

Startup | EN

AX5000 Servo Drive

AX5101, AX5103, AX5106, AX5112, AX5118, AX5125, AX5140, AX5201,
AX5203, AX5206



Table of contents

1 Foreword	5
1.1 Notes on the documentation	5
1.2 Notes on information security	6
1.3 Version numbers	6
1.4 Intended use	6
1.4.1 Dual Use (EU 2021/821)	7
1.5 Documented servo drives	7
2 For your safety	8
2.1 Staff qualification	9
2.2 Notes on the AX5000 servo drive	10
3 Guidelines and Standards	12
3.1 EU conformity	12
3.2 Electromagnetic compatibility	12
3.3 RoHS requirements	12
3.4 UL approval in the USA and Canada	13
3.4.1 UL-specific data	13
3.5 Electrical isolation according to EN 50178 / VDE 160	13
4 Product description	14
4.1 Type key	14
4.2 Scope of supply	15
4.2.1 Standard scope of supply	15
4.2.2 Accessories	15
4.3 Name plates	16
4.4 Technical data	17
4.4.1 Permissible ambient and operating conditions	17
4.4.2 Electrical data - 1-channel servo drive AX51xx	18
4.4.3 Electrical data - 2-channel servo drive AX52xx	20
4.4.4 Mechanical data - 1-channel servo drive AX51xx	21
4.4.5 Mechanical data - 2-channel servo drive AX52x	21
4.5 General overview AX5101...AX5112 and AX520x	22
4.6 General overview AX5118, AX5125 and AX5140	23
4.7 Overview of connectors/terminal points	24
4.7.1 X01 – wide-range voltage input	24
4.7.2 X02 - DC link	24
4.7.3 X03 – 24 V DC supply	25
4.7.4 X04, X05 - EtherCAT integration	25
4.7.5 X06 – digital I/O	26
4.7.6 X11/X21- Feedback, high-resolution	27
4.7.7 X12/X22 - resolver / Hall	28
4.7.8 X13/X23 - motor connection (power)	28
4.7.9 X13 - motor connection (power - AX5140 only)	29
4.7.10 X14/X24 - motor brake, thermal protection, OCT	30
4.7.11 X07 - Internal and external braking resistor (AX5140 only)	31

4.8	Dimensions	32
5	Installation	34
5.1	Mechanical installation	34
5.1.1	Installation in the control cabinet.....	34
5.2	Electrical installation.....	36
5.2.1	Supply network connection (X01)	37
5.2.2	24 V DC supply network connection (X03)	39
5.2.3	Connection of several servo drives to form a drive system.....	40
5.2.4	UL - drive system, configuration example	43
5.2.5	Connection Diagram for AX5101...AX5112 and AX520x	44
5.2.6	Connection Diagram for AX5118, AX5125, and AX5140.....	45
5.3	Motors and cables.....	46
5.3.1	Max. cable lengths including extensions.....	46
6	Important information for commissioning.....	47
7	Project planning – important information.....	48
7.1	Drivetrain design	48
7.1.1	Control quality, moment of inertia ratio and load connection	48
7.2	Energy management.....	48
7.3	EMC, earthing, shield connection and potential.....	49
7.4	Control cabinet	49
8	Appendix.....	50
8.1	Support and Service.....	50
8.1.1	Beckhoff Support.....	50
8.1.2	Beckhoff Service	50
8.2	Headquarters in Germany	50

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.

Trademarks

Beckhoff®, ATRO®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, MX-System®, Safety over EtherCAT®, TC/BSD®, TwinCAT®, TwinCAT/BSD®, TwinSAFE®, XFC®, XPlanar® and XTS® are registered and licensed trademarks of Beckhoff Automation GmbH.

If third parties make use of the designations or trademarks contained in this publication for their own purposes, this could infringe upon the rights of the owners of the said designations.



EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Copyright

© Beckhoff Automation GmbH & Co. KG, Germany.

The distribution and reproduction of this document, as well as the use and communication of its contents without express authorization, are prohibited.

Offenders will be held liable for the payment of damages. All rights reserved in the event that a patent, utility model, or design are registered.

Third-party trademarks

Trademarks of third parties may be used in this documentation. You can find the trademark notices here:

<https://www.beckhoff.com/trademarks>.

1.2 Notes on information security

The products of Beckhoff Automation GmbH & Co. KG (Beckhoff), insofar as they can be accessed online, are equipped with security functions that support the secure operation of plants, systems, machines and networks. Despite the security functions, the creation, implementation and constant updating of a holistic security concept for the operation are necessary to protect the respective plant, system, machine and networks against cyber threats. The products sold by Beckhoff are only part of the overall security concept. The customer is responsible for preventing unauthorized access by third parties to its equipment, systems, machines and networks. The latter should be connected to the corporate network or the Internet only if appropriate protective measures have been set up.

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found in our <https://www.beckhoff.com/secguide>.

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:

AX5101	AX5103	AX5106	AX5112	AX5118
AX5125	AX5140	AX5201	AX5203	AX5206

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:
5 minutes for the AX5101...AX5125 and AX520x
15 minutes for the AX5140
- 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 $\geq 50^{\circ}\text{C}$ 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

	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 a UL approval and must bear the CUS mark on the name plate. If you intend to operate an AX5000 in the USA or Canada, check that the CUS mark is on the name plate.

	AX5000 with UL approval AX5101, AX5103, AX5106, AX5112, AX5118, AX5125, AX5140, AX5201, AX5203 and AX5206
---	--

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

The AX5000 does not include an overheating sensor for the motor.

A wide range of motor sizes can be operated with the AX5000. The threshold for the internal motor overload protection is adjustable
(see "AX5000 Functional Description → Thermal Motor Model").

	Canada! In Canada, the devices are only approved in combination with the AX2090-TS50-3000 transient box, manufactured by Beckhoff Automation.
---	--

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:
 - X01: Mains input
 - X02: DC link
 - X03: DC power supply 24 V DC
 - X06: digital inputs and outputs
 - X07: External braking resistor (only AX5140)
- 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.

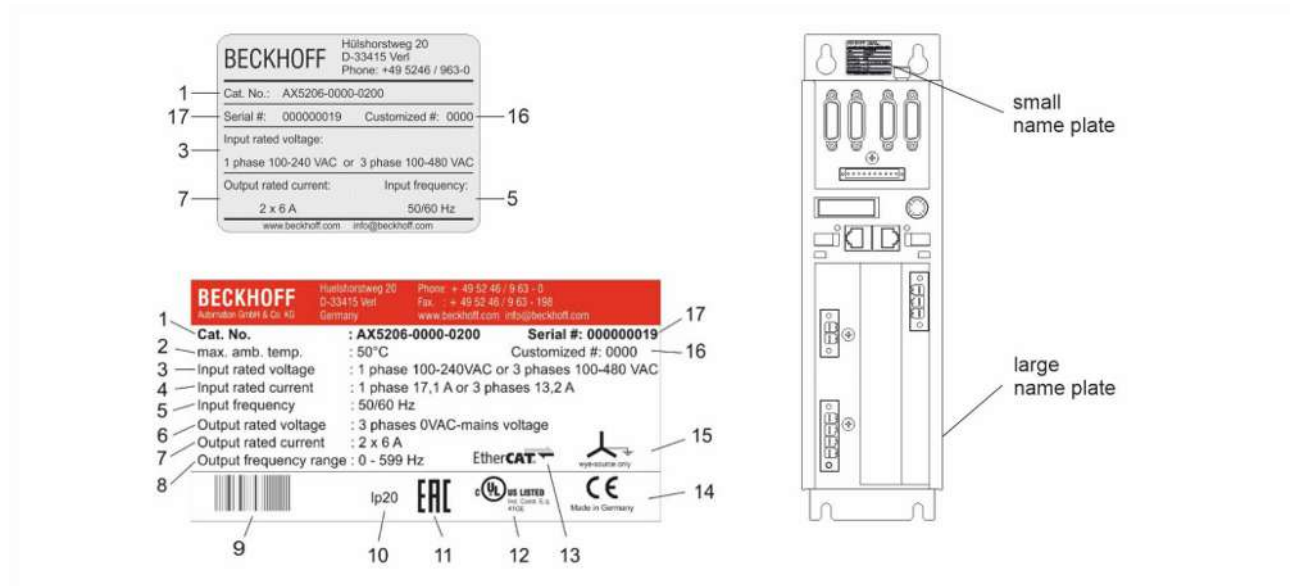


Accessories with UL approval!

