BECKHOFF New Automation Technology

Startup | EN

AX5000 Servo Drive

AX5160, AX5172, AX5190, AX5191, AX5192, AX5193

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1 Foreword

1.1 Notes on the documentation

This description is intended exclusively for trained specialists in control and automation technology who are familiar with the applicable national standards.
The documentation and the following notes and explanations must be complied with when installing and commissioning the components.
The trained specialists must always use the current valid documentation.

The trained specialists must ensure that the application and use of the products described is in line with all safety requirements, including all relevant laws, regulations, guidelines, and standards.

Disclaimer

The documentation has been compiled with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without notice.
Claims to modify products that have already been supplied may not be made on the basis of the data, diagrams, and descriptions in this documentation.

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1.2 Notes on information security

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Beckhoff products and solutions undergo continuous further development. This also applies to security functions. In light of this continuous further development, Beckhoff expressly recommends that the products are kept up to date at all times and that updates are installed for the products once they have been made available. Using outdated or unsupported product versions can increase the risk of cyber threats.

To stay informed about information security for Beckhoff products, subscribe to the RSS feed at https://www.beckhoff.com/secinfo.

1.3 Version numbers

On request we can send you a list of revision levels for changes to the documentation. Please send your request to:

support@beckhoff.com

Origin of the document

This documentation was originally written in German. All other languages are derived from the German original.

Product features

The valid product features are always those specified in the current documentation. Further information given on the product pages of the Beckhoff homepage, in emails or in other publications is not authoritative.

1.4 Intended use

The servo drives of the AX5000 series are **exclusively** designed for torque, speed and position control of suitable asynchronous and synchronous three-phase motors. The maximum permissible effective motor voltage must be higher than or at least equal to the effective mains voltage fed into the servo drive.

The servo drives from the AX5000 series are designed for installation as components in electrical systems or machines and may be operated only as integrated system or machine components.

⚠ WARNING

Caution – Risk of injury!

Basically, electronic devices are not fail-safe. The machine manufacturer is responsible for ensuring that the connected motors and the machine are brought into a safe state in the event of a failure of the drive system.

The servo drives may **only** be operated in enclosed control cabinets and in accordance with the environmental conditions described in the chapter **"Technical data"**.

Improper use

The AX5000 servo drive is **not** suitable for use in the following areas:

- in ATEX zones without a suitable housing
- in areas with aggressive environments (e.g. aggressive gases or chemicals)

The relevant standards and directives for EMC interference emissions must be complied with in residential areas.

For the section **Improper use**, please refer to the system manual.

1.4.1 Dual Use (EU 2021/821)

According to the published EU Regulation No. 2021/821, commercially available VFD are categorized as dual-use items. This means that the Beckhoff AX5000 servo drive belongs to the goods category that could be included in a dual-use listing.

The goods list, "Annex 1" of the Dual Use regulation 2021/821, has been amended accordingly:

- VFD (listed in goods list position 3A225) with a rotary field frequency of ≥600 Hz are subject to export control.
- VFD (listed in goods list position 3A225) with a rotary field frequency of ≤599 Hz are not subject to export control.

Dual Use listing information

The type key of the AX5000 servo drive determines whether export control in accordance with a dual-use listing is required. The dual-use listing is indicated with the letter "g".

- 0 = product not subject to authorization as the rotating field frequency is limited to 599 Hz during production.
- 1 = product subject to export authorization, if applicable

Firmware versions without the supplement "Dual Use conform" can only be operated on the following devices, taking the hardware versions into account:

- HW Version 1.0 (AX5xxx-0000-x0xx): serial number < 68000
- HW Version 1.0 (AX5xxx-0000-x01x)
- HW Version 2.0 (AX5xxx-0000-x20x): serial number < 140000
- HW Version 2.0 (AX5xxx-0000-x21x)

These firmware versions allow operation with a rotating field frequency above 600 Hz; shipping as a single part may be subject to export control.

Firmware versions with the supplement "Dual Use conform" can continue to be operated on all devices, taking the hardware versions into account. These versions support both rotary field frequency ranges (<600 Hz, >=600 Hz), depending on the device. Devices with the option designation "- x21x" or "-x01x": shipment as a single part may be subject to export controls.

For a downgrade, please contact our service department.

1.5 Documented servo drives

This documentation describes the following servo drives of the AX5000 series:

AX5160	AX5172	AX5190	AX5191	AX5192	AX5193	

2 For your safety

Safety regulations

Read the following explanations for your safety.
Always observe and follow product-specific safety instructions, which you may find at the appropriate places in this document.

Exclusion of liability

All of the components are supplied in specific hardware and software configurations depending on the application requirements. Changes to the hardware or software configurations other than those described in the documentation are not permitted and will result in the exclusion of liability on the part of Beckhoff Automation GmbH & Co. KG.

In addition, the following points are excluded from the liability of Beckhoff Automation GmbH & Co. KG:

- Failure to comply with this documentation
- Improper use
- Use of untrained personnel
- Use of unauthorized spare parts

Personnel qualification

This description is only intended for trained specialists in control, automation, and drive technology who are familiar with the applicable national standards.

Signal words

The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

⚠ DANGER
Hazard with high risk of death or serious injury.

⚠ WARNING
Hazard with medium risk of death or serious injury.

⚠ CAUTION
There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE
The environment, equipment, or data may be damaged.

Information on handling the product

This information includes, for example:
recommendations for action, assistance or further information on the product.

NOTICE	
	**UL note!** This symbol indicates important information regarding UL approval

2.1 Staff qualification

This documentation is aimed at trained specialists working in control technology and automation who have knowledge of the applicable and required standards and directives.

Specialists must have knowledge of drive technology and electrical equipment as well as knowledge of safe working on electrical systems and machines. This includes knowledge of proper setup and preparation of the workplace as well as securing the working environment for other persons.

The documentation published at the time must be used for each installation and commissioning. The products must be used in compliance with all safety requirements, including all applicable laws, regulations, provisions and standards.

Instructed person

Instructed persons have a clearly defined task area and have been informed about the work to be carried out. Instructed persons are familiar with:

- the necessary protective measures and protective devices
- the intended use and risks that can arise from use other than for the intended purpose

Trained person

Trained persons meet the requirements for instructed persons. Trained persons have additionally received training from the machine builder or vendor:

- machine-specific or
- plant-specific

Trained specialists

Trained specialists have received specific technical training and have specific technical knowledge and experience. Trained specialists can:

- apply relevant standards and directives
- assess tasks that they have been assigned
- recognize possible hazards
- prepare and set up workplaces

Electricians

Electricians have extensive technical knowledge from their studies, apprenticeships, or specialist training. They have an understanding of control technology and automation. They are familiar with relevant standards and directives. Electricians can:

- independently recognize, avoid and eliminate sources of danger
- implement specifications from the accident prevention regulations
- assess the work environment
- independently optimize and carry out their work

2.2 Notes on the AX5000 servo drive

The safety instructions are designed to avert danger and must be followed during installation, commissioning, production, troubleshooting, maintenance and trial or test assemblies.

The servo drives of the AX5000 series are not designed for stand-alone operation and must always be installed in a machine or system. After installation the additional documentation and safety instructions provided by the machine builder must be read and followed.

⚠ DANGER

Danger to life due to high voltage at the DC link capacitors of the AX5000 servo drive!

Due to the DC link capacitors, the DC link terminal points “DC+ and DC-” and “RB+ and RB-” may still exhibit life-threatening voltages of 875 V DC/890 V DC, even after the servo drive was disconnected from the supply network. It is only safe to work after the voltage has dropped below 50 V.

