Manual

Multi axis servo system AX8000

TDmIAX-8000-0000-0200

Version: 1.6
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BECKHOFF

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1 Foreword

1.1 Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared 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 prior announcement.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents:
EP1590927, EP1789857, DE102004044764, DE102007017835
with corresponding applications or registrations in various other countries.

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1.2 Documentation issue status

Origin of the document

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

Product features

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

Version	Comment
1.6	**Chapter amendment:** Definitions **1.5**; UL-specific chapter **2.3.1**; Type plate for supply and axis module **4.1.1 – 4.1.2**; General description AX8620 and AX8640 **4.3.1 – 4.3.2**; Wide voltage range **5.1.1.1**; Structure of the servo system **5.1**; Electrical data **–** power supply modules **5.2.3**; Dimensions **5.2.6**; Installation conditions in the control cabinet **6.1**; Drilling pattern and installation example **6.2**; Block diagrams **7.1 – 7.2**; Power supply **7.3.1 – 7.3.7**; Positioning within the system **8.3.2**; **New chapter:** UL configuration example of a system group **2.3.1.1**; Connection of the protective conductors **6.3** **Removed chapters:** Electrical data – power supply modules **5.2.2**
1.5	**Chapter amendment:** Scope of the documentation **1.2.1**; Intended use **1.3**; Dual use **1.3.1**; Electromagnetic compatibility **2.2**; For your safety **3**; Description of symbols **3.2**; Notes on AX8000 multi-axis servo system **3.3**; Type plate for supply and axis module **4.1.1** and **4.1.2;** System description **5.1.1;** Ambient and operating conditions **5.2.1**; Electrical installation **7**; Block diagrams **7.1** and **7.2**; Power supply **7.3**; **New and restructured chapter:** UL approval in the USA and Canada **2.3**; Accessories **4.2** is now **4.4;** Total motor cable lengths **7.6**
1.4	**Chapter amendment:** 1.5; 1.6; 2.1; 4.1.1; 4.1.2; 7.5.2; 7.7.2 **New chapter:** Drive-integrated safety technology **4.2**

1.2.1 Scope of the documentation

The overall documentation package for the AX8000 multi-axis servo system is comprised of the following manuals:

AX8000 -	Definition
System manual	Description of the mechanical and electrical parameters as well as all information necessary for the use of the AX8000 multi-axis servo system.
Startup (this documentation)	User manual for the installation and assembly of the AX8000 multi-axis servo system.
Commissioning under TwinCAT3	Commissioning tutorial under TwinCAT3 including user information on the TC DriveManager 2 and a description of the safety function STO (Safe Torque Off) over FSoE (Safety over EtherCAT).
CoE - object description	Documentation of CAN over EtherCAT – objects with attribute tables.
Diagnostic messages	Documentation of the error messages of the AX8000 multi-axis servo system with attribute tables and problem/solution descriptions.
AX2090-BW8x brake resistors	Operating instructions for the use and installation of the AX2090-BW8x brake resistors as accessories for the AX8000 multi-axis servo system.

1.3 Appropriate use

The AX8000 multi-axis servo system is exclusively designed for the operation of suitable synchronous motors with torque, speed and position control. The max. permissible effective voltage of the motors must be higher than or at least equal to the effective mains voltage supplied to the servo system.

The supply, axis and capacitor modules of the AX8000 multi-axis servo system are installed exclusively as components in electrical systems or machines. They may only be put into operation as integrated components of the system.

⚠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 fault in the drive system.

The components and modules listed above may only be operated in a closed control cabinet, taking into consideration the environmental and operating conditions [▶ 27] described in the section: "Technical Data".

Improper use

The AX8000 multi-axis servo system 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. The servo drives may only be installed in housings and control cabinets with appropriate shielding attenuation.

1.3.1 Dual Use (EU1382/2014)

According to the EU directive 1382/2014 published on 30/12/2014, commercially available frequency converters – that also means the Beckhoff product series: AX8000 multi-axis servo systems are now newly classified as dual-use goods.

The goods list, Annex I of the Dual Use directive 428/2009 has been amended accordingly:

- Frequency converters (listed in goods list position 3A225) ≥ 600 Hz are subject to export control.
- Frequency converters (AX8000 multi-axis servo system) with a rotary field frequency of 599 Hz are **not** subject to export control.

The multi-axis servo system AX8000 is only available with a rotating field frequency of max. 599 Hz delivered. This is sufficient for commissioning all synchronous servomotors of the Series AM8x00 with full performance.

1.4 Documented modules

This documentation describes the following modules of the AX8000 multi-axis servo system:

Power supply modules:
AX8620, AX8640

Axis modules:
AX8108, AX8118, AX8206

Option modules:
AX8810 (capacitor module)

1.5 Definitions

Term	Explanation
AX8000, servo drive	General term for linked modules of the AX8000 series
Axis module	Component to which the motors are connected.
AX-Bridge	Toolless connection of the DC link, the EtherCAT fieldbus system and the system supply with the power supply module and the connected modules through a rail system with quick coupling.
Brake resistor	When the DC-DC link capacitors can no longer absorb energy generated by braking of the motors, it is fed to a brake resistor and converted to heat.
Braking	Braking of the motors generates regenerative energy, which is fed back to the DC link.
Dual-axis module	Component to which up to 2 motors can be connected.
Single-axis module	Component to which only 1 motor can be connected.
Supply module	Component that is connected to the mains supply and supplies the connected modules with direct voltage via the DC link.
FE	Functional earth
FSoE	Safety over EtherCAT protocol
Option module	Component that can make additional functions available.
PE	Earth connection
Test contacts	Easily accessible diagnostic points for the main operating voltages.
Safety	Term for the Beckhoff Automation safety technology.
STO	STO (Safe Torque Off) is a TwinSAFE safety function for drive technology.
TwinSAFE	TwinSAFE is an open and scalable safety technology from Beckhoff Automation.
DC link	DC accumulators (capacitors) for supplying the drive modules with direct voltage.
DC link system	Connection between the DC links of supply modules and connected axis modules with AX bridge.

2 Guidelines and Standards

NOTE

Proof of CE conformity of the machine or system!

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 manufacturers has provided evidence of CE conformity of the complete machine or system.

2.1 EU declaration of conformity

Supply of EC declaration of conformity:

Beckhoff Automation GmbH & Co. KG will gladly provide you with the certificates for all products on request at: info@beckhoff.com

2.2 Electromagnetic compatibility (EMC)

Beckhoff Automation GmbH & Co. KG guarantees the conformity of the AX8000 multi-axis servo system to the EMC Directive 2014/30/EU.

Applied harmonized standards:

- IEC / EN 61800-5-3

Installation of electrical systems and components

In order to be able to establish an effective protective earth conductor system, in addition to the protective conductors and all electronic components all conductive components of a machine must be included in the protective earth conductor system through equipotential bonding.

⚠CAUTION

Attachment of the protective earth conductor!

When installing electrical systems and components, the protective earth conductors should always be connected first and removed last. The specifications for the protective earth conductor connections depend on the level of leakage currents:

- The minimum requirement for the protective earth conductor is a KU value[1)] of 4.5
- The minimum requirement for leakage currents is I_L < 10 mA or KU = 6 for I_L > 10 mA.

[1)] The KU value is a variable for the classification of safety-related types of failure for protection against dangerous shock current and excessive heating. A value of KU = 4.5 in relation to interruption is attained:

- with a permanently attached protective earth conductor ≥ 1.5 mm²
- for protective earth conductor connections ≥ 2.5 mm² with connectors for industrial systems (IEC 60309-2).

KU = 6 in relation to interruption is attained with permanently connected conductors ≥ 10 mm², wherein the type of connection and routing must comply with the standards applicable to PE conductors.

2.3 UL approval for the US and Canada

The German translation of this chapter is purely informative!

All statements made in the English version (AX8000 – System Manual Version 1.0) of this chapter are binding!

The following components of the AX8000 multi-axis servo system are cULus-certified (E-number E195162):

Modules from the AX8000 series with UL certification

AX8620, AX8640, AX8108, AX8118, AX8206, AX8810

The above components are permitted to bear the certification logo on the type plate. If you wish to operate a servo drive from the AX8000 series in the USA or Canadian economic areas, please check whether the cULus sign appears on the type plate.

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

2.3.1 UL-specific chapter

The integrated protection against short circuit is no substitute for the external mains protection. The mains protection must comply with the manufacturer's specification and the national and international regulations and laws.

Components of the AX8000 multi-axis servo system must be operated on mains supplies that can supply a maximum current carrying capacity of 5 kA at 480 V_{AC}.
UL circuit breakers of class "J" are to be used for protection.

- AX8620 power supply modules must be fuse-protected with 30 A max.
- AX8640 power supply modules must be fuse-protected with 60 A max.

With regard to alternatives to the UL circuit breakers of the class "J", be sure to refer to the UL standard "UL 508 A, chapter SB4.2.3, exception no. 1".

c UL US	**Fuse holders with UL approval** Possible configuration examples are described in the further course of this document. Before implementing a UL configuration, please contact your UL certification body and discuss further necessary boundary conditions. Furthermore, when using fuse holders, care must be taken that they have also been tested and manufactured in accordance with the applicable standards of the UL certification body.

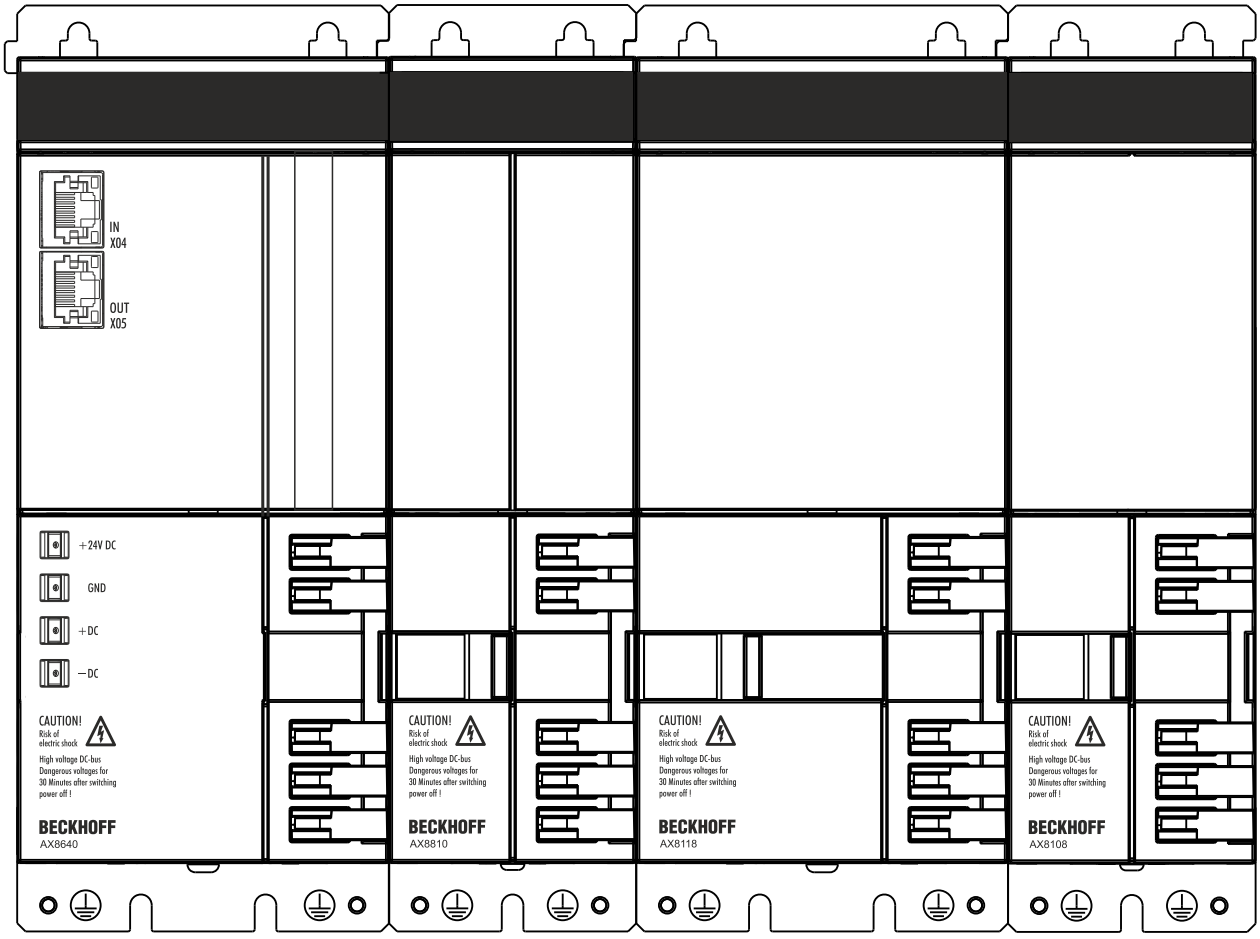
2.3.1.1 UL configuration example of a system group

System group with UL approval:

The following figure describes a possible configuration example, a system group consisting of several AX8000 devices with UL approval. Please note that prior to implementation on your machine or system, it is essential to consult your responsible UL certification authority, to discuss all further and required boundary conditions. Furthermore, when using fuse holders, it is important to ensure that they comply with the current directives and standards of the UL certification body and that they have been tested accordingly.