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

	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...+50 °C
Ambient temperature for transport/storage	-25 °C...+70 °C
Air humidity	5% to 95%, non-condensing
Pollution degree	2 according to EN 60204 / EN 50178
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	Total device current ≤ 3 A: free convection Total device current > 3 A: built-in temperature-controlled fan
Protection rating	IP20
Vibration test (EN 60068-2-6)	Frequency range: 10...500 Hz Amplitude: 10...58 Hz = 0.075 mm pk-pk 59...500 Hz = 1 g
Shock test (EN 60068-2-27)	Half sine wave amplitude: 5 g Duration: 30 ms Number of impacts: 3 per axis and direction (18 impacts total)
Repetitive shock test (EN 60068-2-27)	Half sine wave amplitude: 5 g Duration: 30 ms Number of impacts: 1000 per axis and direction (6000 impacts total)

4.4.2 Electrical data - 1-channel servo drive AX51xx

4.4.2.1 1-phase connection AX5101...AX5106

Electrical data	AX5101	AX5103	AX5106
Rated output current [A]	1.5	3	4.5
Smallest parameterizable channel peak current at full current resolution [A]	0.35	1	1
Peak output current [A] ¹⁾	4.5	7.5	13
Rated supply voltage [V AC]	1x 100-10%...240+10%		
Max. DC link voltage [V DC] ²⁾	875		
DC link capacitance [μF]	235		
Rated apparent power [kVA] S1 operation (selection)			
120 V AC	0.3	0.6	0.94
230 V AC	0.6	1.2	1.8
Power loss [W] ³⁾	35	50	85
Continuous braking power (internal braking resistor) [W]	50	50	150
Max. braking power [kW] (internal braking resistor)	14		
Min. braking resistor [Ω] (external braking resistor)	47		
Max. braking power [kW] (external braking resistor)	15		

¹⁾ Irms for up to 7 s

²⁾ Info: The higher the power drawn from the DC link, the more the
°°°°DC link voltage drops

³⁾ S1 operation, including power supply, without brake chopper

4.4.2.2 3-phase connection AX5101...AX5140

Electrical data	AX						
	AX5101	AX5103	AX5106	AX5112	AX5118	AX5125	AX5140
Rated output current [A]	1.5	3	6	12	18	25 ¹⁾	40
Smallest parameterizable channel peak current at full current resolution [A]	0.35	1	1	6	12	12	18
Max. output current ³⁾ [A]	4.5	7.5	13	26 ⁴⁾	36	50	80
Rated supply voltage [V AC]	3 x 100-10%...480+10% ²⁾						
Max. DC link voltage [V DC]	875						
DC link capacitance [μF]	235	470	940	1175	1485		
Rated apparent power [kVA] S1 operation (selection)							
120 V AC	0.3	0.6	1.2	2.5	3.4	4.8	8.3
230 V AC	0.6	1.2	2.4	4.8	7.2	10.0	16.0
400 V AC	1.0	2.1	4.2	8.3	12.5	17.3	27.7
480 V AC	1.2	2.5	5.0	10.0	15.0	20.8	33.3
Power loss ⁵⁾ [W]	35	50	85	160	255	340	510
Continuous braking power [W] (internal braking resistor)	50	50	150	90	200	200	150
Max. braking power [kW] (internal braking resistor)	14				26	26	26
Min. braking resistor [Ω] (external braking resistor)	47	47	47	30	22	22	22 ⁶⁾
Max. braking power [kW] (external braking resistor)	15	15	15	23.5	32	32	32

¹⁾ cULus = 24 A

²⁾ cULus = AX5118 and AX5125 = 3 x 480 V°AC ± 10%

³⁾ I_{eff} for max. 7 s, at a clock frequency of 8 kHz (IDN P-0-0001)

⁴⁾ I_{rms} for max. 7 s, if rotating field frequency ≥ 1.5 Hz

⁵⁾ S1 operation, including power supply, without brake chopper

⁶⁾ Braking resistor <22 Ω → Please contact our support team

4.4.3 Electrical data - 2-channel servo drive AX52xx

4.4.3.1 1-phase connection

Electrical data	AX5201	AX5203	AX5206
Rated output current / channel [A]	1.5	3	4.5
Smallest parameterizable channel peak current at full current resolution [A]	0.35	1	1
Max. rated channel current [A]	3	4.5	9
Total rated output current [A]	3	4.5	9
Max. output current ¹⁾ / channel [A]	5	10	13
Max. output current ¹⁾ as total device current [A]	10	20	26
Rated supply voltage [V AC]	1x 100-10%...240+10%		
Max. DC link voltage [V DC]	875		
DC link capacitance [μF]	235	235	470
Rated apparent power [kVA] S1 operation (selection)			
120 V AC	0.6	1.2	2.5
230 V AC	1.2	2.4	4.8
Power loss ²⁾ [W]	55	85	160
Continuous braking power [W] (internal braking resistor)	50	150	90
Max. braking power [kW] (internal braking resistor)	14		
Min. braking resistor [Ω] (external braking resistor)	47		
Max. braking power [kW] (external braking resistor)	15		

¹⁾ Irms for max. 7 s

²⁾ S1 operation, incl. power supply, without brake chopper

4.4.3.2 3-phase connection

Electrical data	AX5201	AX5203	AX5206
Rated output current per channel [A]	1.5	3	6
Smallest parameterizable channel peak current at full current resolution [A]	0.35	1	1
Max. rated channel current [A]	3	6	9
Total rated output current [A]	3	6	12
Max. output current ¹⁾ / channel [A]	5	10	13
Max. output current ¹⁾ as total device current [A]	10	20	26
Rated supply voltage [V AC]	3x 100-10%...480+10%		
Max. DC link voltage [V DC]	875		
DC link capacitance [μF]	235	235	470
Rated apparent power [kVA] S1 operation (selection)			
120 V AC	0.6	1.2	2.5
230 V AC	1.2	2.4	4.8
400 V AC	2.1	4.2	8.3
480 V AC	2.5	5.0	10.0
Power loss ²⁾ [W]	55	85	160
Continuous braking power (internal braking resistor) [W]	50	150	90
Max. braking power (internal braking resistor) [kW]	14		
Min. braking resistor (external braking resistor) [Ω]	47		
Max. braking power (external braking resistor) [kW]	15		

¹⁾ Irms for max. 7 s

²⁾ S1 operation, incl. power supply, without brake chopper

SCCR values:

AX5x01...AX5140 = 18 kA

4.4.4 Mechanical data - 1-channel servo drive AX51xx

Mechanical data	AX5101	AX5103	AX5106	AX5112	AX5118	AX5125	AX5140
Weight, (approx.) [kg]	4	4	5	5	11	11	13
Width [mm]	92				185		
Height [mm]	317.70						
Depth [mm] without connectors / accessories	232						

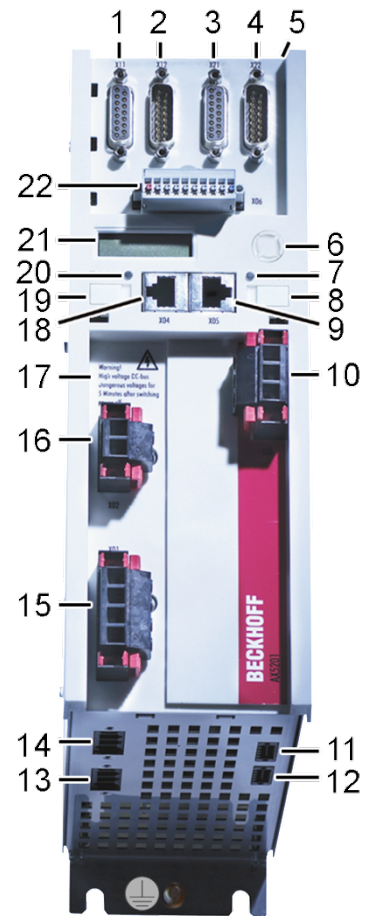
4.4.5 Mechanical data - 2-channel servo drive AX52x

Mechanical data	AX5201	AX5203	AX5206
Weight [kg]	approx. 5	approx. 6	approx. 6
Width [mm]	92		
Height [mm]	317.70		
Depth without connectors / accessories [mm]	232		

4.5 General overview AX5101...AX5112 and AX520x

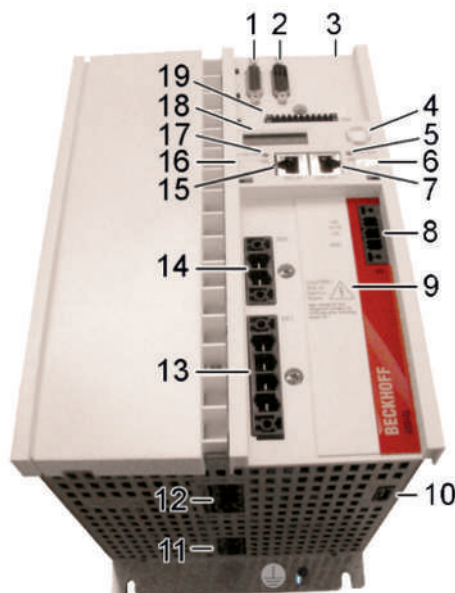
The servo drive shown below is a 2-channel device. Components that are only available for the second channel are identified in the item description.

Position	Name	
1	X11 – Feedback connection, encoder	
2	X12 – Feedback connection, resolver	
3	X21 – Feedback connection, encoder Channel B (only for 2-channel unit)	
4	X22 – Feedback connection, resolver Channel B (only for 2-channel unit)	
5	X3x – Optional slot for safety card X4x – Option slot for expansion cards	
6	Navigation rocker	
7	Status LED for EtherCAT output	
8	Labeling field	
9	X05 – Socket for EtherCAT output	
10	X03 – Power supply, 24 V DC input	
11	X14 – Sensor for motor temperature and brake	
12	X24 – Socket for Thermal Contact and Brake Channel B (only for 2-channel unit)	
13	X23 - motor connection (U, V, W, PE) Channel B (only for 2-channel unit)	
14	X13 - motor connection (U, V, W, PE)	
15	X01 Mains supply 100...480 V	
16	X02 – DC link output (875 V DC voltage) Connection for the external braking resistor	
17	 WARNING	875 V°DC Voltage at the DC link terminals X02. After the unit is shut down a life-threatening voltage remains for 5 minutes. The device is safe once the voltage has fallen below 50 V.
18	X04 – socket for EtherCAT input	
19	Labeling field	
20	Status LED for EtherCAT input	
21	Display	
22	X06 – Connection for digital inputs/outputs	



4.6 General overview AX5118, AX5125 and AX5140

The servo drive illustrated below is an AX5140; the devices with 18 A or 25 A are structurally similar apart from pos. 11 "X07" (external braking resistor).



Item descriptions:

Pos.	Name	Pos.	Name
1	X11 – Feedback connection, encoder	11	X07 - External braking resistor (only AX5140)
2	X12 – Feedback connection, resolver	12	X13 - motor connection (U, V, W, PE)
3	X3x – Optional slot for safety card X4x – Option slot for expansion cards	13	X01 - Mains supply 100 - 480 V
4	Navigation rocker	14	X02 – DC link output (875 V DC voltage). Connection for the external braking resistor (AX5118 and AX5125 only)
5	Status LED for EtherCAT output	15	X04 – socket for EtherCAT input
6	Labeling field	16	Labeling field
7	X05 – Socket for EtherCAT output	17	Status LED for EtherCAT input
8	X03 – Power supply, 24 V DC input	18	Display
9	 WARNING 875 V DC voltage at the DC link terminals X02. 15 minutes after shutdown of the device, life-threatening voltage is still present. The device is safe once the voltage has fallen below 50 V.	19	X06 – Connection for digital inputs/outputs
10	X14 – Sensor for motor temperature and brake		

4.7 Overview of connectors/terminal points

4.7.1 X01 – wide-range voltage input

AX51xx and AX52xx



Terminal point	Connection		Tightening torque
	3-phase	1-phase	
L1	Phase L1	Phase L1	0.5...0.6 Nm
L2	Phase L2	not used	
L3/ N	Phase L3	Neutral conductor	
PE	Protective conductor	Protective conductor	

4.7.2 X02 - DC link

⚠ DANGER

Serious risk of injury due to high electrical voltage!

Life-threatening voltage of 875 V DC is still present at the DC+ and DC- terminals of the X02 DC link terminals after shutdown of the device. Only remove the connector if you wish to configure a drive system with the AX-Bridge. Only remove the white hexagonal plugs if the terminal points are to be rewired.

- Wait **15 minutes** after shutdown of the power supply
- Check the voltage and continue working if the voltage has dropped below 50 V DC.

AX5101...AX5125 and AX520x



Terminal point	Connection		Tightening torque
DC+	DC link +	External braking resistor and DC link network	0.5...0.6 Nm
DC –	DC link –		

AX5140



Terminal point	Connection		Tightening torque
DC+	DC link +	DC link network only	1.2...1.5 Nm
DC-	DC link –		

4.7.3 X03 – 24 V DC supply

AX51xx and AX52xx



Terminal point	Connection	Tightening torque
Up +	Peripheral supply 24 V DC $\pm 10\%$ (depending on the motor holding brake)	0.5...0.6 Nm
Us +	System supply 24 V DC $\pm 25\%$	
GND	GND	

Current consumption

Terminal point	AX5101...AX5112, AX52xx	AX5118, AX5125	AX5140
Up +	Depending on the connected loads (see X06 and X14, X24)		
Us +	0.4 A...0.8 A	1.1 A	1.6 A

4.7.4 X04, X05 - EtherCAT integration

AX51xx and AX52xx



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

4.7.5 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.

