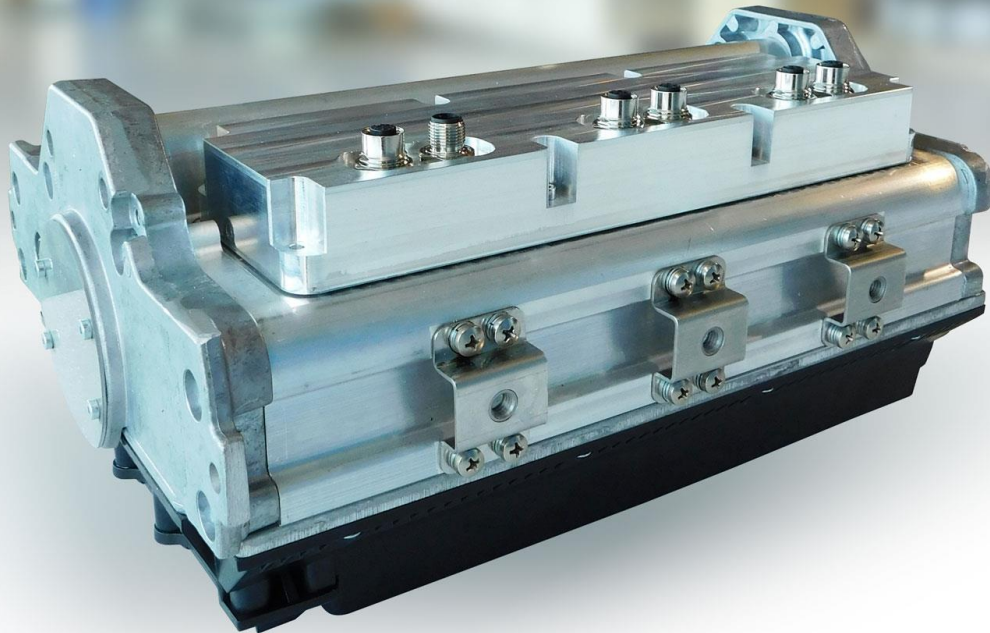




# AxS

## User's Manual



*Supported Models*  
AX -S 600-SI-1

REV: 01 (English)  
DATE: Nov 14, 2024

Phase Motion Control S.p.a. Via Cibrario 4 - 16154 Genova, Italy - [www.phase.eu](http://www.phase.eu)

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This may not be the latest revision of this publication and may not reflect all current product changes.  
Contact Phase Motion Control Spa. for the latest revision of this data sheet and information on other product enhancements.*

# Summary

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## General Information

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### 1.1 Manual History

Note:

PMC keeps the printed version of user’s manuals as current as possible. From a safety standpoint, however, the current version from the Phase website must be used ([www.phase.eu](http://www.phase.eu)).

Rev	Date	Comment
Version 01	2024-11-14	

*Table 1: Manual history*

### 1.2 Notes

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## System Overview

### 2.1 Introduction

The AXS series high power density PM inverter drive modules are high reliability, compact, direct liquid cooled inverters designed for mobility applications where compactness, low mass and ruggedness are essential. DC bus working voltage compliance is from 350 to 850 Vdc. SI type modules consist of 1, 2 and 3 drive modules, respectively, IGBT based, which can be run in parallel or phase staggered to minimize PWM ripple.

### 2.2 Applications

- Propulsion drives (boats, submarines, pumps, actuators)
- Ground traction (truck, bus, earth moving equipment, electric substitution of hydraulic actuators)
- Electric & hybrid aviation

### 2.3 Main characteristics

- Direct cooled IGBT stage (SI series);
- Optimized layout with non electrolytic capacitors to minimize voltage overshoot
- Fully digital gate driver with active clamping
- Ruggedized case, vibration and shock proof, IP 65 protection
- 1 MHz current sensing bandwidth
- Switchable PWM frequency up to 16 kHz (with derating) -
- Continuous, accurate monitoring of device temperatures under all operating conditions
- Multiple drive synchronization with single sensor for redundant operation on multi winding motor

### 2.4 Warnings

- This equipment may be connected to more than one live circuit.
- Wait at least 5 minutes after isolating supplies and check that the voltage between DC+ and DC- has reduced to a safe level before working on the equipment.
- Surfaces on the coolant pipes can reach high temperatures and remain hot for some time after power is removed.
- Ensure that all coolant has cooled to a safe temperature and the equipment is suitably drained and isolated before the external pipework is disconnected from the equipment.

