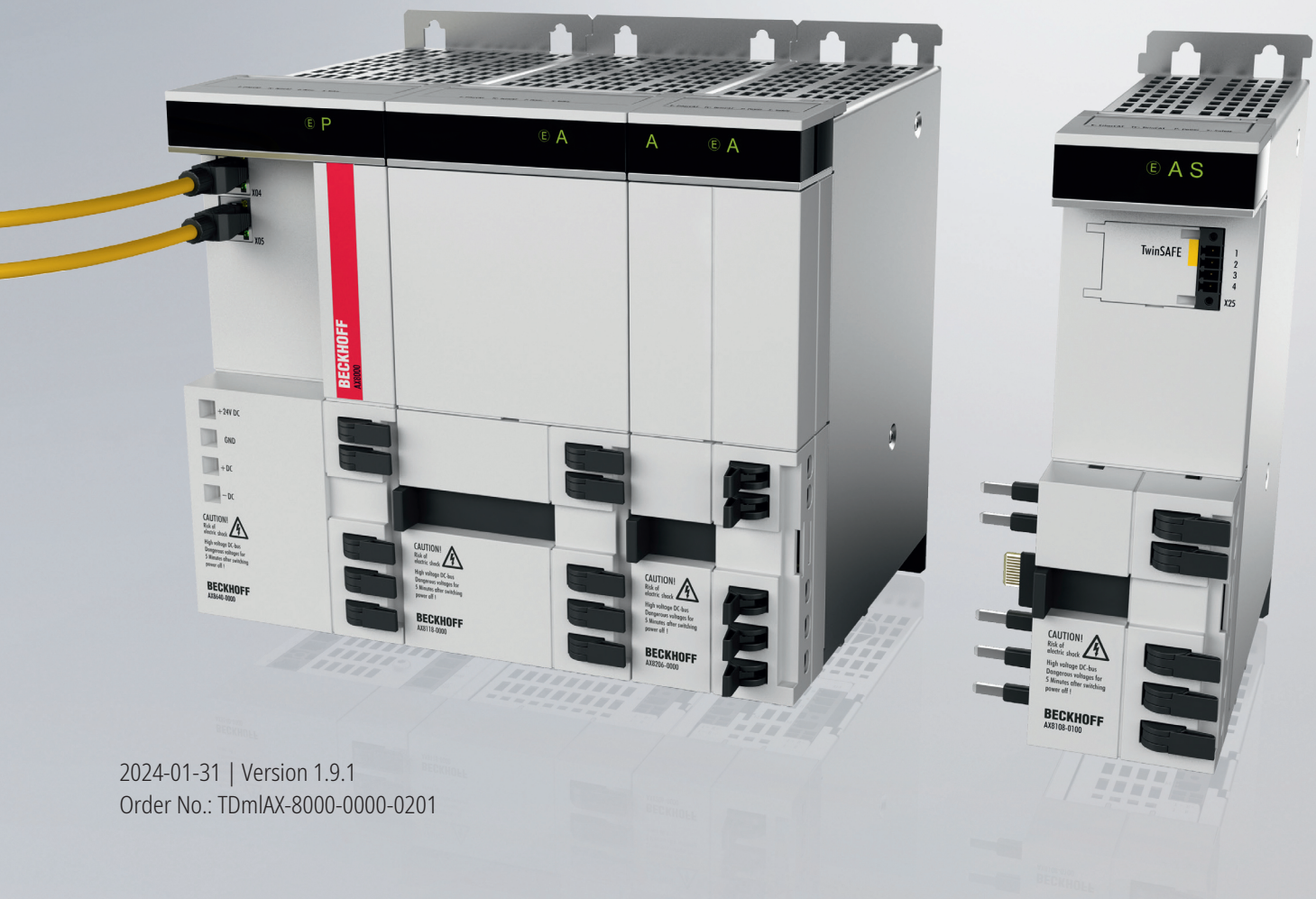


# BECKHOFF New Automation Technology

Operating instructions | EN

## AX8000

Multi-axis servo system



2024-01-31 | Version 1.9.1

Order No.: TDmlAX-8000-0000-0201



# Table of contents

<b>1 Documentation notes</b>	<b>7</b>
1.1 Disclaimer	7
1.1.1 Trademarks	7
1.1.2 Patents	7
1.1.3 Limitation of liability	8
1.1.4 Copyright	8
1.2 Version numbers	9
1.3 Scope of the documentation	10
1.4 Staff qualification	11
1.5 Safety and instruction	13
1.6 Explanation of symbols	13
1.7 Beckhoff Services	15
1.7.1 Support services	15
1.7.2 Training offerings	15
1.7.3 Service offerings	15
1.7.4 Headquarters Germany	16
1.7.5 Downloadfinder	16
<b>2 For your safety</b>	<b>17</b>
2.1 Safety pictograms	17
2.2 General safety instructions	18
2.2.1 Before operation	18
2.2.2 During operation	19
2.2.3 After operation	19
<b>3 Product overview</b>	<b>20</b>
3.1 Power supply modules AX86xx	20
3.1.1 Name plate	21
3.1.2 Type key	23
3.2 Axis modules AX81xx / AX82xx	24
3.2.1 Name plate	25
3.2.2 Type key	26
3.3 Combined modules AX85xx	27
3.3.1 Name plate	29
3.3.2 Type key	30
3.4 Capacitor module AX8810	31
3.4.1 Name plate	31
3.4.2 Type key	32
3.5 Product characteristics	33
3.6 Ordering options	34
3.6.1 Multi-feedback interface	34
3.6.2 Drive-integrated safety technology	34
3.7 Intended use	36
3.7.1 Improper use	36
3.8 Dual Use	36
<b>4 Technical data</b>	<b>37</b>

4.1	Data for operation and environment.....	37
4.2	Power supply modules .....	39
4.2.1	DC power supply module .....	39
