta's Programming Guide).

However, the ENABLE-A and ENABLE-B commands are always to be sent via terminal board regardless of the inverter programming mode.

3.7.6. Serial Communications Ratings

Baud rate:	configurable between 1200 and 38,400 bps (default value: 38,400 bps)
Data format:	8 bits
Start bit:	1
Parity: (1)	NO, EVEN, ODD
Stop bit:	2,1
Protocol:	MODBUS RTU
Supported functions:	03h (Read Holding Registers) 06h (Write Single Registers) 10h (Write Multiple Registers)
Device address:	configurable between 1 and 247 (default value: 1)
Electric standard:	RS485
Inverter response delay:	configurable between 0 and 1000 ms (default value: 5 ms)
End of message timeout:	configurable between 0 and 10,000 ms (default value: 0 ms)
Communications Watch Dog: (2)	configurable between 0 and 65,000 s (default value: disabled)

(1) Ignored when receiving

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



NOTE

For the parameters relating to the configuration of the serial communications, see Sinus Penta's Programming Guide.

3.8. Auxiliary Power Supply

The VTEST auxiliary supply pin is located on the connector of serial port 0. If 9VDC voltage (in respect to GND) is delivered to the VTEST input, the inverter control board activates, as well as the keypad and the option boards (if any). This mode is very useful when you need to:

- 1) read and write the inverter parameters with no need to apply AC 3-phase supply;
- 2) keep "ON" the control board, the keypad and the option boards in case of AC 3-phase supply loss (backup functionality).

When auxiliary supply is applied and no AC 3-phase supply is delivered, the alarms relating to the power section are disabled and the motor cannot be started up.

The auxiliary supply input features are the following:

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



CAUTION

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

Elettronica Santerno provides a suitable power supply unit as an option; see ES914 Power Supply Unit Board in the Motor Drives Accessories - User Manual.

4. START UP

**CAUTION**

Make sure that the safety procedures are observed. See SAFETY STATEMENTS.

**CAUTION**

In particular, make sure that all installation instructions are observed. See Installing and Operating the Equipment.

**CAUTION**

If the STO function integrated into the drive is to be used, follow the instructions given in the Safe Torque Off Function - Application Manual.

The detailed start up procedures for IFD, VTC and FOC asynchronous motor control are given in the Programming Guide.

This section covers the basic startup procedures for IFD, VTC, FOC asynchronous motor control configurations.

Any detail concerning startup procedures of the devices configured as “RGN” (regenerative inverter) is given in the Guide to the Regenerative Application.

Any detail concerning startup procedures of the devices configured as “SYN” (application for synchronous motors) is given in the Guide to the Synchronous Motor Application.

For more details on the equipment functionality, please consult Sinus Penta's Programming Guide.

**DANGER**

Before changing the equipment connections, shut off the inverter and wait at least 20 minutes to allow for the discharge of the heat sinks in the DC-link.

**DANGER**

At startup, if the connected motor rotates in the wrong direction, send a low frequency reference in IFD mode and check to see if the direction of rotation is correct. In respect to its shaft, the motor normally rotates clockwise if the connection sequence is U, V, W and if a positive reference is set (FWD). Contact the motor manufacturer to check the preset direction of rotation of the motor.

**CAUTION**

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

5. TECHNICAL SPECIFICATIONS

Earthing system

TN-S, TN-C, TN-CS, TT (not corner earthed) systems
 For IT (ungrounded) systems please contact Elettronica Santerno

Power Range

- kW connected motor/voltage range
- 1.5~260 kW 200÷240 Vac, 3phase
- 2.2~1750 kW 380÷415 Vac, 3phase
- 3~2000 kW 440÷460 Vac, 3phase
- 3.7~2100 kW 480÷500 Vac, 3phase
- 3~2500 kW 525÷575 Vac, 3phase
- 3~3000 kW 660÷690 Vac, 3phase

- Degree of protection/size

STAND ALONE:

IP20/UL Open Type from Size S05 to Size S32,

IP00/UL Open Type from Size S41 to Size S70

IP00 from Size S75 to Size S90,

IP21/UL Type 1 from Size S05 to Size S52 with NEMA 1 Glandkit

IP54 from Size S05 to Size S32

BOX: IP54

CABINET: IP42 and IP54.

Overvoltage category

III (refer to EN 61800-5-1)

MTBF

500,000 hours at 40 °C and rated output current.

Specifications for motor wiring

- Motor voltage range/precision
- 0÷V_{mains}, ÷2%
- Current/torque to motor/time
- 105÷200% for 2 min. every 20 min. up to S30.
- 105÷200% for 1 min. every 10 min. from S32.
- Starting torque/max. time
- 240% for a short time
- Output frequency/resolution (*)
- 0÷1000 Hz (**), resolution 0.1 Hz
- Braking torque:
- DC braking 30%*C_n
- Braking while decelerating up to 20%*C_n (with no braking resistor)
- Braking while decelerating up to 150%*C_n (with braking resistors)
- Carrier frequency with adjustable silent random modulation (for more details, please refer to the Carrier Frequency Setting section and the Sinus Penta's Programming Guide.

Mains

- VAC supply voltage/tolerance
- 2T → 200÷240 Vac, 3phase, -15% +10%
- 4T → 380÷500 Vac, 3phase, -15% +10%
- 5T → 500÷600 Vac, 3phase, -15% +10%
- 6T → 575÷690 Vac, 3phase, -15% +10%
- Maximum voltage imbalance: ±3% of the rated supply voltage
- (Class 3 according to CEI EN 61000-2-4).

- VDC supply voltage/tolerance

2T → 280÷340 Vdc, -15% +10%

4T → 530÷705 Vdc, -15% +10%

5T → 705÷845 Vdc, -15% +10%

6T → 815÷970 Vdc, -15% +10%

The DC voltage power supply for size S41, S42, S51, S52, S60, S60P, S64, S74 and S84 requires an external precharge circuit of the DC bus capacitors.

- Supply frequency (Hz)/tolerance

50÷60 Hz, ±20%

Environmental Requirements

- Ambient temperature

-10 °C to +55 °C

It might be necessary to apply 2% derating of the rated current for every degree beyond the stated temperatures depending on the inverter model (see Maximum allowable Operating Temperature). (***)

For UL508C Open Type

Equipment, the maximum surrounding air temperature is +40 °C.



NOTE

- Storage temperature

-25 °C ÷ +70 °C

- Humidity

5 ÷ 95% (non-condensing)

- Altitude

Max. altitude for installation 2000 m a.s.l. For installation above 2000 m and up to 4000 m, please contact Elettronica Santerno.

Above 1000 m, derate the rated current by 1% every 100 m. (***)

- Vibrations

Lower than 9.8 m/s² (= 1.0G)

- Installation environment

Pollution degree 2 or better (according to EN 61800-5-1 and for UL508C Open Type Equipment). Do not install in direct sunlight and in places exposed to conductive dust, corrosive gases, vibrations, water sprinkling or dripping; do not install in salty environments.

- Operating atmospheric pressure

86 ÷ 106 kPa

- Cooling system

Forced air-cooling

**NOTE (*)**

The maximum output frequency is limited in respect to the preset carrier frequency (for more details, please refer to the Programming Guide).

**NOTE (**)**

Depending on the models and always on request (for more details, please consult the Programming Guide).

The following may be considered as a whole:

- altitude > 1000m and
- $T < T_{\text{max allowable ambient temperature}}$

**NOTE (***)**






The overall derating may be reduced by applying 2% uprating of the rated current per degree below $T_{\text{max allowable ambient temperature}}$ —always without exceeding the rated current.

E.g.: Penta 0260 4T S41 operated at 2000 m (-10%) and 38 °C (+4%):

$$445 \times 0.90 \times 1.04 = 416.5 \text{ A.}$$

If the same model was used at 2000 m (-10%) and 30 °C (+20%) it would be:

$$445 \times 0.90 \times 1.20 = 480.6 \text{ A} > 445 \text{ A. Hence rated current is kept at 445 A.}$$

MOTOR CONTROL	Motor control methods	IFD = Voltage/Frequency with symmetrical PWM modulation VTC = Vector Torque Control (Sensorless vector direct torque control) FOC = Field adjustment with field regulation and torque for asynchronous motors SYN = Vector for permanent magnet synchronous motors (PMSM)
	Frequency / speed setting resolution	Digital reference: 0.1 Hz (IFD control); 1 rpm (VTC control); 0.01 rpm (FOC control) 12-bit Analog reference: 4096 in respect to speed range
	Speed precision at constant rpm	Open loop: $\pm 0.5\%$ of max. speed Closed loop (when using an encoder): $< 0.01\%$ of max. speed
	Torque accuracy	Open loop: $< 6\%$ of rated torque Closed loop (when using an encoder): $< 4\%$ of the rated torque
	Overload capacity	Up to 2 times rated current for 120 sec.
	Starting torque	Up to 200% Cn for 120 secs and 240% Cn for a short duration
	Torque boost	Programmable for a rated torque increase
OPERATION	Operation method	Operation via terminal board, keypad, MODBUS RTU serial interface, field bus interface
	Input signals	
	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	7 configurable digital inputs; 2 preset inputs for the Safe Torque Off function (ENABLE-A, ENABLE-B)
	Multispeed	15 sets of programmable speed values $\pm 32,000$ rpm; first 3 sets with resolution 0.01 rpm (FOC control)
	Ramps	4 + 4 accel./decel. ramps, 0 to 6,500 secs; possibility to set user-defined patterns.
	Output signals	
	Digital outputs	4 configurable digital outputs with possibility to set internal timers for activation/deactivation delay: 1 push-pull output, 20÷48 Vdc, 50 mA max. 1 open collector, NPN/PNP output, 5÷48 Vdc, 50 mA max 2 relay outputs with change-over contacts, 250 Vac, 30 Vdc, 5A
PROTECTIONS	Auxiliary voltage	24 Vdc $\pm 5\%$, 200 mA
	Reference voltage for potentiometer	+ 10 Vdc $\pm 0.8\%$, 10 mA -10 Vdc $\pm 0.8\%$, 10 mA
	Analog outputs	3 configurable analog outputs, $-10 \div 10$ Vdc, $0 \div 10$ Vdc, $0(4) \div 20$ mA, resolution 9/11 bits
COMMUNICATION DISPLAY	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 and VTC SW only), auxiliary trip from digital input, serial communication failure, control board failure, precharge circuit failure, inverter overload conditions for long duration, unconnected motor, encoder (if any) failure, overspeed.
	Warning	INVERTER OK, INVERTER ALARM, acceleration – constant rpm – deceleration, current/torque limiting, POWER DOWN, SPEED SEARCHING, DC braking, autotune.
	Operating data	Frequency/torque/speed reference, output frequency, motor speed, torque demand, generated torque, current to motor, voltage to motor, DC bus voltage, motor-absorbed power, digital input condition, digital output condition, trip log (last 5 alarms), operating time, auxiliary analog input value, PID reference, PID feedback, PID error value, PID regulator output, PID feedback with programmable multiplying factor.
SAFETY REQUIREMENTS	Serial link	Standard incorporated RS485 multidrop 247 drops MODBUS RTU communication protocol
	Field bus	Profibus-DP®, PROFIdrive®, DeviceNet®, CANopen®, Ethernet (MODBUS® TCP, Profinet, Ethernet IP, EtherCat), Metasys® N2, BACnet® with option boards.
	PERFORMANCE AND FUNCTIONALITY	EN 61800-5-1, STO function according to EN 61800-5-2 SIL 3, EN ISO 13849 PL d
Compliance		EN 61800-2 and EN 60146-1-1
		    

5.1. Choosing the Product

The inverters of the Sinus Penta series are dimensioned based on the application allowable current and overload.

The Sinus Penta series is characterized by 3 current values:

- **I_{nom}** is the continuous current that can be delivered;
- **I_{max}** is the max. current that can be delivered under overload conditions for a time period of 120s every 20 min or for a time period of 60s every 10 min based on the different inverter models;
- **I_{peak}** is the maximum current that can be delivered under overload conditions for a time period of 3s.

