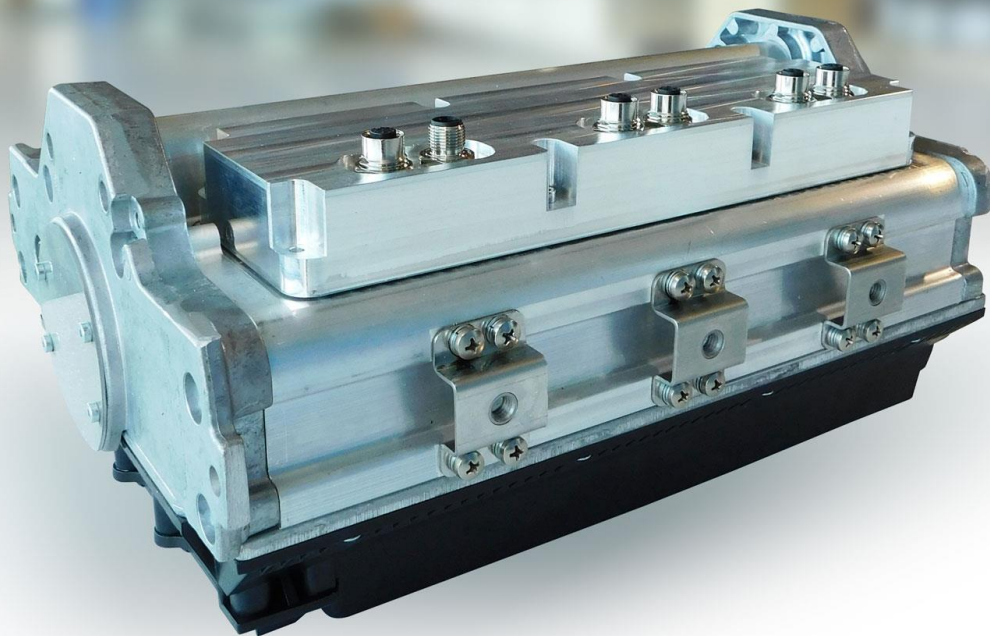




AxS

User's Manual



Supported Models
AX -S 600-SI-1

REV: 01 (English)
DATE: nov 20, 2024

Phase Motion Control S.p.a. Via Cibrario 4 - 16154 Genova, Italy - www.phase.eu

Disclaimer:

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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.*

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General Information

1.1 Abbreviations

Abbreviations used in the present document:

PMC: Phase Motion Control; PWM: pulse width modulation; EtherPMC: proprietary Phase Motion Control Ethernet based fieldbus; PM: pulse modulation; DC: direct current; AC: alternate current;

1.2 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).

Rev	Date	Comment
Version 01	2024-11-14	

Table 1: Manual history

1.3 Notes

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.

For higher current applications, multiple AxS Inverters can be run in parallel or phase staggered to minimize PWM ripple, synchronized via PMC proprietary BUS, EtherPMC.

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 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

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.

2.5 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.

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.



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.



Surfaces on the coolant pipes, drives, connectors, can reach high temperatures and remain hot for some time after power is removed. Don't touch any components: a burn injury may result

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.



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



Risk of explosion and fire iside 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 personnel allowed to install the described devices



Informations in this manual are not intendended to allow any unauthorized mechanical, electrical or software mantainance 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 a copy is available to the end user.

Technical Data

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)
Minimum Operating DC Link Voltage	350	Vdc	
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

- 1) DC link voltage = 750 Vdc, Coolant temperature = 60 C, Output voltage = 500 Vac power factor 0.85, PWM frequency = 8 kHz
- 2) DC link voltage = 550 Vdc, Coolant temperature = 60 C, Output voltage = 350 Vac power factor 0.85 PWM frequency = 8 kHz
- 3) 30 sec, duty cycle < 10% 4) PWM frequency selectable and switchable on the fly

*For other application conditions contact Phase Motion Control Spa.