To configure the current-limiting circuit breakers for your system group, proceed as follows:

Determine the total rated output currents of all AX8000 modules in the system group.



In our example, we use an AX8640-0000 power supply module, an AX8810-0000 capacitor module, an AX8118-0000 axis module and an AX8108-0000 axis module.

Calculation:

Rated output current of the AX8118-0000 (**18 A**) and AX8108-0000 (**8 A**) axis modules = **26 A**.

Total rated output current = **26 A** x correction factor 1.1 = **28.6 A**.
According to the calculation, the system group would have to be fuse-protected with **28.6 A**.
Please select the next larger default rating according to UL508A, Table SB4.2 for the sizing of your fuse protection.

Selection of current-limiting circuit breakers according to UL508A, Table SB4.2:

In our configuration example, we select a UL circuit breaker according to UL508A, Table SB4.2 of type "G" with 40 A, based on the total rated output current.

	**UL test report for the AX8000 multi-axis servo system:** All modules (supply, option and axis modules) of the AX8000 multi-axis servo system meet the requirements of the relevant UL certification authority and may bear the cULus logo and the E-number E195162 on the type plate. Please note that the tested system group of the multi-axis servo system has been protected with a current-limiting circuit breaker of type "J" with 60 A. A higher fuse type has not been tested in accordance with the standards and guidelines of the UL certification body and is therefore not permitted for a system group.

2.3.2 UL-specific data

What's important:

- Components from the AX8000 multi-axis servo system may be used in an environment with non-conductive dirt. This corresponds to the degree of soiling **2**. Note that occasionally, depending on the environmental conditions, temporary conductivity can be expected due to condensation.
- The wiring must be done using copper conductors with a thermal conductivity of at least 60 °C - 75 °C.
- Various sizes of motor can be operated. The level of the internal motor overload protection switch is adjustable.

	**Canadian economic area!** In Canada the devices are only approved with a transient suppression on the input side. **Technical requirements for the device for transient suppression:** • Rated voltage: 480 V (Ph / GND), 480 V (PH / PH) • Overload category: 3 • Protection against a rated surge voltage peak: 4 kV

3 For your safety

Read the section on safety and heed the notices to protect yourself against personal injury and material damages.

Liability limitations

All the components of the AX8000 multi-axis servo system are supplied in certain hardware and software configurations appropriate for the conditions of the application. Unauthorized modifications to the hardware and/or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

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

- Failure to comply with this documentation
- Improper use [▶ 7]
- Untrained personnel
- Use of unauthorized spare parts

3.1 Staff qualification

Only technical personnel with knowledge of control and automation technology may carry out any of the illustrated work steps on the Beckhoff software and hardware, in particular on the AX8000 multi-axis servo system.

The technical personnel must have knowledge of drive technology and electrical systems and must also know how to work safely on electrical equipment and machines.

This also includes:

- production planning and
- securing of the working environment (e.g. securing the control cabinet against being switched on again).

The technical personnel must be familiar with the current and necessary standards and directives for the automation and drive environment.

3.2 Description of symbols

In this documentation the following symbols are used with an accompanying safety instruction or note. The safety instructions must be read carefully and followed without fail!

Symbols that warn of personal injury:

⚠DANGER

Serious risk of injury!

This is an extremely dangerous situation. Disregarding the safety notice will lead to serious permanent injuries or even death.

⚠WARNING

Risk of injury!

This is a dangerous situation. Disregarding the safety notice may lead to serious injuries.

⚠CAUTION

Personal injuries!

This is a dangerous situation. Disregarding the safety notice may lead to minor injuries.

Symbols that warn of damage to property or equipment:

NOTE

Warning of damage to property or the environment!

This notice indicates disturbances in the operational procedure that could damage the product or the environment.

Symbols indicating further information or tips:

Tip or pointer!

This notice provides important information that will be of assistance in dealing with the product or software. There is no immediate danger to product, people or environment.

c UL us	**cULus note!** This symbol indicates important information regarding UL certification.
c RU us	**cRUus note!** This symbol indicates important information regarding cRUus certification.
c UL us LISTED Ind. Cond. E.q. 41GE	**cULus listed note!** This symbol indicates important information regarding cULus listed certification.

3.3 Notes on the AX8000 multi-axis servo system

The notes are intended to avert danger and facilitate the handling of the AX800 multi-axis servo system. They must be followed during installation, commissioning, production, troubleshooting, maintenance and trial or test assemblies.

The multi-axis servo system from the AX8000 series is not capable of running alone. It must always be installed in a machine or system. After installation the additional documentation and safety instructions provided by the machine manufacturer must be read and followed.

⚠DANGER

Danger to life due to high voltage on the DC link capacitors of the servo drive AX8000!

The DC link capacitors RB+ and RB- and the test contacts DC+ and DC- on the **supply**, **axis** and **option modules** can carry life-threatening voltages of ≥ 875 V_{DC}.

Take the following measures to avert danger:

- After disconnecting the servo drive from the mains supply, wait until the voltage has fallen below 50 V_{DC}. Only then is it safe to work.
- Measure the voltage on the test contacts properly.
- Secure the work area properly and wear the PPE.

⚠CAUTION

Proper connection of the protective earth conductor!

Protective earth systems must be connected when installing electrical systems and components.

Please observe the following notes when installing the protective earth conductor:

- Read section 3.2: "Electromagnetic compatibility (EMC)", in particular the parts regarding the attachment of a protective earth conductor.
- Make sure that the protective earth conductor has been firmly connected.
- Disconnect the servo drive from the mains supply. Secure the control cabinet and the device against being switched on again.
- Wear PPE.

⚠WARNING

Serious burns due to hot surfaces on the devices!

The surface temperature of the devices can reach ≥ 50 °C during operation of the 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 sufficiently. 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.

NOTE

Notes on operation of the AX8000 multi-axis servo system:

- Read this manual completely and carefully before using the servo drive. Notify the responsible sales office immediately if any passages are not understandable. Refrain from working on the servo drive.
- When carrying out the electrical installation, ensure that the correct fuses/circuit breakers are selected between the mains supply and the supply module. Further information can be found in the "Electrical installation" section.

NOTE

Damage to the environment or devices

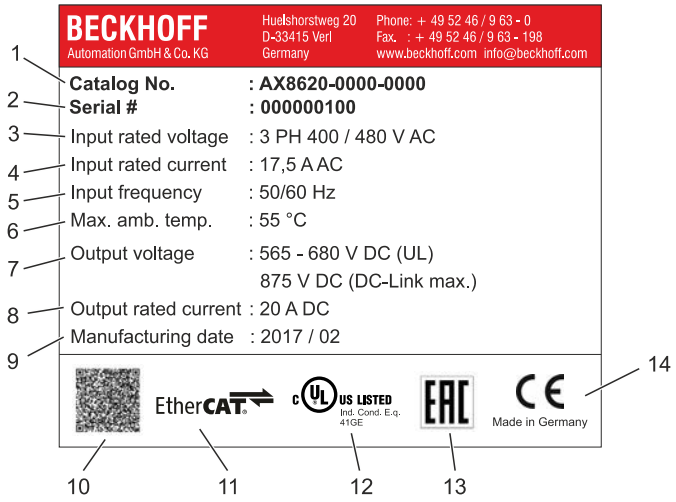
- During installation it is essential to ensure that the specified ventilation clearances and climatic conditions are adhered to. Further information can be found in the "Technical data [▶ 27]" and "Mechanical installation [▶ 32]" sections.
- If the servo drive is operated in contaminated ambient air, the cooling openings must be checked regularly for blockage.
- 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 AX8000 is in operation.

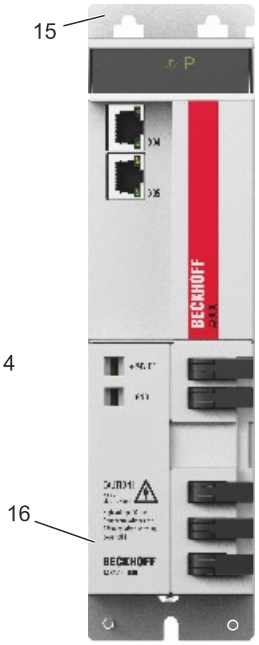
4 Product overview

4.1 Name plate and type key

4.1.1 Supply modules

Name plate





No.	Position	No.	Position	No.	Position
1	Order number	7	Rated output voltage	13	CE conformity
2	Serial number	8	Rated output current	14	EAC approval
3	Rated input voltage	9	Date of manufacture	15	Serial number sticker
4	Rated input current	10	QR code	16	Attachment of the type plate
5	Input frequency	11	EtherCAT conformity		
6	Max. ambient temperature	12	cULus certification		

Type key

AX 8 6 y z - a b c d - 0000

Product line
Servo drives

Series
AX8000

Power supply
6
in combination with „a“

Rated output current
20 = A DC (Single phase supply)
20 = 20 A DC (Three phase supply)
40 = 40 A DC (Three phase supply)

Version
0 = Standard

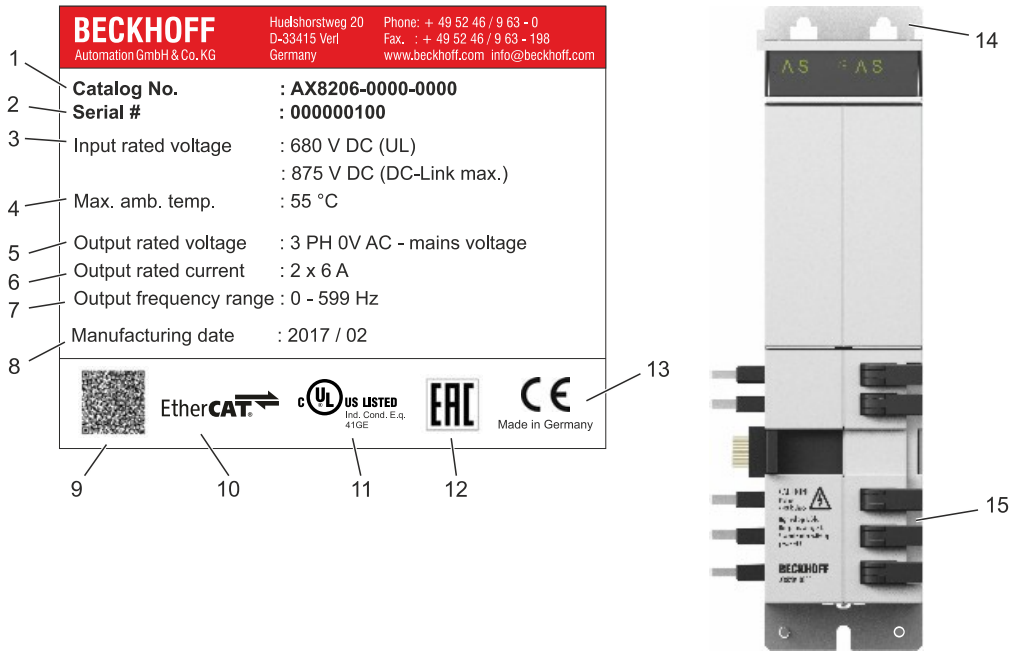
Hardware features
0 = Standard

Reserved
0 = Standard

Power supply
0 = 3-phase 100 - 480 V AC

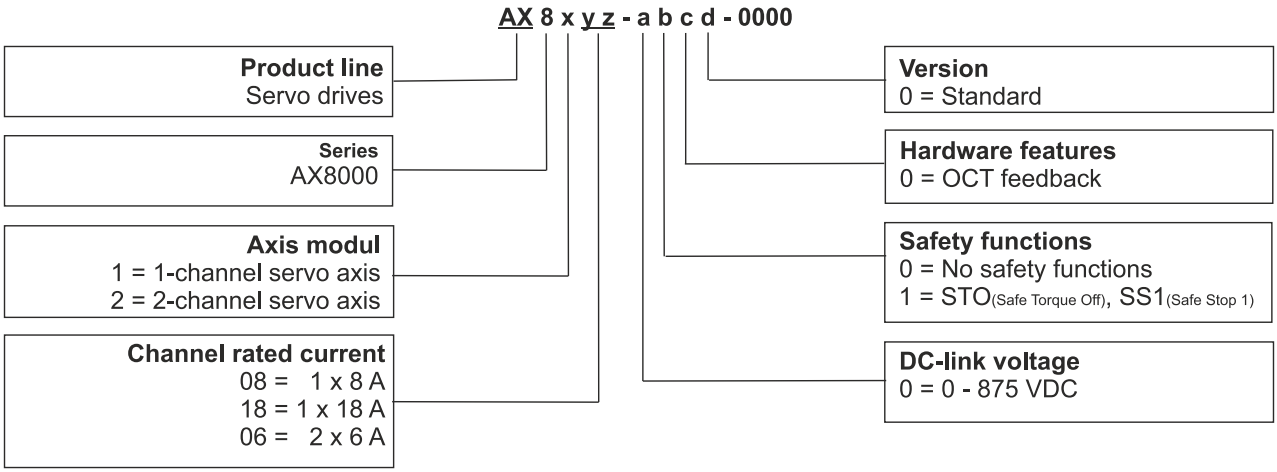
4.1.2 Axis modules

Type plate



No.	Location	No.	Location	No.	Location
1	Order number	6	Rated output current	11	cULus certification
2	Serial number	7	Output frequency range	12	EAC approval
3	Rated input voltage	8	Date of manufacture	13	CE conformity
4	Max. ambient temperature	9	QR code	14	Serial number sticker
5	Rated output voltage	10	EtherCAT conformity	15	Attachment of the type plate