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

Overload	Up to		Applicability
	(60/120s)	(3s)	
LIGHT	120%	144%	Light loads with constant/quadratic torque (pumps, fans, etc.);
STANDARD	140%	168%	Standard loads with constant torque (conveyors, mixers, extruders, etc.);
HEAVY	175%	210%	Heavy loads with constant torque (lifts, presses, bridge cranes, mills, etc.);
STRONG	200%	240%	Very heavy loads with constant torque (spindles, axis control, etc.).

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

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

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



NOTE

Data contained in the tables below relate to standard 4-pole motors, efficiency class IE2.

MAKE SURE THAT:

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

EXAMPLE:

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

Heavy application

Inverter ratings:

I_{nom} : at least 68A
 I_{max} : at least $68A \times 1.6 = 102A$

According to the table, Sinus Penta 0060 providing $I_{nom}=88A$ and $I_{max}=112A$ is to be used for this type of application.

**FIRE
HAZARD**

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

5.1.1. LIGHT Applications: Overload up to 120% (60/120s) or up to 144% (3s)

5.1.1.1. Technical Sheet for 2T and 4T Voltage Classes

Size	Sinus Penta Model		Applicable Motor Power												Inom	Imax	Ipeak (3s)
			200-240Vac			380-415Vac			440-460Vac			480-500Vac					
			kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A			
S05	SINUS	0005	-	-	-	4.5	6	9.0	5.5	7.5	9.7	6.5	9	10.2	10.5	11.5	14
	SINUS	0007	3	4	11.2	5.5	7.5	11.2	7.5	10	12.5	7.5	10	11.8	12.5	13.5	16
	SINUS	0008	3.7	5	13.2	-	-	-	-	-	-	-	-	-	15	16	19
	SINUS	0009	-	-	-	7.5	10	14.8	9.2	12.5	16	9.2	12.5	14.3	16.5	17.5	19
	SINUS	0010	4	5.5	14.6	-	-	-	-	-	-	-	-	-	17	19	23
	SINUS	0011	-	-	-	7.5	10	14.8	9.2	12.5	16	11	15	16.5	16.5	21	25
	SINUS	0013	4.5	6	15.7	-	-	-	-	-	-	-	-	-	19	21	25
	SINUS	0014	-	-	-	7.5	10	14.8	9.2	12.5	16	11	15	16.5	16.5	25	30
	SINUS	0015	5.5	7.5	19.5	-	-	-	-	-	-	-	-	-	23	25	30
	SINUS	0016	7.5	10	25.7	-	-	-	-	-	-	-	-	-	27	30	36
	SINUS	0020	9.2	12.5	30	-	-	-	-	-	-	-	-	-	30	36	43
S12	SINUS	0016	-	-	-	11	15	21	15	20	25	15	20	23.2	27	30	36
	SINUS	0017	-	-	-	15	20	29	18.5	25	30	18.5	25	28	30	32	37
	SINUS	0020	-	-	-	15	20	29	18.5	25	30	18.5	25	28	30	36	43
	SINUS	0023	11	15	36	-	-	-	-	-	-	-	-	-	38	42	51
	SINUS	0025	-	-	-	22	30	41	22	30	36	22	30	33	41	48	58
	SINUS	0030	-	-	-	22	30	41	22	30	36	25	35	37	45	56	67
	SINUS	0033	15	20	50	-	-	-	-	-	-	-	-	-	51	56	68
	SINUS	0034	-	-	-	30	40	55	30	40	48	37	50	53	57	63	76
	SINUS	0036	-	-	-	30	40	55	37	50	58	37	50	53	60	72	86
	SINUS	0037	18.5	25	61	-	-	-	-	-	-	-	-	-	65	72	83
S15	SINUS	0040	22	30	71	37	50	67	45	60	70	50	70	70	72	80	88
	SINUS	0049	25	35	80	45	60	80	50	65	75	55	75	78	80	96	115
S20	SINUS	0060	28	38	88	50	70	87	55	75	85	65	90	88	88	112	134
	SINUS	0067	30	40	96	55	75	98	65	90	100	75	100	103	103	118	142
	SINUS	0074	37	50	117	65	90	114	75	100	116	85	115	120	120	144	173
	SINUS	0086	45	60	135	75	100	133	90	125	135	90	125	127	145	155	186
S30	SINUS	0113	55	75	170	100	135	180	110	150	166	132	180	180	180	200	240
	SINUS	0129	65	90	195	110	150	191	125	170	192	140	190	195	195	215	258
	SINUS	0150	70	95	213	120	165	212	132	180	198	150	200	211	215	270	324
	SINUS	0162	75	100	231	132	180	228	150	200	230	175	238	240	240	290	324

(continued)

(continued)

S41	SINUS	0180	90	125	277	160	220	273	200	270	297	220	300	300	300	340	408		
	SINUS	0202	110	150	332	200	270	341	220	300	326	250	340	337	345	420	504		
	SINUS	0217	120	165	375	220	300	375	250	340	366	260	350	359	375	460	552		
	SINUS	0260	132	180	390	250	340	421	280	380	410	300	410	418	445	560	672		
S51	SINUS	0313	160	220	475	280	380	480	315	430	459	355	485	471	480	600	720		
	SINUS	0367	185	250	550	315	430	528	375	510	540	400	550	544	550	680	792		
	SINUS	0402	200	270	593	400	550	680	450	610	665	500	680	673	680	850	1020		
S60	SINUS	0457	220	300	649	400	550	680	450	610	665	500	680	673	720	880	1056		
	SINUS	0524	260	350	780	450	610	765	500	680	731	560	760	751	800	960	1152		
S60P	SINUS	0598P	-	-	-	500	680	841	560	760	817	630	860	864	900	1100	1152		
S65 ¹⁾	SINUS	0598	-	-	-	500	680	841	560	760	817	630	860	864	900	1100	1320		
	SINUS	0748	-	-	-	560	760	939	630	860	939	710	970	960	1000	1300	1560		
	SINUS	0831	-	-	-	710	970	1200	800	1090	1160	900	1230	1184	1200	1440	1728		
S75 ¹⁾	SINUS	0964	-	-	-	900	1230	1480	1000	1360	1431	1100	1500	1480	1480	1780	2136		
	SINUS	1130	-	-	-	1000	1360	1646	1170	1600	1700	1270	1730	1700	1700	2040	2448		
	SINUS	1296	-	-	-	1200	1650	2050	1400	1830	2000	1460	1990	2050	2100	2520	3024		
S90 ¹⁾	SINUS	1800	-	-	-	1500	2000	2500	1750	2400	2500	1850	2500	2500	2600	3100	3720		
	SINUS	2076	-	-	-	1750	2400	2900	2000	2720	2900	2100	2900	2900	3000	3600	4000		
Inverter supply voltage			200-240Vac; 280-340Vdc.			380-500Vac; 530-705Vdc.													
1) Input inductor and output inductor required.																			

5.1.1.2. Technical Sheet for 2T and 4T Voltage Classes – Parallel-connected Models

Size	Sinus Penta Model	Applicable Motor Power												Inom	Imax
		200-240Vac			380-415Vac			440-460Vac			480-500Vac				
		kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A	A	A
S43 (2xS41)	SINUS 0523	260	350	780	450	610	765	500	680	731	560	760	751	800	960
S53 (2xS51)	SINUS 0599	-	-	-	500	680	841	560	760	817	630	860	864	900	1100
	SINUS 0749	-	-	-	560	760	939	630	860	939	710	970	960	1000	1300
	SINUS 0832	-	-	-	710	970	1200	800	1090	1160	900	1230	1184	1200	1440
S55 (3xS51)	SINUS 0850	-	-	-	800	1090	1334	900	1230	1287	1000	1360	1317	1340	1600
	SINUS 0965	-	-	-	900	1230	1480	1000	1360	1431	1100	1500	1480	1480	1780
	SINUS 1129	-	-	-	1000	1360	1646	1170	1600	1700	1270	1730	1700	1700	2040
Inverter Power Supply		200-240Vac; 280-340Vdc.			380-500Vac; 530-705Vdc.										
See User Manual SINUS PENTA - Parallel-connected Models S41..S52															

Key:

Inom = continuous rated current of the inverter**Imax** = max. current produced by the inverter for 120 seconds every 20 min up to S30, and for 60 seconds every 10 min for S41 and greater**Ipeak** = deliverable current for max. 3 seconds**NOTE**

Data contained in the tables relate to standard 4-pole motors, efficiency class IE2.

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

Size	Sinus Penta Model		Applicable Motor Power						Inom	Imax	Ipeak (3s)
			575Vac			660-690Vac					
			kW	HP	A	kW	HP	A			
S12 5T S14	SINUS 0003		4	5.5	5.7	5.5	7.5	6.3	7	8.5	10
	SINUS 0004		5.5	7.5	7.6	7.5	10	8.4	9	11	13
	SINUS 0006		7.5	10	10	9.2	12.5	10.2	11	13.5	16
	SINUS 0012		9.2	12.5	12.5	11	15	12.1	13	16	19
	SINUS 0018		11	15	14	15	20	16.8	17	21	25
S14	SINUS 0019		15	20	20	18.5	25	21	21	25	30
	SINUS 0021		18.5	25	25	22	30	23	25	30	36
	SINUS 0022		22	30	28	30	40	33	33	40	48
	SINUS 0024		30	40	39	37	50	39	40	48	58
	SINUS 0032		37	50	47	45	60	46	52	63	76
S22	SINUS 0042		45	60	55	55	75	56	60	72	86
	SINUS 0051		55	75	70	75	100	78	80	96	115
	SINUS 0062		65	90	83	75	100	78	85	110	132
	SINUS 0069		75	100	95	90	125	94	105	135	162
S32	SINUS 0076		90	125	115	110	150	113	125	165	198
	SINUS 0088		110	150	138	132	180	133	150	200	240
	SINUS 0131		132	180	168	160	220	158	190	250	300
	SINUS 0164		160	220	198	220	300	220	230	300	360
S42	SINUS 0181		220	300	275	250	340	250	305	380	420
	SINUS 0201		250	340	300	315	430	310	330	420	420
	SINUS 0218		300	410	358	355	485	350	360	465	560
	SINUS 0259		330	450	395	400	550	390	400	560	560
S52	SINUS 0290		355	485	420	450	610	440	450	600	720
	SINUS 0314		400	550	480	500	680	480	500	665	798
	SINUS 0368		450	610	532	560	770	544	560	720	850
	SINUS 0401		560	770	630	630	860	626	640	850	850
S65 ¹⁾	SINUS 0457		630	860	720	710	970	696	720	880	1056
	SINUS 0524		710	970	800	800	1090	773	800	960	1152
	SINUS 0598		800	1090	900	900	1230	858	900	1100	1320
	SINUS 0748		900	1230	1000	1000	1360	954	1000	1300	1440
S70 ¹⁾	SINUS 0831		1000	1360	1145	1240	1690	1200	1200	1440	1440
S75 ¹⁾	SINUS 0964		1270	1730	1480	1530	2090	1480	1480	1780	2136
	SINUS 1130		1460	1990	1700	1750	2380	1700	1700	2040	2448
S80 ¹⁾	SINUS 1296		1750	2380	2100	2100	2860	2100	2100	2520	2520
S90 ¹⁾	SINUS 1800		2000	2720	2400	2400	3300	2400	2600	3100	3600
	SINUS 2076		2500	3400	3000	3000	4000	3000	3000	3600	3600
Inverter supply voltage			500-600Vac; 705-845Vdc.			575-690Vac; 815-970Vdc.					
¹⁾ Input inductor and output inductor required.											