4.2.2	Power supply module 20 A.....	40
4.2.3	Power supply module 20 A / 40 A .....	41
4.3	Axis modules.....	42
4.3.1	Single-channel.....	42
4.3.2	Two-channel.....	43
4.4	Combined power supply modules and axis modules .....	45
4.5	Capacitor module .....	47
4.6	Dimensional drawings .....	48
4.6.1	Narrow modules .....	48
4.6.2	Wide modules.....	50
4.6.3	Combined modules .....	51
<b>5</b>	<b>Scope of supply.....</b>	<b>52</b>
5.1	Packaging .....	53
<b>6</b>	<b>Transport and storage .....</b>	<b>54</b>
6.1	Conditions .....	54
6.2	Transport.....	55
6.3	Long-term storage.....	55
<b>7</b>	<b>Technical description .....</b>	<b>56</b>
7.1	Installation position.....	56
7.2	Residual current circuit breaker .....	56
7.3	Safe system stop .....	56
7.4	Wide voltage range .....	57
7.5	Dimensioning .....	58
7.5.1	DC link capacitance.....	58
7.5.2	Total motor cable length.....	59
7.5.3	Control voltage .....	60
7.6	Display .....	62
7.6.1	Power supply module .....	62
7.6.2	Axis module.....	64
7.6.3	Combined module .....	65
7.7	Capacitor module .....	66
7.7.1	Placement in the group .....	66
7.8	AX8600 Power supply module DC.....	67
7.9	Third-party motors.....	68
7.9.1	Third-party motors and TwinSAFE .....	68
<b>8</b>	<b>Mechanical installation .....</b>	<b>69</b>
8.1	Preparation.....	69
8.1.1	Drilling pattern .....	71
8.2	Modules.....	71
8.2.1	Power supply modules .....	71
8.2.2	Axis modules and capacitor modules.....	73
<b>9</b>	<b>Electrical installation .....</b>	<b>75</b>