## 2.5 Standard

Region	Certification name	Directive	Standard
Europe	CE certification	2014/30/EU	EN 61800-3:2004+A1:2012
		2014/35/EU	EN 61800-5-1:2007
		2006/42/EC	EN 61800-5-1:2007 EN 61800-5-2:2007
USA	UL certification		UL 61800-5-1:2007

Table 2: Standard

### Note:

The relevant certifications obtained for the products are subject to the certification mark indicated on the name- plate. For specific certification information, please consult the sales manager.

## 2.6 Safety first. Warnings and Mandatory Notices



UP to 800 Volts in the described devices  
Section/disconnect all power source before installing, dis/connecting any cables.



Magnetic fields is produced by motors and power devices – keep distances from people with any electronic medical devices (pacemakers implantable defibrillators or similar)



Pay attention working near moving parts connected to motors. Sudden and remote driven movements are possible, especially with fieldbus connections.



Drives and connectors become hot when connected to the power (and remain hot even after power off). Don't touch any components: a burn injury may result



Pay attention using metal made tools and screwdrivers near high voltage devices and cables



Risk of explosion and fire inside or near the motor and power unit. Establish a safe work area, and install devices away from combustible materials



Be careful commissioning or bench testing motors. Torque can lead to uncontrolled motor chassis movements, if not properly fixed to solid surfaces or actuators.



Ground link needed – with adequate and wide contact surfaces



Specific HIGH voltage protecting gloves is necessary in mounting, connecting and working near Electric Motors, Power supplier and cables

Only qualified and authorized from PMC personnel allowed to install the described devices



Informations in this manual are not intended to allow any unauthorized mechanical, electrical or software maintenance or repairs.



This manual must be read entirely before any physical or remote operation on servo motors, drives, power supply and any other electrical parts and cables.

Ensure that a copy of this manual is available to the machinery end user.

## Technical Data

Manual History Unless special stated, the following technical data is valid for all drives of the AXS series.

### 3.1 Electrical – Power Section\*

Specification	Type	Units	Notes
	AXS 600-SI-1		
Continuous Current, 500 Vac PM motor drive	420	Arms	1)
Continuous Current, 350 Vac motor drive	520	Arms	2)
Peak Current (1 sec), 500 Vac PM motor drive	600	Arms	3)
Max Continuous DC Link Operating Voltage	850	Vdc	
Overload voltage threshold	900	Vdc	
Non-Operating DC Link Withstand Voltage	1150	Vdc	
DC Link Capacitance	500	uF	
Maximum PWM Frequency	16	kHz	4)

#### Test conditions

DC link voltage = 750 Vdc, Coolant temperature = 60 C, Output voltage = 500 Vac  
power factor 0.85, PWM frequency = 8 kHz

DC link voltage = 550 Vdc, Coolant temperature = 60 C, Output voltage = 350 Vac  
power factor 0.85 PWM frequency = 8 kHz

30 sec, duty cycle < 10% PWM frequency selectable and switchable on the fly

\*For other applications contact Phase Motion Control Spa.

### 3.2 Electrical – Control & Interface Section (Note: preliminary, TBC)

Specification	All AXS drives	Notes
Analog I/Os	1 programmable output Channel 0-10V 1 programmable input channel 0-10 V	Resolution: 12 bit with oversampling A/D converter I/O
Digital I/Os	1 digital input 2 programmable digital input/output	0-12 V PNP logic
Bus interfaces	Four wire RS422 for programming MODBUS RTU Protocol CanMatrix/CanOpen interface for control, remote monitoring, diagnostics Phaselink (high speed RT Ethernet link, insulated) for drive to drive synchronization and current vector sharing	
Sensor interfaces	Resolver (2 p or an integer, even fraction of motor pole pairs) EnDat 2.0	