5.1.1.4. Technical Sheet for 5T and 6T Voltage Classes – Parallel-connected Models

Size	Sinus Penta Model		Applicable Motor Power						Inom	Imax
			575Vac			660-690Vac				
			kW	HP	A	kW	HP	A	A	A
S44 (2xS42)	SINUS	0459	630	860	720	710	970	696	720	880
S54 (2xS52)	SINUS	0526	710	970	800	800	1090	773	800	960
	SINUS	0600	800	1090	900	900	1230	858	900	1100
	SINUS	0750	900	1230	1000	1000	1360	954	1000	1300
	SINUS	0828	1000	1360	1145	1240	1690	1200	1200	1440
S56 (3xS52)	SINUS	0960	1270	1730	1480	1530	2090	1480	1480	1780
	SINUS	1128	1460	1990	1700	1750	2380	1700	1700	2040
Inverter Supply Voltage			500-600Vac; 705-845Vdc.			575-690Vac; 815-970Vdc.				
See User Manual SINUS PENTA - Parallel-connected Models S41..S52										

Key:

Inom = continuous rated current of the inverter**Imax** = max. current produced by the inverter for 60 seconds every 10 min**Ipeak** = deliverable current for max. 3 seconds**NOTE**

Data contained in the tables relate to standard 4-pole motors, efficiency class IE2.

5.1.2. STANDARD Applications: Overload up to 140% (60/120s) or up to 168% (3s)

5.1.2.1. Technical Sheet for 2T and 4T Voltage Classes

Size	Sinus Penta Model	Applicable Motor Power												Inom	Imax	Ipeak (3 s.)
		200-240Vac			380-415Vac			440-460Vac			480-500Vac					
		kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A			
S05	SINUS 0005	-	-	-	4	5.5	8.4	4.5	6	7.8	5.5	7.5	9.0	10.5	11.5	14
	SINUS 0007	2.2	3	8.5	4.5	6	9.0	5.5	7.5	9.7	6.5	9	10.2	12.5	13.5	16
	SINUS 0008	3	4	11.2	-	-	-	-	-	-	-	-	-	15	16	19
	SINUS 0009	-	-	-	5.5	7.5	11.2	7.5	10	12.5	7.5	10	11.8	16.5	17.5	19
	SINUS 0010	3.7	5	13.2	-	-	-	-	-	-	-	-	-	17	19	23
	SINUS 0011	-	-	-	7.5	10	14.8	9.2	12.5	15.6	9.2	12.5	14.3	16.5	21	25
	SINUS 0013	4	5.5	14.6	-	-	-	-	-	-	-	-	-	19	21	25
	SINUS 0014	-	-	-	7.5	10	14.8	9.2	12.5	15.6	11	15	16.5	16.5	25	30
	SINUS 0015	4.5	6	15.7	-	-	-	-	-	-	-	-	-	23	25	30
	SINUS 0016	5.5	7.5	19.5	-	-	-	-	-	-	-	-	-	27	30	36
SINUS 0020	7.5	10	25.7	-	-	-	-	-	-	-	-	-	30	36	43	
S12	SINUS 0016	-	-	-	9.2	12.5	17.9	11	15	18.3	15	20	23.2	27	30	36
	SINUS 0017	-	-	-	11	15	21	11	15	18.3	15	20	23.2	30	32	37
	SINUS 0020	-	-	-	15	20	29	15	20	25	18.5	25	28	30	36	43
	SINUS 0023	9.2	12.5	30	-	-	-	-	-	-	-	-	-	38	42	51
	SINUS 0025	-	-	-	18.5	25	35	18.5	25	30	22	30	33	41	48	58
	SINUS 0030	-	-	-	22	30	41	22	30	36	25	35	37	45	56	67
	SINUS 0033	11	15	36	-	-	-	-	-	-	-	-	-	51	56	68
	SINUS 0034	-	-	-	25	35	46	30	40	48	30	40	44	57	63	76
	SINUS 0036	-	-	-	30	40	55	30	40	48	37	50	53	60	72	86
	SINUS 0037	15	20	50	-	-	-	-	-	-	-	-	-	65	72	83
S15	SINUS 0040	18.5	25	61	30	40	55	37	50	58	40	55	58	72	80	88
	SINUS 0049	22	30	71	37	50	67	45	60	70	45	60	64	80	96	115
S20	SINUS 0060	25	35	80	45	60	80	55	75	85	55	75	78	88	112	134
	SINUS 0067	30	40	96	55	75	98	60	80	91	65	90	88	103	118	142
	SINUS 0074	37	50	117	65	90	114	70	95	107	75	100	103	120	144	173
	SINUS 0086	40	55	127	75	100	133	75	100	116	85	115	120	145	155	186
S30	SINUS 0113	45	60	135	90	125	159	90	125	135	90	125	127	180	200	240
	SINUS 0129	55	75	170	100	135	180	110	150	166	110	150	153	195	215	258
	SINUS 0150	65	90	195	110	150	191	132	180	198	150	200	211	215	270	324
	SINUS 0162	75	100	231	132	180	228	150	200	230	160	220	218	240	290	324

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S41	SINUS 0180	80	110	250	160	220	273	185	250	279	200	270	273	300	340	408
	SINUS 0202	90	125	277	200	270	341	220	300	326	250	340	337	345	420	504
	SINUS 0217	110	150	332	220	300	375	250	340	375	260	350	359	375	460	552
	SINUS 0260	132	180	390	250	340	421	280	380	410	300	410	418	445	560	672
S51	SINUS 0313	150	200	458	280	380	480	315	430	459	355	485	471	480	600	720
	SINUS 0367	160	220	475	315	430	528	375	510	540	400	550	544	550	680	792
	SINUS 0402	185	250	550	400	550	680	450	610	665	500	680	673	680	850	1020
S60	SINUS 0457	220	300	661	400	550	680	450	610	665	500	680	673	720	880	1056
	SINUS 0524	260	350	780	450	610	765	500	680	731	560	770	751	800	960	1152
S60P	SINUS 0598P	-	-	-	500	680	841	560	760	817	630	860	864	900	1100	1152
S65 ¹⁾	SINUS 0598	-	-	-	500	680	841	560	760	817	630	860	864	900	1100	1320
	SINUS 0748	-	-	-	560	760	939	630	860	939	710	970	960	1000	1300	1560
	SINUS 0831	-	-	-	630	860	1080	800	1090	1160	800	1090	1067	1200	1440	1728
S75 ¹⁾	SINUS 0964	-	-	-	800	1090	1334	900	1230	1287	1000	1360	1317	1480	1780	2136
	SINUS 1130	-	-	-	900	1230	1480	1100	1500	1630	1170	1600	1570	1700	2040	2448
	SINUS 1296	-	-	-	1200	1650	2050	1400	1830	2000	1460	1990	2050	2100	2520	3024
S90 ¹⁾	SINUS 1800	-	-	-	1400	1910	2400	1700	2300	2400	1750	2400	2400	2600	3100	3720
	SINUS 2076	-	-	-	1750	2400	2900	2000	2720	2900	2100	2900	2900	3000	3600	4000
Inverter supply voltage		200-240Vac; 280-340Vdc.			380-500Vac; 530-705Vdc.											
1) Input inductor and output inductor required.																

5.1.2.2. Technical Sheet for 2T and 4T Voltage Classes – Parallel-connected Models

Size	Sinus Penta Model		Applicable Motor Power												Inom	Imax
			200-240Vac			380-415Vac			440-460Vac			480-500Vac				
			kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A		
S43 (2xS41)	SINUS 0523	260	350	780	450	610	765	500	680	731	560	770	751	800	960	
S53 (2xS51)	SINUS 0599	-	-	-	500	680	841	560	760	817	630	860	864	900	1100	
	SINUS 0749	-	-	-	560	760	939	630	860	939	710	970	960	1000	1300	
	SINUS 0832	-	-	-	630	860	1080	800	1090	1160	800	1090	1067	1200	1440	
S55 (3xS51)	SINUS 0850	-	-	-	710	970	1200	800	1090	1160	900	1230	1184	1340	1600	
	SINUS 0965	-	-	-	800	1090	1334	900	1230	1287	1000	1360	1317	1480	1780	
	SINUS 1129	-	-	-	900	1230	1480	1100	1500	1630	1170	1600	1570	1700	2040	
Inverter supply voltage		200-240Vac; 280-340Vdc.			380-500Vac; 530-705Vdc.											
See User Manual SINUS PENTA - Parallel-connected Models S41..S52																

Key:

Inom = continuous rated current of the inverter**Imax** = max. current produced by the inverter for 120s every 20 min up to S30, for 60s every 10 min for S41 and greater**Ipeak** = deliverable current for max. 3 seconds**NOTE**

Data contained in the tables relate to standard 4-pole motors, efficiency class IE2.

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

Size	Sinus Penta Model	Applicable Motor Power						Inom	Imax	Ipeak (3 s.)
		575Vac			660-690Vac					
		kW	HP	A	kW	HP	A			
S12 5T S14	SINUS 0003	4	5.5	5.7	4	5.5	4.8	7	8.5	10
	SINUS 0004	5.5	7.5	7.6	5.5	7.5	6.3	9	11	13
	SINUS 0006	7.5	10	10	7.5	10	8.4	11	13.5	16
	SINUS 0012	7.5	10	10	9.2	12.5	10.2	13	16	19
	SINUS 0018	11	15	14	11	15	12.1	17	21	25
S14	SINUS 0019	11	15	14	15	20	16.8	21	25	30
	SINUS 0021	15	20	20	18.5	25	21	25	30	36
	SINUS 0022	22	30	28	22	30	23	33	40	48
	SINUS 0024	25	35	32	30	40	33	40	48	58
	SINUS 0032	37	50	47	37	50	39	52	63	76
S22	SINUS 0042	45	60	55	45	60	46	60	72	86
	SINUS 0051	55	75	70	55	75	56	80	96	115
	SINUS 0062	65	90	83	75	100	77	85	110	132
	SINUS 0069	75	100	95	90	125	95	105	135	162
S32	SINUS 0076	90	125	115	110	150	113	125	165	198
	SINUS 0088	110	150	135	132	180	133	150	200	240
	SINUS 0131	132	180	168	160	220	158	190	250	300
	SINUS 0164	160	220	198	200	270	198	230	300	360
S42	SINUS 0181	220	300	275	250	340	250	305	380	420
	SINUS 0201	250	340	300	315	430	310	330	420	420
	SINUS 0218	300	410	358	315	430	310	360	465	560
	SINUS 0259	330	450	395	400	550	390	400	560	560
S52	SINUS 0290	355	485	420	450	610	440	450	600	720
	SINUS 0314	400	550	480	450	610	440	500	665	798
	SINUS 0368	450	610	532	500	680	480	560	720	850
	SINUS 0401	450	610	532	630	860	626	640	850	850
S65 ¹⁾	SINUS 0457	560	770	630	630	860	626	720	880	1056
	SINUS 0524	630	860	720	710	970	696	800	960	1152
	SINUS 0598	710	970	800	900	1230	858	900	1100	1320
	SINUS 0748	900	1230	1000	1000	1360	954	1000	1300	1440
S70 ¹⁾	SINUS 0831	1000	1360	1145	1100	1500	1086	1200	1440	1440
S75 ¹⁾	SINUS 0964	1180	1610	1369	1410	1920	1369	1480	1780	2136
	SINUS 1130	1350	1840	1569	1620	2210	1569	1700	2040	2448
S80 ¹⁾	SINUS 1296	1750	2380	2100	1850	2520	1800	2100	2520	2520
S90 ¹⁾	SINUS 1800	2000	2720	2400	2400	3300	2400	2600	3100	3600
	SINUS 2076	2500	3400	3000	3000	4000	3000	3000	3600	3600
Inverter supply voltage		500-600Vac; 705-845Vdc.			575-690Vac; 815-970Vdc.					
¹⁾ Input inductor and output inductor required.										