Type key



4.2 Drive-integrated safety technology

The AX8000 axis modules are also optionally available with integrated safety functions. These correspond to IEC 61800-5-2 and meet the safety standards EN ISO 13849-1:2008
(up to Cat 4, PL e) and IEC 61508:2010 (SIL 3).

Communication takes place via the Safety-over-EtherCAT (FSoE) protocol according to IEC 61784-3-12.
The safety function STO can optionally also be activated via two safely integrated digital inputs.

Order designation	Safety functions
AX8xxx-x**1**xx	• STO (Safe Torque Off) • SS1 (Safe Stop 1) Optionally via safe digital inputs or via FSoE
AX8xxx-x**2**xx	• TwinSAFE (in preparation)

NOTE

Safety-related documentation!

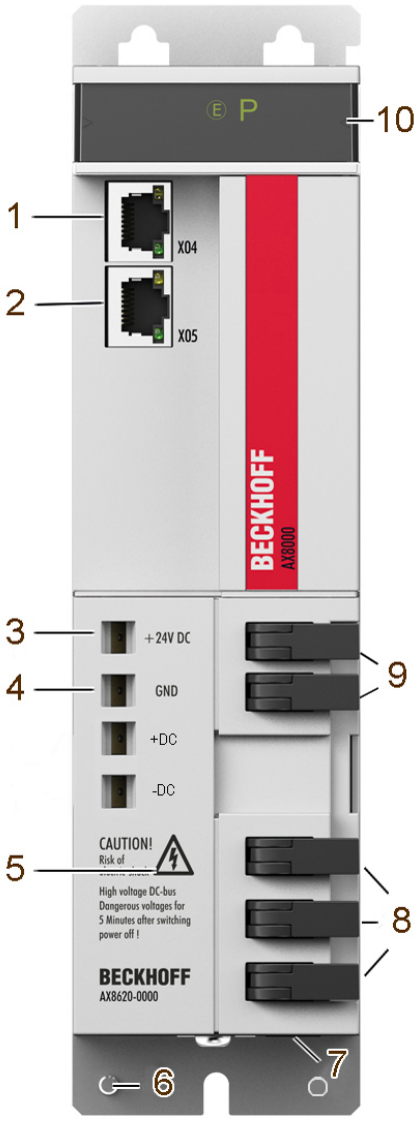
Axis modules with the order designation AX8xx-x**1**xx support the safety functions STO (Safe Torque Off) and SS1 (Safe Stop 1).
Before putting the axis module into operation, read the documentation for:

- AX8911 - TwinSAFE Drive option for AX8000 series servo drives.

4.3 General description

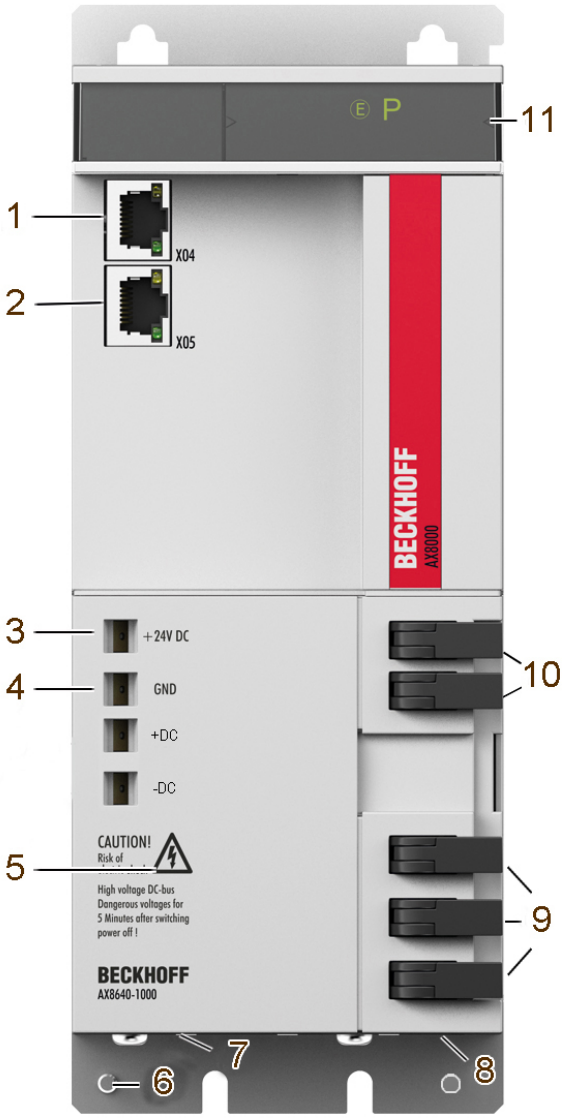
4.3.1 AX8620 power supply module

No.	Designation	
1	X04 - socket for EtherCAT input	
2	X05 - socket for EtherCAT output	
3	Test contact +24 V_{DC}	
4	Test contact GND	
5	**DANGER**	875 V_{DC} voltage at the DC link contacts (3). After switching off, measure the voltage. Safe operation is only possible once the voltage has dropped below 50 V_{DC}.
6	Earthing bolt for protective conductor connections	
7	X01 – 10-pin input terminal for DC, 24 V_{DC}, mains supply, PE (protective earth) and external brake resistor	
8	Quick couplings - DC link and FE	
9	Quick couplings - 24 V_{DC}	
10	Display	



4.3.2 Supply module - AX8640

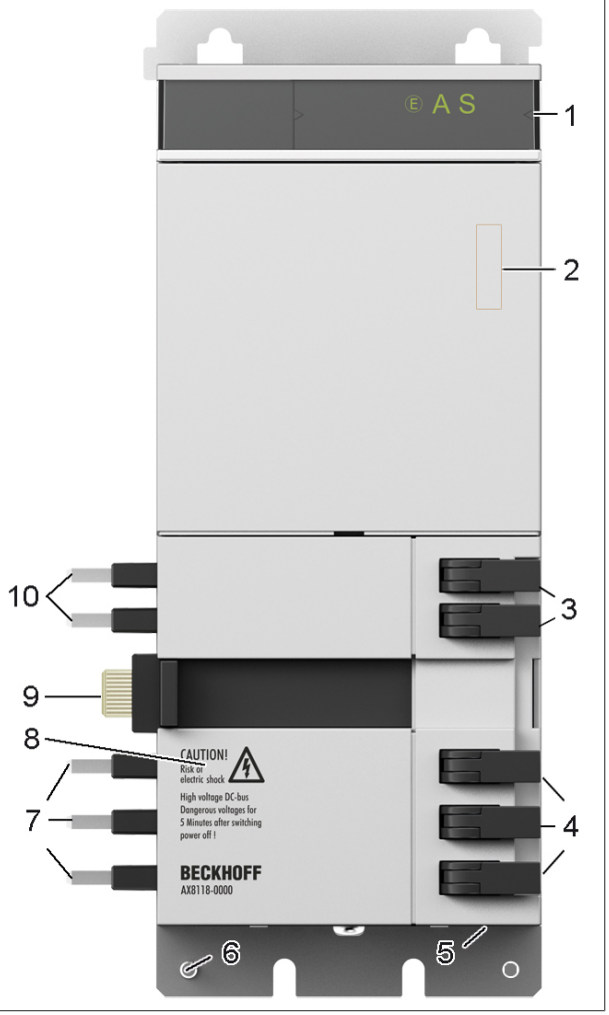
No.	Designation	
1	X04 - socket for EtherCAT input	
2	X05 - socket for EtherCAT output	
3	Test contact +24 V_{DC}	
4	Test contact GND	
5	**DANGER**	875 V_{DC} voltage at the DC link contacts (3). After switching off, measure the voltage. Safe operation is only possible once the voltage has dropped below 50 V_{DC}.
6	Earthing bolt for protective conductor connections	
7	X01 – 4-pin input terminal for mains supply and PE (protective earth)	
8	X02 – 7-pin input terminal for DC, 24 V_{DC} and external brake resistor	
9	Quick couplings - DC link and FE	
10	Quick couplings - 24 V_{DC}	
11	Display	



4.3.3 Axis modules – AX8108 and AX8118

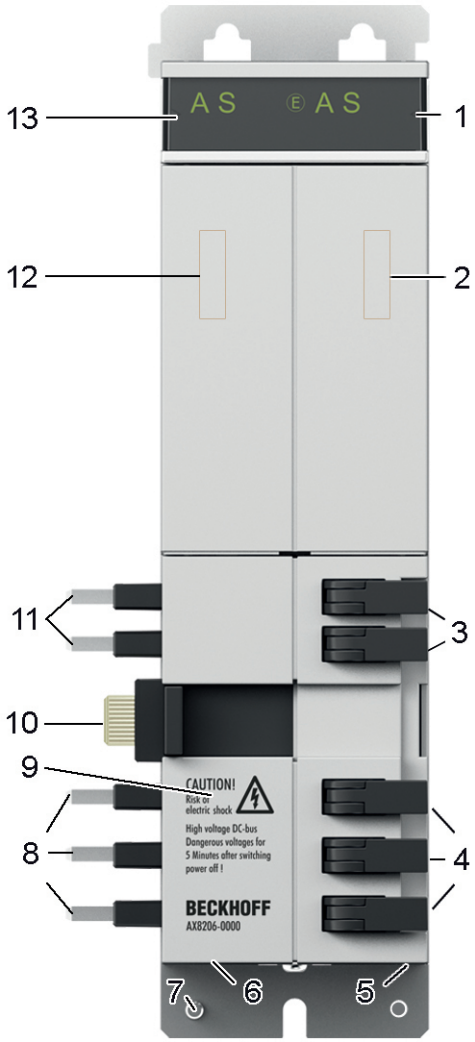
The diagram below shows the AX8118 module. The AX8108 module only differs in the width; otherwise it is identical to the AX8118.

No.	Name	
1	Display	
2	X15 – digital inputs	
3	Quick coupling – 24 V_{DC}	
4	Quick coupling – DC link and FE	
5	X13 – 8-pin motor connector: U, V, W, PE, T+ (OCT+), T- (OCT-), B+ and B-	
6	Earthing bolt	
7	AX-Bridge: DC link and FE	
8	**DANGER**	875 V_{DC} voltage at the DC link rails (4 and 7). After disconnecting measure the voltage at the DC link rails. Safe working is only possible once the voltage has dropped below 50 V_{DC}.
9	AX-Bridge: EtherCAT	
10	AX-Bridge: 24 V_{DC}	



4.3.4 Axis module - AX8206

No.	Name	
1	Display – channel B	
2	X25 – digital inputs (channel B)	
3	Quick coupling – 24 V_{DC}	
4	Quick coupling – DC link and FE	
5	X23 – 8-pin motor plug (channel B): U, V, W, PE, T+ (OCT+), T- (OCT-), B+ and B-	
6	X13 – 8-pin motor plug (channel A): U, V, W, PE, T+ (OCT+), T- (OCT-), B+ and B-	
7	Earthing bolt	
8	AX-Bridge: DC link and FE	
9	**DANGER**	875 V_{DC} voltage at the DC link rails (4 and 8). After disconnecting measure the voltage at the DC link rails. Safe working is only possible once the voltage has dropped below 50 V_{DC}.
10	AX-Bridge: EtherCAT	
11	AX-Bridge: 24 V_{DC}	
12	X15 – digital inputs (channel A)	
13	Display – channel A	



4.4 Accessories

Information about our comprehensive range of accessories can be found in the main Beckhoff main catalog or online under http://www.beckhoff.de.

c UL us	**Accessories with UL certification!** If you want to operate an AX8000 in the US or Canada, please note that any accessories also require UL certification.