### 3.3 Cooling

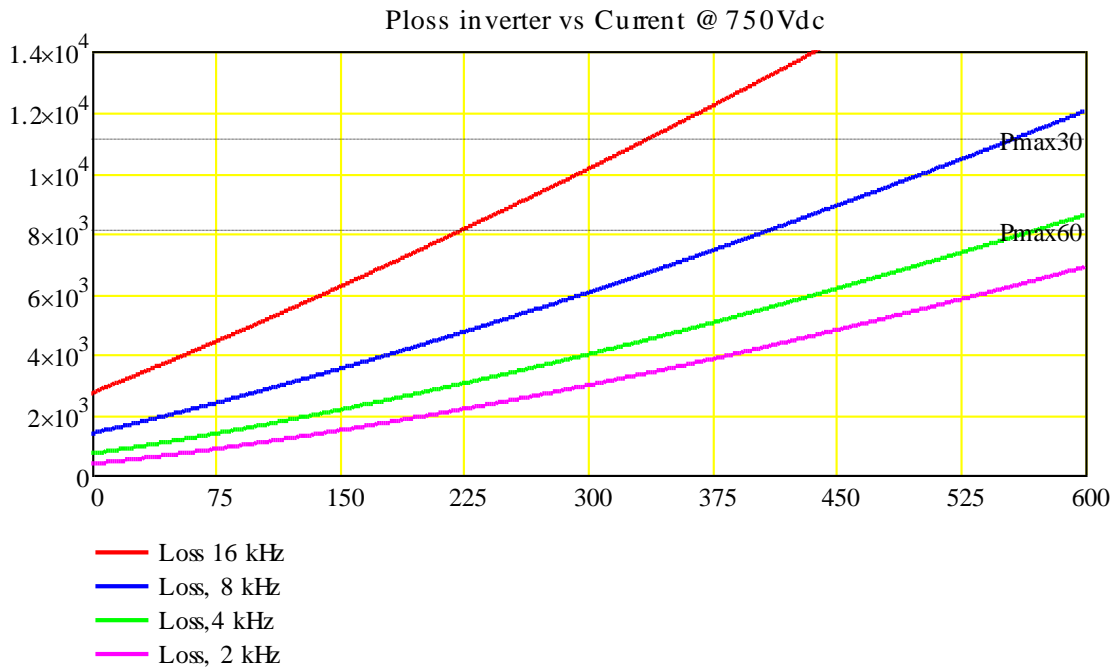
Specification	Value
Coolant Type	Water / Ethylene Glycol Maximum 50% Ethylene Glycol With suitable corrosion inhibitors
Maximum Coolant Inlet Pressure	300kPa
Maximum Coolant Inlet Temperature	60°C
Minimum Coolant Inlet Temperature	0°C
Coolant flow	10 liter/min
Pressure drop in drive circuit	< 0.5 bar
Coolant Strainer	Coolant must be strained to remove particles Maximum recommended strainer mesh is 0.7mm Inspect and clean strainer every six months
Coolant Lifetime	Check coolant constituent concentration every six months Remove coolant, flush system with de-ionized water and refill with new coolant every 24 months.
Coolant Connection Options	2x Quick-Disconnect at bottom of unit (TBC)