Take the following measures to avert danger:

- After disconnecting the servo drive from the supply network, wait:
  15 minutes for the AX5160 and AX5172
  30 minutes for the AX5190 and AX5191
  45 minutes for the AX5192 and AX5193
- Measure the voltage on the test contacts correctly.
- Secure the working area properly and wear the PPE (personal protective equipment).

⚠ WARNING

Serious burns due to hot surfaces on the devices!

The surface temperature of the devices can reach ≥ 50°C during operation of the machine or system. There is an acute risk of sustaining burns to parts of the body and limbs.

Take the following measures to avert danger:

- Do not touch any components (housing, etc.) shortly after or during operation.
- Wait until all components have cooled completely. At least 15 minutes.
- Check the surface temperature with a thermometer.
- DO NOT wear work gloves with a rubber coating. These can fuse with the skin on account of the high temperature and cause serious injuries.

NOTICE

Notes on operation of the AX5000 servo drive

Read this manual completely and carefully before using the servo drive. In the event of any uncertainties please notify your sales office immediately and refrain from working on the servo drive.

During the electrical installation it is essential to ensure that the correct fuses/circuit breakers are used between the supply network and the servo drive. Further information can be found in the chapter "**Electrical installation**".

If a servo drive is installed in a machine it must not be commissioned until proof of compliance of the machine with the latest version of the EU Machinery Directive has been provided. This includes all relevant harmonized standards and regulations required for implementation of this Directive in national legislation.

NOTICE

Damage to the environment or devices

During installation it is essential to ensure that the specified ventilation clearances and climatic conditions are adhered to. Further information can be found in the chapters "**Technical data**" and "**Mechanical installation**".

If the servo drive is operated in contaminated ambient air, the cooling openings must be checked regularly for blockage. These checks should be carried out several times per day.

The servo drives contain components at risk from electrostatic discharge caused by improper handling:

Please ensure you are electrostatically discharged before touching the servo drive directly.

Avoid contact with highly insulating materials (synthetic fibers, plastic film etc.).

Place the servo drive on a conductive surface.

Do not touch the motor connector while the AX5000 is in operation.

3 Guidelines and Standards

3.1 EU conformity

NOTICE

Provision of EU Declaration of Conformity

Beckhoff Automation GmbH & Co. KG will be glad to provide you with EU declarations of conformity and manufacturer's declarations for all products upon request to info@beckhoff.com.

⚠ CAUTION

Personal injuries

Servo drives are **not** products within the meaning of the EU Machinery Directive. Operation of the servo drives in machines or systems is only permitted once the machine or system manufacturer has provided evidence of CE conformity of the complete machine or system.

3.2 Electromagnetic compatibility

The servo drives of the AX5000 series are compliant with

- 2004/108/EC – EMC Directive (until 2016-04-19)
- 2014/30/EU – EMC Directive (from 2016-04-20)

Applied harmonized standards:

- IEC EN 61000-6-2:2005 (Immunity of interference standard for industrial environments)
- IEC EN 61000-6-4:2007+A1:2011 (Emission standard for industrial environments)

3.3 RoHS requirements

The servo drives in the AX5000 series meet the requirements of the

- 2011/65/EU – RoHS Directive

Applied harmonized standards:

- IEC/EN 50581:2012 (Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances)

3.4 UL approval in the USA and Canada

c UL us	The German translation of this chapter is intended for information only! The English version of this chapter is binding.

The following servo drives from the AX5000 series have UL approval and must bear the UL mark

c UL us LISTED Ind. Cond. E.q. 41GE	AX5000 with UL approval AX5160, AX5172, AX5190, AX5191, AX5192 and AX5193

on the name plate. If you intend to operate an AX5000 in the USA or Canada, check that the UL mark is on the name plate.

Below is a list of the relevant chapters that are amended with respect to the UL approval. Furthermore, UL-specific remarks are listed.

3.4.1 UL-specific data

AX5000 devices may be operated in an environment with a pollution degree "2".

AX5000 devices must be wired with copper conductors rated for at least 75°C.

Rated voltage of the control board = 24 V DC

A wide range of motor sizes can be operated with the AX5000. Internal motor overload protection level is adjustable:

The internal motor overload protection is parameterized via the IDN P-0-0062 "Thermal motor model", based on the value of the IDN S-0-0111 "Motor continuous stall current". The IDN P-0-0062 "Time constant" is specified by the motor manufacturer and must be entered here. The IDN P-0-0062 “Warning limit” (Default) is responsible for deciding when a warning is to be generated. The IDN P-0-0062 “Error limit” (Default) is responsible for deciding when the motor is to be switched off. The default values take into account the specific characteristics of the servomotors.

3.5 Electrical isolation according to EN 50178 / VDE 160

The power section (motor connection, DC link connection and mains connection) and the control unit are **doubly** insulated against each other, so that safe shock protection against accidental contact is ensured at all terminals of the control unit without additional measures. The clearance and creepage distances also meet the requirements of the above standard.

4 Product description

The servo drives of the AX5000 series are available as single- or multi-channel versions and are optimized in terms of function and economic efficiency. In conjunction with EtherCAT, the real-time Ethernet system, the integrated control technology offers minimum cycle times and supports fast, highly dynamic positioning tasks.

4.1 Type key

AX 5 x yz – a bc d – e f g h	Explanation
AX	Product range Servo drive
5	Series 5 = AX5000
x	Number of channels 1 = 1-channel 2 = 2-channel
yz	Rated current per channel for single-phase and three-phase connections 1-channel devices: 01 = 1.5 A 03 = 3.0 A 06 = Single-phase: 4.5 A / Three-phase: 6.0 A 12 = 12 A 18 = 18 A 25 = 25 A 40 = 40 A 60 = 60 A 72 = 72 A 90 = 90 A 91 = Three-phase: 110 A 92 = Three-phase: 143 A 93 = Three-phase: 170 A 2-channel devices: 01 = 1.5 A 03 = 3.0 A 06 = 6.0 A
a	Not defined
bc	Not defined
d	Not defined
e	Variants 0 = Standard 1 = Special version / customer-specific version
f	Hardware version 0 = First generation 2 = Second generation
g	Dual Use 0 = ≤ 599 Hz 1 = > 599 Hz
h	Firmware version 0 = v2.06 2 = ≥ v2.10

4.2 Scope of supply

The scope of supply may vary depending on the ordered configuration. Before installing the device please ensure that all ordered components were delivered and that they are undamaged. In the event of any damage please contact the carrier immediately and document the damage.