5 Technical description

5.1 Configuration of the servo system

With a supply module and several axis modules, the servo drives of the AX8000 series offer optimum functionality and cost-effectiveness. Integrated control technology supports fast and highly dynamic positioning tasks. EtherCAT as a high-performance system communication enables ideal interfacing with PC-based control technology.

The AX8000 system enables convenient and fast connection of the DC link of the supply module and several axis modules via an AX Bridge. The connection can be established without tools through spring-loaded terminals for DC link, control circuit and EtherCAT.

The AX8000 was developed specifically for the EtherCAT real-time Ethernet system. The outstanding features of EtherCAT are particularly beneficial for drive technology. They include short cycle time, synchronicity and simultaneity. EtherCAT enables very short cycle times, even in bus systems containing a large number of devices.

The axis modules enable operation of motors with different ratings, thanks to scalable motor current measurement. At an 8 A module the rated motor current can be set between 1 A and 8 A, without affecting the quality of the resolution.

At a two-channel axis module two identical or two different motor versions can be connected. The total rated current of the two motors is relevant for the choice of axis module. Note that the maximum current that can be supplied at any one time is the rated current of the axis module.

5.1.1 System description

Function / characteristic	Supply module	Axis module
Mains supply with mains and phase monitor	x	-
Temperature monitoring: Device Heat sink	x	x
Brake chopper	x	-
DC link connection integrated (AX Bridge) per line	 x -	 x -
Connector including	x (X01, X02)	x (X15, X25)
Digital inputs / channel	-	4
Motors (incl. holding brake control) Synchronous servo motors	 -	 x
Feedback system OCT	 -	 x
Operation modes Torque control Speed control Position control	 - - -	 x x x

Special features of the multi-axis servo system:

- High-speed EtherCAT system communication
- flexible motor type selection
- scalable wide range motor current measurement
- High-speed capture inputs
- Diagnostic and parameter display
- integrated mains filter
- compact design for simple control cabinet installation
- Integrated quick connection system for DC link, control circuit and EtherCAT

The integrated fast control technology of the AX8000 multi-axis servo system with a current control cycle of up to 16 µs supports fast and highly dynamic positioning tasks.

5.1.1.1 Wide voltage range

In order to simplify use on the most diverse voltage systems, the supply modules of the AX8000 multi-axis servo system are equipped with a wide voltage range.

This covers the following different mains supplies:

- **1-phase mains supplies:** 1 x $100_{-10\%}$ V_{AC} - 1 x $240_{+10\%}$ V_{AC}
- **3-phase mains supplies:** 3 x $200_{-10\%}$ V_{AC} - 3 x $480_{+10\%}$ V_{AC}

Country-specific examples of different mains systems:

Country	1-phase mains supplies	3-phase mains supplies
Japan	1 x 100 V_{AC}	3 x 200 V_{AC}
North America	1 x 115 V_{AC}	3 x 480 V_{AC}
Europe	1 x 230 V_{AC}	3 x 400 V_{AC}

5.2 Technical data

5.2.1 Ambient and operating conditions

	**UL-listed!** If you wish to operate a component from the AX8000 multi-axis servo system in a US or Canadian economic area that requires cULus approval, be sure to read section 3.3: "UL approval in the USA and Canada [▶ 10]".

Ambient / operating conditions	Permissible values
Ambient temperature during operation	0 °C to +40 °C up to +55 °C with power derating of 2.5 % / K
Ambient temperature during transport	-25 °C to +70 °C
Ambient temperature during storage	-25 °C to +55 °C
Air humidity	15% to 85%, non-condensing
Level of contamination	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 2000 m with power derating → 1.5 % / 100 m.
Installation position	Vertical
Ventilation	built-in temperature-controlled fan
Protection class	IP 20 except the terminals (IP00)

5.2.2 Electrical data - power supply modules 100 - 480 VAC

1-phase connection

Electrical data	AX8620-0000
Rated input current	10 A_{AC}
Max. input current [1]	20 A_{AC}
Rated supply voltage	1 x $100_{-10\%}$ / $240_{+10\%}$ V_{AC}
Rated output current	5 A_{DC} without mains choke/ 7 A_{DC} with mains choke
Peak output current[1]	14 A_{DC}
Rated output power [2]	2 kW
Max. DC link voltage	875 V_{DC}
DC link capacitance	405 µF
24 V system and peripheral voltage	24 V ± 10%
24 V current consumption	120 mA
Power dissipation (without chopper)	8 W + 6 W / kW
Continuous braking power (**internal** brake resistor)	50 W
Max. braking power (**internal** brake resistor)	21.8 kW
Min. brake resistor (**external** brake resistor)	33 Ω
Continuous braking power (**external** brake resistor)	1.6 kW
Max. braking power (**external** brake resistor)	21.8 kW
Mains filter	Integrated (category "C3")
SCCR value	5 kA

[1] for max. 5 s
[2] at 240 V mains voltage

3-phase connection

Electrical data	AX8620-0000	AX8640-0000
Rated input current	17.5 A_{AC}	35 A_{AC}
Max. input current [1]	35 A_{AC}	70 A_{AC}
Rated supply voltage	3 x $200_{-10\%}$ / $480_{+10\%}$ V_{AC}	
Rated output current	20 A_{DC}	40 A_{DC}
Peak output current[1]	40 A_{DC}	80 A_{DC}
Rated output power [2]	10.7 kW	21.4 kW
Max. DC link voltage	875 V_{DC}	
DC link capacitance	405 µF	625 µF
24 V system and peripheral voltage	24 V ± 10%	
24 V current consumption	120 mA	
Power dissipation (without chopper)	8 W + 6 W / kW	
Continuous braking power (**internal** brake resistor)	50 W	100 W
Max. braking power (**internal** brake resistor)	21.8 kW	43.6 kW
Min. brake resistor (**external** brake resistor)	33 Ω	18 Ω
Continuous braking power (**external** brake resistor)	1.6 kW	3.2 kW
Max. braking power (**external** brake resistor)	21.8 kW	40.1 kW
Mains filter	Integrated (category "C3")	
SCCR value	5 kA	

[1] for up to 5 s
[2] at 240 V mains voltage

5.2.3 Electrical data - axis modules 0 - 875 VDC

Single-channel

Electrical data	AX8108-0000	AX8118-0000
Rated output current	8 A	18 A
Max. DC link voltage	875 V_{DC}	
DC link capacity	135 µF	405 µF
Current consumption 24 V (without holding brake)	500 mA	530 mA
Power dissipation (without holding brake)	12 W + 9 W / A at 240 V AC [2] + 11 W / A at 400 V AC [2] + 12.5 W / A at 480 V AC [2]	12 W + 8 W / A at 240 V AC [2] + 10 W / A at 400 V AC [2] + 11 W / A at 480 V AC [2]
Minimum rated channel current at full current resolution	1 A	5 A
Peak output current [1] 400 V / 480 V [2]	20 A / 18 A	40 A / 36 A

[1] I_{eff} for max. 5 s
[2] Mains voltage

Two-channel

Electrical data	AX8206-0000
Rated output current / channel	6 A
Max. DC link voltage	875 V_{DC}
DC link capacity	135 µF
Current consumption 24 V (without holding brake)	570 mA
Power dissipation (without holding brake)	12 W + 9 W / A at 240 V AC [2] + 11 W / A at 400 V AC [2] + 12.5 W / A at 480 V AC [2]
Minimum rated channel current at full current resolution	1 A
Maximum rated channel current / left channel (A)	6 A
Maximum rated channel current / right channel (B)	8 A
Total rated output current	12 A
Peak output current [1] / left channel (A), 400 V / 480 V [2]	14 A / 14 A
Peak output current [1] / right channel (B), 400 V / 480 V [2]	20 A / 18 A
Peak output current [1]as total device current	28 A

[1] I_{eff} for max. 5 s
[2] Mains voltage

5.2.4 Electrical and mechanical data - option module

Data	AX8810-0000
Capacitance	1755 µF
Max. DC link voltage	875 V_{DC}
Height	230 mm
Width	60 mm
Depth	192 mm
Weight	1.9 kg

5.2.5 Mechanical data

Supply modules

Mechanical data	AX8620	AX8640
Width	60 mm	90 mm
Height without plugs	230 mm	230 mm
Depth without connectors / accessories	192 mm	192 mm
Weight	2.5 kg	3.5 kg

Axis modules

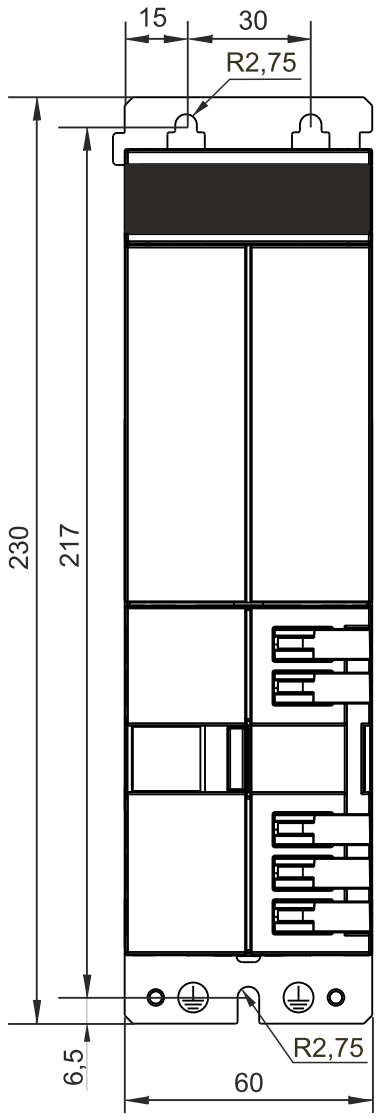
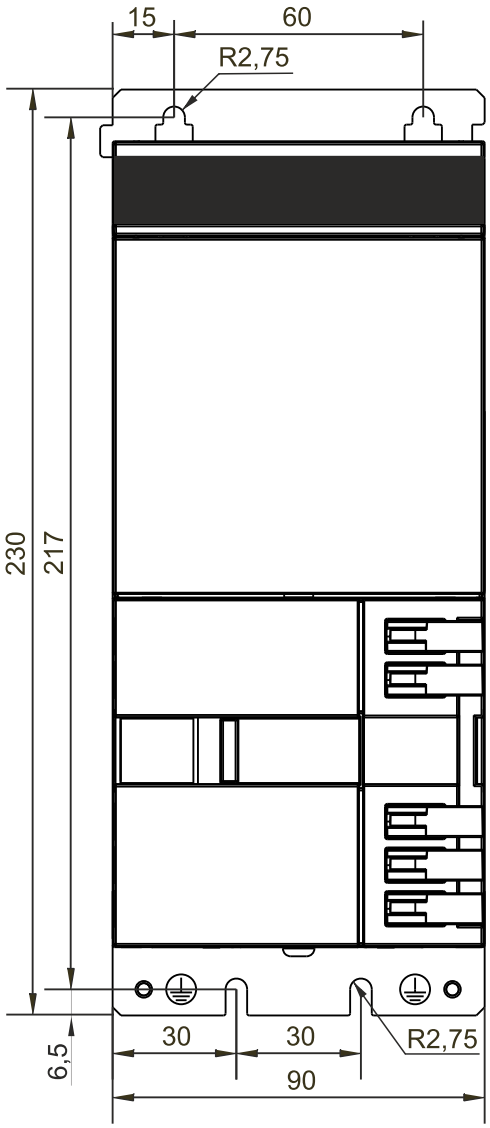
Mechanical data	AX8108 AX8206	AX8118
Width	60 mm	90 mm
Height without plugs	230 mm	230 mm
Depth without connectors / accessories	192 mm	192 mm
Weight	2.0 kg	2.5 kg

Option modules

Mechanical data	AX8810
Width	60 mm
Height without plugs	230 mm
Depth without connectors / accessories	192 mm
Weight	1,9 kg

5.2.6 Dimensions

The AX8000 multi-axis servo system features only modules with two different dimensions – there are narrow modules and wide modules. The specified measurements refer to the actual devices, without plug connectors and cables. The fitting dimensions for control cabinet installation can be found in section "Mechanical installation [▶ 32]".