## Specifications

### 4.1 Performance

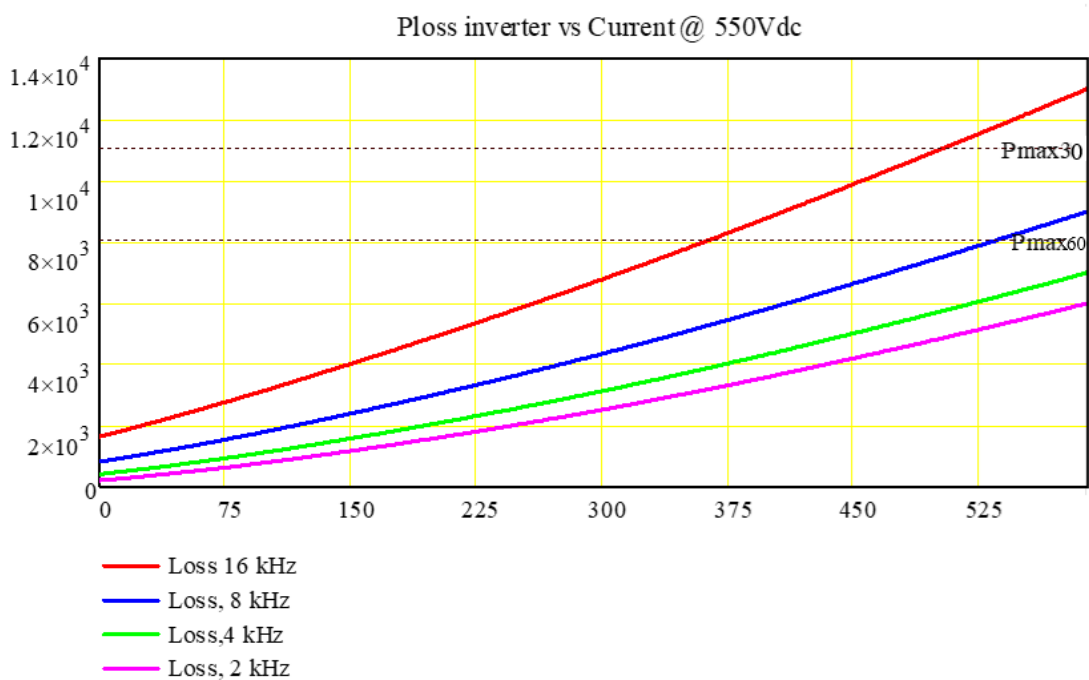
**AX -S 600-SI-1**

**750 V Dc bus**



**AX -S 600-SI-1**

**550 V Dc bus**





## 4.2 Environmental

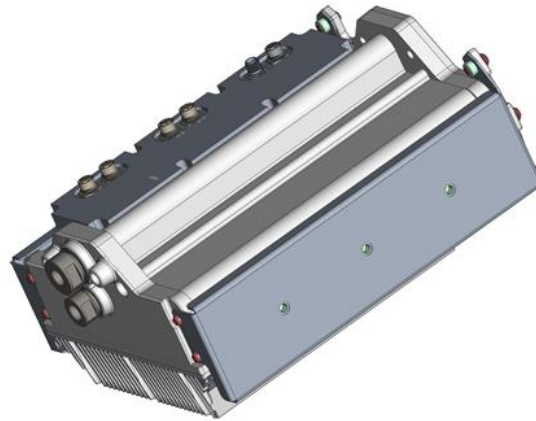
Specification	Value
Ambient Temperature	0 to 60°C
Cabinet air (when opening the unit)	Pollution Degree 2 as per IEC60664-1, UL 840 & CSA C22.2 No. 0.2-93 i.e. clean, free from dust, condensation and conductive or corrosive gases. Maximum chemicals 15ppm H <sub>2</sub> S, 25ppm NO <sub>2</sub> , 25ppm SO <sub>2</sub>
Humidity	5% to 95% RH Unit must not be operated in the presence of condensation.
Altitude	0-2000 m (for higher altitudes contact PMC spa)

## 4.3 Mechanical

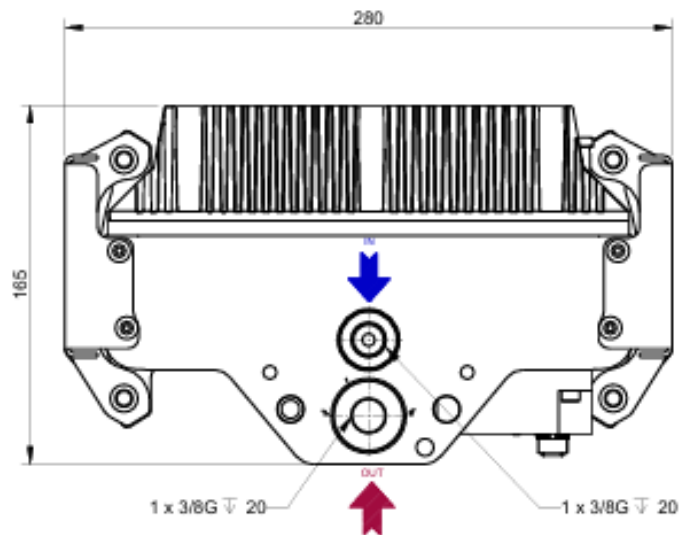
Specification	Value
Dimensions	AXS 600-SI-1: 388 mm W x 254 mm H x 154 mm D
Enclosure	IP65 (IEC 60529:1989; BS EN 60529:1992)
Mass	AXS 600-SI-1: 15 kg