4.2.1 Standard scope of supply

- AX5000 in the ordered performance class
- Connectors for:
  - X03: DC power supply 24 V DC
  - X06: digital inputs and outputs
  - X14: motor temperature sensor and brake
- Startup (this manual)

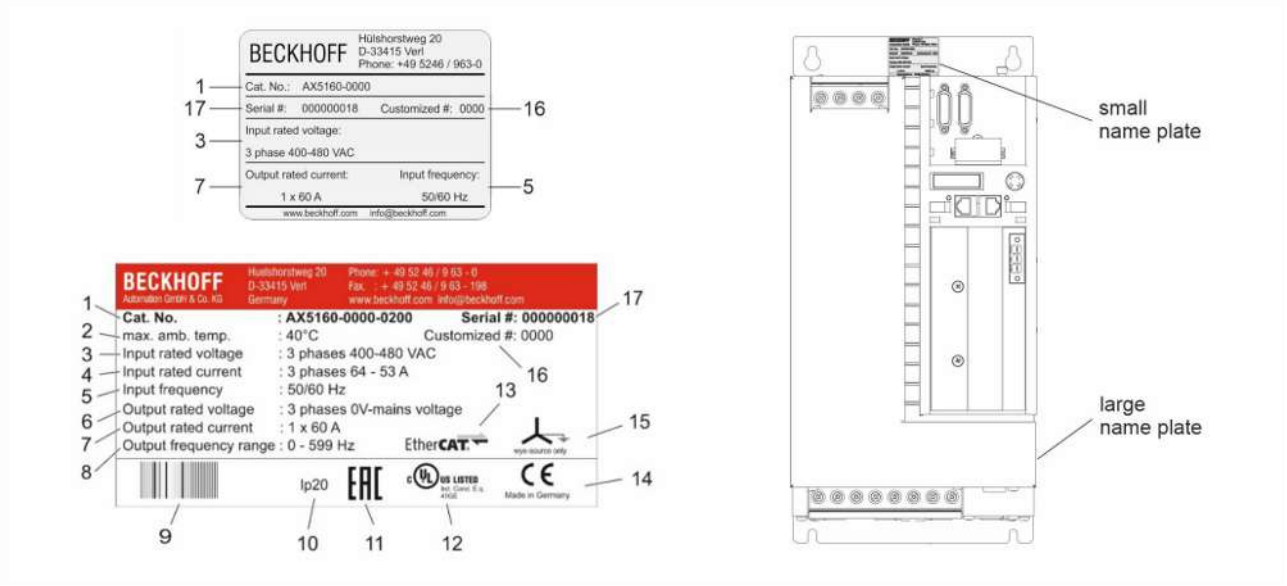
4.2.2 Accessories

A comprehensive list of accessories can be found in the Beckhoff main catalog or on our website at www.beckhoff.com.

c UL us	**Accessories with UL approval!** If you want to operate an AX5000 in the US or Canada, please note that any accessories also require UL approval.

4.3 Name plates

The servo drive features two name plates. A comprehensive name plate can be found on the right-hand side. An extract showing the main data can be found at the top of the servo drive.



1	Order number	7	Rated output current	13	EtherCAT compliant
2	Max. ambient temperature	8	Output frequency range	14	CE compliant
3	Rated input voltage	9	Barcode	15	Standard supply network with grounded center
4	Rated input current	10	Protection class	16	Customer-specific
5	Input frequency	11	EAC approval	17	Serial number
6	Rated output voltage	12	cULus approval		

4.4 Technical data

c UL us	**UL approval!** If you want to operate an AX5000 in the USA or Canada, be sure to observe chapter 3.3.

4.4.1 Permissible ambient and operating conditions

Ambient / operating conditions	Permissible values
Ambient temperature during operation	0°C...+40°C up to 55°C with power derating (2% per °C)
Ambient temperature during transport	-25°C...+70°C
Ambient temperature during storage	-25°C...+55°C
Air humidity	15% to 85%, non-condensing
Pollution degree	2 according to EN 0664-1
Corrosion protection	Normally not required. Under extreme operating conditions separate measures must be agreed with the manufacturer.
Operating altitude	up to 1000 m above sea level without power derating from 1000 m up to 3000 m with power derating □ 1.5% / 100 m.
Installation position	vertical
Ventilation	built-in temperature-controlled fan
Protection rating	IP20 except the terminals (IP00)
Vibration test (EN 60068-2-6)	Frequency range: 10…150 Hz Amplitude: 10…58 Hz = 0.075 mm pk-pk 59…150 Hz = 1 g

4.4.2 Electrical data

Electrical data	AX5160	AX5172	AX5190	AX5191	AX5192	AX5193
Rated output current (1)	60 A	72 A	90 A	110 A	143 A	170 A
Minimum rated motor current at full current resolution	16 A	20 A	25 A	30 A	35 A	40 A
Peak output current (2)	120 A	144 A	180 A	180 A	215 A	221 A
Rated supply voltage	3x 400-10%…480+10% V AC					
Max. DC link voltage	890 V DC					
Rated apparent power S1 mode (selection) 400 V AC 480 V AC	 42 kVA 45 kVA	 50 kVA 54 kVA	 62 kVA 67 kVA	 76 kVA 82 kVA	 99 kVA 107 kVA	 118 kVA 127 kVA
Power loss (3)	830 W	1010 W	1300 W	1600 W	2100 W	2500 W
Min. braking resistance (**external** braking resistor)	13 Ω	13 Ω	10 Ω	10 Ω	6.5 Ω	6.5 Ω
Max. braking power (**external** braking resistor)	52 kW	52 kW	67 kW	67 kW	103 kW	103 kW
Mains chokes (4)			**AX2090-ND50-xxxx**			
	---	---	-0090	-0110	-0143	-0170
Mains filter (4)			**AX2090-NF50-xxxx**			
	integrated		-0100	-0150	-0150	-0180
DC link capacitance	900 µF		1060 µF	2120 µF	3180 µF	4240 µF
SCCR value	5 kA		10 kA			

(1) With a rated supply voltage of 480 V AC, the rated current must be reduced by 10% or the ambient temperature reduced to ≤35°C. The specified values apply for an output rotational frequency > 5 Hz

(2) Irms for max. 3 s with a preload of max. 70% of the rated current

(3) S1 mode, including power supply unit, without brake chopper

(4) Required for compliance with EN 61800-3 (EMC product standard) C3 (industrial environment) with a maximum motor cable length of 25 m.

SCCR value:

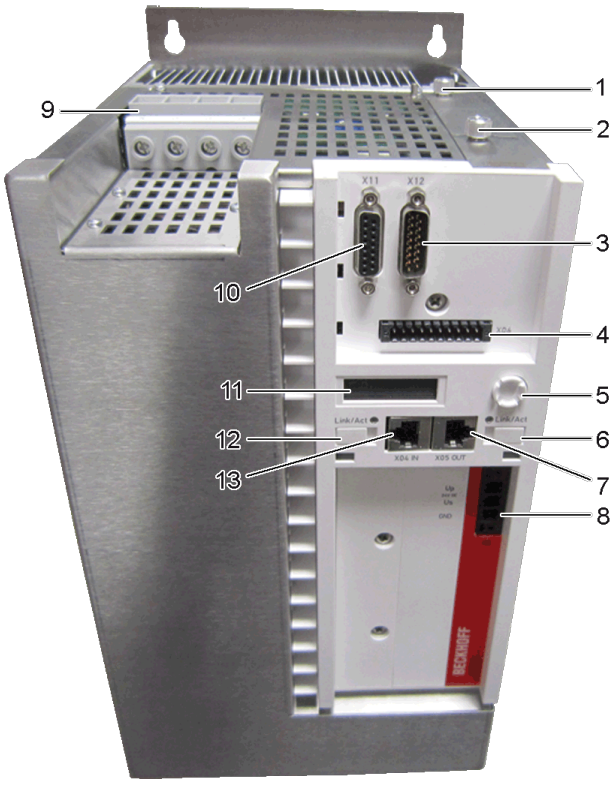
10 kA

4.4.3 Mechanical data

Mechanical data	AX5160	AX5172	AX5190	AX5191	AX5192	AX5193
Weight, approx. [kg]	14	14	31	31	38	38
Width [mm]	190		283	283	283	283
Height without connectors [mm]	345		540	540	540	540
Depth without connectors / accessories [mm]	259		253	253	334	334

4.5 General overview AX5160 and AX5172

The servo drive shown below is an AX5172; the AX5160 is identical.