5.1.2.4. Technical Sheet for 5T and 6T Voltage Classes – Parallel-connected Models

Size	Sinus Penta Model		Applicable Motor Power						Inom	Imax
			575Vac			660-690Vac				
			kW	HP	A	kW	HP	A		
S44 (2xS42)	SINUS	0459	560	770	630	630	860	626	720	880
S54 (2xS52)	SINUS	0526	630	860	720	710	970	696	800	960
	SINUS	0600	710	970	800	900	1230	858	900	1100
	SINUS	0750	900	1230	1000	1000	1360	954	1000	1300
	SINUS	0828	1000	1360	1145	1100	1500	1086	1200	1440
S56 (3xS52)	SINUS	0960	1180	1610	1369	1410	1920	1369	1480	1780
	SINUS	1128	1350	1840	1569	1620	2210	1569	1700	2040
Inverter supply voltage			500-600Vac; 705-845Vdc.			575-690Vac; 815-970Vdc.				
See User Manual SINUS PENTA - Parallel-connected Models S41..S52										

Key:

Inom = continuous rated current of the inverter**Imax** = max. current produced by the inverter for 60 seconds every 10 min**Ipeak** = deliverable current for max. 3 seconds**NOTE**

Data contained in the tables relate to standard 4-pole motors, efficiency class IE2.

5.1.3. HEAVY Applications: Overload up to 175% (60/120s) or up to 210% (3s)

5.1.3.1. Technical Sheet for 2T and 4T Voltage Classes

Size	Sinus Penta Model		Applicable Motor Power												Inom	Imax	Ipeak (3 s.)
			200-240Vac			380-415Vac			440-460Vac			480-500Vac					
			kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A			
S05	SINUS 0005	-	-	-	3	4	6.4	3.7	5	6.6	4.5	6	7.2	10.5	11.5	14	
	SINUS 0007	1.8	2.5	7.3	4	5.5	8.4	4.5	6	7.8	5.5	7.5	9.0	12.5	13.5	16	
	SINUS 0008	2.2	3	8.5	-	-	-	-	-	-	-	-	-	15	16	19	
	SINUS 0009	-	-	-	4.5	6	9.0	5.5	7.5	9.7	7.5	10	11.8	16.5	17.5	19	
	SINUS 0010	3	4	11.2	-	-	-	-	-	-	-	-	-	17	19	23	
	SINUS 0011	-	-	-	5.5	7.5	11.2	7.5	10	12.5	9.2	12.5	14.3	16.5	21	25	
	SINUS 0013	3.7	5	13.2	-	-	-	-	-	-	-	-	-	19	21	25	
	SINUS 0014	-	-	-	7.5	10	14.8	9.2	12.5	15.6	11	15	16.5	16.5	25	30	
	SINUS 0015	4	5.5	14.6	-	-	-	-	-	-	-	-	-	23	25	30	
	SINUS 0016	4.5	6	15.7	-	-	-	-	-	-	-	-	-	27	30	36	
SINUS 0020	5.5	7.5	19.5	-	-	-	-	-	-	-	-	-	30	36	43		
S12	SINUS 0016	-	-	-	9.2	12.5	17.9	11	15	18.3	12.5	17	18.9	27	30	36	
	SINUS 0017	-	-	-	9.2	12.5	17.9	11	15	18.3	12.5	17	18.9	30	32	37	
	SINUS 0020	-	-	-	11	15	21	15	20	25	15	20	23.2	30	36	43	
	SINUS 0023	7.5	10	25.7	-	-	-	-	-	-	-	-	-	38	42	51	
	SINUS 0025	-	-	-	15	20	29	18.5	25	30	18.5	25	28	41	48	58	
	SINUS 0030	-	-	-	18.5	25	35	22	30	36	22	30	33	45	56	67	
	SINUS 0033	11	15	36	-	-	-	-	-	-	-	-	-	51	56	68	
	SINUS 0034	-	-	-	22	30	41	25	35	40	28	38	41	57	63	76	
	SINUS 0036	-	-	-	25	35	46	30	40	48	30	40	44	60	72	86	
	SINUS 0037	15	20	50	-	-	-	-	-	-	-	-	-	65	72	83	
S15	SINUS 0040	15	20	50	25	35	46	30	40	48	37	50	53	72	80	88	
	SINUS 0049	18.5	25	61	30	40	55	37	50	58	45	60	64	80	96	115	
S20	SINUS 0060	22	30	71	37	50	67	45	60	70	50	70	70	88	112	134	
	SINUS 0067	25	35	80	45	60	80	50	70	75	55	75	78	103	118	142	
	SINUS 0074	30	40	96	50	70	87	55	75	85	65	90	88	120	144	173	
	SINUS 0086	32	45	103	55	75	98	65	90	100	75	100	103	145	155	186	
S30	SINUS 0113	45	60	135	75	100	133	75	100	116	90	125	127	180	200	240	
	SINUS 0129	50	70	150	80	110	144	90	125	135	110	150	153	195	215	258	
	SINUS 0150	55	75	170	90	125	159	110	150	166	132	180	180	215	270	324	
	SINUS 0162	65	90	195	110	150	191	132	180	198	140	190	191	240	290	324	

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S41	SINUS 0180	75	100	231	132	180	228	160	220	237	160	220	218	300	340	408	
	SINUS 0202	80	110	250	150	200	264	185	250	279	200	270	273	345	420	504	
	SINUS 0217	110	150	332	185	250	321	220	300	326	220	300	300	375	460	552	
	SINUS 0260	110	150	332	200	270	341	260	350	390	280	380	393	445	560	672	
S51	SINUS 0313	132	180	390	220	300	375	260	350	390	300	400	413	480	600	720	
	SINUS 0367	150	200	458	250	340	421	315	430	459	355	485	471	550	680	792	
	SINUS 0402	160	220	475	315	430	528	375	510	540	400	550	544	680	850	1020	
S60	SINUS 0457	200	270	593	315	430	528	400	550	576	450	610	612	720	880	1056	
	SINUS 0524	220	300	661	355	480	589	450	610	665	500	680	673	800	960	1152	
S60P	SINUS 0598P	-	-	-	400	550	680	500	680	731	560	760	751	900	1100	1152	
S65 ¹⁾	SINUS 0598	-	-	-	400	550	680	500	680	731	560	760	751	900	1100	1320	
	SINUS 0748	-	-	-	500	680	841	560	760	817	630	860	864	1000	1300	1560	
	SINUS 0831	-	-	-	560	760	939	630	860	939	710	970	960	1200	1440	1728	
S75 ¹⁾	SINUS 0964	-	-	-	710	970	1200	800	1090	1160	900	1230	1184	1480	1780	2136	
	SINUS 1130	-	-	-	800	1090	1334	900	1230	1287	1000	1360	1317	1700	2040	2448	
	SINUS 1296	-	-	-	1000	1360	1650	1100	1500	1630	1170	1600	1560	2100	2520	3024	
S90 ¹⁾	SINUS 1800	-	-	-	1200	1650	2050	1450	1970	2050	1500	2000	2050	2600	3100	3720	
	SINUS 2076	-	-	-	1400	1910	2400	1700	2300	2400	1750	2400	2400	3000	3600	4000	
Inverter supply voltage		200-240Vac; 280-340Vdc.			380-500Vac; 530-705Vdc.												
¹⁾ Input inductor and output inductor required.																	

5.1.3.2. Technical Sheet for Voltage Classes 2T and 4T – Parallel-connected Models

Size	Sinus Penta Model		Applicable Motor Power												Inom	Imax
			200-240Vac			380-415Vac			440-460Vac			480-500Vac				
			kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A		
S43 (2xS41)	SINUS	0523	220	300	661	355	480	589	450	610	665	500	680	673	800	960
S53 (2xS51)	SINUS	0599	-	-	-	400	550	680	500	680	731	560	760	751	900	1100
	SINUS	0749	-	-	-	500	680	841	560	760	817	630	860	864	1000	1300
	SINUS	0832	-	-	-	560	760	939	630	860	939	710	970	960	1200	1440
S55 (3xS51)	SINUS	0850	-	-	-	630	860	1080	710	970	1043	800	1090	1067	1340	1600
	SINUS	0965	-	-	-	710	970	1200	800	1090	1160	900	1230	1184	1480	1780
	SINUS	1129	-	-	-	800	1090	1334	900	1230	1287	1000	1360	1317	1700	2040
Inverter Supply Voltage			200-240Vac; 280-340Vdc.			380-500Vac; 530-705Vdc.										
See User Manual SINUS PENTA - Parallel-connected Models S41..S52																

Key:

Inom = continuous rated current of the inverter**Imax** = max. current produced by the inverter for 120s every 20 min up to S30, for 60s every 10 min for S41 and greater**Ipeak** = deliverable current for max. 3 seconds**NOTE**

Data contained in the tables relate to standard 4-pole motors, efficiency class IE2.

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

Size	Sinus Penta Model		Applicable Motor Power						Inom	Imax	Ipeak (3 s.)
			575Vac			660-690Vac					
			kW	HP	A	kW	HP	A			
S12 5T S14	SINUS	0003	3	4	4.4	4	5.5	4.8	7	8.5	10
	SINUS	0004	4	5.5	5.7	4	5.5	4.8	9	11	13
	SINUS	0006	5.5	7.5	7.6	7.5	10	8.4	11	13.5	16
	SINUS	0012	7.5	10	10	7.5	10	8.4	13	16	19
	SINUS	0018	9.2	12.5	12.5	11	15	12.1	17	21	25
S14	SINUS	0019	11	15	14	11	15	12.1	21	25	30
	SINUS	0021	15	20	20	15	20	16.8	25	30	36
	SINUS	0022	18.5	25	25	22	30	23	33	40	48
	SINUS	0024	22	30	28	22	30	23	40	48	58
	SINUS	0032	30	40	39	37	50	39	52	63	76
S22	SINUS	0042	37	50	47	37	50	39	60	72	86
	SINUS	0051	45	60	55	55	75	56	80	96	115
	SINUS	0062	55	75	70	55	75	56	85	110	132
	SINUS	0069	55	75	70	75	100	78	105	135	162
S32	SINUS	0076	75	100	95	90	125	94	125	165	198
	SINUS	0088	110	150	135	110	150	113	150	200	240
	SINUS	0131	110	150	135	160	220	158	190	250	300
	SINUS	0164	132	180	168	185	250	185	230	300	360
S42	SINUS	0181	185	250	225	220	300	220	305	380	420
	SINUS	0201	200	270	240	250	340	250	330	420	420
	SINUS	0218	220	300	275	315	430	310	360	465	560
	SINUS	0259	280	380	336	355	485	341	400	560	560
S52	SINUS	0290	300	400	358	400	550	390	450	600	720
	SINUS	0314	330	450	395	450	610	440	500	665	798
	SINUS	0368	355	485	420	500	680	480	560	720	850
	SINUS	0401	400	550	473	560	770	544	640	850	850
S65 ¹⁾	SINUS	0457	500	680	585	560	770	544	720	880	1056
	SINUS	0524	560	770	630	630	860	626	800	960	1152
	SINUS	0598	630	860	720	710	970	696	900	1100	1320
	SINUS	0748	710	970	800	900	1230	858	1000	1300	1440
S70 ¹⁾	SINUS	0831	800	1090	900	1000	1360	954	1200	1440	1440
S75 ¹⁾	SINUS	0964	1000	1360	1145	1220	1660	1187	1480	1780	2136
	SINUS	1130	1170	1600	1360	1400	1910	1360	1700	2040	2448
S80 ¹⁾	SINUS	1296	1340	1830	1560	1610	2190	1560	2100	2520	2520
S90 ¹⁾	SINUS	1800	1750	2400	2050	2100	2860	2100	2600	3100	3600
	SINUS	2076	2000	2720	2400	2400	3300	2400	3000	3600	3600
Inverter Supply Voltage			500-600Vac; 705-845Vdc			575-690Vac; 815-970Vdc					
¹⁾ Input inductor and output inductor required.											