9.1	Project planning .....	75
9.1.1	Energy management .....	76
9.1.2	Control cabinet structure .....	76
9.1.3	Drivetrain .....	76
9.2	Block diagrams.....	77
9.2.1	AX8600 DC Power supply module .....	77
9.2.2	AX8620 Power supply module 20 A.....	78
9.2.3	AX8640 Power supply module 40 A.....	79
9.2.4	AX85xx combined power supply modules and axis modules 25 A / 40 A.....	80
9.2.5	AX81x8 Single-axis module 8 A / 18 A.....	81
9.2.6	AX8206 Dual-axis module 6 A .....	82
9.3	Grounding .....	83
9.3.1	Module connection .....	84
9.3.2	Protective earth .....	86
9.4	Connector power supply 24 V .....	87
9.4.1	ZS4800-2001 / Connector power supply modules AX8620 .....	87
9.4.2	ZS4800-2002 / Connector power supply modules AX8600 .....	87
9.4.3	ZS4800-2003 / Connector combined modules AX85xx .....	88
9.4.4	ZS4800-2042 / Connector power supply modules AX8640 .....	88
9.5	Connector voltage input .....	89
9.5.1	ZS4800-2001 / Connector power supply modules AX8620 .....	89
9.5.2	ZS4800-2002 / Connector power supply modules AX8600 .....	89
9.5.3	ZS4800-2041 / Connector power supply modules AX8640 .....	90
9.5.4	Terminal strip on AX85xx .....	90
9.6	Connector external brake resistor .....	91
9.6.1	ZS4800-2001 / Connector power supply modules AX8620 .....	91
9.6.2	ZS4800-2002 / Connector combined modules AX8600 .....	91
9.6.3	ZS4800-2042 / Connector power supply modules AX8640 .....	92
9.6.4	ZS4500-2047 / Connector combined modules AX85xx .....	92
9.7	DC link.....	93
9.7.1	Terminal strip.....	93
9.8	Fieldbus system .....	93
9.9	Multi-feedback.....	94
9.9.1	EnDat 2.2 / 22 or BiSS C.....	94
9.9.2	Sin/Cos or TTL (diff.) .....	97
9.10	Motor feedback OCT .....	98
9.10.1	ZS4800-2013 / Connector axis modules AX81xx / AX8206.....	98
9.11	Motor connector AX85xx.....	99
9.11.1	ZS4800-2043 / Connector combined modules AX85xx .....	99
9.12	Holding brake OCT .....	100
9.12.1	ZS4500-2014 / Connector combined modules AX85xx .....	100
9.13	Digital inputs.....	101
9.13.1	ZS4800-2015 / Connector I/O .....	102
9.14	Leakage currents .....	103
9.15	Supply networks.....	104
9.15.1	Three-phase connection.....	105
9.15.2	Single-phase connection .....	106

9.15.3 Isolating transformers .....	111
9.16 Fuse protection .....	112
9.16.1 CE conform .....	112
9.16.2 UL-compliant .....	113
9.16.3 Device fusing .....	114
<b>10 Commissioning .....</b>	<b>116</b>
10.1 Before commissioning .....	116
10.2 During commissioning .....	116
10.3 Prerequisites during operation .....	117
10.4 After operation .....	117
<b>11 Maintenance and cleaning .....</b>	<b>118</b>
11.1 Intervals .....	118
<b>12 Accessories .....</b>	<b>119</b>
12.1 Brake resistor .....	119
12.2 Brake resistor IP65 .....	119
12.3 Mains choke .....	119
12.4 Mains filter .....	120
<b>13 Decommissioning .....</b>	<b>121</b>
13.1 Disassembly .....	121
13.2 Disposal .....	122
13.2.1 Returning to the vendor .....	122
<b>14 Guidelines and Standards .....</b>	<b>123</b>
14.1 Standards .....	123
14.2 Guidelines .....	124
14.2.1 Electrical isolation .....	124
14.3 Test centers .....	125
14.4 EU conformity .....	125
14.5 UL certification .....	126
14.5.1 USA and Canada .....	126
<b>15 Notes .....</b>	<b>127</b>
<b>16 Notes .....</b>	<b>128</b>
<b>Index .....</b>	<b>129</b>

# 1 Documentation notes

## 1.1 Disclaimer

Beckhoff products are subject to continuous further development. We reserve the right to revise the operating instructions 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 these operating instructions.

### 1.1.1 Trademarks

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

The use of other brand names or designations by third parties may lead to an infringement of the rights of the owners of the corresponding designations.

### 1.1.2 Patents

The EtherCAT technology is protected by patent rights through the following registrations and patents with corresponding applications and registrations in various other countries:

- EP1590927
- EP1789857
- EP1456722
- EP2137893
- DE102015105702



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

## 1.1.3 Limitation of liability

All components in this product as described in the operating instructions are delivered in a specific configuration of hardware and software, depending on the application regulations. Modifications and changes to the hardware or software configuration that go beyond the documented options are prohibited and nullify the liability of Beckhoff Automation GmbH & Co. KG.

**The following is excluded from the liability:**

- Failure to observe these operating instructions
- Improper use
- Use of untrained personnel
- Use of unauthorized spare parts

## 1.1.4 Copyright

© Beckhoff Automation GmbH & Co. KG, Germany

The copying, distribution and utilization of this document as well as the communication of its contents to others without express authorization is prohibited. Offenders will be held liable for the payment of damages.