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

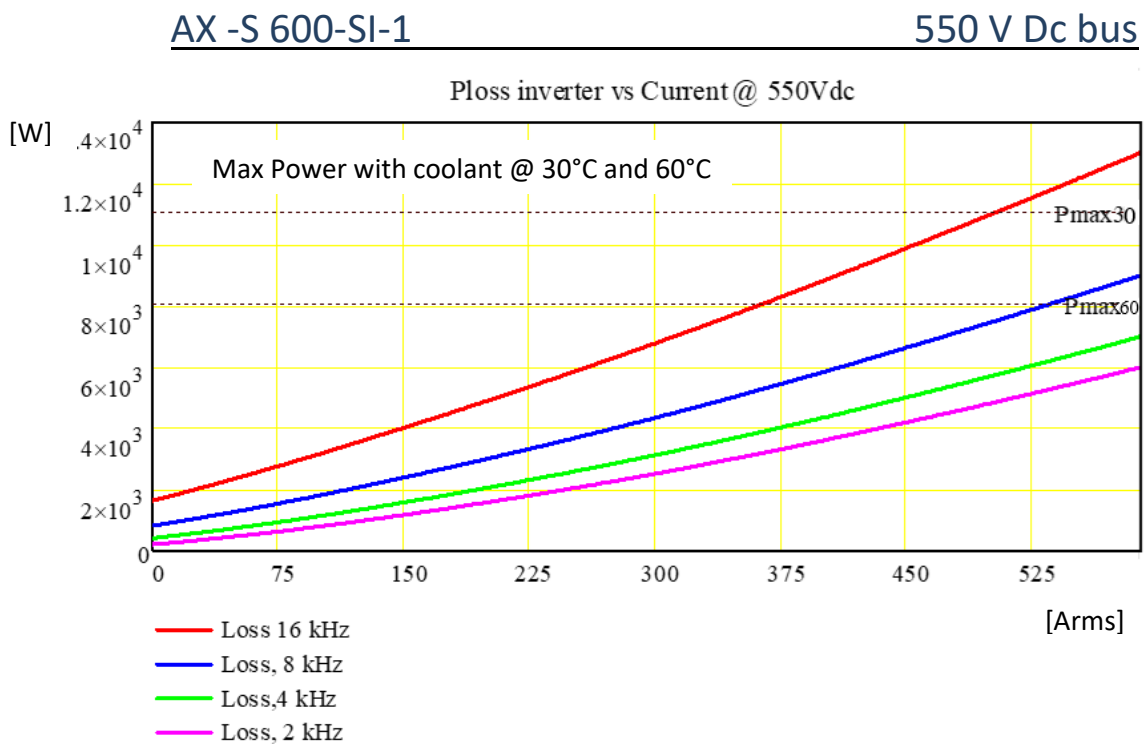
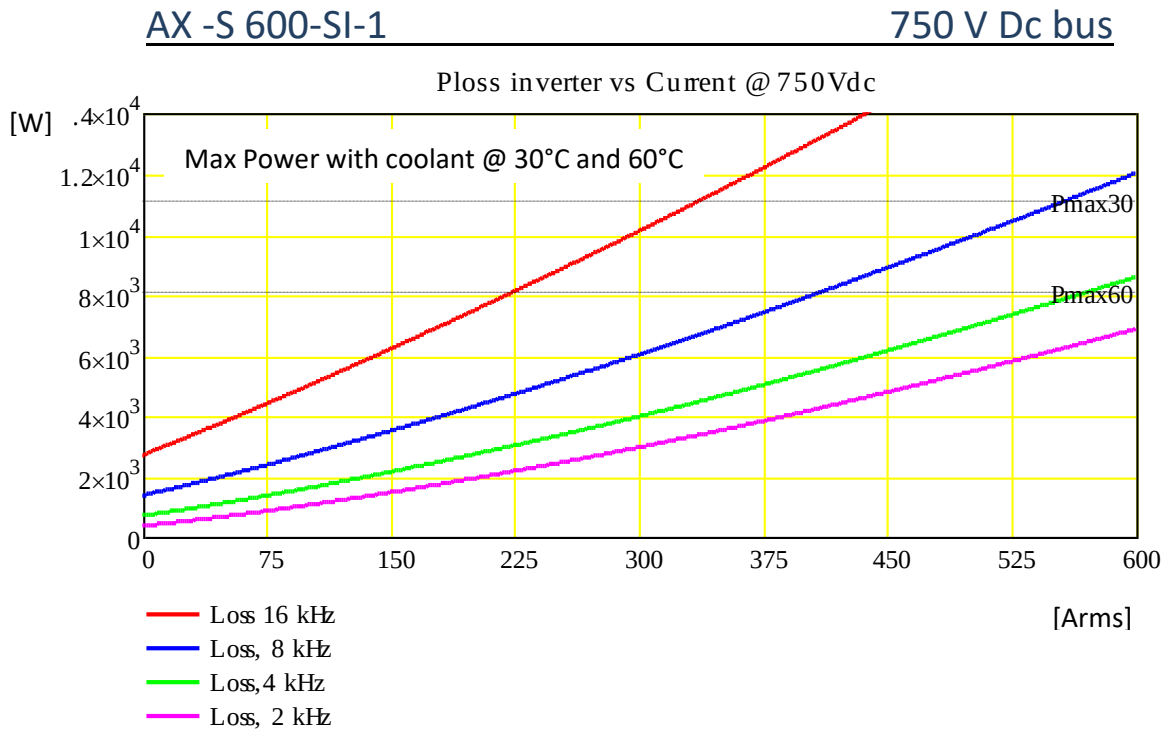
Specification	All AXS drives	Notes
Analog I/Os	1 programmable output Channel 0-10V 1 programmable input channel 0-10 V	Resolution: 12 bit with oversampling A/D converter I/O
Digital I/Os	3 digital input 3 digital output	0-12 V PNP logic
Bus interfaces	Four wire RS422 for programming MODBUS RTU Protocol CanMatrix/CanOpen interface for control, remote monitoring, diagnostics EtherPMC (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	3/8G female fittings