AX8620, AX8108, AX8206, AX8810	AX8640, AX8118
	

The diagrams are schematic diagrams.

6 Mechanical Installation

⚠WARNING

Danger of injury through electrocution!

Injuries can be sustained through electrocution during the mounting and commissioning of the AX8000 multi-axis servo system.

The installation may only be carried out by trained and qualified technical personnel who are well-versed in electrical and automation technology. Furthermore, the national accident prevention regulations must be adhered to.

Take the following measures to avert danger:

- Wear personal protective equipment (PPE).
- Before starting work, read the section For your safety [▶ 14] carefully.
- Place the electrical environment (servo drive, control cabinet, etc.) in a safe, voltage-free state.
  - ⇨ Remove all relevant mains fuses.
  - ⇨ Turn off the main switch and secure it against being turned on again.
  - ⇨ 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.

NOTE

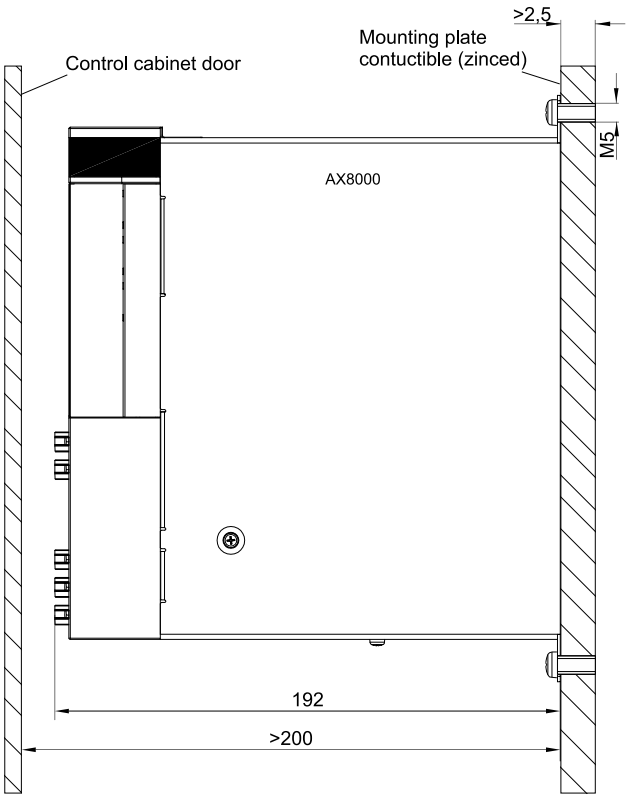
Destruction of the servo drive!

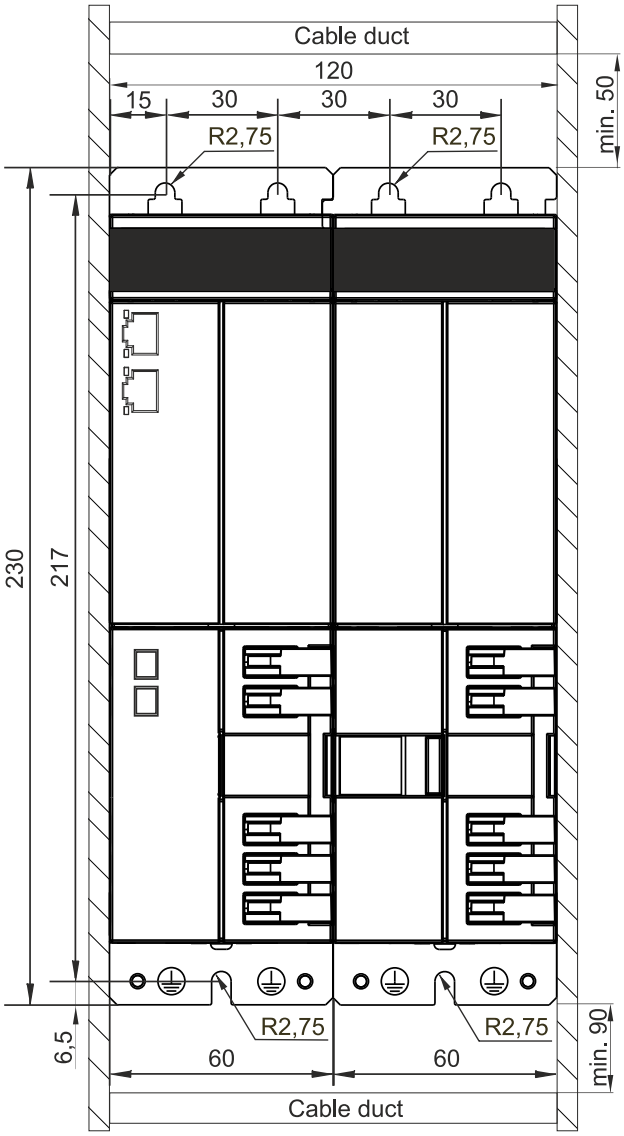
Observe the following notes to avoid damage to or destruction of the components during the mechanical installation of the AX8000 multi-axis servo system:

- Always install the servo drive vertically.
- Provide adequate ventilation for the servo drive. The permissible environmental conditions can be found in the section "Environmental and operating conditions [▶ 27]".
- It is essential to adhere to the required distances (see diagrams below).

6.1 Installation conditions in the control cabinet

When dimensioning the control cabinet, consider that you may have to install input filters, mains chokes and brake resistors for your application. Appropriate space should be provided for these components, so that adequate ventilation is ensured.





WARNING

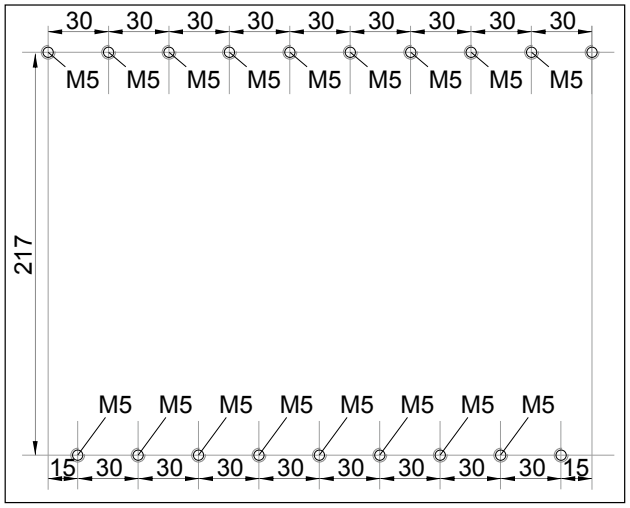
Risk of injury through electric shock!

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

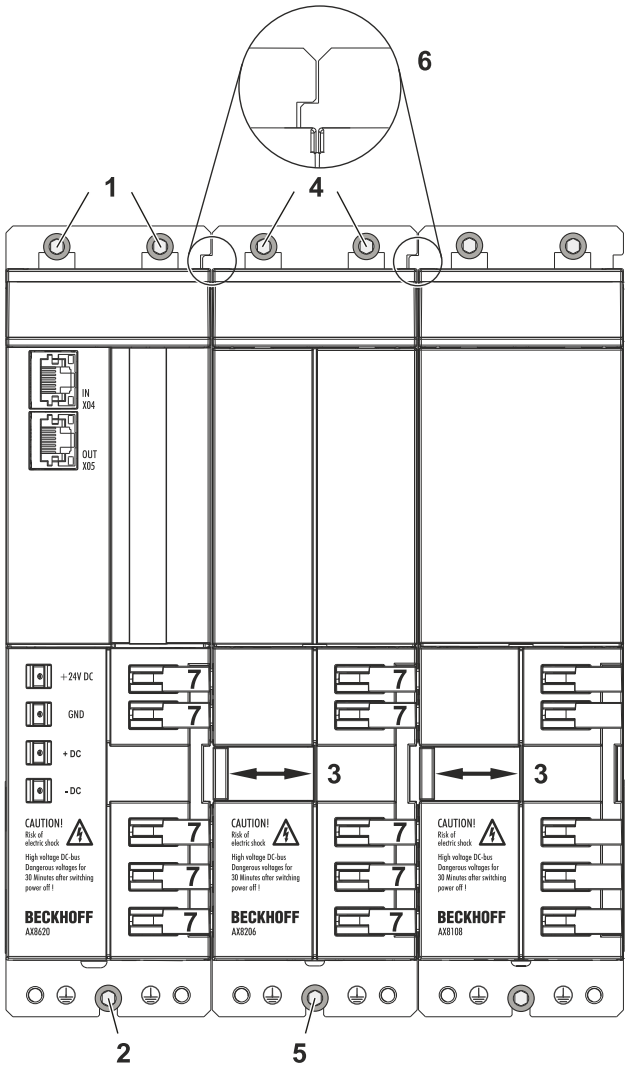
6.2 Drilling pattern and installation example

Before you start with the installation, make the threaded holes in the mounting plate according to the universal drilling pattern for screwing on the AX8000 multi-axis servo system.

Universal drilling pattern



If you equip the mounting plate with the universal drilling pattern, you can change the configuration of the multi-axis system at any time without having to redrill all of the holes.



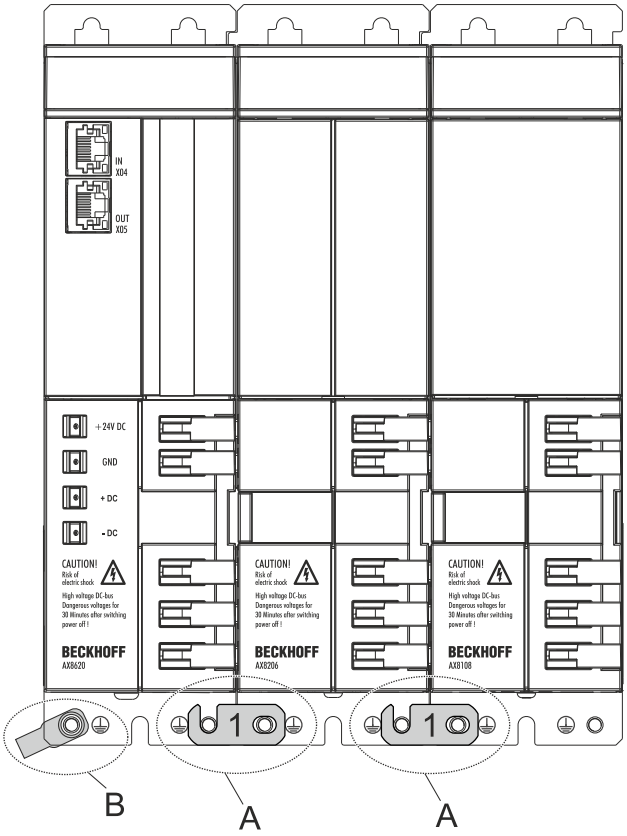
Procedure:

- Loosely screw in the three flat-head screws (M5 x 5) (1 and 2).
- Hang the AX8620 power supply module on the flat-head screw (2) and gently push it against the mounting plate. The upper screw heads should slip through the rectangular openings into the mounting holes.
- Tighten the three flat-head screws (1 and 2) with a torque of 3 Nm.

Mounting further modules:

- For all relevant modules, push the AX-Bridge (3) into the right end position.
- Loosely screw in the three flat-head screws (M5x5) (4 and 5).
- Hang the AX8206 axis module on the flat-head screw (5) and gently push it against the mounting plate. The upper screw heads should slide through the mounting holes.
- The detail (6) shows the integrated mounting aid. Ensure that the bar is flush with the cutout and the rear panels do not overlap.
- Tighten the three flat-head screws (4 and 5) with a torque of 3 Nm.
- Now open the quick couplings (7) and push the AX-Bridge (3) to the left end position for all relevant modules. Close the quick couplings (7) again.

6.3 Connecting the protective conductors



Grounding hanger and hex nuts with flange and serrations are used for the shield connection of the AX8000 multi-axis servo system. They are included in the scope of supply of the AX8206 or AX81x8 axis modules.