We reserve all rights in the event of registration of patents, utility models and designs.

## 1.2 Version numbers



### **Provision of revision levels**

On request, you can obtain a list of revision levels for changes in the operating instructions.

- Send your request to [motion-documentation@beckhoff.com](mailto:motion-documentation@beckhoff.com).

### **Origin of the document**

These operating instructions were originally written in German. All other languages are derived from the German original.

### **Product features**

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



## 1.3 Scope of the documentation

Apart from these operating instructions, the following documents are part of the overall documentation:

Documentation	Definition
AX8000 Functional description	Documentation of the various functions of the AX8000 multi-axis servo system
AX86x0 Power supply module Object description	Operating instructions with short descriptions and attribute tables of the power supply modules of the AX8000 multi-axis servo system
AX86x0 Power supply module Diagnosis messages	Documentation of the error messages of the AX8000 multi-axis servo system with attribute tables, problem descriptions and possible solutions
AX2090-BW80 braking resistors	Operating instructions for the use and installation of the AX2090-BW80 braking resistors as accessories for the AX8000 multi-axis servo system
AX2090-BW65 braking resistors IP65	Operating instructions for the use and installation of the AX2090-BW65 braking resistors with the protection class IP65 as accessories for the AX8000 multi-axis servo system
AX2090-ND80 mains chokes	Operating instructions for the use and installation of the AX2090-ND80 mains chokes as accessories for the AX8000 multi-axis servo system
AX2090-TT80 isolating transformers	Data sheet with mechanical and electrical data as well as initial information on the use of the AX2090-TT80 isolating transformers as accessories for the AX8000 multi-axis servo system
Mains filters AX2090-NF80	Operating instructions for the use and installation of the AX2090-NF80 mains filter as accessories for the AX8000 multi-axis servo system

## 1.4 Staff qualification

These operating instructions are intended for trained control and automation specialists with 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 operating instructions published at the respective time of each installation and commissioning is to be used. 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

## **Qualified electricians**

Qualified electricians have comprehensive technical knowledge gained from a course of study, an apprenticeship or technical training. They have an understanding of control technology and automation. They are familiar with relevant standards and directives. Qualified 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

## 1.5 Safety and instruction

Read the contents that refer to the activities you have to perform with the product. Always read the chapter For your safety in the operating instructions. Observe the warnings in the chapters so that you can handle and work with the product as intended and safely.

## 1.6 Explanation of symbols

Various symbols are used for a clear arrangement:

- ▶ The triangle indicates instructions that you should execute.
- The bullet point indicates an enumeration.
- [...] The square brackets indicate cross-references to other text passages in the document.
- [1] The number in the square brackets refers to the position in the adjacent figure.
- [+] The plus sign in square brackets indicates ordering options and accessories.

In order to make it easier for you to find text passages, pictograms and signal words are used in warning notices:

### **DANGER**

Failure to observe will result in serious or fatal injuries.

### **WARNING**

Failure to observe may result in serious or fatal injuries.

### **CAUTION**

Failure to observe may result in minor or moderate injuries.

## NOTICE

Notes are used for important information on the product. The possible consequences of failure to observe these include:

- Malfunctions of the product
- Damage to the product
- Damage to the environment



### Information

This sign indicates information, tips and notes for dealing with the product or the software.



### Examples

This symbol shows examples of how to use the product or software.



### QR-Codes

This symbol shows a QR code, via which you can watch videos or animations. Internet access is required in order to use it.


You can read the QR code, for example, with the camera of your smartphone or tablet. If your camera doesn't support this function you can download a free QR code reader app for your smartphone. Use the Appstore for Apple operating systems or the Google Play Store for Android operating systems.

*If you cannot read the QR code on paper, make sure that the lighting is adequate and reduce the distance between the reading device and the paper. In the case of documentation on a monitor screen, use the zoom function to enlarge the QR code and reduce the distance.*



## 1.7 Beckhoff Services

Beckhoff and its international partner companies offer comprehensive support and service.

 [www.beckhoff.com/en-en/support/global-availability/](http://www.beckhoff.com/en-en/support/global-availability/)

### 1.7.1 Support services

The Beckhoff Support offers technical advice on the use of individual Beckhoff products and system planning. The support engineers offer you competent assistance, for comprehension questions as well as for commissioning.