Specifications

4.1 Performance



4.2 Environmental

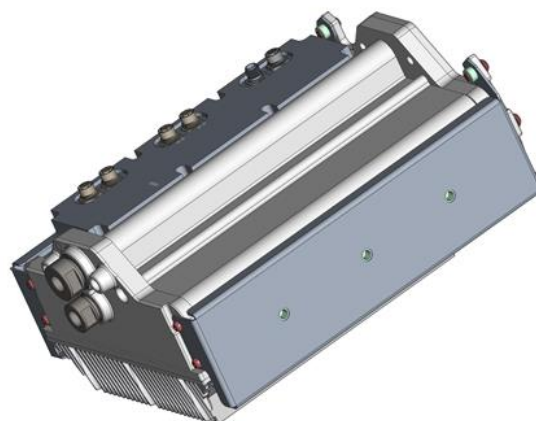
Specification	Value
Ambient Temperature	0 to 60°C
Cabinet air (when opening the unit)	Pollution Degree 2 as per IEC60664-1, UL 840 & CSA C22.2 No. 0.2-93 i.e. clean, free from dust, condensation and conductive or corrosive gases. Maximum chemicals 15ppm H ₂ S, 25ppm NO ₂ , 25ppm SO ₂
Humidity	5% to 95%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

4.3 Mechanical

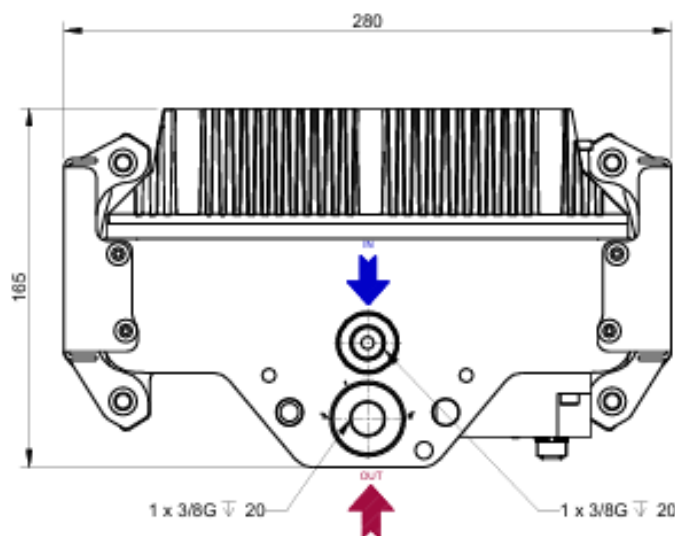
Specification	Value
Dimensions	AXS 600-SI-1: 383 mm W x 280 mm H x 280 mm D
Enclosure	IP65 (IEC 60529:1989; BS EN 60529:1992)
Mass	AXS 600-SI-1: 15 kg