The infographic on the left shows the following items:

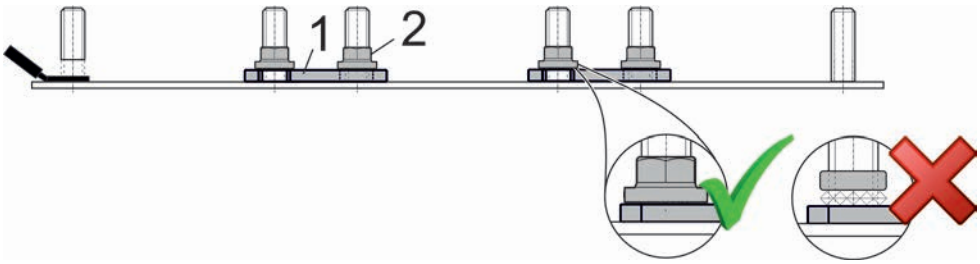
A → Connection of the individual modules to a drive system via grounding hanger. The grounding hanger are mechanically locked at the right-hand earthing bolt of each module and attached and mechanically secured to the left-hand earthing bolt of the adjacent module.

B → Establishment of protective earth via the left-hand earthing bolt at the power supply module and the mounting plate of the control cabinet. The connection is established using a cable with an annular cable lug (minimum cross-section for protective conductors 10 mm^2) and a spring washer.

Both items (A) and (B) are explained later in this chapter, based on examples.

Procedure for establishing the device connection (A)

The following section provides information on the correct installation of the device connection for a multi-axis drive system consisting of an AX8620 power supply module and two AX8206 axis modules.



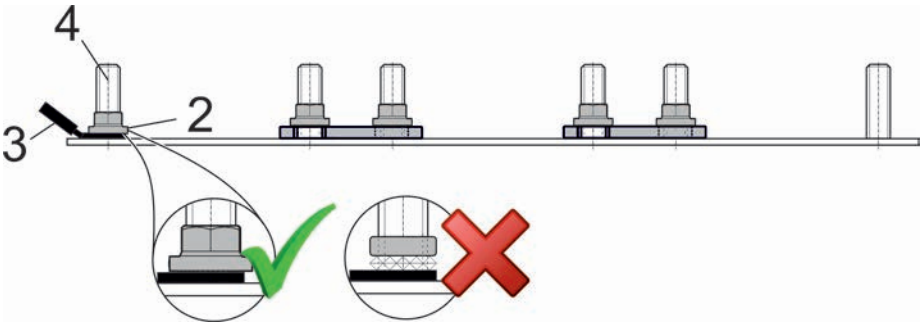
To establish the device connection (A) proceed as follows:

- Feed the grounding hanger [1] with the elongated hole to the left-hand earthing bolt of the supply or axis module. Ensure that the opening of the grounding hanger [1] faces upwards.
- Turn the supplied hex nut [2] onto the grounding bolt at the long hole. Now tighten the hex nut with a tightening torque of 2.3 Nm.
- In the next step, place another hexagon nut [2] on the grounding bolt on the opening of the grounding hanger [1]. Now tighten the hex nut with a tightening torque of 2.3 Nm.

You have successfully connected your devices via the earthing bolt [1].
Now apply the protective earth (B).

Procedure for applying the protective earth (B):

The following section provides information on the correct installation of the protective earth for a multi-axis drive system consisting of an AX8620 power supply module and two AX8206 axis modules.



To apply the protective earth (B) proceed as follows:

- Assemble a cable with a annular cable lug and a minimum cross-section of 10 mm².
- Attach the cable lug [3] to the left-hand earthing bolt [4] of the first module of your drive system (the AX8620 power supply module in this example).
- Now place the supplied hex nut [2] on the cable lug [3] on the earthing bolt (B). Now tighten the hex nut with a tightening torque of 2.3 Nm.
- The other end of your pre-assembled cabled now has to be properly attached to the mounting plate of the control cabinet. Ensure that the mounting plate of your control cabinet is unpainted. Clean the contact surfaces before the installation.

You have successfully connected your protective earth via the earthing bolt [4].

NOTE

Connecting the protective conductor!

Connect a protective earth conductor cable with an as large as possible cross-section to the cable lug [4] and connect this to the central protective conductor terminal in the control cabinet.
Further information on the protective earth conductor can be found in chapter: "Electromagnetic compatibility [▶ 10]".

Selection of the hex nuts with flange and serrations:

Only use the following components for establishing the protective conductor connection at the AX8000 multi-axis servo system:

- Hex nuts with flange and serrations of class 8 (ISO 4161) with zinc plated surfaces.

EMC, earthing, screen connection and potential

The AX8000 multi-axis servo system 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 AX8000 multi-axis servo system 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). Ensure that there is adequate earthing (large-area low-impedance connection) of all relevant components (incl. control cabinet). Use pre-assembled Beckhoff motor and feedback cables as these are optimally adapted to the drive system and reduce interference to a minimum. Ensure that the connectors are properly connected.

NOTE

EMC – compatible installation of the AX8000 multi-axis servo system:

For further information of earthing, screen connection and potential please read the EMC – information brochure. You will find the document on the Beckhoff homepage www.beckhoff.com.

7 Electrical installation

⚠DANGER

Danger to life due to high voltage on the DC link capacitors of the servo drive AX8000!

The DC link capacitors RB+ and RB- and the test contacts DC+ and DC- on the **supply**, **axis** and **option modules** can carry life-threatening voltages of ≥ 875 V_{DC}.

Take the following measures to avert danger:

- After disconnecting the servo drive from the mains supply, wait until the voltage has fallen below 50 V_{DC}. Only then is it safe to work.
- Measure the voltage on the test contacts properly.
- Secure the work area properly and wear the PPE.

⚠WARNING

Risk of injury through electric shock!

Injuries can be sustained through electric shock during the mounting and commissioning of the AX8000 multi-axis servo system.

The installation may only be carried out by trained and qualified technical personnel who are well-versed in electrical and automation technology. Furthermore, the national accident prevention regulations must be adhered to.

Take the following measures to avert danger:

- Before starting work, read the section For your safety [▶ 14] carefully.
- Place the electrical environment (servo drive, control cabinet, etc.) in a safe, voltage-free state.
  - ⇨ Remove all relevant mains fuses.
  - ⇨ Turn off the main switch and secure it against being turned on again.
- Put up a warning sign. Wear personal protective equipment (PPE).
- The control and power connections for the motors may be live, even if the motor is prevented from rotating by the internal brake.

⚠CAUTION

Max. DC link capacitance of the AX8000 multi-axis servo system:

Each module has a specified DC link capacitance. When the mains are first connected, the supply module loads the whole DC link.
For planning the drive system note the max. DC link capacitance:

Drive system up to 240 VAC supply: 16725 µF
Drive system up to 480 VAC supply: 4226 µF
Example at 400 VAC:
1 x AX8640-0000 = 675 µF + 10 x AX8206-0000 = 1350 µF + 1 x AX8810-0000 = 1755 µF
Total capacitance = 3780 µF = OK

⚠CAUTION

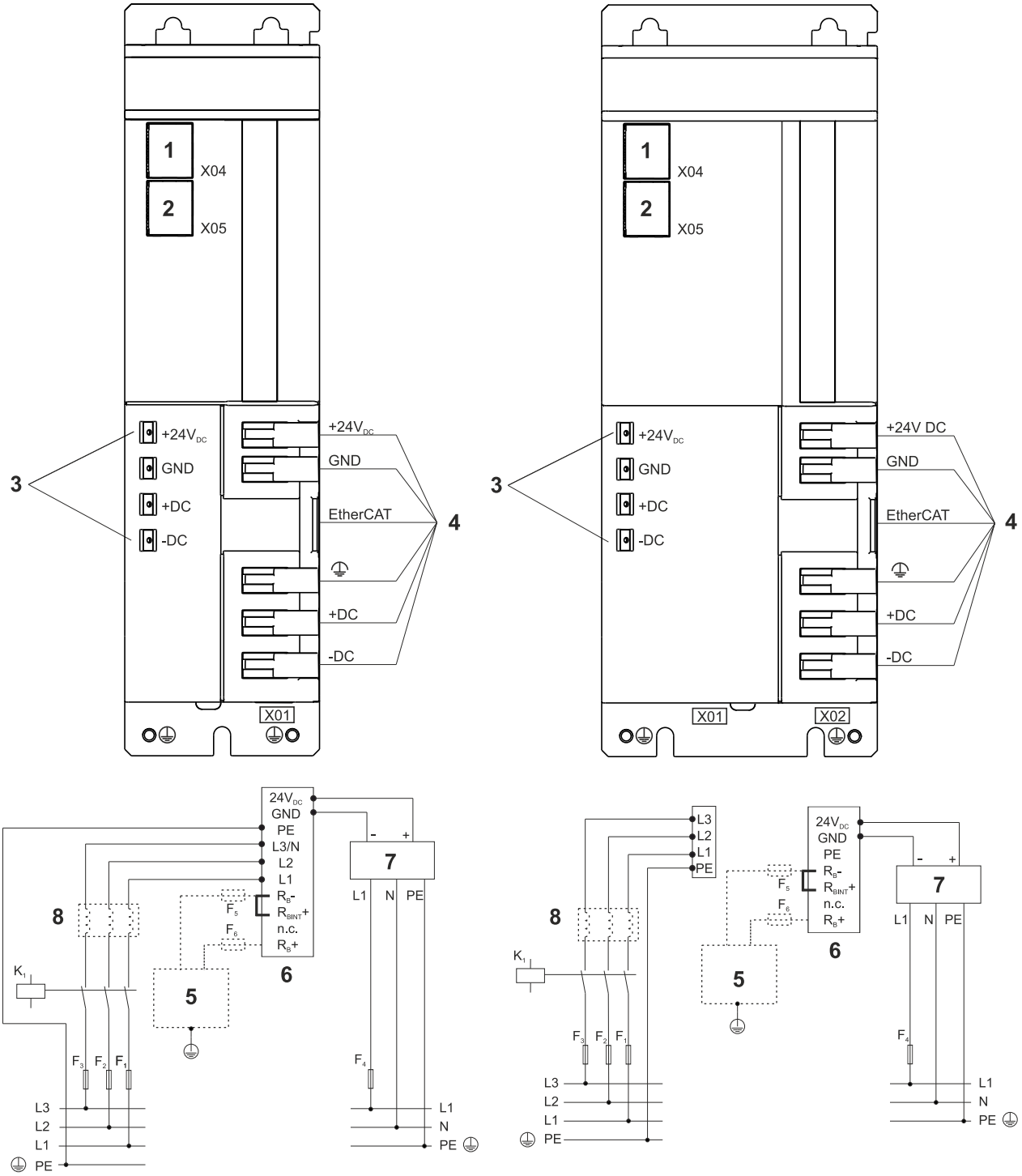
Connection of the protective earth conductor (PE) to the AX8000 multi-axis servo system!

Potential equalization of the entire system must be carried out in order to avoid interference (EMC) and personal injuries.
Each servo drive must be connected via the earthing bolts on the device according to IEC 60364-4-41:2005 and DIN VDE 0100-410:2007-06.

Special features in a drive system:

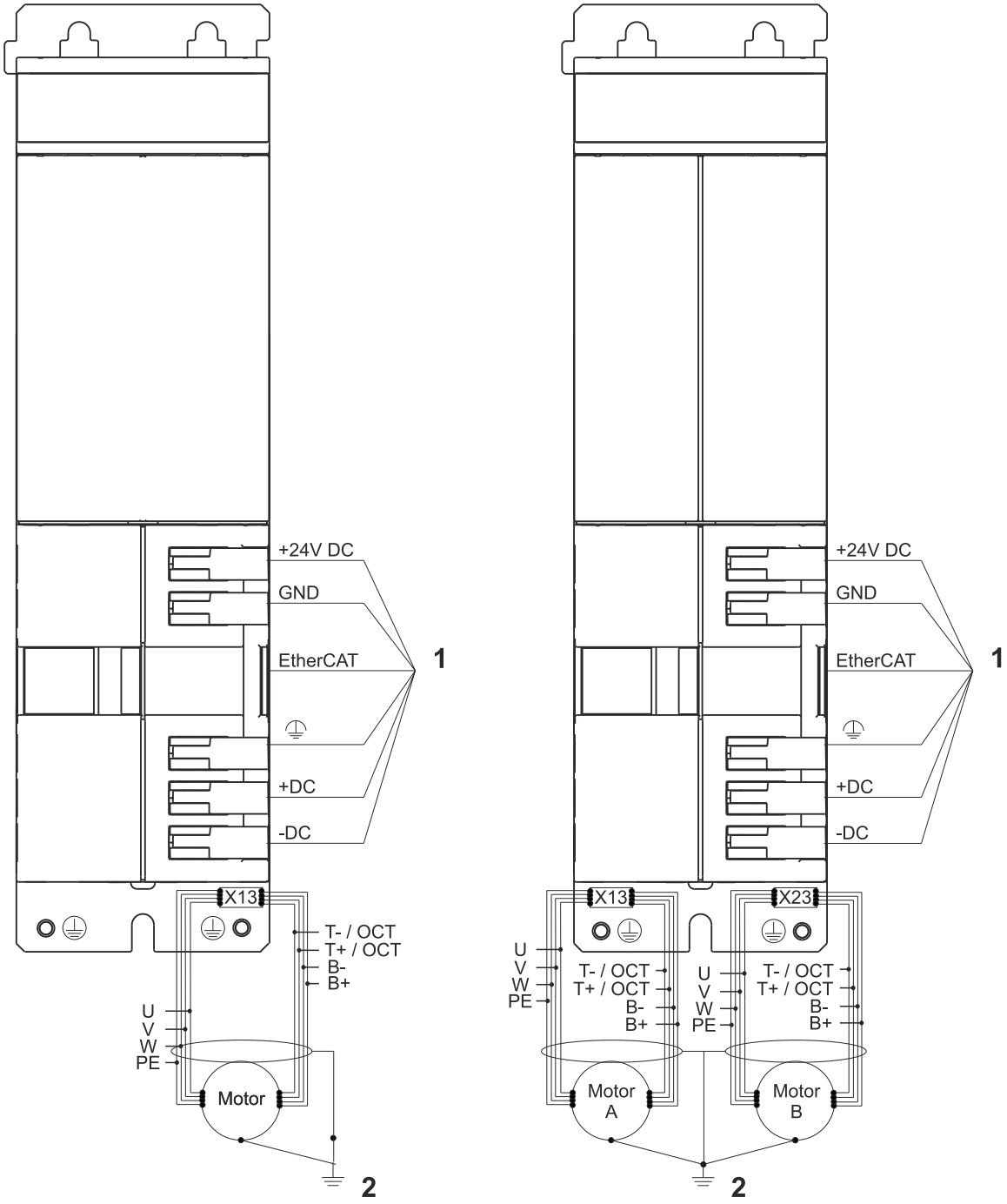
In a drive system, the individual components of the AX8000 multi-axis servo system must be connected via the earthing bolts. In addition, a standard-compliant PE connection must be installed on the start and end modules of the system.

7.1 Block diagram - AX8620 and AX8640



Item no.	Explanation
1	Connection socket for incoming EtherCAT cable
2	Connection socket for outgoing EtherCAT cable
3	Measuring and test contacts on the devices
4	Quick coupling of the AX8000 multi-axis servo system (AX bridge)
5	Optional brake resistor **Caution:** When using the optional brake resistors with the AX8000 servo system, the bridge of the 10-pin supply plug "X01" (between R_{B-} and R_{Bint}) must be removed.
6	Schematic contacts on the 10-pin supply plug "X01"
7	Power supply unit with 24 V_{DC} supply voltage
8	Optional mains choke

7.2 Block diagram - AX81xx and AX82xx



Item no.	Explanation
1	Fast connection of the AX8000 multi-axis servo system (AX bridge)
2	Motor cable: **ZK4800-80xx-xxxx** (including OCT)

7.3 Power supply

NOTE

Connection sequence of the AX8000 multi-axis servo system!

The connection order of the modules is arbitrary. However, Beckhoff Automation GmbH recommends that the rated output current of the modules be reduced starting from the supply module.

A configuration example you will find in the chapter: Positioning within the system [▶ 49].

⚠CAUTION

DC link group of the supply modules!

To manufacture a DC link group of the supply modules, pay attention to the total rated current of the connected components.

Various aspects need to be considered here.

- The plug connectors for the AX8620 / AX8640 have a current carrying capacity of 38 A / 70 A.
- The bus bar system has a current carrying capacity of 50 A.

⚠CAUTION

Dimensioning of the connection cable for the supply module!

The dimensioning depends on the total rated current of the devices and must conform to EN 60204-1. The connection plugs for the AX8620 are designed for a max. conductor cross-section of 6 mm^2, those for the AX8640 for a max. conductor cross-section of 16 mm^2.

7.3.1 Standard connection to the mains supply (X01)

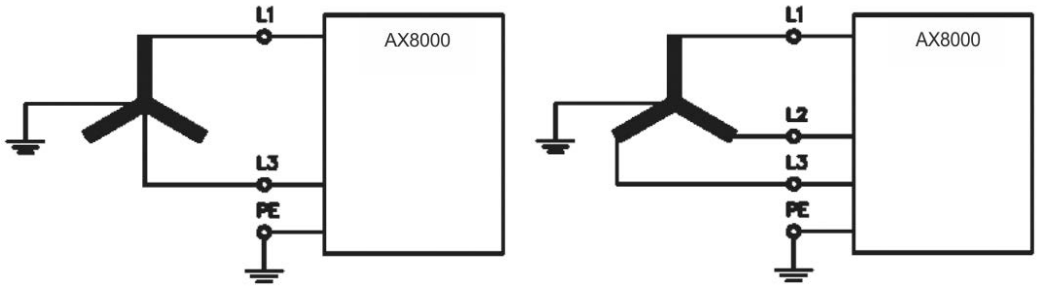
The power supply modules of the AX8000 series are equipped with a wide-range voltage input **X01** and can be connected to single-phase voltage systems between 100 V_{AC} and 240 V_{AC} or 3-phase systems between 200 V_{AC} and 480 V_{AC}.

Mains supply

Connection to the standard mains supply (TT/TN) with earthed center is described below. Connection to other mains types, e.g. "IT", are possible.

Connection to the standard mains supply (TT / TN) with earthed center

1-phase 100 $_{-10\%}$.- 240 $_{+10\%}$ V_{AC}, 50/60 Hz 3-phase 200 $_{-10\%}$.- 480 $_{+10\%}$ V_{AC}, 50/60 Hz



NOTE

Further standard connections for supply networks:

Further connections to different supply networks are described in the system manual of the AX8000 multi-axis servo system. Information can be found in chapter:
"Electrical installation; Power supply; Further types of connection"

X01 – voltage input on AX8620

Commissioning

Commissioning of the AX8000 is only possible if the terminal points **"Rbin+"** and **"RB -"** are bridged (delivery state) or an external brake resistor is connected to the terminal points "R_B +" and "R_B -".

Without this measure the AX8000 is stopped with an error message.

Infographic	Terminal point	Connection	Max. wire cross-section	Tightening torque
	PE	Protective conductor	6 mm² (AWG 8)	0.5 – 0.6 Nm (4.4 – 5.3 lbf in)
	L3 / N	Phase L3 / N (for 1-phase power supply)		
	L2	Phase L2		
	L1	Phase L1		

X01 – voltage input on AX8640

Infographic	Terminal point	Connection	Max. wire cross-section	Tightening torque
	L3 / N	Phase L3	16 mm² (AWG 6)	1.2 – 1.5 Nm (10.6 – 13.3 lbf in)
	L2	Phase L2		
	L1	Phase L1		
	PE	Protective conductor		

7.3.2 24 VDC supply (X01)

The supply connection **X01** is used for supplying the supply modules of the AX8000 with 24 V_{DC} system voltage.

⚠CAUTION

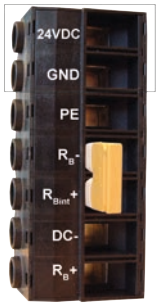
Observe the voltage tolerances for safe operation!

When connecting motors with holding brake it is essential to observe the voltage tolerances.

X01 – 24 V_{DC} voltage input on AX8620

Infographic	Terminal point	Connection	Max. wire cross-section	Tightening torque
	24 VDC	24 V_{DC} ±10% System and peripheral voltage	6 mm² (AWG 8)	0.5 – 0.6 Nm (4.4 – 5.3 lbf in)
	GND	GND		

X02 – 24 V_{DC} voltage input on AX8640

Infographic	Terminal point	Connection	Max. wire cross-section	Tightening torque
	24 VDC	24 V_{DC} ±10% System and peripheral voltage	16 mm² (AWG 6)	1.2 – 1.5 Nm (10.6 – 13.3 lbf in)
	GND	GND		

Commissioning

Commissioning of the AX8000 is only possible if the terminal points **"Rbin+"** and **"RB -"** are bridged (delivery state) or an external brake resistor is connected to the terminal points "R_B +" and "R_B -".

Without this measure the AX8000 is stopped with an error message.

7.3.3 Fusing, CE-compliant

External fuse protection

⚠CAUTION

Fire hazard through short circuit!

The recommended fuses are used for line protection. The servo drives are equipped with integrated self-protection.

Fuse protection	AX8620-0000	AX8640
AC supply (max.) *)	30 A	60 A
24 V supply (max.)	20 A	

*) Mains fuses of operating class "gG (A)" according to IEC60269 or automatic circuit-breakers with characteristic "C" shall be used.

NOTE

UL configuration example of a system group:

Please also note the UL configuration example of a system group with components of the AX8000 multi-axis servo system. All relevant information on the configuration and fuse protection of the system group can be found in chapter:

"UL configuration example of a system group" [▶ 12]

Internal fuse protection

Fuse protection	Fuse
24 V – system voltage / peripherals	electronic
Brake resistor (internal)	electronic

7.3.4 DC link (external DC link-connection currently not permitted)

NOTE

Destruction of the multi axis servo system AX8000:

An **"external"** DC link group (e.g. AX5000 with AX8000) is currently not permitted.

⚠DANGER

Danger to life due to high voltage on the DC link capacitors of the servo drive AX8000!

The DC link capacitors RB+ and RB- and the test contacts DC+ and DC- on the **supply**, **axis** and **option modules** can carry life-threatening voltages of ≥ 875 V_{DC}.

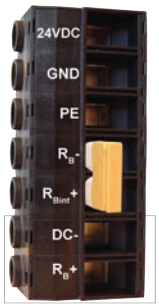
Take the following measures to avert danger:

- After disconnecting the servo drive from the mains supply, wait until the voltage has fallen below 50 V_{DC}. Only then is it safe to work.
- Measure the voltage on the test contacts properly.
- Secure the work area properly and wear the PPE.

X01 – DC link on AX8620

Infographic	Terminal point	Connection	Max. wire cross-section	Tightening torque
	n.c.	not used	6 mm² (AWG 8)	0.5 – 0.6 Nm (4.4 – 5.3 lbf in)
	R_B+	Brake resistor + (DC link voltage DC +)		

X02 – DC link on AX8640

Infographic	Terminal point	Connection	Max. wire cross-section	Tightening torque
	DC -	DC link -	16 mm² (AWG 6)	1.2 – 1.5 Nm (10.6 – 13.3 lbf in)
	R_B+	DC link +		

7.3.5 External and internal brake resistor

⚠DANGER

Danger to life due to high voltage on the DC link capacitors of the servo drive AX8000!

The DC link capacitors RB+ and RB- and the test contacts DC+ and DC- on the **supply**, **axis** and **option modules** can carry life-threatening voltages of ≥ 875 V_{DC}.

Take the following measures to avert danger:

- After disconnecting the servo drive from the mains supply, wait until the voltage has fallen below 50 V_{DC}. Only then is it safe to work.
- Measure the voltage on the test contacts properly.
- Secure the work area properly and wear the PPE.

Connection instructions

Before you can connect the external brake resistor, you have to remove the bridge between the contacts **"RB – "** and **"RB_{INT} +"**.
Connect the PE connection of the brake resistor with the earthing bar of the control cabinet.

X01 – brake chopper output on AX8620

Infographic	Terminal point	Connection	Max. wire cross-section	Tightening torque
	R_B -	Ext. brake resistor -	6 mm^2 (AWG 8)	0.5 – 0.6 Nm (4.4 – 5.3 lbf in)
	R_B +	Ext. brake resistor +		

X02 – brake chopper output on AX8640

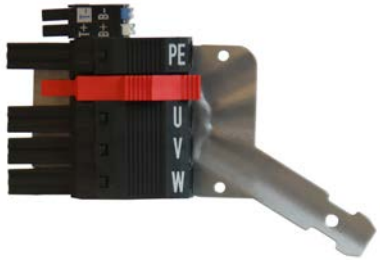
Infographic	Terminal point	Connection	Max. wire cross-section	Tightening torque
	R_B -	Ext. brake resistor -	16 mm^2 (AWG 6)	1.2 – 1.5 Nm (10.6 – 13.3 lbf in)
	R_B +	Ext. brake resistor +		

7.3.6 EtherCAT (X04 and X05)

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

7.3.7 Motor feedback connector (X13 and X23) AX81xx and AX8206

For two-channel axis modules this combined motor and feedback connector is required for both channel "A" and channel "B"; it is part of pre-assembled Beckhoff motor cables.