5.1.3.4. Technical Sheet for Voltage Classes 5T and 6T – Parallel -connected Models

Size	Sinus Penta Model	Applicable Motor Power						Inom	Imax
		575Vac			660-690Vac				
		kW	A	A	kW	HP	A	A	A
S44 (2xS42)	SINUS 0459	500	680	585	560	770	544	720	880
S54 (2xS52)	SINUS 0526	560	770	630	630	860	626	800	960
	SINUS 0600	630	860	720	710	970	696	900	1100
	SINUS 0750	710	970	800	900	1230	858	1000	1300
	SINUS 0828	800	1090	900	1000	1360	954	1200	1440
S56 (3xS52)	SINUS 0960	1000	1360	1145	1220	1660	1187	1480	1780
	SINUS 1128	1170	1600	1360	1400	1910	1360	1700	2040
Inverter supply voltage		500-600Vac; 705-845Vdc.			575-690Vac; 815-970Vdc.				
See User Manual SINUS PENTA - Parallel-connected Models S41..S52									

Key:

Inom = continuous rated current of the inverter**Imax** = max. current produced by the inverter for 60 seconds every 10 min**Ipeak** = deliverable current for max. 3 seconds**NOTE**

Data contained in the tables relate to standard 4-pole motors, efficiency class IE2.

5.1.4. STRONG Applications: Overload up to 200% (60/120s) or up to 240% (3s)

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

Size	Sinus Penta Model	Applicable Motor Power												Inom	I _{max}	I _{peak} (3s)
		200-240Vac			380-415Vac			440-460Vac			480-500Vac					
		kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A			
S05	SINUS 0005	-	-	-	2.2	3	4.9	3	4	5.6	3.7	5	6.1	10.5	11.5	14
	SINUS 0007	1.5	2	6.1	3	4	6.4	3.7	5	6.6	4.5	6	7.2	12.5	13.5	16
	SINUS 0008	1.8	2.5	7.3	-	-	-	-	-	-	-	-	-	15	16	19
	SINUS 0009	-	-	-	4	5.5	8.4	4.5	6	7.8	5.5	7.5	9.0	16.5	17.5	19
	SINUS 0010	2.2	3	8.5	-	-	-	-	-	-	-	-	-	17	19	23
	SINUS 0011	-	-	-	4.5	6	9.0	5.5	7.5	9.7	7.5	10	11.8	16.5	21	25
	SINUS 0013	3	4	11.2	-	-	-	-	-	-	-	-	-	19	21	25
	SINUS 0014	-	-	-	5.5	7.5	11.2	7.5	10	12.5	9.2	12.5	14.3	16.5	25	30
	SINUS 0015	3.7	5	13.2	-	-	-	-	-	-	-	-	-	23	25	30
	SINUS 0016	4	5.5	14.6	-	-	-	-	-	-	-	-	-	27	30	36
	SINUS 0020	4.5	6	15.7	-	-	-	-	-	-	-	-	-	30	36	43
S12	SINUS 0016	-	-	-	7.5	10	14.8	9.2	12.5	15.6	11	15	16.5	27	30	36
	SINUS 0017	-	-	--	7.5	10	14.8	9.2	12.5	15.6	12.5	17	18.9	30	32	37
	SINUS 0020	-	-	-	9.2	12.5	17.9	11	15	18.3	12.5	17	18.9	30	36	43
	SINUS 0023	5.5	7.5	19.5	-	-	-	-	-	-	-	-	-	38	42	51
	SINUS 0025	-	-	-	11	15	21	15	20	25	15	20	23.2	41	48	58
	SINUS 0030	-	-	-	15	20	29	18.5	25	30	18.5	25	28	45	56	67
	SINUS 0033	7.5	10	25.7	-	-	-	-	-	-	-	-	-	51	56	68
	SINUS 0034	-	-	-	18.5	25	35	22	30	36	22	30	33	57	63	76
	SINUS 0036	-	-	-	22	30	41	25	35	40	28	38	41	60	72	86
	SINUS 0037	11	15	36	-	-	-	-	-	-	-	-	-	65	72	83
S15	SINUS 0040	12.5	17	41	22	30	41	25	35	40	30	40	44	72	80	88
	SINUS 0049	15	20	50	25	35	46	30	40	48	37	50	53	80	96	115
S20	SINUS 0060	18.5	25	61	30	40	55	37	50	58	45	60	64	88	112	134
	SINUS 0067	20	27	66	32	45	59	40	55	63	50	70	70	103	118	142
	SINUS 0074	22	30	71	37	50	67	45	60	70	55	75	78	120	144	173
	SINUS 0086	25	35	80	45	60	80	55	75	85	65	90	88	145	155	186
S30	SINUS 0113	30	40	96	55	75	98	65	88	100	75	100	103	180	200	240
	SINUS 0129	37	50	117	65	90	114	75	100	116	85	115	120	195	215	258
	SINUS 0150	45	60	135	75	100	133	90	125	135	90	125	127	215	270	324
	SINUS 0162	55	75	170	90	125	159	110	150	166	110	150	153	240	290	324

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S41	SINUS	0180	60	85	185	110	150	191	120	165	184	132	180	180	300	340	408			
	SINUS	0202	65	90	195	132	180	228	150	200	230	160	220	218	345	420	504			
	SINUS	0217	75	100	231	150	200	260	160	220	245	185	250	257	375	460	552			
	SINUS	0260	90	125	277	160	220	273	200	270	307	200	270	273	445	560	672			
S51	SINUS	0313	110	150	332	185	250	321	220	300	326	250	340	337	480	600	720			
	SINUS	0367	120	165	375	200	270	341	250	340	366	260	350	359	550	680	792			
	SINUS	0402	132	180	390	280	380	480	315	430	462	355	480	471	680	850	1020			
S60	SINUS	0457	160	220	475	280	380	480	330	450	493	375	510	497	720	880	1056			
	SINUS	0524	185	250	550	315	430	528	375	510	540	400	550	544	800	960	1152			
S60P	SINUS	0598P	-	-	-	355	480	589	400	550	591	450	610	612	900	1100	1152			
S65 ¹⁾	SINUS	0598	-	-	-	355	480	589	400	550	591	450	610	612	900	1100	1320			
	SINUS	0748	-	-	-	400	550	680	500	680	731	560	760	751	1000	1300	1560			
	SINUS	0831	-	-	-	450	610	765	560	760	817	630	860	864	1200	1440	1728			
S75 ¹⁾	SINUS	0964	-	-	-	560	770	939	710	970	1043	800	1090	1067	1480	1780	2136			
	SINUS	1130	-	-	-	710	970	1200	800	1090	1160	900	1230	1184	1700	2040	2448			
	SINUS	1296	-	-	-	800	1090	1334	900	1230	1287	1000	1360	1317	2100	2520	3024			
S90 ¹⁾	SINUS	1800	-	-	-	1000	1360	1650	1170	1600	1650	1200	1650	1650	2600	3100	3720			
	SINUS	2076	-	-	-	1200	1650	2050	1450	1970	2050	1500	2000	2050	3000	3600	4000			
Inverter supply voltage			200-240Vac; 280-340Vdc.			380-500Vac; 530-705Vdc.														
1) Input inductor and output inductor required.																				

5.1.4.2. Technical Sheet for Voltage Classes 2T and 4T – Parallel-connected Models

Size	Sinus Penta Model		Applicable Motor Power												Inom	Imax
			200-240Vac			380-415Vac			440-460Vac			480-500Vac				
			kW	HP	A	kW	HP	A	kW	HP	A	kW	HP	A		
S43 (2xS41)	SINUS	0523	185	250	550	315	430	528	375	510	540	400	550	544	800	960
S53 (2xS51)	SINUS	0599	-	-	-	355	480	589	400	550	591	450	610	612	900	1100
	SINUS	0749	-	-	-	400	550	680	500	680	731	560	760	751	1000	1300
	SINUS	0832	-	-	-	450	610	765	560	760	817	630	860	864	1200	1440
S55 (3xS51)	SINUS	0850	-	-	-	500	680	841	630	860	939	710	970	960	1340	1600
	SINUS	0965	-	-	-	560	770	939	710	970	1043	800	1090	1067	1480	1780
	SINUS	1129	-	-	-	710	970	1200	800	1090	1160	900	1230	1184	1700	2040
Inverter Supply Voltage			200-240Vac; 280-340Vdc.			380-500Vac; 530-705Vdc.										
See User Manual SINUS PENTA - Parallel-connected Models S41..S52																

Key:

Inom = continuous rated current of the inverter**Imax** = max. current produced by the inverter for 120s every 20 min up to S30, for 60s every 10 min for S41 and greater**Ipeak** = deliverable current for max. 3 seconds**NOTE**

Data contained in the tables relate to standard 4-pole motors, efficiency class IE2.

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

Size	Sinus Penta Model	Applicable Motor Power							Inom	Imax	Ipeak (3s)
		575Vac			660-690Vac						
		kW	HP	A	kW	HP	A				
S12 5T S14	SINUS 0003	3	4	4.4	3	4	3.7	7	8.5	10	
	SINUS 0004	4	5.5	5.7	4	5.5	4.8	9	11	13	
	SINUS 0006	4	5.5	5.7	5.5	7.5	6.3	11	13.5	16	
	SINUS 0012	5.5	7.5	7.6	7.5	10	8.4	13	16	19	
	SINUS 0018	7.5	10	10	9.2	12.5	10.2	17	21	25	
S14	SINUS 0019	9.2	12.5	12.5	11	15	12	21	25	30	
	SINUS 0021	11	15	14	11	15	12	25	30	36	
	SINUS 0022	15	20	20	18.5	25	21	33	40	48	
	SINUS 0024	18.5	25	25	22	30	23	40	48	58	
	SINUS 0032	25	35	32	30	40	33	52	63	76	
S22	SINUS 0042	30	40	39	30	40	33	60	72	86	
	SINUS 0051	37	50	47	45	60	46	80	96	115	
	SINUS 0062	45	60	55	55	75	56	85	110	132	
	SINUS 0069	45	60	55	55	75	56	105	135	162	
S32	SINUS 0076	55	75	70	75	100	77	125	165	198	
	SINUS 0088	75	100	95	90	125	95	150	200	240	
	SINUS 0131	90	125	115	110	150	115	190	250	300	
	SINUS 0164	110	150	138	132	180	140	230	300	360	
S42	SINUS 0181	160	220	198	200	270	198	305	380	420	
	SINUS 0201	160	220	198	220	300	220	330	420	420	
	SINUS 0218	200	270	240	250	340	250	360	465	560	
	SINUS 0259	220	300	275	315	430	310	400	560	560	
S52	SINUS 0290	250	340	300	355	480	341	450	600	720	
	SINUS 0314	280	380	336	375	510	360	500	665	798	
	SINUS 0368	315	430	367	400	550	390	560	720	850	
	SINUS 0401	355	480	410	500	680	480	640	850	850	
S65 1)	SINUS 0457	400	550	480	500	680	480	720	880	1056	
	SINUS 0524	450	610	532	560	770	544	800	960	1152	
	SINUS 0598	560	770	630	630	860	626	900	1100	1320	
	SINUS 0748	630	860	720	800	1090	773	1000	1300	1440	
S70 1)	SINUS 0831	710	970	800	900	1230	858	1200	1440	1440	
S75 1)	SINUS 0964	900	1230	1000	1000	1360	954	1480	1780	2136	
	SINUS 1130	1000	1360	1145	1100	1500	1086	1700	2040	2448	
S80 1)	SINUS 1296	1150	1570	1337	1380	1880	1337	2100	2520	2520	
S90 1)	SINUS 1800	1460	1990	1700	1750	2380	1700	2600	3100	3600	
	SINUS 2076	1750	2400	2050	2100	2860	2100	3000	3600	3600	
Inverter supply voltage		500-600Vac; 705-845Vdc			575-690Vac; 815-970Vdc						
1) Input inductor and output inductor required.											