Item descriptions:

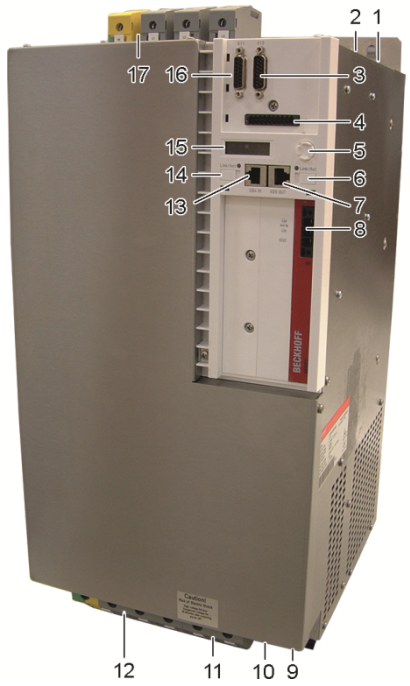
No.	Name		No.	Name
1	X4x | Option slot for expansion cards		9	X01 | Mains supply 400…480 V
2	X3x | Option slot for safety card		10	X11 | Feedback connection, encoder
3	X12 | Feedback connection, resolver		11	Display
4	X06 | Connection for digital inputs/outputs		12	Inscription label
5	Navigation rocker		13	X04 | Socket for the EtherCAT input
6	Inscription label		14	X14 | Sensor for motor temperature and brake
7	X05 | Socket for the EtherCAT output		15	Connection for the external braking resistor
8	X03 | Power supply, 24 V DC input			DC link output (890 V DC voltage).
	DANGER	890 V DC voltage at the DC link terminals. Once the device has been shut down dangerous voltage will still be present for a further 15 minutes. The device is safe once the voltage has fallen below 50 V. (check the voltage)		Motor connection (U, V, W, PE)

4.6 General overview AX5190 and AX5191

Item descriptions:

No.	Name			No.	Name
1	X4x | Option slot for expansion cards			9	X14 | Sensor for motor temperature and brake
2	X3x | Option slot for safety card			10	DC link output (890 V DC voltage) Connection for the external braking resistor
3	X12 | Feedback connection, resolver			11	Motor connection (U, V, W, PE)
4	X06 | Connection for digital inputs/outputs			12	X04 | Socket for the EtherCAT input
5	Navigation rocker			13	Inscription label
6	Inscription label			14	Display
7	X05 | Socket for the EtherCAT output			15	X11 | Feedback connection, encoder
8	X03 | Power supply, 24 V DC input			16	X01 | Mains supply 400…480 V
	 **DANGER**	890 V DC voltage at the DC link terminals. Once the device has been shut down dangerous voltage will still be present for a further 30 minutes. The device is safe once the voltage has fallen below 50 V. (check the voltage)			

4.7 General overview AX5192 and AX5193



Item descriptions:

No.	Name		No.	Name
1	X4x | Option slot for expansion cards		9	X14 | Sensor for motor temperature and brake
2	X3x | Option slot for safety card		10	X07 | External braking resistor
3	X12 | Feedback connection, resolver		11	DC link output (890 V DC voltage)
4	X06 | Connection for digital inputs/outputs		12	Motor connection (U, V, W, PE)
5	Navigation rocker		13	X04 | Socket for the EtherCAT input
6	Inscription label		14	Inscription label
7	X05 | Socket for the EtherCAT output		15	Display
8	X03 | Power supply, 24 V DC input		16	X11 | Feedback connection, encoder
	 **DANGER**	890 V DC voltage at the DC link terminals. Once the device has been shut down dangerous voltage will still be present for a further 45 minutes. The device is safe once the voltage has fallen below 50 V (check the voltage).	17	X01 | Mains supply 400…480 V

4.8 Overview of connectors/terminal points

4.8.1 X01 – voltage input

AX5160 and AX5172

Terminal point	Connection
L1	Phase L1
L2	Phase L2
L3	Phase L3
PE	Protective conductor

AX5190 and AX5191

Terminal point	Connection
L1	Phase L1
L2	Phase L2
L3	Phase L3
PE	Protective conductor

AX5192 and AX5193

Terminal point	Connection
L1	Phase L1
L2	Phase L2
L3	Phase L3
PE	Protective conductor

4.8.2 X07 – External braking resistor

⚠ DANGER

Serious risk of injury due to high electrical voltage!

A life-threatening voltage of 890 V DC remains present at the RB+ and RB- terminals even after the device has been shut down.

- After shutdown, wait
  15 minutes
  for the AX5160/AX517230 minutes for the AX5190/AX5191
  45 minutes for the AX5192/AX5193
- Check the voltage

NOTICE

Damage to devices

Connect the PE connection of the external braking resistor to the central grounding bar.

AX5160 and AX5172

Terminal point	Connection
RB +	Ext. braking resistor +
RB -	Ext. braking resistor -

AX5190 and AX5191

Terminal point	Connection
RB +	Ext. braking resistor +
RB -	Ext. braking resistor -

AX5192 and AX5193

Terminal point	Connection
RB +	Ext. braking resistor +
RB -	Ext. braking resistor -

4.8.3 X13 – motor connection

AX5160 and AX5172

Terminal point	Connection
U	Motor connection U
V	Motor connection V
W	Motor connection W
PE	Protective conductor

AX5190 and AX5191

Terminal point	Connection
U	Motor connection U
V	Motor connection V
W	Motor connection W
PE	Protective conductor

AX5192 and AX5193

Terminal point	Connection
U	Motor connection U
V	Motor connection V
W	Motor connection W
PE	Protective conductor

4.8.4 X02 – DC link network

⚠ DANGER

Serious risk of injury due to high electrical voltage!

A life-threatening voltage of 890 V DC remains present at the DC+ and DC- terminals even after the device has been shut down.

- After shutdown, wait
  15 minutes
  for the AX5160/AX517230 minutes for the AX5190/AX5191
  45 minutes for the AX5192/AX5193
- Check the voltage

AX5160 and AX5172

Terminal point	Connection
DC +	DC link +
DC –	DC link –

AX5190 and AX5191

Terminal point	Connection
DC +	DC link +
DC –	DC link –

AX5192 and AX5193

Terminal point	Connection
DC +	DC link +
DC –	DC link –

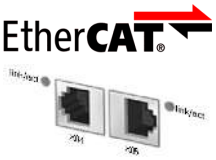
4.8.5 X03 – 24 V DC supply

AX5160, AX5172, AX5190, AX5191, AX5192, AX5193

Terminal point	Connection	Current consumption
Up +	24 V DC -0/+25% periphery (e.g. separate braking voltage)	depending on the connected loads (see X06 and X14)
Us +	24 V DC □25% - system supply	60 A…72 A = 3 A 90 A…170 A = 10 A
GND	GND	

4.8.6 X04, X05 - EtherCAT integration

AX5160, AX5172, AX5190, AX5191, AX5192, AX5193



Terminal point	Connection
X04 (IN)	incoming EtherCAT cable
X05 (OUT)	outgoing EtherCAT cable

4.8.7 X06 – digital I/O

⚠ CAUTION

Destruction of the AX5000!

This connector is not designed for external power supply. It is supplied via the 24 V DC supply (Up) of connector X03.