AX51xx and AX52xx



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 (-)	



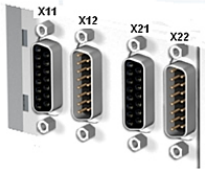
Output current

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

4.7.6 X11/X21- Feedback, high-resolution

AX51xx and AX52xx

X11 = channel A, X21 = channel B



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 -

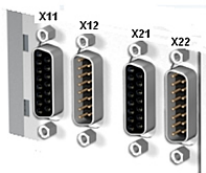
¹⁾ **Attention: wire break detection is not supported for TTL encoders.**

²⁾ The maximum output current is 0.25 A per channel

4.7.7 X12/X22 - resolver / Hall

AX51xx and AX52xx

X12 = channel A, X22 = channel B



Pin	Resolver	Analog Hall sensor
1	Temp. (only PTC, Klixon or bimetal!)	n.c.
	Switching threshold: $1300\ \Omega \pm 3\%$	
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 ¹⁾
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 ¹⁾
15	n.c.	GND (supply)

¹⁾ The angle must be configured

4.7.8 X13/X23 - motor connection (power)

AX5101...AX5125 and AX520x

X13 = channel A, X23 = channel B



Terminal point	Connection	Tightening torque (knurled screws)
U	Motor connection U	0.6 Nm
V	Motor connection V	
W	Motor connection W	
PE	Protective conductor	
Shielding bracket	Shield	

4.7.9 X13 - motor connection (power - AX5140 only)

AX5140



Terminal point	Connection	Tightening torque (knurled screws)
U	Motor connection U	1.0 Nm
V	Motor connection V	
W	Motor connection W	
PE	Protective conductor	
Shielding bracket	Shield	

● Feedback problems with loose screw connection

i The shield connection is established via the shielding bracket of the motor connector. Please tighten the two knurled screws firmly with a screwdriver. An inadequate shield connection due to a loose plug can lead to feedback problems.

4.7.10 X14/X24 - motor brake, thermal protection, OCT

AX51xx and AX52xx

X14 = channel A, X24 = channel B



Pin assignment for AX5000-xxxx-0000 (hardware 1)

Terminal point	Connection	Output current	Conductor cross-section	Tightening torque
T-	Temp. - ¹⁾		0.2...1.5 mm ²	0.2...0.25 Nm
T+	Temp. + ¹⁾			
PE	Signal pair shield			
B-	Brake (GND)			
B+	Brake (Up) +	max. 1.5 A		

¹⁾ switch, KTY 83-1xx or KTY 84-1xx

Pin assignment for AX5000-xxxx-0200 (hardware 2)

Terminal point	Connection	Output current	Conductor cross-section	Tightening torque
T-	OCT – and temperature		0.2...1.5 mm ²	0.2...0.25 Nm
T+	OCT + and temperature			
PE	Signal pair shield			
B-	Brake (GND)			
B+	Brake (Up) +	max. 2.2 A		



Output current

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

4.7.11 X07 - Internal and external braking resistor (AX5140 only)

DANGER

Serious risk of injury due to high electrical voltage!

A life-threatening voltage of 875 V DC remains present at the +RB and -RB terminals of the X07 brake terminals even after the device has been shut down. Only remove the connector if you wish to configure a drive system with the AX-Bridge. Only remove the white hexagonal plugs if the terminal points are to be rewired.

- Wait **15 minutes** after shutdown of the power supply
- Check the voltage and continue working if the voltage has dropped below 50 V DC.

AX5140



Terminal point	Connection
PE	Protective conductor
+RB	External braking resistor +
+RBint	Internal braking resistor +
-RB	Braking resistor GND



Commissioning requirement

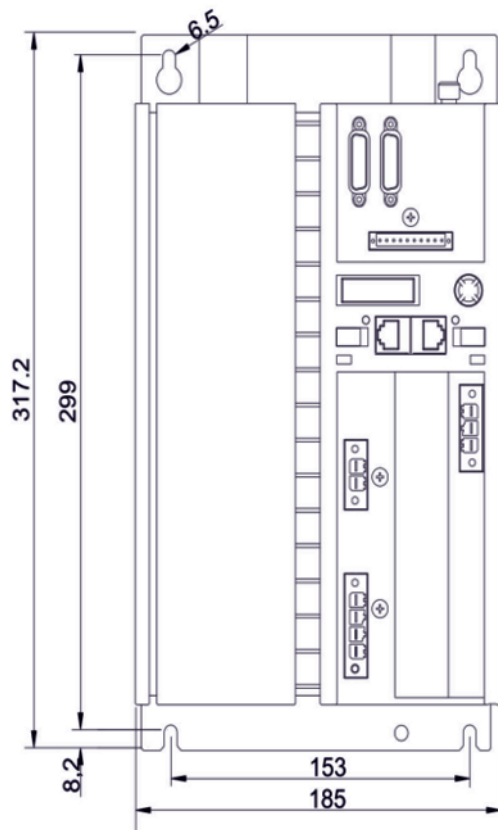
Commissioning the AX5140 can only be carried out when the terminal points "+RBint" and "+RB" are bridged (delivery state) or an external braking resistor is connected (terminal points "+RB" and "-RB"). If these measures are not taken then the AX5140 will be stopped with the error message "FD4B – undervoltage".

4.8 Dimensions

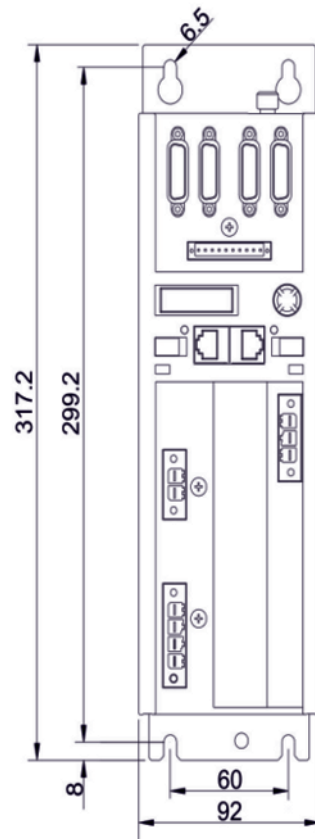
The specified dimensions refer to the device itself, excluding any connectors or cables. The installation dimensions for control cabinet installation can be found in chapter "Mechanical installation → Installation examples".

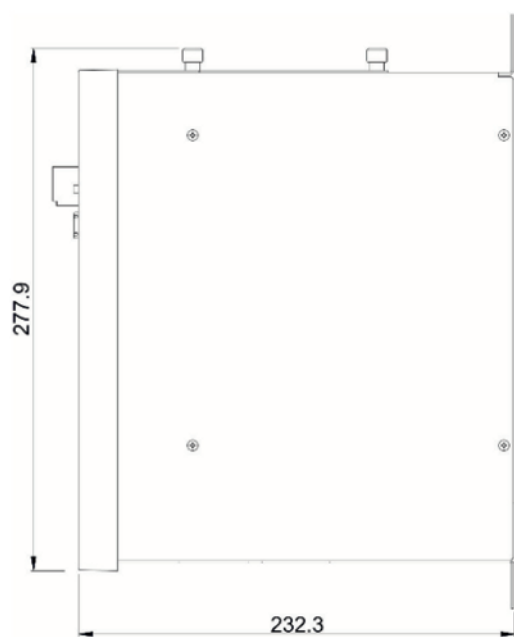
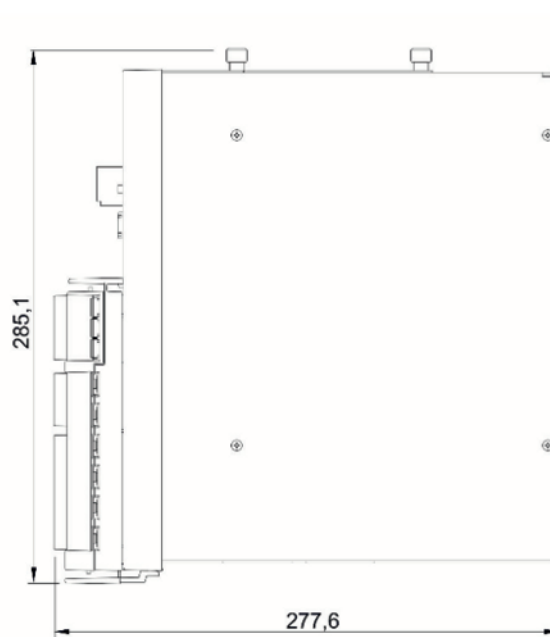
All figures in millimeters