 +49 5246 963-157

 [support@beckhoff.com](mailto:support@beckhoff.com)

 [www.beckhoff.com/en-en/support/our-support-services/](http://www.beckhoff.com/en-en/support/our-support-services/)

### 1.7.2 Training offerings

Training in Germany takes place at the Beckhoff branches or, after consultation, at the customer's premises. Beckhoff offers both face-to-face and online training courses.

 +49 5246 963-5000

 [training@beckhoff.com](mailto:training@beckhoff.com)

 [www.beckhoff.com/en-en/support/training-offerings/](http://www.beckhoff.com/en-en/support/training-offerings/)

### 1.7.3 Service offerings

The Beckhoff service experts support you worldwide in all areas of after-sales service.

 +49 5246 963-157

 [service@beckhoff.com](mailto:service@beckhoff.com)

 [www.beckhoff.com/en-en/support/our-service-offerings/](http://www.beckhoff.com/en-en/support/our-service-offerings/)

## 1.7.4 Headquarters Germany

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33415 Verl, Germany

☎ +49 5246 963-0

✉ [info@beckhoff.com](mailto:info@beckhoff.com)

🌐 [www.beckhoff.com/en-en/](http://www.beckhoff.com/en-en/)

A detailed overview of the Beckhoff locations worldwide can be found at:

🌐 [www.beckhoff.com/en-en/company/global-presence/](http://www.beckhoff.com/en-en/company/global-presence/)

## 1.7.5 Downloadfinder

In the Download finder you will find configuration files, technical documentation and application reports to download.

🌐 [www.beckhoff.com/documentations](http://www.beckhoff.com/documentations)

## 2 For your safety

Read this chapter containing general safety information. The chapters in these operating instructions also contain warning notices. Always observe the safety instructions for your own safety, the safety of other persons and the safety of the product.

When working with control and automation products, many dangers can result from careless or incorrect use. Work particularly thoroughly, not under time pressure and responsibly towards other people.

### 2.1 Safety pictograms

You will find safety symbols on Beckhoff products and packaging. The symbols may be glued, printed, or lasered on and may vary depending on the product. They serve to protect people and to prevent damage to the products. Safety symbols may not be removed and must be legible for the user.



#### Warning of high voltage!

The DC link capacitors and test contacts on all modules may carry hazardous voltages up to 848 V<sub>DC</sub>.

## 2.2 General safety instructions

This chapter provides you with instructions on safety when handling the product. This product is not capable of stand-alone operation and is therefore categorized as an incomplete machine. The product must be installed in a machine or plant by the machine manufacturer. Read the documentation prepared by the machine manufacturer.

### 2.2.1 Before operation

#### **Protective equipment**

Do not remove or bypass any protective devices. Check all protective devices before operation. Make sure that all emergency switches are present at all times and can be reached by you and other people. People could be seriously or fatally injured by unprotected machine parts.

#### **Shut down and secure the machine or plant**

Shut down the machine or plant. Secure the machine or plant against being inadvertently started up.

#### **Correctly ground electrical components or modules**

Avoid electric shocks due to improper grounding of electrical components or modules. Ground all conductive components according to the specifications in the chapters "Electrical Installation" and "Mechanical Installation".

#### **Keep the immediate environment clean**

Keep your workplace and the surrounding area clean. Ensure safe working.

#### **Check safety pictograms**

Check whether the designated pictograms are on the product. Replace missing or illegible stickers.

#### **Observe tightening torques**

Mount and repeatedly check connections and components, complying with the prescribed tightening torques.

#### **Use the original packaging only**

When shipping, transporting, storing and packing, use the original packaging or non-conductive materials.

## 2.2.2 During operation

### Observe the discharge times of the capacitors

Observe the following delay times after disconnecting from the mains supply:

- |                             |                   |
|-----------------------------|-------------------|
| • AX8600, AX8620 and AX8640 | <b>30 minutes</b> |
| • AX8108, AX8118 and AX8206 | <b>30 minutes</b> |
| • AX8525 and AX8540         | <b>30 minutes</b> |

Note: In the power supply module the control word can be set to "Fast discharge DC link" in object 0x8000:11. This can trigger a rapid discharge of the DC link when the mains voltage is switched off. This allows the waiting time to be bypassed. Please note the general conditions of the object.