NOTICE

Output current

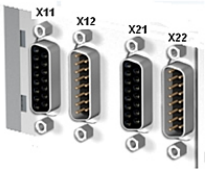
The specified output currents are maximum values. The actual values depend on your current configuration.

AX5160, AX5172, AX5190, AX5191, AX5192, AX5193

Terminal point	Connection	Output current
24	Output voltage (Up 24 V DC +)	max. 1 A
0	Input 0	
1	Input 1	
2	Input 2	
3	Input 3	
4	Input 4	
5	Input 5	
6	Input 6	
7	Input 7 or output (configurable) (Up 24 V DC +)	max. 0.5 A
0 V	Output voltage GND (-)	

4.8.8 X11 – feedback, high-resolution

AX5160, AX5172, AX5190, AX5191, AX5192, AX5193

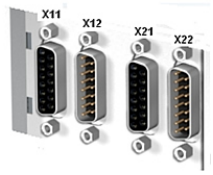


Pin	EnDat®/BiSS®	Hiperface	Sin / Cos 1Vpp	TTL 1)
1	SIN +	SIN +	SIN +	n.c.
2	GND_5 V	GND_11 V	GND_5 V	GND_5 V
3	COS +	COS +	COS +	n.c.
4	US_5 V 2)	n.c.	US_5 V 2)	US_5 V 2)
5	DX + (Data)	DX + (Data)	n.c.	B +
6	n.c.	US_11 V 2)	n.c.	n.c.
7	n.c.	n.c.	REF Z	REF Z
8	CLK + (Clock)	n.c.	n.c.	A +
9	REFSIN	REFSIN	REFSIN	n.c.
10	GND_Sense	n.c.	GND_Sense	GND_Sense
11	REF COS	REF COS	REF COS	n.c.
12	US_5 V Sense	n.c.	US_5 V Sense	US_5 V Sense
13	DX - (Data)	DX - (Data)	n.c.	B -
14	n.c.	n.c.	Z +	Z +
15	CLK- (Clock)	n.c.	n.c.	A -

1) Attention: wire break detection is not supported for TTL encoders.
2) The maximum output current is 0.25 A per channel

4.8.9 X12 - resolver / Hall

AX5160, AX5172, AX5190, AX5191, AX5192, AX5193



Pin	Resolver	analog Hall sensor
1	Temp. (only PTC, Klixon or bimetal!) Switching threshold: 1300 □ □ 3%	n.c.
2	AGND	n.c.
3	COS - (S3)	n.c.
4	SIN - (S4)	n.c.
5	REF - (R2)	n.c.
6	n.c.	SIN 1Vpp
7	n.c.	-120° or -90° 1Vpp *
8	n.c.	US_11 V (supply)
9	Temp._GND	n.c.
10	COS + (S1)	n.c.
11	SIN + (S2)	n.c.
12	REF + (R1)	n.c.
13	n.c.	REFSIN 1Vpp
14	n.c.	REF -120° or -90° 1Vpp *
15	n.c.	GND (supply)

*) The angle must be configured

4.8.10 X14 – motor brake, thermal contact

NOTICE

Output current

The specified output currents are maximum values. The actual values depend on your current configuration.

AX5160, AX5172, AX5190, AX5191, AX5192, AX5193

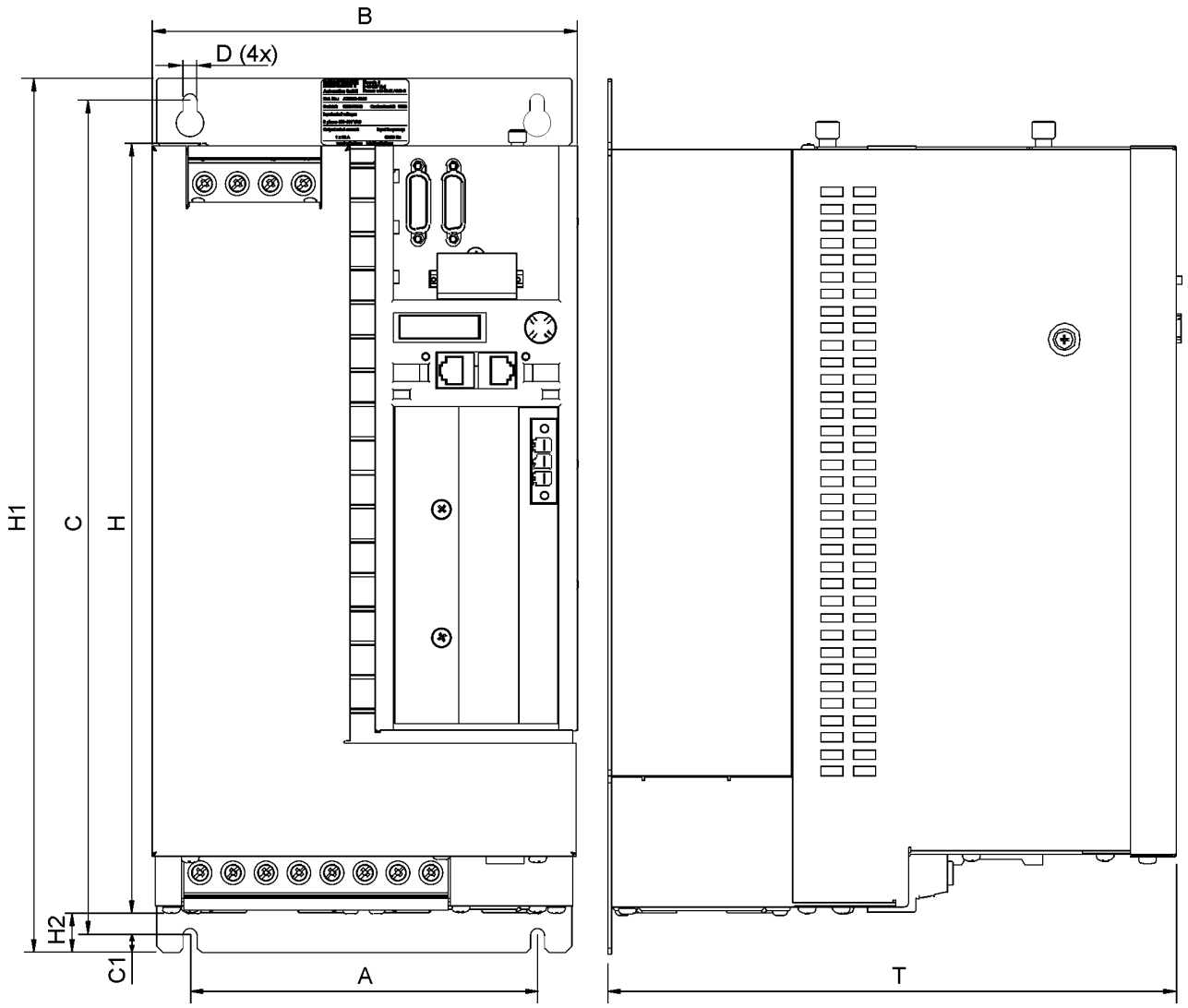
Terminal point	Connection	Output current
T-	Temp. - *	
T+	Temp. + *	
PE	Signal pair shield	
B-	Brake (GND)	
B+	Brake (Up) +	max. 2.2 A

*) switch, KTY 83-1xx or KTY 84-1xx

4.9 Dimensions

The specified dimensions refer to the device itself, excluding any connectors or cables. The installation dimensions for control cabinet installation can be found in chapter "Mechanical installation Installation examples".