AX5118, AX5125 und AX5140



AX5101...AX5112, AX5201...AX5206



AX5000 ohne AX-Bridge

AX5000 mit AX-Bridge


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

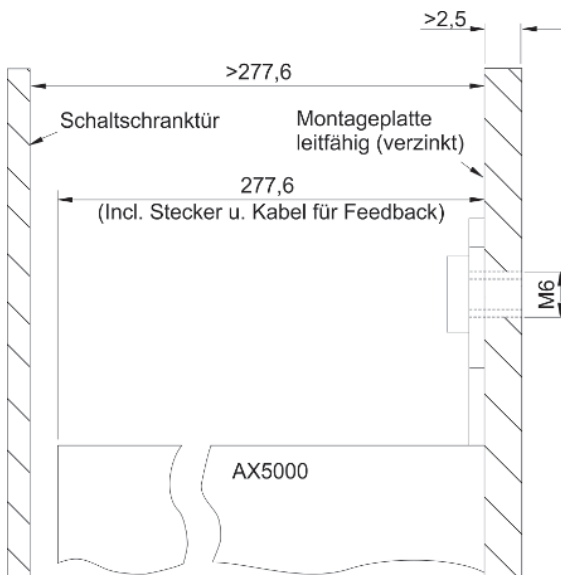
Destruction of the servo drive!

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.

⚠ DANGER

Risk of injury from electric shock!

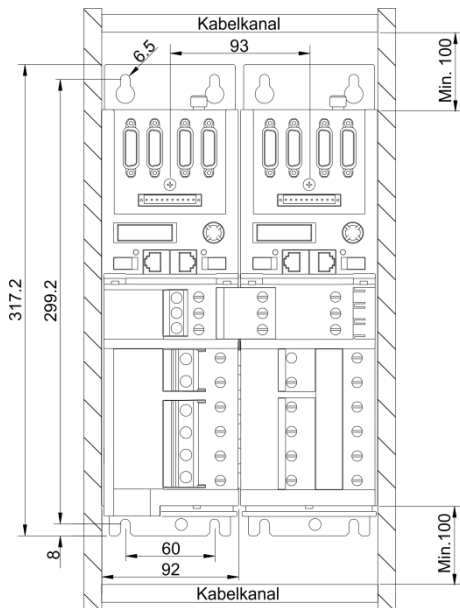
The mounting plate must be grounded according to the statutory regulations.

⚠ CAUTION

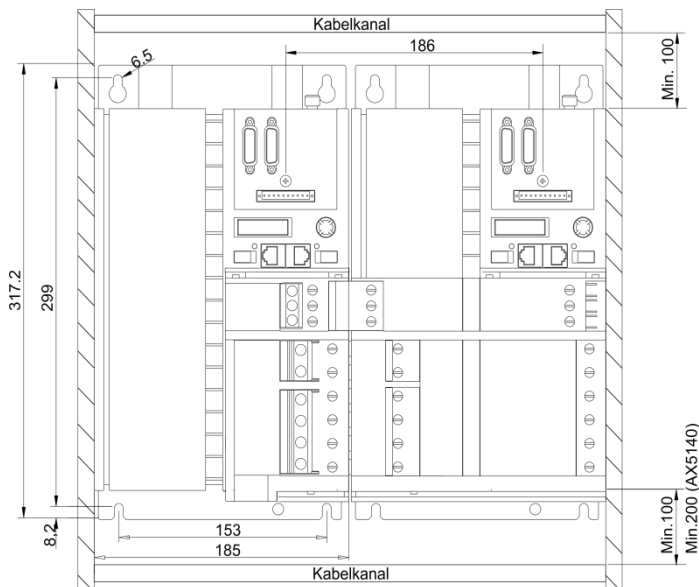
Connecting the protective earth conductor to the AX5000

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).

5.1.1.1 Installation example - AX5101...AX5112 and AX5201...AX5206



5.1.1.2 Installation example - AX5118...AX5125 and AX5140



5.2 Electrical installation

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

	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 "X02" after the servo drive has been disconnected from the supply network. Wait 5 minutes 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)

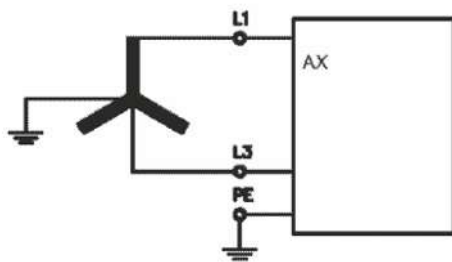
The servo drives of the AX5000 series are equipped with a wide-range voltage input "X01" and can be connected to voltage systems between one-phase 100 V AC -10% and three-phase 480 V AC +10%.



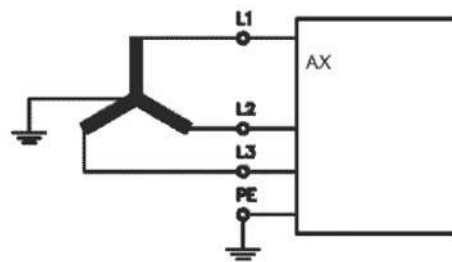
Note

Connection to the standard supply network (TT/TN) with grounded center is described below. For information on connections to other supply networks (e.g., IT network, isolating transformers, etc.), please refer to the "AX5000 User Manual" on the enclosed CD or download it from the website at www.beckhoff.com.

1 phase 100_{-10%} ... 240_{+10%} V AC



3 phase 100_{-10%} ... 480_{+10%} V AC



The AX5000 may only be connected to a standard supply network with a grounded center, whereby the max. voltage to ground may not exceed 277 V (+10%).

5.2.1.1 External fuse protection for individual devices, CE-compliant



Caution

Fire hazard through short circuit!

The following data refer to individual devices. Please note the sum current of all connected devices in a multi-axis system.

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

Single-phase

Fuse protection	AX5101	AX5103	AX5106	AX5201	AX5203	AX5206
AC supply ¹⁾ [A]	10	10	16	10	16	20
24-V supply [AT]	5					
Braking resistor	electronic					

¹⁾ Mains fuses of operating class "gG" with characteristic "T" or automatic circuit breakers with characteristic "C" must be used.

Three-phase

Fuse protection	AX5101	AX5103	AX5106	AX5201	AX5203	AX5206
AC supply ¹⁾ [A]	6	6	10	10	10	20
24-V supply [AT]	5					
Braking resistor	electronic					

Fuse protection	AX5112	AX5118	AX5125	AX5140
AC supply ¹⁾ [A]	20	35	35	50
24-V supply [AT]	5			
Braking resistor	electronic			

¹⁾ Mains fuses of operating class “gG” with characteristic “T” or automatic circuit breakers with characteristic “C” must be used.