### Do not work on live electrical parts

Do not open the multi-axis servo system while it is live. Measure the voltage on the DC link test contacts DC+ und DC-. Only work on the multi-axis servo system when the voltage has dropped to < 50 V. Ensure that the protective conductor is connected properly. Never loosen electrical connections when live. Disconnect all components from the mains and secure them against being switched on again.

### Do not touch hot surfaces

Check the cooling of the surfaces with a thermometer. Do not touch the components during and immediately after operation. Allow the components to cool sufficiently after switching off.

### Avoid overheating

Operate the components according to the technical specifications. Refer here to the chapter: "Technical data". Provide for sufficient cooling. Switch the components off immediately if the temperature is too high.

## 2.2.3 After operation

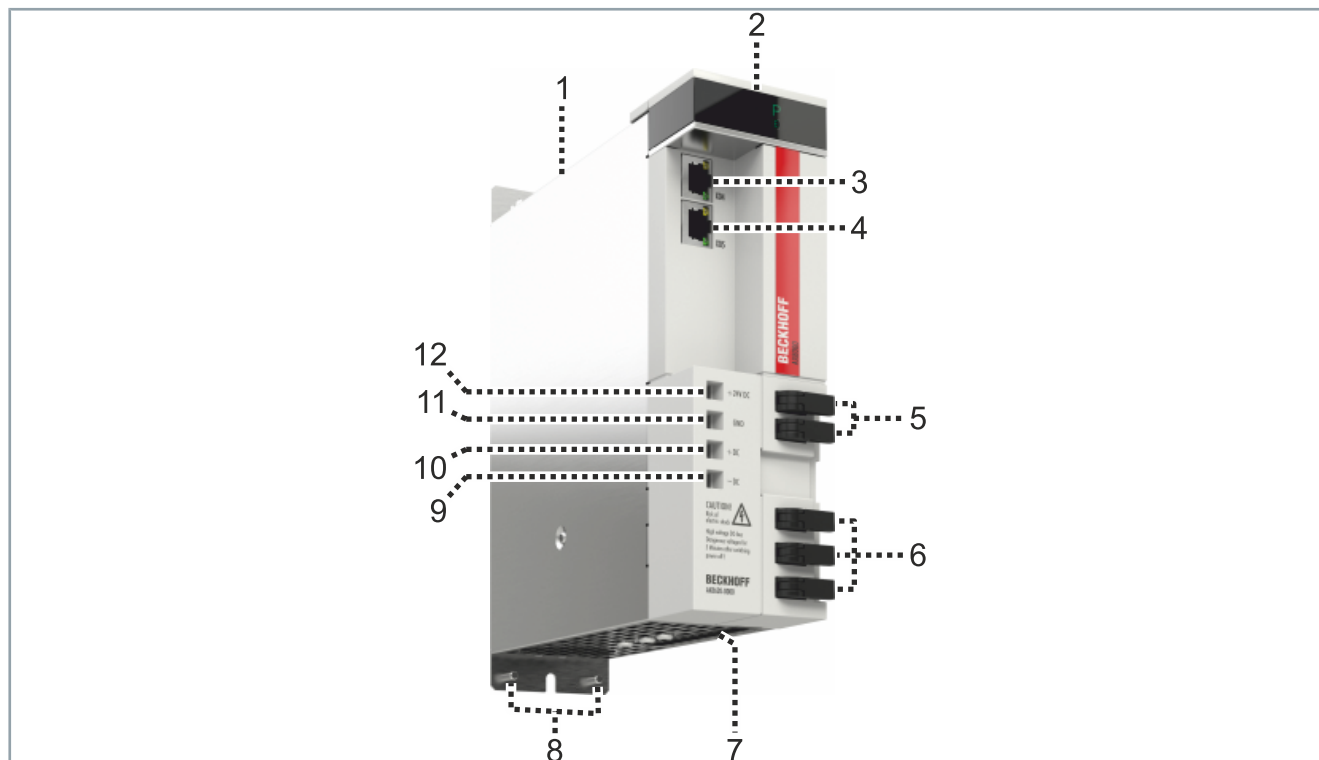
### De-energize and switch off components before working on them

Check the functionality of all safety-relevant devices. Secure the working environment. Secure the machine or plant against being inadvertently started up. Observe the chapter: "Decommissioning".