## Dimensions and Installation

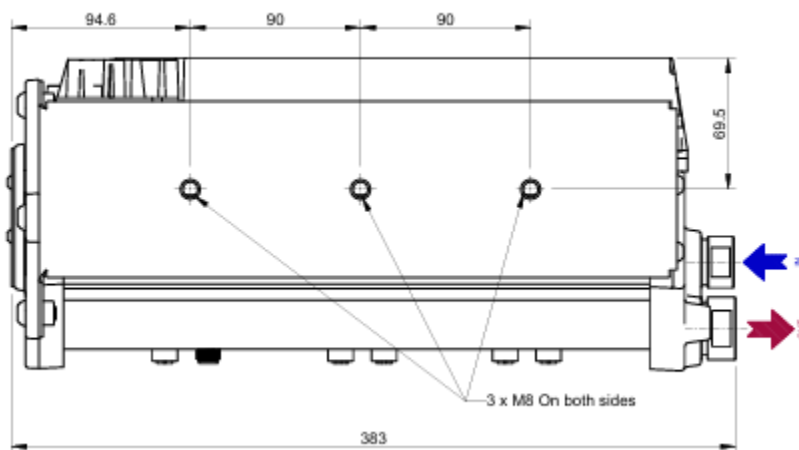
### 5.1 Dimensions



3D view

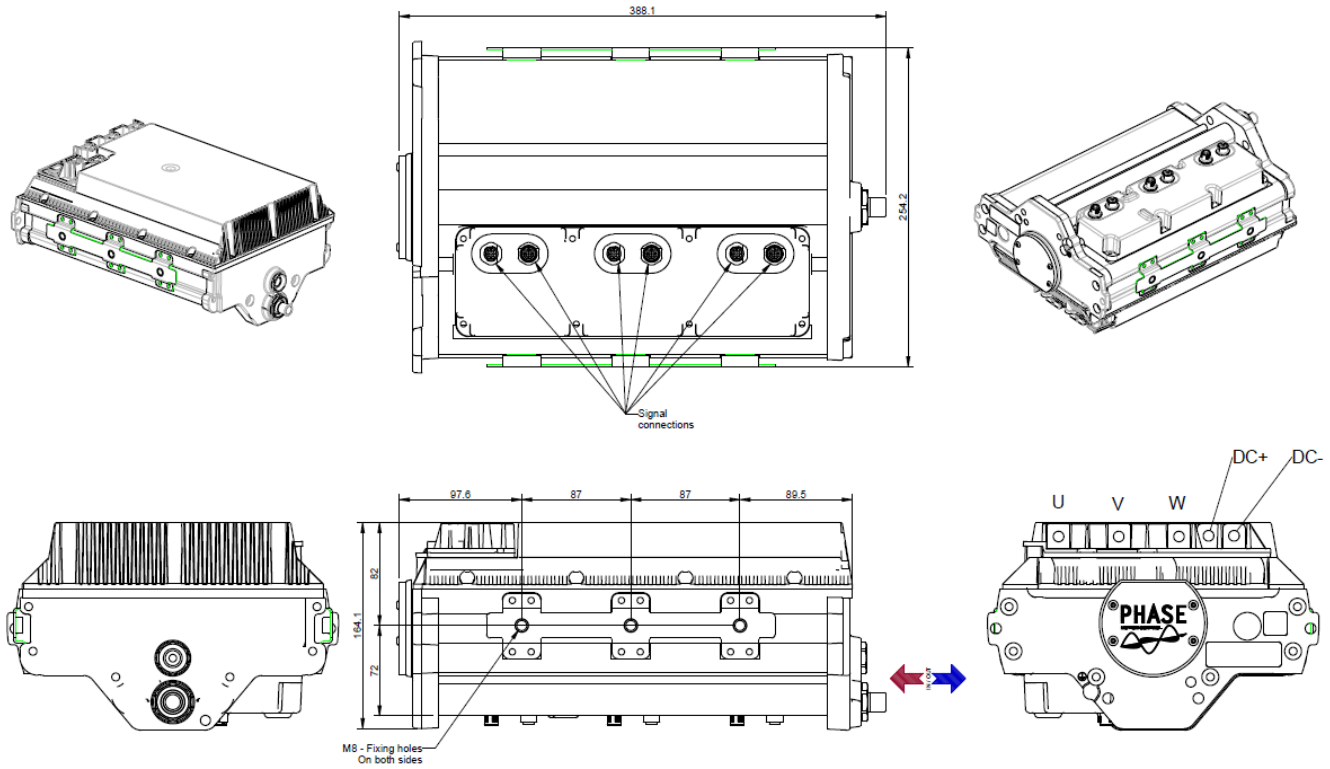


Front view



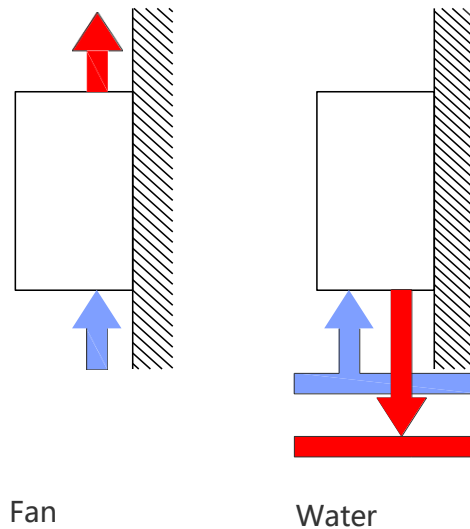
Side view

## 5.2 Connectors Location



Connectors and mounting holes location

## 5.3 Liquid cooling



Use a cooling floor, water or oil as the cooling medium, and carry away the heat generated by the power unit when flowing through the radiator. The loss power of the drive is mostly absorbed by the cooling medium and discharged to the outside of the control cabinet. This solution is smaller, enables higher power density, and has no fan noise.

## 5.4 Installation

- Transport, installation and use of the drives are reserved to qualified staff
- The opening of the drive's enclosure or protections, or a defective installation, can lead to damages
- The technical data on the unit's nameplates must be observed
- The units must be installed and cooled according to the regulations stated in the documentation
- Ensure that no components or contacts are bent or touched during transport.
- When working on energized controllers, national requirements for accidents prevention must be observed
- Installation must comply with regulations (cable cross sections, fuses, protective conductor connections)
- All control inputs and outputs of the drives are insulated with a "basic" insulation (functional). Another level of protection must be implemented for personal safety against electrical contact
  - When using current-operated protective devices, please note that the controller have internal DC rectification. A DC fault current is therefore possible. Some differential current protection systems are made inoperative by DC current leakage. Use only "universal" or pulse operated protection devices. The RFI filter which is built into the drives cause leakage current to flow in the ground wires. This current may cause tripping of too sensitive differential device and need to be taken into account while sizing differential devices
- Irrespective of the CE mark on the motor, it is reminded that the compliance of the required limit values with the legal EMC regulations remain the responsibility of the manufacturer of the system or machine.