5.2.1.2 Internal fuse protection, CE-compliant

Circuit	Fuse
24 V DC - system voltage [AF]	3.4
24 V DC - peripheral voltage	electronic
Braking resistor	electronic

5.2.1.3 External fuse protection, UL-compliant

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 18,000 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 I_p let-through current and I_2t of the new fuse are not greater than that of the specified fuse. See table SB4.2 for maximum let-through currents (I_p) and I_2t .

Single-phase

Fuse protection	AX5101	AX5103	AX5106	AX5201	AX5203	AX5206
AC supply (max.) [A]	6	12	20	12	20	20
24 V supply (max.) [AT]	3					
Braking resistor	electronic					

Three-phase

Fuse protection	AX5101	AX5103	AX5106	AX5201	AX5203	AX5206
AC supply (max.) [A]	6	12	20	12	20	20
24 V supply (max.) [AT]	3					
Braking resistor	electronic					

Fuse protection	AX5112	AX5118	AX5125	AX5140
AC supply (max.) [A]	20	35	45	80
24 V supply (max.) [AT]	3			
Braking resistor	electronic			

5.2.1.4 Internal fuse protection, UL-compliant

Circuit	Fuse
24 V DC system voltage [A]	3.4 ¹⁾
24 V DC - peripheral voltage	electronic
Braking resistor	electronic

¹⁾ Equipment with a "F" tripping characteristic is used.

5.2.1.5 External drive system fuse protection

Rule of thumb: Determine the rated sum currents of the devices, multiply with the correction factor and round up to the next higher standard level.

Example: 1 AX5103 + 2 AX5201 + 2 AX5203

$3\text{ A} + 6\text{ A} + 12\text{ A} = 21 \times 1.1 = 23.1\text{ A} \rightarrow$ **selected 25 A**

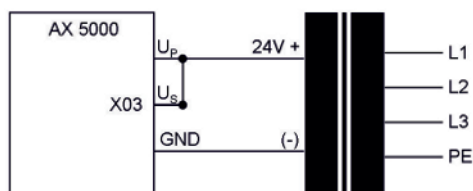
	Special requirements for a drive system Please note the configuration example in chapter 5.2.4.
--	---

5.2.2 24 V DC supply network connection (X03)

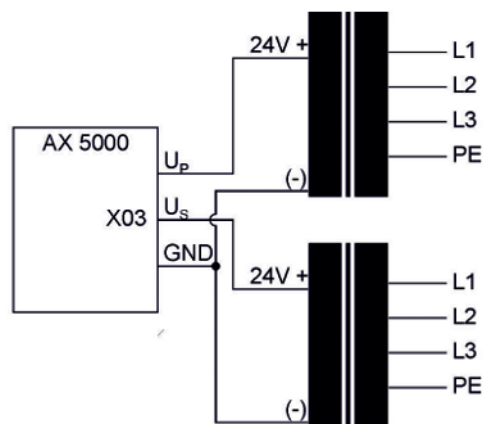
The 24 V DC connection "**X03**" is used for supplying the control electronics and periphery with DC voltage. The control electronics and the periphery can be supplied separately with two different voltage sources.

 Note	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.
--	--

Versorgung durch ein Netzteil



Versorgung durch zwei Netzteile



5.2.3 Connection of several servo drives to form a drive system

**Drive system with UL approval**

Please note the configuration example in chapter 5.2.4.

⚠ CAUTION**Destruction of the devices**

The connection sequence of the devices is not arbitrary. The rated sum current of the device must decrease from the mains supply onwards. AX5112, AX5106, AX5203, AX5201 = OK
AX5201, AX5112, AX5203 ≠ OK

All devices in a drive system are always to be disconnected from and reconnected to the supply network together (emergency shutdown, mains contactor etc.).

⚠ CAUTION**Danger for persons and equipment**

Note the rated sum current of the connected devices.

According to CE, the current-carrying capacity of the power busbars of the AX-Bridge is limited to 85 A.

⚠ CAUTION**Destruction of the external braking resistor**

An external braking resistor may not be connected to the X02 terminal point (DC link) in a drive system. Use an external brake module AX5021 for this.

5.2.3.1 Connection example - module AX5901 and AX5911 (AX-Bridge)

This connection technology enables a safe system to be set up very quickly. The modules are attached to plug contacts X01, X02 and X03, the relevant sliders are pushed to the left and screwed tight. According to CE, the current-carrying capacity of the power busbars of the AX-Bridge is limited to 85 A.

⚠ CAUTION

Risk of injury due to electric shock

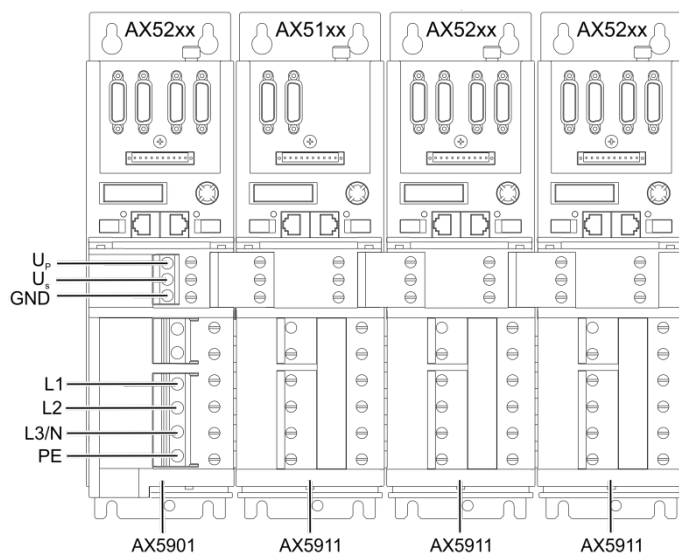
Move all busbar sliders to the left limit stop in order to ensure full current-carrying capacity. Then tighten all screws with a torque of 2.2 Nm.

⚠ CAUTION

Personal injuries

Please ensure that the connection cable for the AX5901 power supply module is adequately dimensioned. The dimensioning depends on the rated sum current and must comply with EN 60204-1.

The supply connection is established as described in chapters 5.2.1 and 5.2.2.



Data of the terminal points

Terminal point	Wire design	max. wire cross-section	Tightening torque
L1-L3, PE	solid wire	10 mm ² ; AWG 7	2.2 Nm
L1-L3, PE	stranded wire with ferrule	16 mm ² ; AWG 5	2.2 Nm
L1-L3, PE	stranded / multi-wire	25 mm ² ; AWG 3	2.2 Nm
Us, Up, GND		16 mm ² ; AWG 5	2.2 Nm

5.2.3.2 Connection example - wiring in series without AX-bridge

Wire the relevant connections using individual cables.