AX5160, AX5172, AX5190, AX5191, AX5192, AX5193



	A [mm]	B [mm]	C [mm]	C1 [mm]	D [mm]	H [mm]	H1 [mm]	H2 [mm]	T [mm]	Mounting-Screws
AX5160	158	190	380	8	6.5	345	398	16.5	259	4 x M5
AX5172	158	190	380	8	6.5	345	398	16.5	259	4 x M5
AX5190	200	280	582	10	9	540	603	10	254	4 x M8
AX5191	200	280	582	10	9	540	603	10	254	4 x M8
AX5192	200	280	575	10	9	540	600	20	335	4 x M8
AX5193	200	280	575	10	9	540	600	20	335	4 x M8

5 Installation

⚠ DANGER

Risk of injury from electric shock!

Set the electrical components (servo drive, control cabinet, etc.) to a safe, de-energized state before starting the installation or deinstallation.

5.1 Mechanical installation

⚠ CAUTION

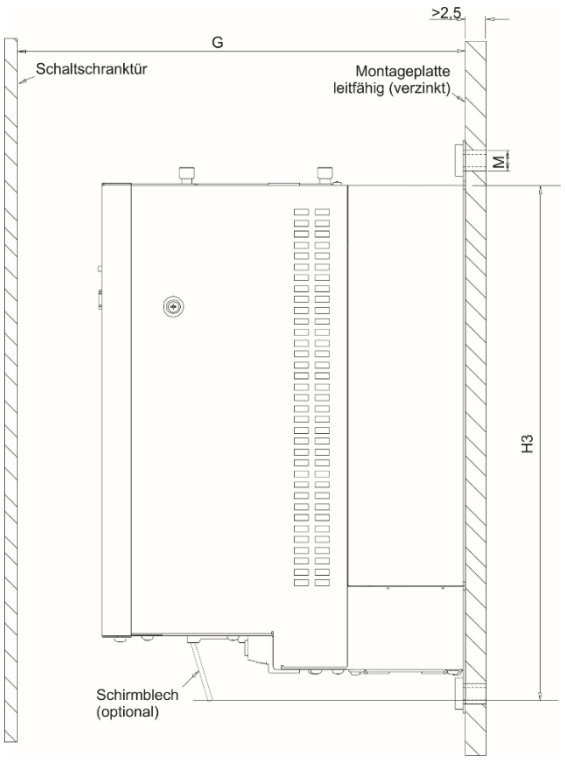
Destruction of the servo drive!

Always install the servo drive vertically.

Provide adequate ventilation for the servo drive. The permissible environmental conditions are specified in the chapter "Technical data".

It is essential to adhere to the required distances (see diagrams below).

5.1.1 Installation in the control cabinet



All dimensions in mm.

	G	M (screw)	H3
AX5160 and AX5172	≥ 300	4 x M5	445
AX5190 and AX5191	≥ 300	4 x M8	640
AX5192 and AX5193	≥ 500	4 x M8	640

⚠ DANGER

Risk of injury from electric shock!

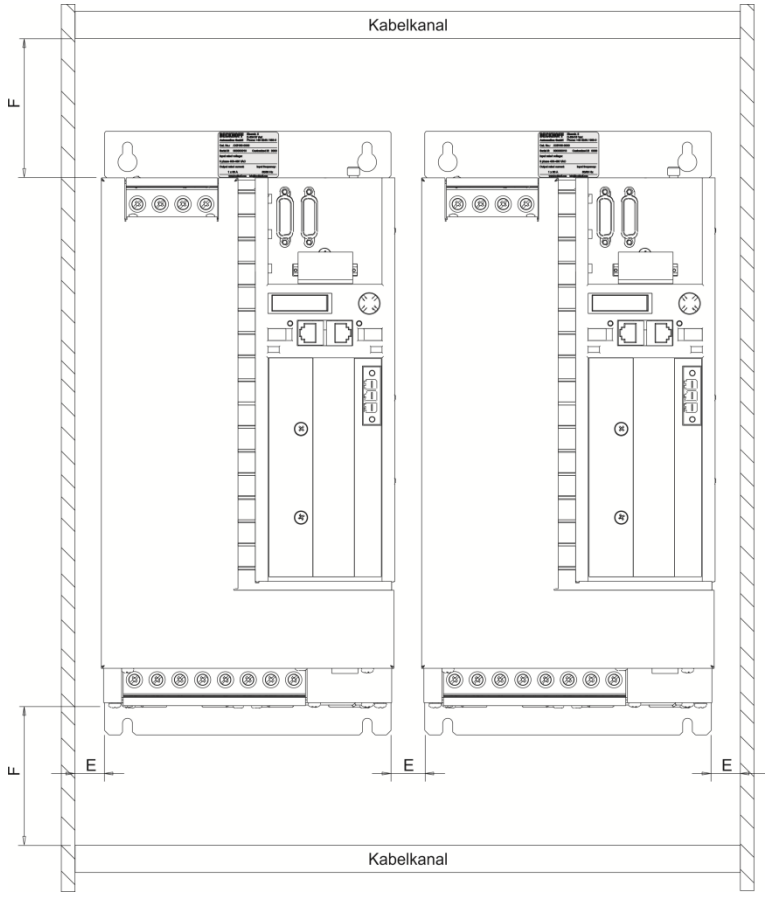
The mounting plate must be grounded according to the statutory regulations.

⚠ CAUTION

Connecting the protective earth conductor to the AX5000

The AX5000 servo drives are equipped with grounding bolts on the device housing. When connecting the protective earth conductor via the grounding bolt, use **at least** the cross-section that is present at the wide-range voltage input X01 (PE).

5.1.2 Installation example

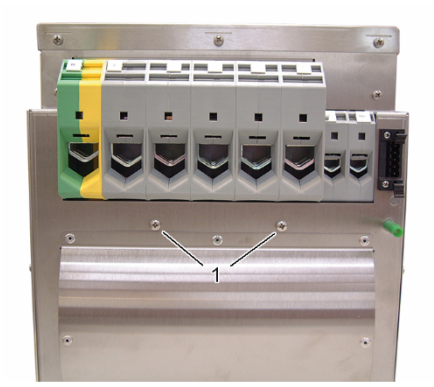


All dimensions in mm.

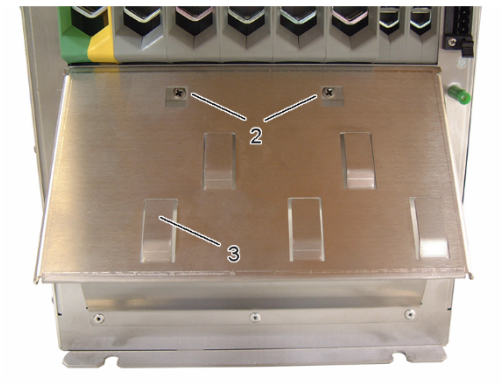
	F	E
AX5160 and AX5172	≥ 180	20
AX5190 and AX5191	≥ 180	40
AX5192 and AX5193	≥ 180	40

5.1.3 Installation of the shielding bracket (optional)

Carry out the following steps to install the shielding bracket.



Remove the screws 1.
(Do not reuse.)



Position the shielding bracket at the intended location.

Fasten the shielding bracket with the screws 2.
(Use the new screws supplied.)

Connect the cables to the terminals provided.

Attach the shield to the straps 3.