## 3 Product overview

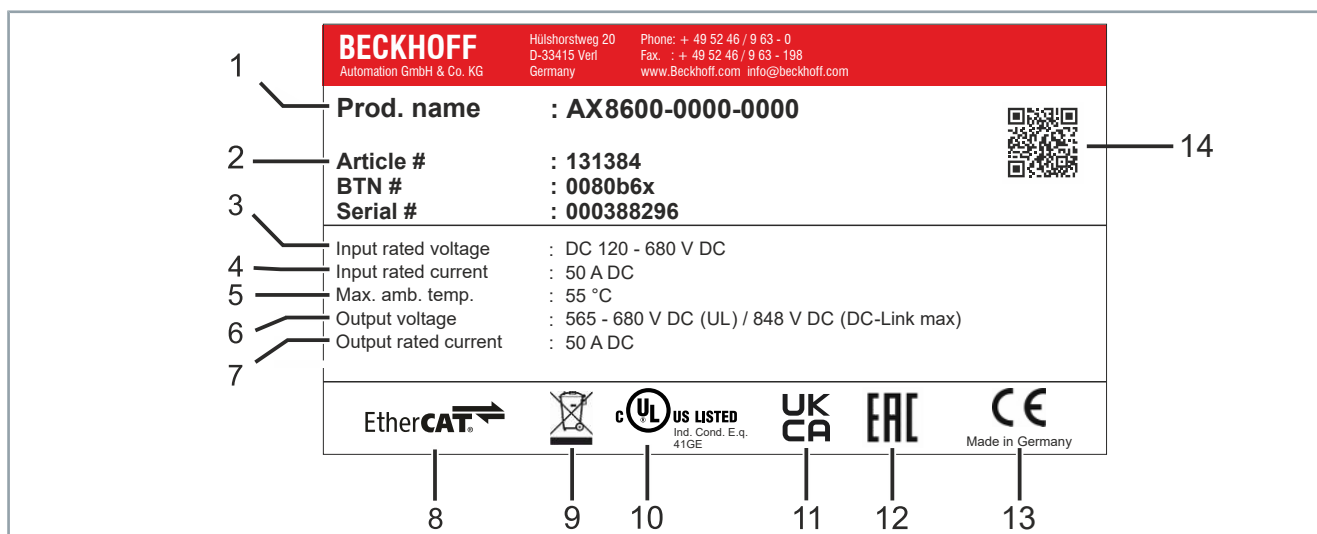
### 3.1 Power supply modules AX86xx



Item number	AX8600	AX8620	AX8640
1	Housing		
2	Display		
3	Fieldbus EtherCAT input X04		
4	Fieldbus EtherCAT output X05		
5	Quick coupling 24 V <sub>DC</sub> ; AX bridge		
6	Quick coupling, DC link and protective earth PE; AX bridge		
7	Input terminal X01 7-pin; 24 V <sub>DC</sub> , DC mains, PE and external braking re- sistor	Input terminal X01 10-pin; 24 V <sub>DC</sub> , AC mains, PE and external braking re- sistor	Input terminal X01 4-pin; AC mains, PE Input terminal X02 6-pin; 24 V <sub>DC</sub> , PE and exter- nal braking resistor
8	Grounding bolt		
9	Test contact DC link DC-		
10	Test contact DC link DC+		
11	Test contact GND		
12	Test contact +24 V <sub>DC</sub>		

### 3.1.1 Name plate

- DC power supply module AX8600



Item number	Explanation
1	Order number
2	Order number Beckhoff Traceability Number Serial number
3	Nominal input voltage
4	Nominal input current
5	Maximum ambient temperature
6	Nominal output voltage
7	Nominal output current
8	EtherCAT conformity
9	Disposal according to WEEE directive
10	cULus approval
11	UKCA conformity
12	EAC conformity
13	CE approval
14	Data-Matrix Code

- Power supply modules AX8620 and AX8640

1

2

3

4






5


6

7

8

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Automation GmbH & Co. KG  
Hülshorstweg 20  
D-33415 Verl  
Germany  
Phone: + 49 52 46 / 9 63 - 0  
Fax: + 49 52 46 / 9 63 - 198  
www.Beckhoff.com info@beckhoff.com

**Prod. name** : AX8620-0000-0000  
**Article #** : 131384  
**BTN #** : 0080b6x  
**Serial #** : 000388296  
Input rated voltage : 3 PH 400 / 480 V AC  
Input rated current : 17,5 A AC  
Input frequency : 50/60 Hz  
Max. amb. temp. : 55 °C  
Output voltage : 565 - 680 V DC (UL) / 848 V DC (DC-Link max)  
Output rated current : 20 A DC  
**EtherCAT**  
  