⚠ CAUTION

Damage to persons and devices

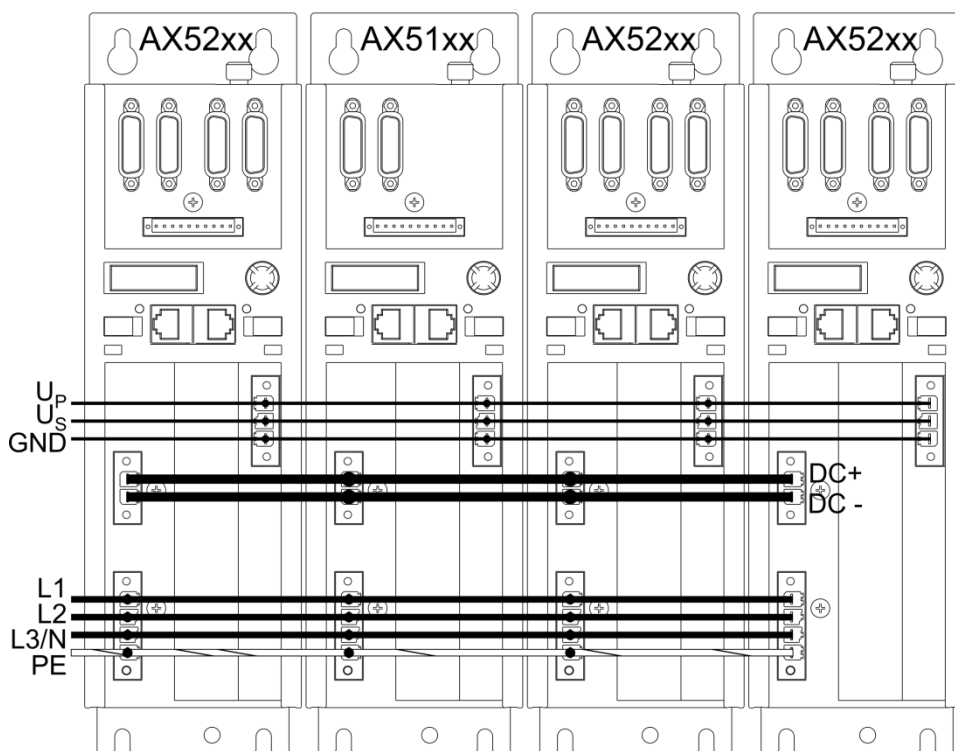
Please ensure that the final supply network connection cable is adequately dimensioned. The dimensioning depends on the rated sum current and must comply with EN 60204-1.

To create a DC link network wire the X02 connections with a suitable cable. Voltages up to 875 V may be present.

The connectors are designed for a maximum current intensity of 41 A and a maximum conductor cross-section of 6 mm².

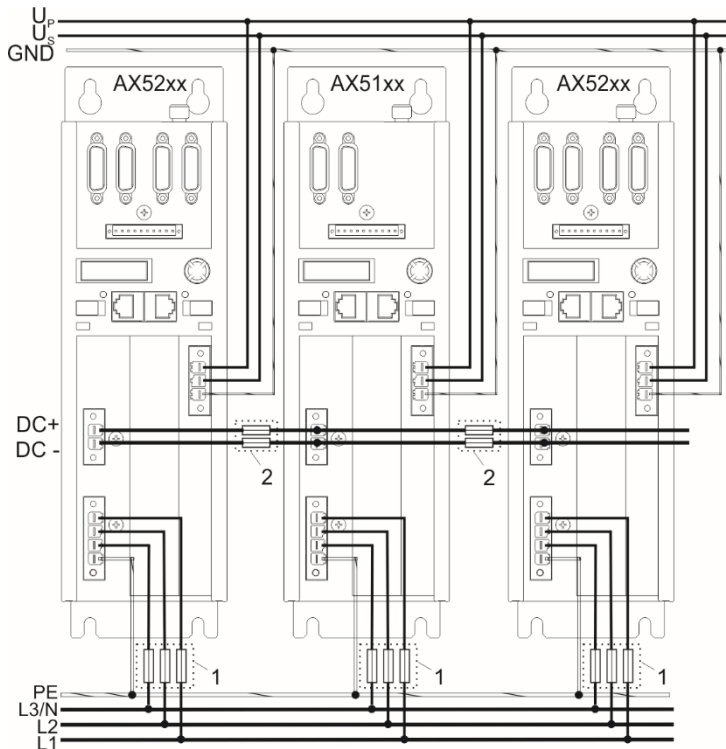
Do not reverse the phases between the devices.

The supply connection is established as described in chapters 5.2.1 and 5.2.2.



5.2.4 UL - drive system, configuration example

	Drive system with UL approval The following illustration shows a possible configuration example. Before implementation, please contact your UL certificate authority and discuss further necessary boundary conditions. Please note that the AX-Bridge does not have UL approval.
---	--



Legend:

1 = UL-circuit breaker (480 V AC)

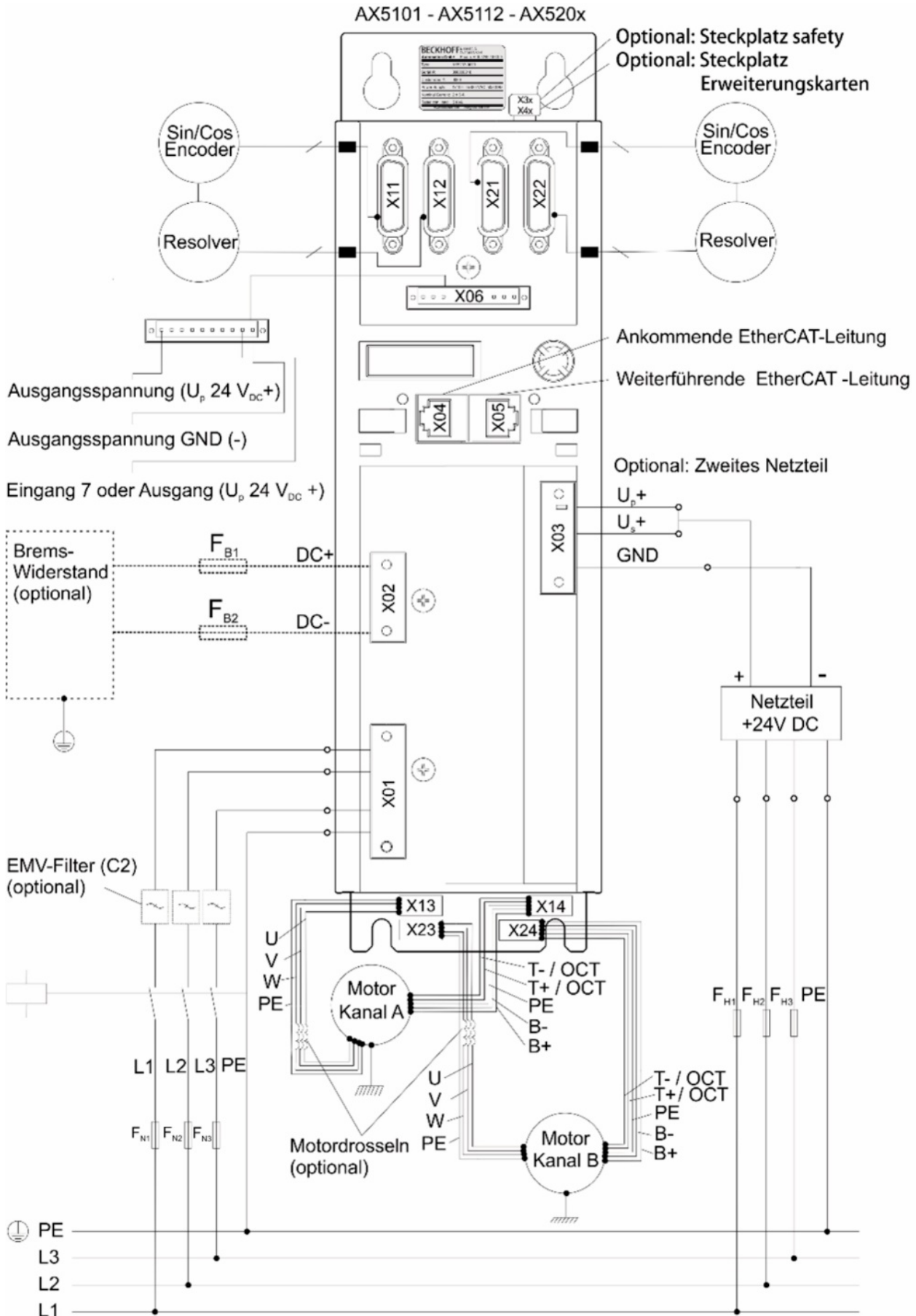
2 = UL circuit breaker (700 V AC / 800 V DC) e.g. Ferrule FWP from Cooper-Bussmann