5.2 Electrical installation

c UL us	**UL approval!** If you want to operate an AX5000 in the USA or Canada, be sure to observe chapter 3.3.

c UL us	**Drive system with UL approval** Please consult our applications department with respect to the requirements for a drive system with UL approval.

⚠ DANGER

Serious risk of injury from electric shock

Due to the DC link capacitors dangerous voltage may persist at the DC link contacts DC+ and DC- after the servo drive has been disconnected from the supply network. Wait **15 minutes** for the AX5160/AX5172, **30 minutes** for the AX5190/AX5191 and **45 minutes** for the AX5192/AX5193 after disconnecting and measure the voltage at the DC link contacts DC+ and DC-. The device is safe once the voltage has fallen below 50 V.

⚠ DANGER

Serious risk of injury from electric shock

Before installation, wiring and commissioning it is essential to read the chapter "Safety".

Before installing, uninstalling or wiring the servo drives and the motors please note the following:

- Remove all relevant fuses in the supply network.
- Switch off the main system switch and secure it with a lock.
- Put up a warning sign.

⇨ The control and power connections for the motors may be live, even if the motor is prevented from rotating by the internal brake.

⚠ CAUTION

Destruction of the devices

Check the rated voltage and current of the servo drive and the connected motors.

Once the AX5000 has been disconnected from the supply network, (emergency shutdown, mains contactor etc.), wait at least 3 minutes before switching it on again or query the status of IDN "P-0-0205" (see "IDN description" in the documentation).

5.2.1 Supply network connection (X01)

⚠ CAUTION

Fire hazard through short circuit

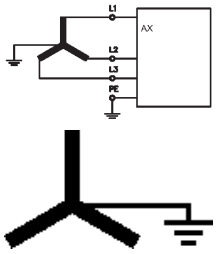
The recommended fuses are designed for line protection. The servo drives feature integrated self-protection.

The servo drives of the AX5000 series are equipped with a wide-range voltage input "**X01**" and can be connected to voltage systems between three-phase 400 V AC -10% and three-phase 480 V AC +10%.

TT/TN network with grounded center

Connection to the standard supply network (TT/TN) with grounded center is described below. Connections to other supply networks are not permitted.

three-phase 400 -10%…480 +10% V AC



The AX5000 may only be connected to a standard supply network with a grounded center, whereby the voltage to ground may be max. 277 V (+ 10%).

5.2.1.1 External fuse protection for individual devices, CE-compliant

Three-phase

Fuse protection	AX5160	AX5172	AX5190	AX5191	AX5192	AX5193
AC supply (max.)*)	80 A	100 A	125 A	160 A	200 A	224 A
24 V supply (max.)	4 AT		10 AT			
Braking resistor	electronic					

*) Mains fuses of class “gG” or automatic circuit breakers with characteristic “C” must be used.

5.2.1.2 External fuse protection for individual devices, UL-compliant

External fuse protection of the supply network

The integrated protection against short circuit is no substitute for the external fuse protection of the supply network. The fuse protection of the supply network must comply with the manufacturer's specifications and the national and international regulations and laws.

Use UL circuit breakers of class RK5 for the mains-side fuse protection.

The integrated protection against short circuit is no substitute for the external fuse protection of the supply network. The fuse protection of the supply network must comply with the manufacturer's specifications and the national and international regulations and laws.

Can be used in supply networks with a maximum current-carrying capacity of 18000 A at 480 V AC. For alternatives to UL Class RK5 circuit breakers, be sure to refer to UL Standard UL 508 A, Chapter SB4.2.3, Exception No. 1. For further questions regarding UL circuit breakers, please contact the appropriate certificate authority.

SB4.2.3 A high fault short-circuit current value for a motor controller, overload relay or combined motor controller as specified in SB4.2.2 (a) or (c) may be used as the short-circuit current value of the component if the specified branch circuit protection device is provided.

Exception 1: Where the specified BCPD is a Class CC, G, J, L, RK1, RK5 or T fuse with respect to the high fault SCCR, a fuse of a different class may be used at the same high fault rated power, provided the Ip let-through current and I2t of the new fuse are not greater than that of the specified fuse. See table SB4.2 for maximum let-through currents (Ip) and I2t.

Three-phase

Fuse protection	AX5160	AX5172	AX5190	AX5191	AX5192	AX5193
AC supply (max.)	80 A	100 A	125 A	150 A	200 A	225 A
24 V supply (max.)	4 AT		10 AT			
Braking resistor	electronic					

AX5160 and AX5172:

Can be used in supply networks with a maximum current-carrying capacity (SCCR) of 5 kA at 480 V. For mains-side fuse protection, use only UL-approved circuit breakers of class RK5 with a maximum rated current of 100 A.

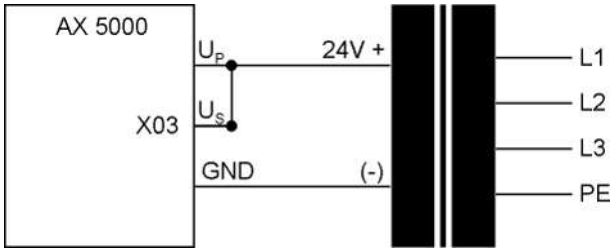
AX5190, AX5191, AX5192, AX5193:

Can be used in supply networks with a maximum current-carrying capacity (SCCR) of 10 kA at 480 V. For mains-side fuse protection, use only UL-approved circuit breakers of class RK5 with a maximum rated current of 225 A.

5.2.2 24 V DC supply network connection (X03)

The 24 V DC connection **"X03"** is used for supplying the control electronics and periphery with DC voltage. The control electronics and the periphery can be supplied separately with two different voltage sources.

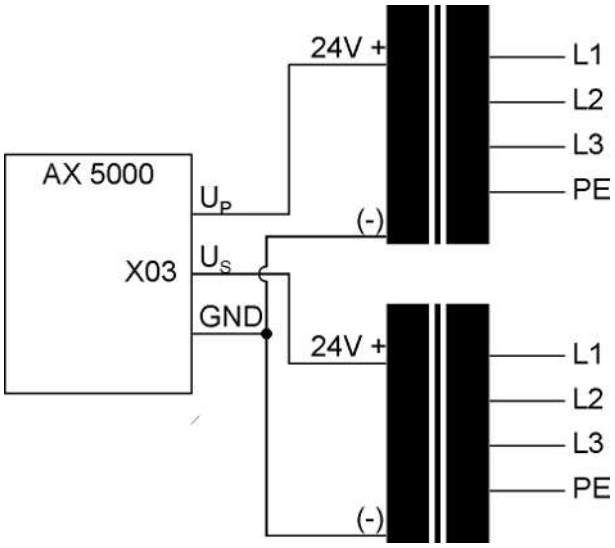
Supply via one power supply unit



Wiring of the 24 V DC power supply

If one power supply unit is used for the 24 V DC power supply, the connections US and UP must be bridged, in order to ensure that both the control electronics and the periphery are supplied.

Supply via two power supply units



5.3 Motors and cables

With longer motor cables the resulting commutation currents can lead to EMC interferences. Use the tables below to check whether mains chokes or mains filters have to be used in your application. When selecting the control cabinet ensure that there is adequate space for mains chokes and mains filters, etc.

Lay the power and signal lines in separate metal cable channels or, if both types of cable use the same metal cable channel, make sure there is a grounded separating metal wall between the cables.

Motor chokes and individual devices

For the AX5160 to AX5193 series no motor chokes are required.