Dimensions and Installation

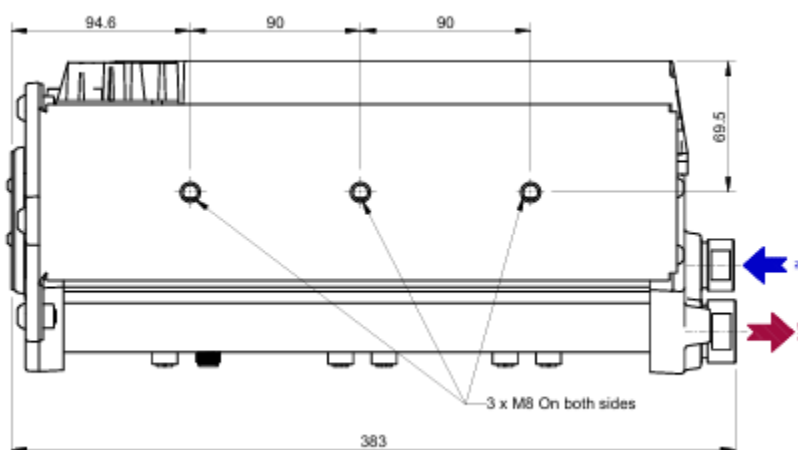
5.1 Dimensions



3D view

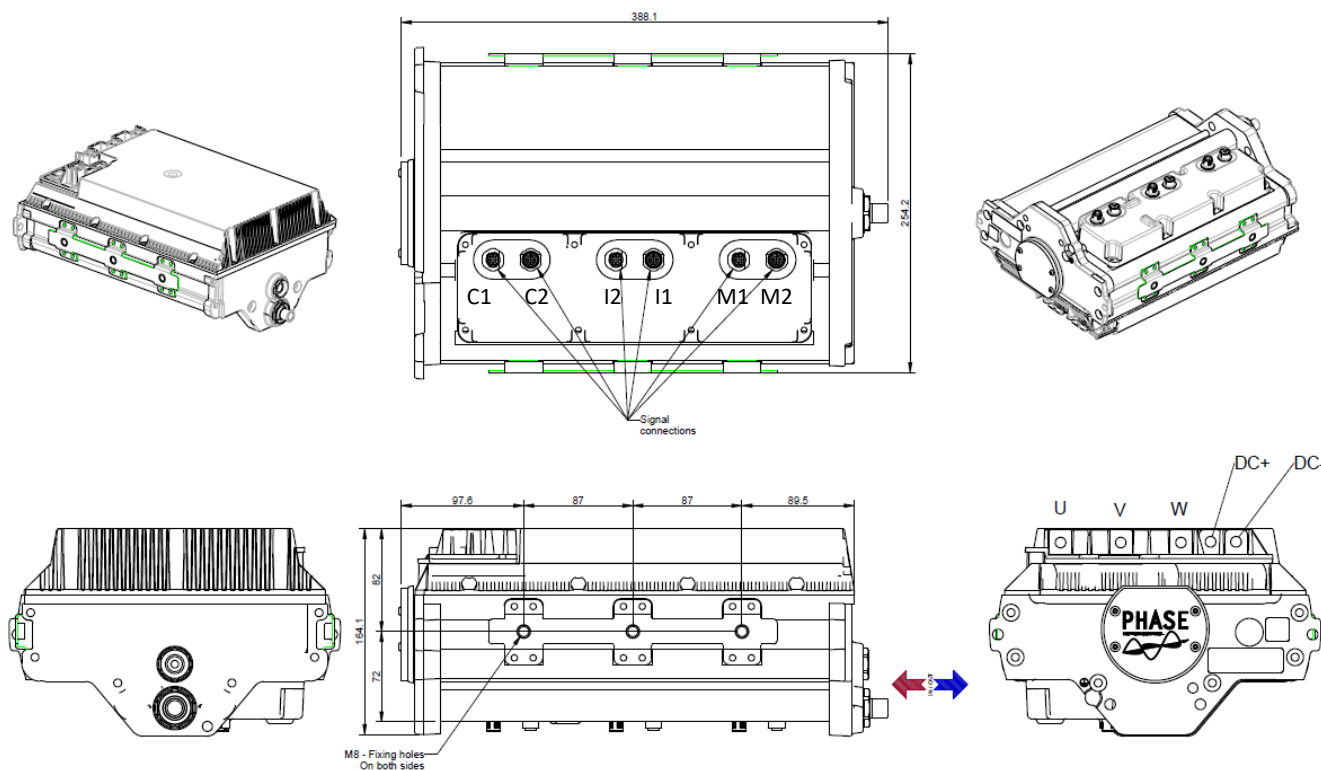


Front view



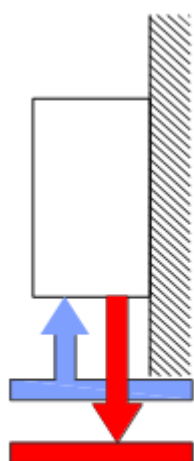
Side view

5.2 Connectors Location



Connectors and mounting holes location

5.3 Liquid cooling



Water

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.