Infographic	Terminal point	Connection	Max. wire cross-section	Tightening torque
	PE	Protective conductor	6 mm² (AWG 8)	push in
	U	Motor connection U		
	V	Motor connection V		
	W	Motor connection W		
	T -	OCT – and temp. -*)		
	T +	OCT + and temp. + *)		
	B -	Motor brake GND		
	B +	Motor brake +		

*) Digital: KTY 83-1xx, KTY 84-1xx or KTY 21-6

Max. motor brake current:

The max. output current for the motor brake (B– and B+) is:

1 A for AX8108 and AX8206
2 A for AX8118

7.3.8 Digital inputs (X15 and X25)

For two-channel axis modules this plug connector is required both for channel "A" and for channel "B". The use of terminal points 1 and 2 differs between the power supply modules AX8xxx-x0xx and AX8xxx-x1xx. Please refer to the table below for further information on terminal point assignment.

Infographic	Terminal point	Connection AX8xxx-x0xx	Max. wire cross-section	Connection AX8xxx-x1xx	Max. wire cross-section	Tightening torque
	1	Dig. Input 1 (20 µs)	with wire end sleeve according to DIN 46 228/1 max. 1.5 mm² (AWG 16)	Dig. safety input 1 (20 µs)	with wire end sleeve and collar according to DIN 46 228/4 max. 1 mm² (AWG 17)	push in
	2	Dig. Input 2 (20 µs)		Dig. safety input 2 (20 µs)		
	3	Dig. Input 3 (8 µs)		Dig. Input 3 (8 µs)		
	4	Dig. Input 4 (8 µs)		Dig. Input 4 (8 µs)		

NOTE

Safety-related documentation!

Axis modules with the order designation AX8xx-x**1**xx support the safety functions STO (Safe Torque Off) and SS1 (Safe Stop 1).
Before putting the axis module into operation, read the documentation for:

- AX8911 - TwinSAFE Drive option for servo drives of the AX8000 series.

7.4 Total motor cable length

Total motor cable length in compliance with EMC Category C3 (industrial area)

	Motor cable length per motor	Total motor cable length per drive system	Number of axes per drive system
without mains choke	max. 25 m	max. 300 m	• limited by the max. chargeable DC link capacitance (see chapter: "Electrical installation [▶ 37]") and • limited by the 24 V_{DC} supply (max. 50 A_{DC}). The requirement is determined through the module and motor braking current.
with mains choke AX2090-ND80-xxxx	max. 50 m	max. 500 m	

*always in relation to the connection to a common AX86x0 supply module

Practical example:

Existing drive system comprising:

- Motors from the AM8031-0D21 series (4 units)
  - Cable lengths (in m): 4, 10, 15 and 22 m
- Motors from the AM8051-0G21 series (4 units)
  - Cable lengths (in m): 16, 18, 21, 25 m
- AX8206 axis modules (4 units) and AX8620 power supply module

Total standstill current (I_0) of all motors:

4 x 1.95 A (AM8031) + 4 x 4.75 A (AM8051) = **26.8 A**

Total standstill current (I_0) x estimated simultaneity factor:

26.8 A x 0.7 **= 18.76 A** (the AX8620 power supply module was selected on the basis of this calculation).

24 V DC current consumption of all components:

0.12 A (AX8620) + 4 x 0.57 A (AX8206) + 4 x 0.33 A (brake) + 4 x 0.54 A (brake) = **5.88 A_{DC}**

Result:

The max. single cable length is ≤ 25 m √ **Requirement fulfilled**

The total cable length is 131 m (≤ 300 m) √ **Requirement fulfilled**

The max. DC link capacitance is: 945 µF* (≤ 4226 µF) √ **Requirement fulfilled**

The 24 V_{DC} current consumption of all components is: 5.88 A_{DC} (≤ 50 A_{DC}) √ **Requirement fulfilled**

Therefore no mains choke is required.

NOTE

Maximum loadable DC link capacity:

The different DC link capacities of the modules of the multi axis servo system AX8000 please refer to the chapter: "Electrical installation [▶ 37]."

8 Option modules

8.1 Installation

The option modules are installed in the same way as described in section Mechanical Installation [▶ 32]. The electrical installation mainly consists of connecting the AX Bridge via slider and interlock. If further steps are required, the instructions can be found in a separate section under the description of the individual option modules.

⚠DANGER

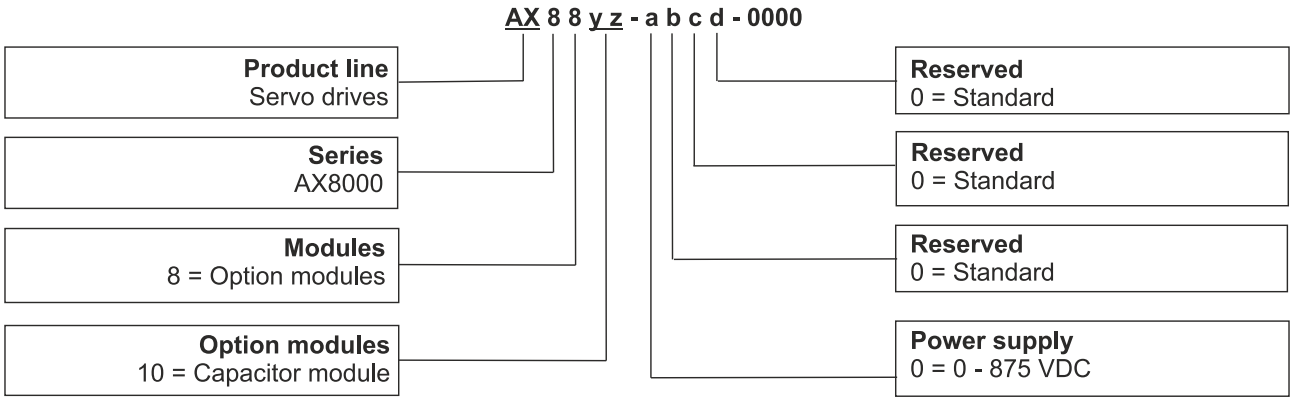
Danger to life due to high voltage on the DC link capacitors of the servo drive AX8000!

The DC link capacitors RB+ and RB- and the test contacts DC+ and DC- on the **supply**, **axis** and **option modules** can carry life-threatening voltages of ≥ 875 V_{DC}.

Take the following measures to avert danger:

- After disconnecting the servo drive from the mains supply, wait until the voltage has fallen below 50 V_{DC}. Only then is it safe to work.
- Measure the voltage on the test contacts properly.
- Secure the work area properly and wear the PPE.

8.2 Option modules type key



8.3 AX8810 - capacitor module

The capacitor module extends the DC link capacity and is particularly suitable in combination with the 1-phase supply of the AX8620-1000 for supporting the DC link. Voltage peaks during motor braking are absorbed and stored. This largely avoids the need for connecting the external brake resistor and reduced the power dissipation.

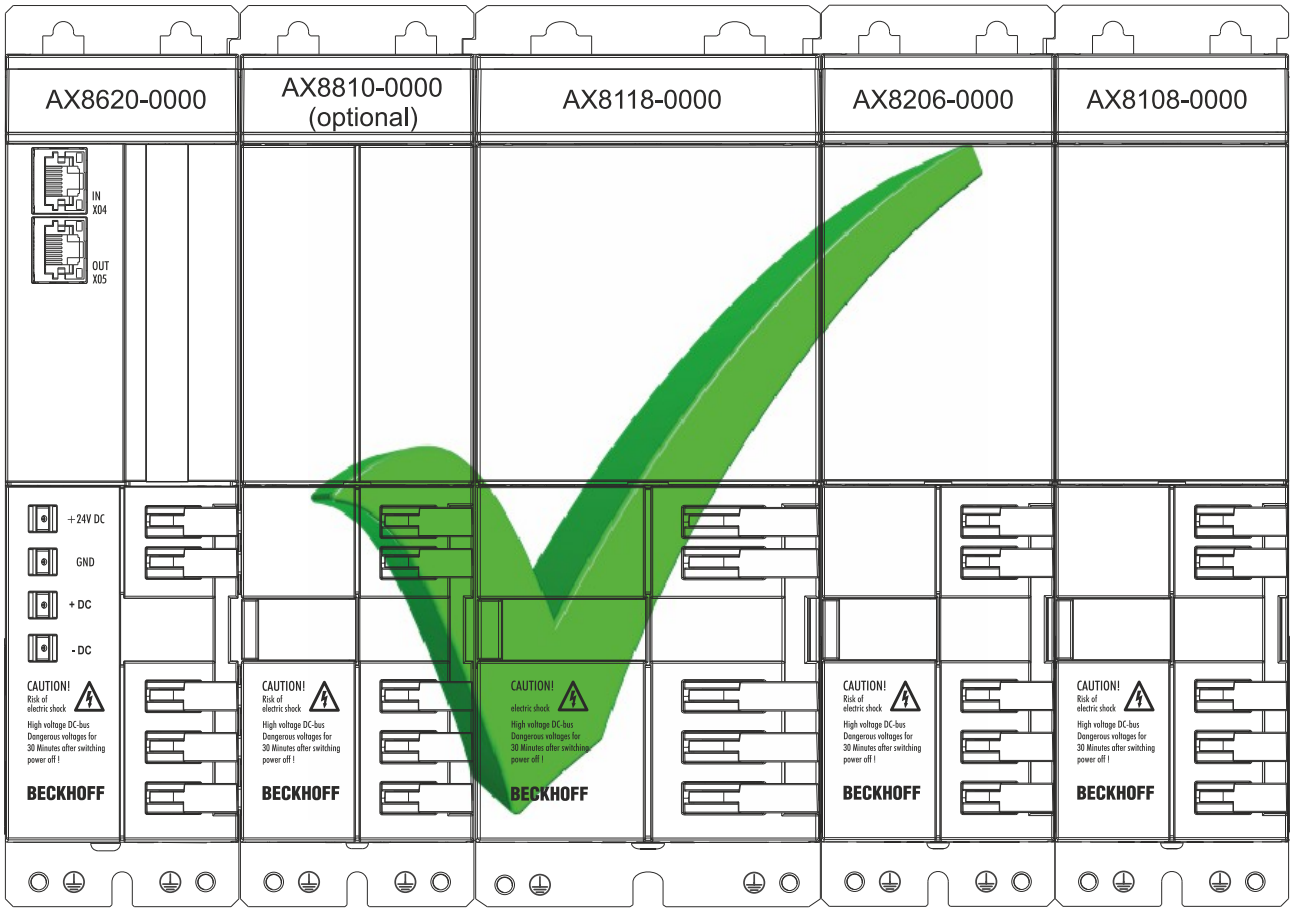
8.3.1 Positioning within the system

Supply voltage: 100 V_{AC} – 480 V_{AC}

For this supply voltage, an optional AX8810-**0000** capacitor module should be placed directly to the right of the AX8620 or AX8640 power supply module. It is recommendable to configured the AX8000 multi-axis servo system starting from the largest rated output current (e.g. AX8118) down to the smallest rated output current (e.g. AX8108).

In our example, a system group is structured as follows:

Power supply module AX8620 → capacitor module AX8810 → axis module AX8118 (18 A rated output current) → axis module AX8206 (2 x 6 A rated output current) → AX8108 (8 A rated output current)



9 Project planning

9.1 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 section can only give a rough overview of electrical design.

9.2 Energy management

If the quality of the mains supply is impaired due to wide fluctuations in voltage, then both the servo drive specification and the speed range of the motor will need to be considered. With a positive tolerance for voltage fluctuation the upper limit value of the wide voltage input of the AX8000 needs to be taken into account. With a negative tolerance of the voltage fluctuation it must be checked whether the decrease in speed caused by the low voltage is permissible. With these motors what is known as field weakening operation (check availability) of the servo drive may provide a solution. If the mains supply does not meet the specifications for operation of the AX8000, 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 brake resistors. If you are already using similar drive systems, the AX8000 offers a convenient diagnostic system for determining the load on the brake resistors and for transferring the values. Previous experience with drive systems shows that in such a system much smaller or even no external brake resistors need to be used.
The Beckhoff software “TCMotionDesigner” is available for energy management purposes.

9.3 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. Position the control cabinet as close as possible to the machine so that the motor cables can be as short as possible. In addition, the control cabinet should have an earthed metal rear panel to which the AX8000 incl. periphery are attached so that safe earthing can be guaranteed. If you are unable to guarantee these conditions you need to earth the AX8000 and the relevant components using an approved cable of adequate size.

9.4 Drive train design

Application, servo drive, motors and gear mechanism 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 working life is not impaired and the necessary control quality can be maintained.
The Beckhoff software “TCMotionDesigner” is available for configuration of the drivetrain and selection of suitable components.

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