5.1.4.4. Technical Sheet for Voltage Classes 5T and 6T – Parallel-connected Models

Size	Sinus Penta Model	Applicable Motor Power							Inom	Imax
		575Vac			660-690Vac					
		kW	HP	A	kW	HP	A	A	A	
S44 (2xS42)	SINUS 0459	400	550	480	500	680	480	720	880	
S54 (2xS52)	SINUS 0526	450	610	532	560	770	544	800	960	
	SINUS 0600	560	770	630	630	860	626	900	1100	
	SINUS 0750	630	860	720	800	1090	773	1000	1300	
	SINUS 0828	710	970	800	900	1230	858	1200	1440	
S56 (3xS52)	SINUS 0960	900	1230	1000	1000	1360	954	1480	1780	
	SINUS 1128	1000	1360	1145	1100	1500	1086	1700	2040	
Inverter Supply Voltage		500-600Vac; 705-845Vdc.			575-690Vac; 815-970Vdc.					
See User Manual SINUS PENTA - Parallel-connected Models S41..S52										

Key:

Inom = continuous rated current of the inverter**Imax** = max. current produced by the inverter for 60 seconds every 10 min**Ipeak** = deliverable current for max. 3 seconds**NOTE**

Data contained in the tables relate to standard 4-pole motors, efficiency class IE2.

5.2. Carrier Frequency Setting

The continuous current (I_{nom}) generated by the inverter in continuous operation type S1 at 40°C depends on carrier frequency. The higher the carrier frequency, the more the motor is silent; the control performance is enhanced, but this causes a greater heating of the inverter, thus affecting energy saving. Using long cables (especially shielded cables) for connecting the motor is not recommended when the carrier frequency is high.

The max. recommended carrier values that can be set in parameter **C002** (Carrier Frequency menu) based on the continuous current delivered by the Sinus Penta are given in the tables below.



CAUTION

Larger combinations of carrier frequency and continuous output currents may trigger alarm **A094** (Heat sink overtemperature).

For example, if a Penta S05 0014 4T with 11 kHz carrier frequency is to be used, the max. continuous output current exceeding $0.70 \cdot I_{nom}$ may trigger alarm **A094**.

5.2.1. IP20 and IP00 Models – 2T-4T Voltage Classes

Size	Sinus Penta Model	Maximum Recommended Carrier Frequency (kHz) (parameters C001 and C002) based on the output current				Carrier (kHz)	
		I_{nom}	$0.85 \cdot I_{nom}$	$0.70 \cdot I_{nom}$	$0.55 \cdot I_{nom}$	Def.	Max.
S05 4T	0005	12.8	16	–	–	5	16
	0007	10	12.8	16	–	5	16
	0009	5	8	11	16	5	16
	0011	5	8	11	16	5	16
	0014	5	8	11	16	5	16
S05 2T	0007	16	–	–	–	5	16
	0008	10	–	–	–	5	10
	0010	10	–	–	–	5	10
	0013	10	–	–	–	5	10
	0015	10	–	–	–	5	10
	0016	10	–	–	–	3	10
	0020	5	10	–	–	3	10
S12 4T	0016	10	–	–	–	3	10
	0017	8	10	–	–	3	10
	0020	8	10	–	–	3	10
	0025	5	6	8	10	3	10
	0030	5	6	8	10	3	10
	0034	5	10	–	–	3	10
	0036	5	10	–	–	3	10
S12 2T	0023	10	–	–	–	3	10
	0033	10	–	–	–	3	10
	0037	3	8	10	–	3	10

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Size	Sinus Penta Model	Maximum Recommended Carrier Frequency (kHz) (parameters C001 and C002) based on the output current				Carrier (kHz)	
		Inom	0.85* Inom	0.70* Inom	0.55* Inom	Def.	Max.
S15 2T/4T	0040	5	8	16	—	3	16
	0049	3	5	10	12.8	3	12.8
S20 2T/4T	0060	10	—	—	—	3	10
	0067	10	—	—	—	3	10
	0074	10	—	—	—	3	10
	0086	5	—	10	—	3	10
S30 2T/4T	0113	4	8	10	—	2	10
	0129	3	6	10	—	2	10
	0150	4	5	7	8	2	8
	0162	3	4	6	8	2	8
S41 2T/4T	0180	6	—	—	—	2	6
	0202	4	6	—	—	2	6
	0217	3	5	6	—	2	6
	0260	2	3	6	—	2	6
S51 2T/4T	0313	5	—	—	—	2	5
	0367	3	5	—	—	2	5
	0402	2	3	5	—	2	5
S60 2T/4T	0457	4	—	—	—	2	4
	0524	4	—	—	—	2	4
S60P 4T	0598P	2	4	—	—	2	4
S65 4T	0598	4	—	—	—	2	4
	0748	4	—	—	—	2	4
	0831	4	—	—	—	2	4
S75 4T	0964	4	—	—	—	2	4
	1130	4	—	—	—	2	4
	1296	4	—	—	—	2	4
S90 4T	1800	2	4	—	—	2	4
	2076	2	4	—	—	2	4

Size	Sinus Penta Model	Maximum Recommended Carrier Frequency (kHz) (parameters C001 and C002) based on the output current				Carrier (kHz)	
		Inom	0.85* Inom	0.70* Inom	0.55* Inom	Def.	Max.
2xS41 2T/4T	0523	2	3	6	—	2	6
2xS51 4T	0599	5	—	—	—	2	5
	0749	3	5	—	—	2	5
	0832	2	3	5	—	2	5
3xS51 4T	0850	5	—	—	—	2	5
	0965	3	5	—	—	2	5
	1129	2	3	5	—	2	5

5.2.2. IP20 and IP00 Models – 5T-6T Voltage Classes

Size	Sinus Penta Model	Maximum Recommended Carrier Frequency (kHz) (parameters C001 and C002) based on the output current				Carrier (kHz)	
		Inom	0.85* Inom	0.70* Inom	0.55* Inom	Def.	Max.
S12 5T	0003	5	—	—	—	3	5
	0004	5	—	—	—	3	5
	0006	5	—	—	—	3	5
	0012	4	5	—	—	3	5
	0018	3	4	5	—	3	5
S14 6T	0003	5	—	—	—	3	5
	0004	5	—	—	—	3	5
	0006	5	—	—	—	3	5
	0012	5	—	—	—	3	5
	0018	5	—	—	—	3	5
S14 5T/6T	0019	5	—	—	—	3	5
	0021	5	—	—	—	3	5
	0022	5	—	—	—	3	5
	0024	4	5	—	—	3	5
	0032	3	4	5	—	3	5
S22 5T/6T	0042	5	—	—	—	3	5
	0051	4	5	—	—	3	5
	0062	4	5	—	—	3	5
	0069	3	4	5	—	3	5
S32 5T/6T	0076	4	—	—	—	2	4
	0088	4	—	—	—	2	4
	0131	3	4	—	—	2	4
	0164	2	3	4	—	2	4
S42 5T/6T	0181	2	3	4	—	2	4
	0201	2	3	4	—	2	4
	0218	2	—	3	4	2	4
	0259	2	—	3	4	2	4
S52 5T/6T	0290	3	4	—	—	2	4
	0314	3	—	4	—	2	4
	0368	2	3	4	—	2	4
	0401	2	—	3	4	2	4
S65 5T/6T	0457	4	—	—	—	2	4
	0524	4	—	—	—	2	4
	0598	3	4	—	—	2	4
	0748	2	—	—	—	2	2
S70 5T/6T	0831	2	—	—	—	2	2
S75 5T/6T	0964	2	—	—	—	2	2
	1130	2	—	—	—	2	2
S80 5T/6T	1296	2	—	—	—	2	2
S90 5T/6T	1800	2	—	—	—	2	2
	2076	2	—	—	—	2	2

Size	Sinus Penta Model	Maximum Recommended Carrier Frequency (kHz) (parameters C001 and C002) based on the output current				Carrier (kHz)	
		Inom	0.85* Inom	0.70* Inom	0.55* Inom	Def.	Max.
2xS42 5T/6T	0459	2	—	3	4	2	4
2xS52 5T/6T	0526	3	4	—	—	2	4
	0600	3	—	4	4	2	4
	0750	2	3	4	—	2	4
	0828	2	—	3	4	2	4
3xS52 5T/6T	0960	2	3	4	—	2	4
	1128	2	—	3	4	2	4

5.2.3. IP54 Models – 2T-4T Voltage Classes

Size	Sinus Penta Model	Maximum Recommended Carrier Frequency (kHz) (parameters C001 and C002) based on the output current				Carrier (kHz)	
		Inom	0.85* Inom	0.70* Inom	0.55* Inom	Def.	Max.
S05 4T	0005	12.8	16	–	–	5	16
	0007	10	12.8	16	–	5	16
	0009	5	8	11	16	5	16
	0011	5	8	11	16	5	16
	0014	5	8	11	16	5	16
S05 2T	0007	16	–	–	–	5	16
	0008	10	–	–	–	5	10
	0010	10	–	–	–	5	10
	0013	10	–	–	–	5	10
	0015	10	–	–	–	5	10
	0016	10	–	–	–	3	10
	0020	Unavailable model as IP54					
S12 4T	0016	10	–	–	–	3	10
	0017	8	10	–	–	3	10
	0020	8	10	–	–	3	10
	0025	5	6	8	10	3	10
	0030	5	6	8	10	3	10
	0034	3	6	10	–	3	10
	0036	3	6	8	10	3	10
S12 2T	0023	10	–	–	–	3	10
	0033	10	–	–	–	3	10
	0037	3	8	10	–	3	10
S15 2T/4T	0040	5	8	16	16	3	16
	0049	3	5	10	12.8	3	12.8
S20 2T/4T	0060	10	–	–	–	3	10
	0067	10	–	–	–	3	10
	0074	10	–	–	–	3	10
	0086	5	–	10	–	3	10
S30 2T/4T	0113	4	8	10	–	2	10
	0129	3	6	10	–	2	10
	0150	4	5	7	8	2	8
	0162	3	4	6	8	2	8

5.2.4. IP54 Models – 5T-6T Voltage Classes

Size	Sinus Penta Model	Maximum Recommended Carrier Frequency (kHz) (parameters C001 and C002) based on the output current				Carrier (kHz)	
		Inom	0.85* Inom	0.70* Inom	0.55* Inom	Def.	Max.
S12 5T	0003	5	–	–	–	3	5
	0004	5	–	–	–	3	5
	0006	5	–	–	–	3	5
	0012	4	5	–	–	3	5
	0018	3	4	5	–	3	5
S14 6T	0003	5	–	–	–	3	5
	0004	5	–	–	–	3	5
	0006	5	–	–	–	3	5
	0012	5	–	–	–	3	5
	0018	5	–	–	–	3	5
S14 5T/6T	0019	5	–	–	–	3	5
	0021	5	–	–	–	3	5
	0022	5	–	–	–	3	5
	0024	4	5	–	–	3	5
	0032	Unavailable model as IP54					
S22 5T/6T	0042	5	–	–	–	3	5
	0051	4	5	–	–	3	5
	0062	4	5	–	–	3	5
	0069	3	4	5	–	3	5
S32 5T/6T	0076	4	–	–	–	2	4
	0088	4	–	–	–	2	4
	0131	3	4	–	–	2	4
	0164	2	3	4	–	2	4

5.3. Maximum allowable Operating Temperature without Derating

**NOTE**

Apply 2% derating of the rated current for every degree over, but not exceeding maximum 55 °C.

Formula: $I_{nom\ derated} = I_{nom} \times [1 - \Delta T \times 2\%]$

**NOTE**

For UL508C Open Type Equipment, the maximum surrounding air temperature is +40 °C.

**NOTE**

The temperature values below are related to the drive continuously operating at its rated current (I_{nom}). If the motor current is lower than the rated drive current, higher operating temperatures are allowed.

E.g.: A Sinus Penta 0036 S12 4T ($I_{nom} = 60$ A) paired with a 400 V 25 kW 46 A motor (Heavy overload) may operate at 50 °C, because at that temperature the rated current is derated to 48 A (higher than the motor temperature, which is 46 A).

Formula: $60 \times [1 - (50 - 40) \times 0.02] = 48$ A.