- For installations different from the typical application (e.g.: use of unscreened cables, use of multiple drives, etc.) the conformity to the CE-EMC directive requires a check of the machine or system regarding EMC limits.
- The user of the machine is responsible for the compliance with the EMC directive.
- Screen all power cables from filters to drive and from drive to motor with shield coverage greater than 85%.
- Signal cables must always be shielded as above.
- The shields and grounds connections must be made on the chassis of the motor, on the specific screws
- The power wires should be distant from the signal and supply, avoiding crosses, angled or narrow passages
- If sensitive instruments are used (for example analogue, non preamplified transducers, load cells, thermocouples etc.) keep a safe distance between the instrumentation ground and the power ground
- All devices (drives, filters, motors) must be grounded on a single bar: wires as straight and short as possible

## 5.4 Maintenance

- Maintenance is not required in advance, if ambient and working conditions are kept within the limits.
- Inspections must be scheduled to check humidity, rust, heat, noisy, unstable or damaged parts.
- Safety functions periodic tests must be made to check mechanical and electrical response.
- Alarm list must periodically checked using Commissioning Tool, taking notes of recorded faults.



Maintenance period and life expectancy depends on the environment and operating conditions



Always ensures that no voltage is applied during maintenance operations



Only expert and authorized personnel can evaluate and operate for periodic maintenance

## Connections

### 6.1 Connections Overview

#### High Voltage / Power Connections

Connection	AXS 600-SI-1
AC Power Terminals	3 flat copper bar terminals 5x20 with 8,5 mm hole
DC Power Terminals	2 flat copper bar terminals 5x20 with 8,5 mm hole
Ground Connection	1 x M6 threaded hole

#### Low Voltage / Control Connections

##### Optional interface

Terminals	Function	Specifications and Notes
TBD	Programmable analog output 0-10 V	20 mA max load. Can be programmed as a feedback or as a controlled source for external potentiometer input
TBD	Programmable analog input 0-10 V	Can be programmed as position, speed or torque setting
TBD	Digital inputs	Up to 3 programmable inputs, 24 V PNP logic, one programmable digital output, 24 V, 100 mA
TBD	Digital output	