	Fuse holders with UL approval Note when using UL circuit breakers that the necessary fuse holders also have to carry UL approval.
---	--

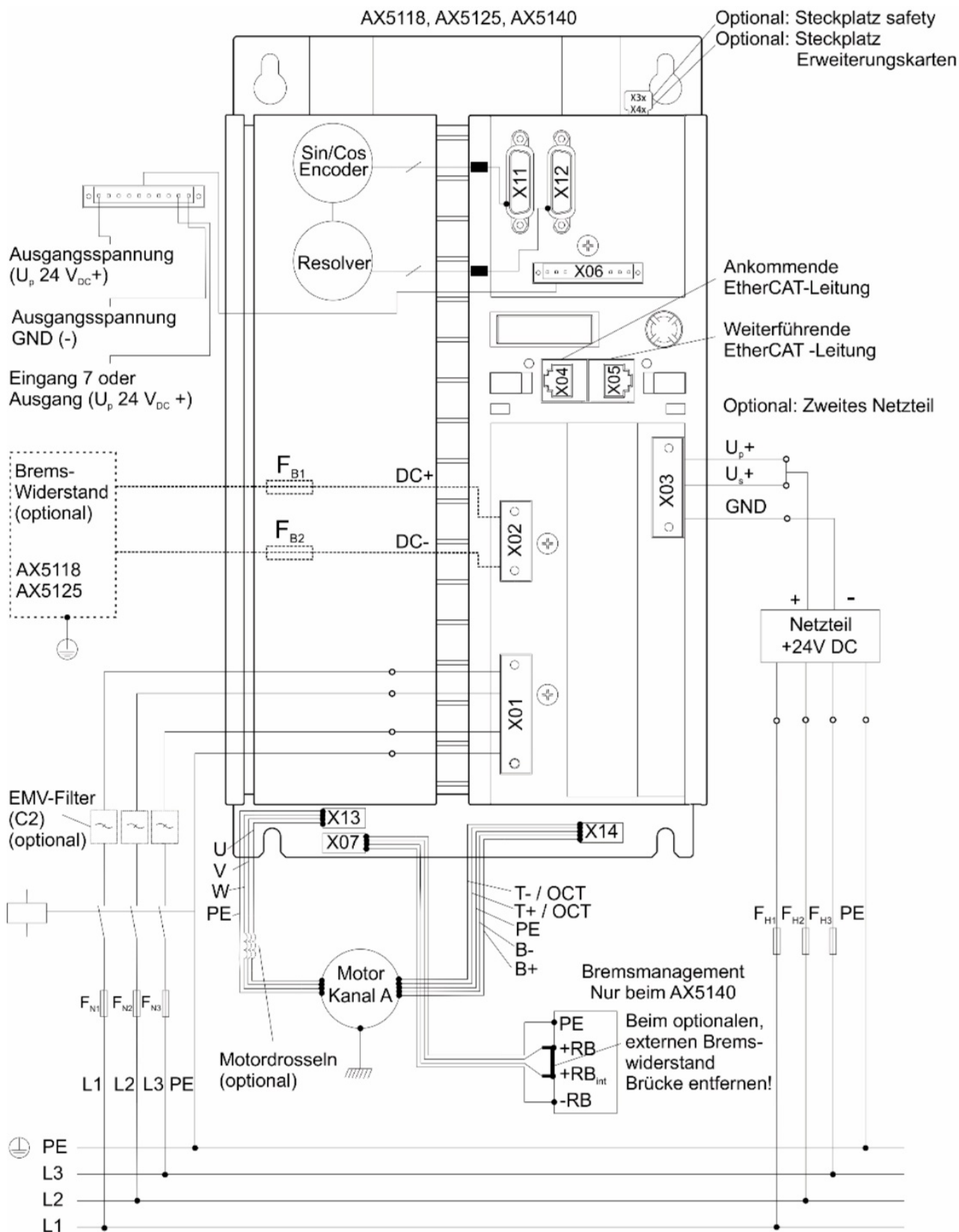
Dimensioning of the UL circuit breaker (2)

The dimensioning of the fuses (2) in the DC link is application-dependent. The motor and the load profile are directly factored into the calculation; please take this into account during the design process.

5.2.5 Connection Diagram for AX5101...AX5112 and AX520x



5.2.6 Connection Diagram for AX5118, AX5125, and AX5140



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

No motor choke is required for the AX5140 series.

5.3.1 Max. cable lengths including extensions

Rated motor voltage up to 400 V AC

Motor choke	AX5101...AX5112, AX52xx		AX5118, AX5125		AX5140	
	C2 ¹⁾	C3	C2 ¹⁾	C3	C2	C3
Without	<25 m	<25 m	<25 m	<25 m	-	<30 m
AX2090-MD50-0012	<100 m	<100 m	-	-	-	-
AX2090-MD50-0025	-	-	<50 m	<50 m	-	-

¹⁾ For compliance with EN 61800-3 only with mains filter AX2090-NF50-0014.

²⁾ For compliance with EN 61800-3 only with mains filter AX2090-NF50-0032.

● Sensitive sensors

In exceptional cases (sensitive sensors, etc.) it can be necessary to use a motor choke even for motor cable lengths <25 m.

Rated motor voltage up to 480 V AC

Motor choke	AX5101...AX5112, AX52xx		AX5118, AX5125		AX5140	
	C2 ¹⁾	C3	C2 ²⁾	C3	C2	C3 ³⁾
Without	<20 m	<20 m	<20 m	<20 m	-	⁴⁾
AX2090-MD50-0012	<100 m	<100 m	-	-	-	-
AX2090-MD50-0025	-	-	<50 m	<50 m	-	-

¹⁾ For compliance with EN 61800-3 only with mains filter AX2090-NF50-0014.

²⁾ For compliance with EN 61800-3 only with mains filter AX2090-NF50-0032.

³⁾ C3 with up to 70 m without mains choke possible for devices with order number AX5140-0000-1202.

⁴⁾ Please contact our applications department

In exceptional cases (sensitive sensors, etc.) it can be necessary to use a motor choke even for motor cable lengths <20 m.

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

Beckhoff Automation GmbH & Co. KG

Hülshorstweg 20

33415 Verl

Germany

Phone: +49 5246 963-0

E-Mail: info@beckhoff.com

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.

Trademark statements

Beckhoff®, ATRO®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, MX-System®, Safety over EtherCAT®, TC/BSD®, TwinCAT®, TwinCAT/BSD®, TwinSAFE®, XFC®, XPlanar® and XTS® are registered and licensed trademarks of Beckhoff Automation GmbH.

Third-party trademark statements

BiSS is a trademark of IC Haus GmbH.

EnDat is a trademark of Dr. Johannes Heidenhain GmbH.

More Information:

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com