5.3.1. 2T-4T Voltage Classes

Size	SINUS PENTA Model	Operating Temperature without derating (°C)	Rated Current (A)
S05 2T	0007	50	12.5
	0008	50	15
	0010	50	17
	0013	50	19
	0015	50	23
	0016	45	27
	0020	40	30
S12 2T	0023	50	38
	0033	45	51
	0037	40	65
S05 4T	0005	50	10.5
	0007	50	12.5
	0009	40	16.5
	0011	40	16.5
	0014	40	16.5
S12 4T	0016	45	27
	0017	40	30
	0020	40	30
	0025	40	41
	0030	40	45
	0034	40	57
	0036	40	60
S15	0040	40	72
	0049	40	80
S20	0060	45	88
	0067	40	103
	0074	45	120
	0086	40	145
S30	0113	45	180
	0129	40	195
	0150	45	215
	0162	40	240

(continued)

(continued)

Size	SINUS PENTA Model	Operating Temperature without derating (°C)	Rated Current (A)
S41	0180	45	300
	0202	40	345
	0217	45	375
	0260	40	445
S51	0313	50	480
	0367	50	550
	0402	40	680
S60	0457	45	720
	0524	40	800
S60P	0598P	50	900
S65	0598	50	900
	0748	45	1000
	0831	40	1200
S75	0964	50	1480
	1130	45	1700
	1296	40	2100
S90	1800	50	2600
	2076	45	3000

Size	SINUS PENTA Model	Operating Temperature without derating (°C)	Rated Current (A)
2xS41 2T/4T	0523	40	800
2xS51 4T	0599	50	900
	0749	50	1000
	0832	40	1200
3xS51 4T	0850	50	1340
	0965	50	1480
	1129	40	1700

5.3.2. 5T-6T Voltage Classes

Size	SINUS PENTA Model	Operating Temperature without derating (°C)	Rated Current (A)
S12 5T	0003	50	7
	0004	50	9
	0006	50	11
	0012	50	13
	0018	40	17
S14	0003	50	7
	0004	50	9
	0006	50	11
	0012	50	13
	0018	50	17
	0019	50	21
	0021	50	25
	0022	50	33
	0024	50	40
	0032	40	52
S22	0042	50	60
	0051	45	80
	0062	45	85
	0069	40	105
S32	0076	50	125
	0088	50	150
	0131	45	190
	0164	40	230
S42	0181	50	305
	0201	40	330
	0218	45	360
	0259	40	400
S52	0290	50	450
	0314	50	500
	0368	45	560
	0401	40	640
S65	0457	50	720
	0524	50	800
	0598	50	900
	0748	45	1000
S70	0831	40	1200
S75	0964	50	1480
	1130	45	1700
S80	1296	40	2100
S90	1800	50	2600
	2076	45	3000

(continued)

(continued)

Size	SINUS PENTA Model	Operating Temperature without derating (°C)	Rated Current (A)
2xS42 5T/6T	0459	40	720
2xS52 5T/6T	0526	50	800
	0600	50	900
	0750	45	1000
	0828	40	1200
	0960	45	1480
3xS52 5T/6T	1128	40	1700

5.4. Short-circuit Currents

The Short Circuit Current is referred to the maximum Drive power. All the Motor Drive models are rated for Standard Fault Current values in accordance with UL508C and based on an Internal Solid State Short Circuit protection whose operation and whose manufacturing process complies UL508C.

CLASS 2T-4T		
Size	SINUS PENTA Model	Short Circuit Current
		kA
S05 2T	All models	5
S12 2T	All models	5
S05 4T	All models	5
S12 4T	0016..0025	5
	0030..0036	10
S15	All models	10
S20	All models	10
S30	All models	18
S41	0180..0202	18
	0217..0260	30
S51	0313	30
	0367..0402	42
S60	All models	42
S64/S65	All models	85
S74/S75	0964..1130	150
	1296	200
S84/S90	All models	200

CLASS 5T-6T		
Size	SINUS PENTA Model	Short Circuit Current
		kA
S12 5T	All models	5
S14	0003..0022	5
	0024..0032	10
S22	All models	10
S32	0076	10
	0088..0164	18
S42	0181..0259	30
S52	0290..0401	42
S64/S65	All models	85
S64/S70	All models	150
S74/S75	All models	150
S74/S80	All models	200
S84/S90	All models	200

6. NORMATIVE REFERENCES

The Sinus Penta drives comply with the following directives:

- Electromagnetic Compatibility Directive 2014/30/UE
- Low Voltage Directive 2014/35/UE



CAUTION

Suitable external filtering systems are to be provided in order to ensure compliance with EMC (2014/30/UE) standard.



CAUTION

The drives of the Penta Marine series require the filters envisaged by the DNV Marine standard to suit the EMC profile requirements, which are strictest than the CE requirements.

6.1. Electromagnetic Compatibility Directive

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 switching to be found in any device, i.e. switching power supply units 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.

Immunity and emissions may be concerned (EN 61800-3, ed. 2).

EN 61800-3 defines the immunity levels and the emission levels required for the 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 ed.2.

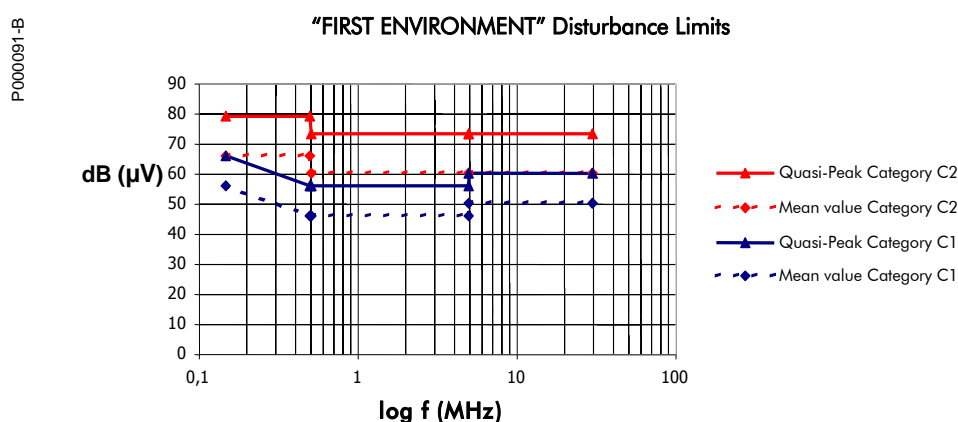
FIRST ENVIRONMENT	Environment including domestic devices and industrial devices which are connected directly to a low-voltage mains (with no intermediate transformer) for domestic usage.
SECOND ENVIRONMENT	Environment including industrial connections different from "First Environment" connections.
PDS 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

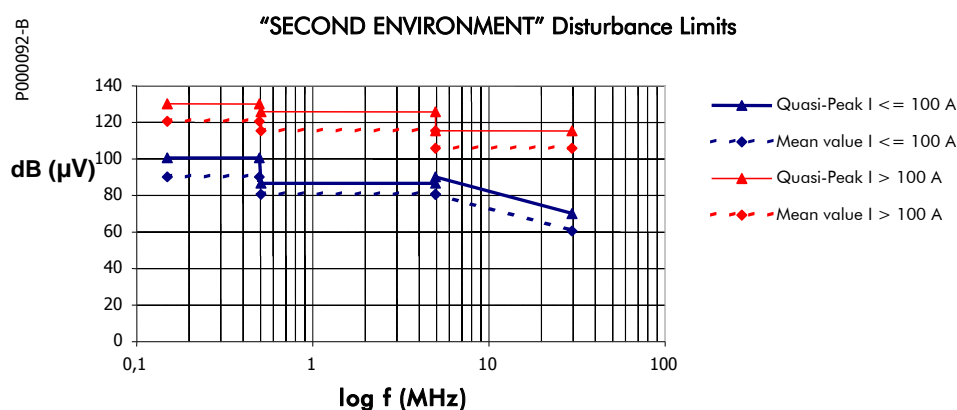
The standards in force also define the allowable emission level for different environments.

The diagrams below pertain to the emission limits allowed by EN 61800-3 ed.2.



----- **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.

Figure 86: Conducted emission limits

The inverters manufactured by ELETTRONICA SANTERNO allow choosing among four levels:

- B** suppression of the emissions for power drive systems installed in the FIRST ENVIRONMENT, Category C1.
- A1** suppression of the emissions for power drive systems installed in the FIRST ENVIRONMENT, Category C2.
- A2** suppression of the emissions for power drive systems installed in the SECOND ENVIRONMENT, Category C3, for currents <400A, Category C4 for currents ≥400A;
- 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;

Additional external EMC filters may be installed to bring emissions of devices of level **I** or **A2** or **A1** to level **B**.

Immunity levels

Electromagnetic disturbance is caused by harmonics, semiconductor switching, voltage variation-fluctuation-dissymmetry, mains failures and frequency variations; electrical equipment must be immune from electromagnetic disturbance.

The following tests are required by EN 61800-3 Ed.2:

EN 61800-3 Ed.2	<p>- Immunity:</p> <p>EN 61000-4-2/IEC 61000-4-2 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 2: Electrostatic Discharge Immunity Test. Basic EMC Publication.</p> <p>EN 61000-4-3/IEC 61000-4-3 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 3: Radiated, Radio-frequency, Electromagnetic Field Immunity Test.</p> <p>EN 61000-4-4/IEC 61000-4-4 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 4: Electrical Fast Transient/Burst Immunity Test. Basic EMC Publication.</p> <p>EN 61000-4-5/IEC 61000-4-5 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 5: Surge Immunity Test.</p> <p>EN 61000-4-6/IEC 61000-4-6 Electromagnetic Compatibility (EMC). Part 4: Testing and Measurement Techniques. Section 6: Immunity from Radiofrequency Fields Induced Disturbance.</p>
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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 Directive 2014/30/UE (please visit santerno.com).



CAUTION

Products with ID "I" in column 7 in the nameplate (Delivery Check section):
These devices are not provided with EMC filters. They can produce radio interference in domestic environments; additional measures should be taken to suppress radio interference.

Suitable external filtering systems are to be provided in order to ensure compliance with EMC (2014/30/UE) standard.



CAUTION

Products with ID "A2" in column 7 in the nameplate (Delivery Check section); the following regulation is provided:

These are category C3 devices (for currents <400A) or category C4 (for currents ≥400A) according to EN 61800-3. They can produce radio interference in domestic environments; additional measures should be taken to suppress radio interference.



CAUTION

Products with ID "A1" in column 7 in the nameplate (Delivery Check section):
These are category C3 devices according to EN 61800-3. They can produce radio interference in domestic environments; additional measures should be taken to suppress radio interference.



CAUTION

EMC filters are designed for earthed networks (TN or TT). Filters for floating networks (IT) can be supplied on demand.

6.1.1. 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 (power supply unit cables, motor cables, signal cables).

The figure shows how disturbance takes place:

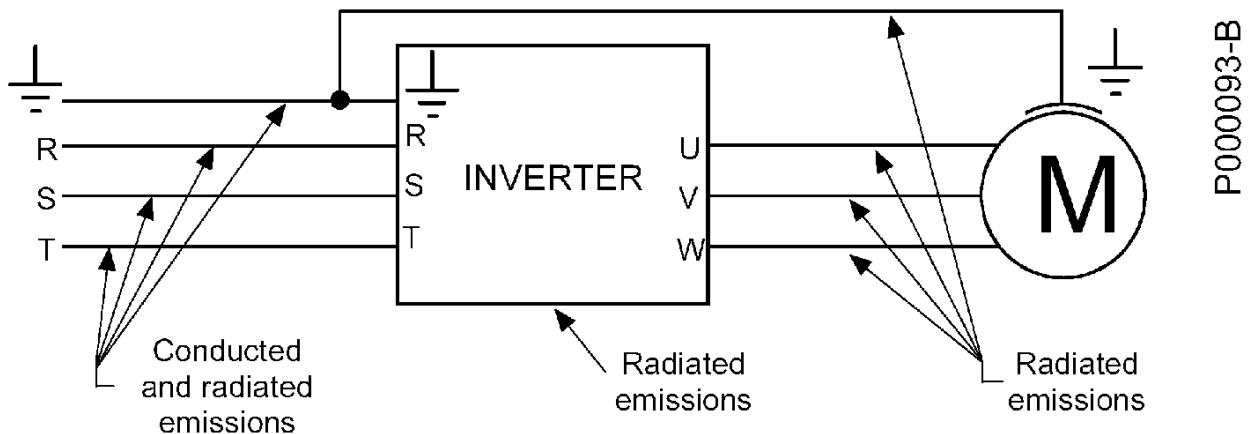


Figure 87: Disturbance sources in a power drive system equipped with an inverter

The measures to be taken to suppress disturbance include: grounding enhancement; changes made to the cabinet structure; installation of mains filters on the line and installation of output toroid filters on the motor cables; optimization of the wiring and cable shielding.