Maximum Coolant Inlet Pressure 300kPa

Coolant flow 10 liter/min

Check Pag. 9 for all cooling specifications

5.3 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

- Check coolant constituent concentration every six months
- Other maintenance is not required in advance, if all 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

6.2 Connectors Pinout

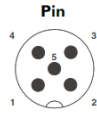
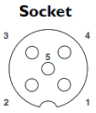
Low Voltage, Motor, Sensor, Control Connections

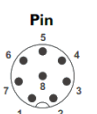
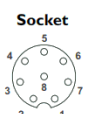
Overview

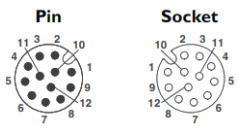
The drive control is operated through 6 M12 type connectors.

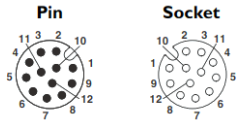
The connection functions are:

- 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

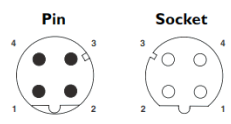
M1 - Motor signal M12x5 A-coded Female		 
Pin N.	Connector name	Notes
1	PTC+	Motor temperature sensor 1
2	PTC-	Motor temperature sensor 1
3	PT1000+	Motor temperature sensor 2
4	PT1000-	Motor temperature sensor 2
5	N.C.	
Connector body	Shield	

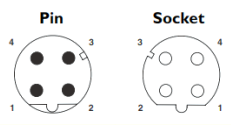
M2 - Motor sensor M12x8 A-coded Female		 
Pin N.	Connector name	Notes
1	Exc +	Resolver Excitation +
2	Exc -	Resolver Excitation -
3	Sin + / Endat Clk+	Resolver Sin + / Endat Clk+
4	Sin - / Endat Clk -	Resolver Sin + / Endat Clk -
5	Cos + / Endat Data +	Resolver Cos + / Endat Dat +
6	Cos - / Endat Data -	Resolver Cos - Endat Dat -
7	Sensor supply +	Programmable 0 .. 13.5 V
8	Sensor supply -	0 V Sensor
Connector body	Shield	

C1 - Control interface 1 (Main) M12x12 A-coded, Female		
		
Pin N.	Connector name	Notes
1	Aux Supply +	10-28 V, 2 A max
2	Aux supply 0 V	
3	Can H	Isolated main CAN line
4	Can L	Isolated main CAN line
5	Can GND	Main CAN GND
6	n.c.	
7	RS 422 Tx+	Isolated serial interface
8	RS 422 Tx -	Isolated serial interface
9	RS 422 Rx+	Isolated serial interface
10	RS 422 Rx-	Isolated serial interface
11	Gnd 422	Serial interface GND
12	Drive enable	Digital input 2
Connector body	Shield	

C2 - Control interface 2 (Redundancy) M12x12 A-coded, Male		
		
Pin N.	Connector name	Notes
1	Digital Output 0	High Out = AuxVcc-1V
2	Digital Output 1	High Out = AuxVcc-1V
3	Can H	Isolated Auxiliary CAN line
4	Can L	Isolated Auxiliary CAN line
5	Can GND	Auxiliary CAM GND
6	Digital 0V Reference	0V Ref. for digital signals
7	Digital Input 0	LOW = 0V, HIGH = 10-30V
8	Digital Input 1	LOW = 0V, HIGH = 10-30V
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	
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I1 – EtherPMC / EtherCAT IN M12x4 D-coded Female		
Pin N.	Connector name	Notes
1	TX+	
2	RX+	
3	TX-	
4	RX-	
housing	Shield	

I2 - EtherPMC / EtherCAT OUT M12x4 D-coded Female		
Pin N.	Connector name	Notes
1	TX+	
2	RX+	
3	TX-	
4	RX-	
housing	Shield	

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