#### Auxiliary Power Supply

Auxiliary power is necessary to power the drive and the sensors and is separate from power terminals. Power must be fed on terminals with following characteristics:

Terminals	Function	Specifications and Notes
32	CONTROL POWER SUPPLY [+]	Provides power for controller interface and SiC drivers 12-28 V DC, +/-5%, 1 A maximum load Voltage transients during power on/off must be monotonic Supply must meet application power loss ride-through requirements. [-] terminals are connected to system 0V [GROUND] on the C.I.B.
35	CONTROL POWER SUPPLY [-]	

Customers wishing to provide their own auxiliary power should contact PMC for further information and approval of proposed power supply equipment and connections.

Customers **MUST NOT** use an unapproved auxiliary power scheme, doing so will void the product warranty

## 6.2 Connectors Pinout

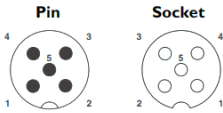
### Low Voltage, Motor, Sensor, Control Connections

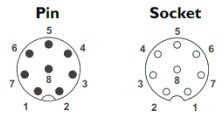
#### Overview

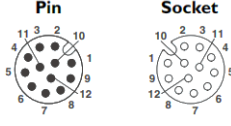
The drive control is operated through 6 M12 type connectors.

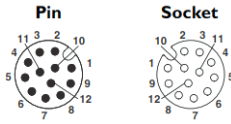
The connection functions are:

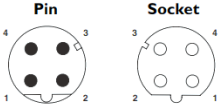
- M1,M2 Motor temperature & protection, motor position sensor
- C1,C2 Serial control bus (CanMatrix/CanOpen) on redundant bus, RS422, aux power, programmable I/Os
- I1,I2 High speed RT Ethernet intradrive (EtherPMC) connection for data sharing and synchronization between multiple drives

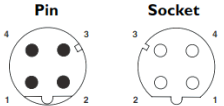
<b>M1 - Motor signal</b> M12x5 A-coded Female		
Pin N.	Connector name	Notes
1	PTC+	
2	PTC-	
3	PT1000+	
4	PT1000-	
5	N.C.	
Connector body	Shield	

<b>M2 - Motor sensor</b> M12x8 A-coded Female		
Pin N.	Connector name	Notes
1	Exc +	
2	Exc -	
3	Sin +	Endat Clk+
4	Sin -	Endat Clk-
5	Cos +	Endat Dat +
6	Cos -	Endat Dat +
7	Sensor supply +	Programmable
8	Sensor supply -	Programmable
Connector body	Shield	

<b>C1 - Control interface 1 (Main)</b> M12x12 A-coded, Female		
Pin N.	Connector name	Notes
1	Aux Supply	12 V, 2A
2	GND	
3	Can H	
4	Can L	
5	Can GND	
6	n.c.	
7	RS 422 Tx+	
8	RS 422 Tx -	
9	RS 422 Rx+	
10	RS 422 Rx-	
11	Digital input Enable	
12	n.c.	
Connector body	Shield	

<b>C2 - Control interface 2 (Redundancy)</b> M12x12 A-coded, Male		
Pin N.	Connector name	Notes
1	n.c.	
2	n.c.	
3	Can H	
4	Can L	
5	Can GND	
6	Digital 0V Reference	0V Ref. for digital signals
7	Programmable Digital I/O	LOW = 0V, HIGH = 12V
8	Programmable Digital I/O	LOW = 0V, HIGH = 12V
9	Programmable Analogue Input	0-10V
10	Programmable Analogue Output	0-10V
11	0V Analogue	0V Ref. for analog signals
12	n.c.	
Connector body	Shield	

<b>I1 - Intradrive IN (RT Ethernet)</b> M12x4 D-coded Female		
Pin N.	Connector name	Notes
1	TX+	
2	RX+	
3	TX-	
4	RX-	
housing	Shield	

<b>I2 - Intradrive OUT (RT Ethernet)</b> M12x4 D-coded Female		
Pin N.	Connector name	Notes
1	TX+	
2	RX+	
3	TX-	
4	RX-	
housing	Shield	



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**PHASE MOTION CONTROL S.P.A**  
HEADQUARTERS - Via Luigi Cibrario 4, 16154  
Genova, Italy  
Phone +39 010 835161

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