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.

6.1.2. The Power Supply 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.

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

6.1.2.2. 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.

B) 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.

C) Hinged parts or mobile parts (i.e. doors) must be made of metal and capable of restoring electrical conductivity once closed.

D) Segregate cables based 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 (CTs and VTs) DC supply (10V, 24V)
Low sensitivity	Digital inputs and outputs: opto-isolated commands, relay outputs
Low perturbation	Filtered AC supply
High perturbation	Power circuits in general inverter non-filtered AC supply contactors inverter-motor wires

Measures to take when wiring the cabinet or the system:

- Sensitive signals and perturbator signals must never exist within a cable.
- Avoid that cables carrying sensitive signals and perturbator signals run parallel at short distance: whenever possible, paths of cables carrying sensitive signals and perturbator signals should be reduced to a minimum.
- Move away as much as possible any cables carrying sensitive signals and perturbator signals. The distance between segregated cables should be proportional to the cable length. Whenever possible, cable crossing should be perpendicular.

Wires connecting the motor or load mainly generate disturbance. Disturbance is important in inverter power drive systems or the devices installed on the machine, and could interfere with any equipment installed on the machine or with local communication circuits located near the inverter (radiotelephones, mobile phones). Follow the instructions below to solve these problems:

- Provide for a motor cable path as short as possible.
- Shield the power cables to the motor; ground shielding 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 shielding (this type of cables is available on the market with a cross-section up to 35mm² per phase); if no shielded cable having a suitable cross-section is available, segregate power cables in grounded, metal raceways.
- Shield signal cables and ground shielding 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 inductor (toroid) (approx. 100 μ H) to the inverter-Motor connection.

Limiting the disturbance in the motor cables will also limit mains disturbance.

Shielded cables allow both signal sensitive cables and perturbator cables to run in the same raceway. When using shielded cables, 360° shielded is obtained with collars directly bolted to the ground support.

The figure below illustrates the correct wiring of an enclosure containing an inverter; example of the correct wiring of an inverter installed inside an enclosure.

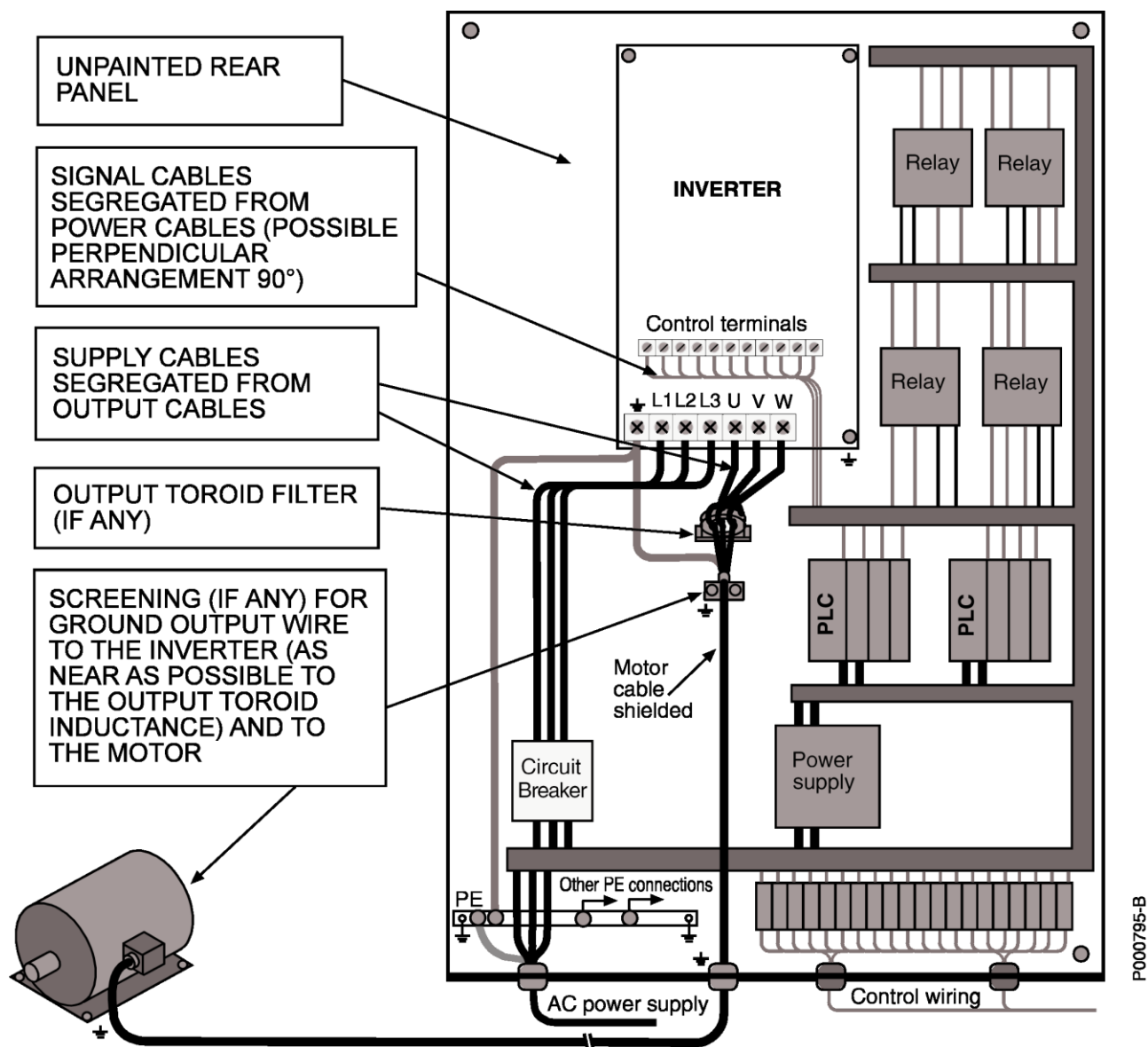


Figure 88: Example of correct wiring of an inverter inside a cabinet

6.1.2.3. Input and Output Filters

The inverters of the Sinus Penta series may be delivered with incorporated input filters; in that case, models are marked with A1, A2, B in the ID number.

If built-in filters are fitted, disturbance amplitude ranges between allowable emission limits.

As for devices of group 1, class B for standard EN 55011 just install an additional output toroid filter (e.g. type 2xK618) on the models with incorporated filter A1; make sure that the three cables between the motor and the inverter go through the core. The figure shows the wiring diagram for the line, the inverter and the motor.

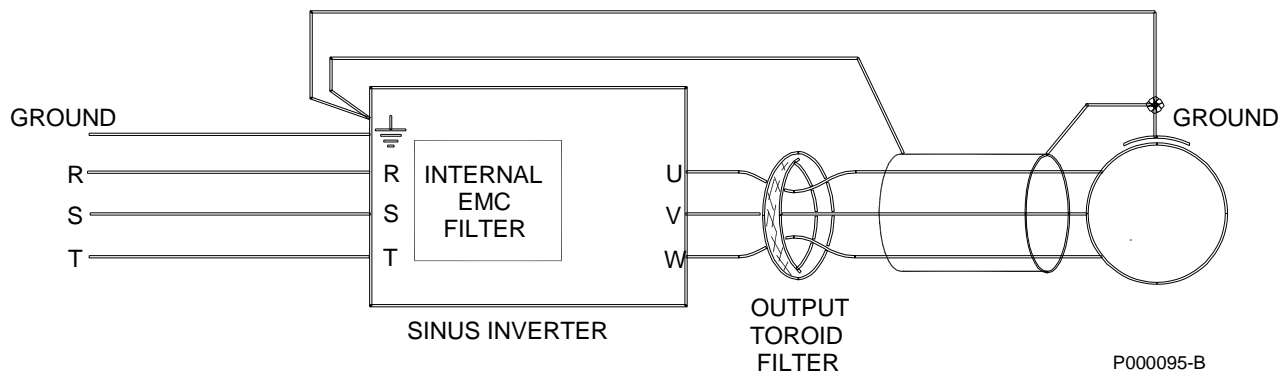


Figure 89: Wiring the toroid filter for the inverters of the Sinus Penta series



NOTE

Install the output filter near the inverter to comply with the standards in force (leave a minimum clearance for the cable connections).



NOTE

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



NOTE

Additional external EMC filters may be installed to bring emissions of devices of level **I** or **A2** to level **B** (part numbers AC171x, AC181x and AC182x).

6.2. Low Voltage Directive

The Low Voltage Directive requirements are met by the Sinus Penta drives as they comply with harmonized technical standard EN 61800-5-1, Variable Frequency Drives. Part 5-1: Safety Requirements - Electrical, Thermal and Energy.

The Sinus Penta drives may be integrated into a machine as they also meet the applicable requirements of technical standard EN 60204-1, Safety of machinery - Electrical equipment of machines - General requirements. Part 1: General rules.

7. INDEX

A

Air cooling	22
Alarms	107; 147
Application	
Heavy	149
Light	149
Standard.....	149
Strong.....	149
Auxiliary power supply	143

B

Box	41
-----------	----

C

Cabinet.....	43; 182
Choosing the product	148

D

Dissipated power	24
Disturbance.....	181
Download.....	132

E

Efficiency.....	24; 29
Encoder.....	115
Environmental requirements.....	21; 145

F

Filters	
Toroid.....	182
FOC	8; 9
Frequency	
carrier	167

G

Ground connection	11; 98
-------------------------	--------

H

Handling.....	19
---------------	----

I

IFD.....	8; 9
Inputs	
Analog.....	117; 122
Auxiliary	119
Digital.....	113; 116
Frequency	115

K

Keypad	131
Remoting.....	70; 131; 134

L

LEDs.....	131
-----------	-----

M

Mains failure	180
Maintenance	26
Motor	
applicable.....	145
Multi-motor	149

N

Noise Level	29
-------------------	----

O

Output	
Filters	185
Frequency	145
Outputs	
Analog	130
Digital	123; 126; 129
Frequency	125
Relay.....	128
Overload.....	148
Heavy	159
Light	151
Standard.....	155
Strong.....	163

P

Permanent Magnets Motors.....	14
Piercing templates	45; 47; 55; 58
Power	
Cables.....	87; 183
Connections	57
Terminals.....	12; 59; 103
Power Connections	59
PTC	100; 117; 121

R

RESET	114
RGN	9

S

SAFETY.....	11; 144
Serial communications.....	138
Serial Communications	142
Short-circuit Currents.....	177
Size	24; 29
Spare	112
Standard mounting	45; 55; 58
START	113
Start up	144



SYN.....	8; 9	Unpacking	19
T		Upload.....	132
Terminals		V	
Control	99	Voltage Class	
Power	79	2T-4T	155; 156; 159; 163
Thermal protection	12; 121	5T-6T	153; 154; 157; 158; 161; 165; 166
Through-panel assembly.....	47	VTC	8; 9
Twelve-Pulse Connection	59; 76	W	
U		Weight.....	24; 29
UL-Approved Fuses	89; 94; 97	Wiring diagram	61; 63
UL-Approved Surge Protective Devices	90		