5.3.1 Max. cable lengths including extensions

Rated motor voltage up to 480 V AC

Servo drive	Category C2		Category C3	
	with mains filter	with mains filter and mains choke	without mains filter and without mains choke	with mains filter and mains choke
AX5160[1)]	max. 10 m	max. 25 m	max. 25 m	max. 50 m
AX5172[2)]	max. 10 m	max. 25 m	max. 25 m	max. 50 m
AX5190[3)]	---	max. 10 m	---	max. 25 m
AX5191[4)]	---	max. 10 m	---	max. 25 m
AX5192[5)]	---	max. 10 m	---	max. 25 m
AX5193[6)]	---	max. 10 m	---	max. 25 m

For compliance with EN 61800-3 only in conjunction with the following accessories:

[1)] Mains filter AX2090-NF50-0063 and mains choke AX2090-ND0060
[2)] Mains filter AX2090-NF50-0100 and mains choke AX2090-ND0072
[3)] Mains filter AX2090-NF50-0100 and mains choke AX2090-ND0090
[4)] Mains filter AX2090-NF50-0150 and mains choke AX2090-ND0110
[5)] Mains filter AX2090-NF50-0150 and mains choke AX2090-ND0143
[6)] Mains filter AX2090-NF50-0180 and mains choke AX2090-ND0170

To keep line perturbations (distortion reactive power) as low as possible, a mains choke should always be used.

Malfunction in residential areas

Mains chokes are products with restricted availability in accordance with EN 61800-3. The products may cause radio interference in residential areas. In this case, necessary measures must be taken by the operator.

6 Important information for commissioning

⚠ WARNING

Caution – Risk of injury

Basically, electronic devices are not fail-safe. The machine manufacturer is responsible for ensuring that the connected motors and the machine are brought into a safe state in the event of a failure of the drive system.

Please be aware each time before commissioning the AX5000 that connected motors can make uncontrolled movements, which cannot always be prevented even by the AX5000's integrated diagnostic system, or may permit uncontrolled movements until the diagnostic system responds. Analyze your system and take suitable precautions to prevent damage being caused by these uncontrolled movements.

Potential causes of uncontrolled movements

The diagnostic system of the AX5000 is equipped with complex plausibility checks, which constantly monitor installation, handling, parameterization and operation and, if necessary, interrupt them with a diagnostic message. The points listed below are monitored by default, although it is not possible to cover all eventualities. Therefore, with respect to the following points, you must always consider whether the driven axes can only perform permissible movements.

- For incorrect commutation results (e.g. during wake & shake), please refer to the chapter "AX5000_ System manual□Advanced system characteristics□Commutation methods□Commutation error "F2A0"" on our homepage.
- **Take special care with synchronous motors from third-party suppliers**
  When replacing the motor / feedback or the SysMan file (.TSM), always execute the command "P-0-0166" without load connection and evaluate the result. If necessary, correct the commutation offset as described in the chapter "AX5000_System manual□Advanced system characteristics□Commutation methods".
- Input of invalid parameters
- Measuring transducer and/or signal transducer defective or incorrectly adjusted
- Cables defective or not adequately shielded
- Incorrectly attached sensors

⚠ CAUTION

Increased attention in the event of vertical axes!

When commissioning vertical axes, the risk consideration described above is to be carried out with particular care. An uncontrolled movement can mean the sudden falling down of a load in this case.

7 Project planning – important information

The more thoroughly a machine or plant project is thought through in advance, the less risk there is of having to carry out expensive modifications during or after commissioning. This applies to both the mechanical and electrical design. This chapter can only provide a brief overview of electrical project planning.

7.1 Drivetrain design

Application, servo drive, motors and gear units must be adapted to each other so that there is an adequate safety margin for all components as a degree of sluggishness appears over time due to high temperatures or wear. Make sure that the components in the working area of the system have adequate reserves so that the service life is not impaired and the necessary control quality can be maintained.

7.1.1 Control quality, moment of inertia ratio and load connection

Control quality is dependent on the parameters "moment of inertia ratio" and "load connection":

Control quality / Dynamics	Moment of inertia ratio
Good	up to 3:1
Medium	up to 5:1
Bad	from 5:1

The "Control quality / dynamics" is primarily affected by the mass moment of inertia: a poor "Control quality / dynamic" due to an unfavorable mass moment of inertia cannot be improved even with a very good load connection. Likewise, however, a good "Control quality / dynamic" due to a favorable mass moment of inertia can be reduced through a poor load connection.

7.2 Energy management

If the quality of the supply network is impaired by high voltage fluctuations, both the specifications of the servo drive and the speed range of the motor must be taken into account. If the voltage fluctuation tolerance is positive, the upper limit of the AX5000's wide-range voltage input must be observed. If the voltage fluctuation tolerance is negative, it must be checked whether the torque reduction caused by the missing voltage is permissible. With these motors, the so-called field weakening operation (check availability) of the servo drive may provide a remedy. If the mains supply does not meet the specifications for operation of the AX5000, then isolating transformers, mains chokes, mains filters or other measures may be required. An energy efficient drive system operates in a drive system with a shared DC link and shared internal and possibly also external braking resistors or brake modules. If you are already using similar drive systems, the AX5000 offers a convenient diagnostic system for determining the load on the braking resistors and for transferring the values. Previous experience with drive systems shows that in such a system much smaller or even no external braking resistors / brake modules need to be used.

7.3 EMC, earthing, shield connection and potential

The AX5000 corresponds to EMC category "C3" (industrial sector) in terms of conducted interference emissions. If you wish to use components which comply with a higher category you can limit the AX5000 conducted interference emissions with the aid of additional filters to such a degree that this complies with the EMC category "C2" (residential and industrial environment) or "C1" (residential environments). Ensure that there is adequate earthing (large-area low-impedance integration) of all relevant components (incl. control cabinet). The AX5000 incl. periphery, control cabinet, machine bed and motors must be at the same potential, as the AX5000 control quality will suffer under differing potentials and operational malfunction may result. Using the shield connection for potential equalization is not permitted. If you cannot ensure a uniform reference potential, you must install adequately sized equipotential bonding conductors. Smooth operation is only guaranteed by faultless shield connections of the cables. The shields must be applied generously at both ends and must on no account be disconnected. Use Beckhoff pre-assembled motor and feedback lines, as they are optimally matched to the drive system and minimize interference. Ensure that the connectors are properly connected: this applies to the motor connector in particular.

7.4 Control cabinet

The dimensions of the control cabinet must be sufficient to accommodate all components with the specified distances. Remember that high temperatures may necessitate forced cooling. Place the control cabinet as close as possible to the machine so that the motor cables can be kept as short as possible.
In addition, the control cabinet should have a metal, grounded back wall on which the AX5000 and its peripherals are mounted to ensure proper grounding. If you are unable to guarantee these conditions you need to earth the AX5000 and the relevant components using an approved cable of adequate size.

8 Appendix

8.1 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

8.1.1 Beckhoff Support

Beckhoff offers comprehensive technical support that deals not only with the application of individual Beckhoff products, but offers extensive additional services:

Support

design, programming, and commissioning of complex automation systems

extensive training program for Beckhoff system components

Hotline: +49 5246 963-157
email: support@beckhoff.com

8.1.2 Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service

Local service

Repair service

spare parts service

Hotline: +49 5246 963-460
email: service@beckhoff.com

8.2 Headquarters in Germany

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The addresses of the worldwide Beckhoff subsidiaries and representatives can be found on our website at www.beckhoff.com.

You can also find further documentation for Beckhoff components there.

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