 **US LISTED**  
Ind. Cond. E.q.  
41GE  
  
  
 Made in Germany



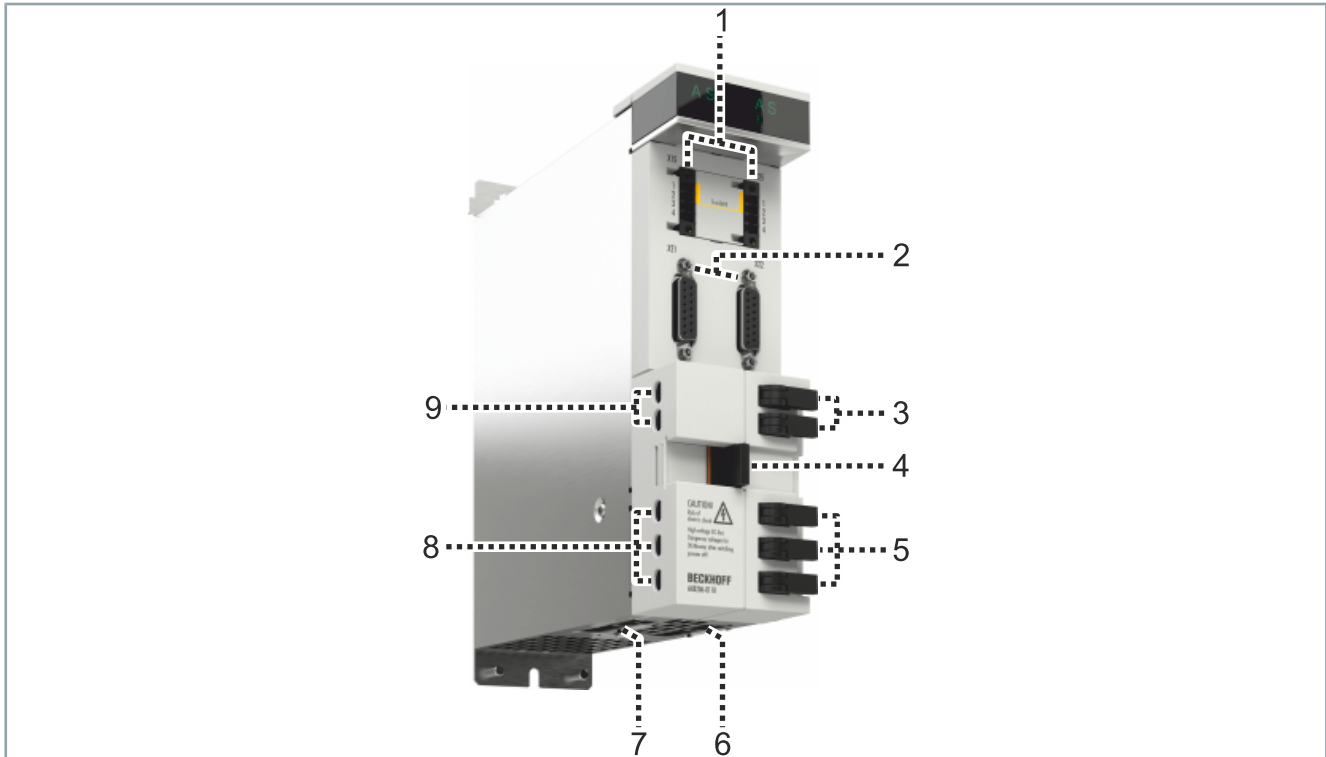
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Item number	Explanation
1	Order number
2	Order number Beckhoff Traceability Number Serial number
3	Nominal input voltage
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8	Nominal output current
9	EtherCAT conformity
10	Disposal according to WEEE directive
11	cULus approval
12	UKCA conformity
13	EAC conformity
14	CE approval
15	Data-Matrix Code

### 3.1.2 Type key

AX 8x yz - a b c d - 0000	Explanation
AX	Product area • Servo drive
8	Series • AX8000
x	Supply • 6 In combination with "a"
yz	Nominal output current • 00 = maximum 50 A <sub>DC</sub> - DC supply 20 = 7 A <sub>DC</sub> - Single-phase supply 20 A <sub>DC</sub> - Three-phase supply 40 = 40 A <sub>DC</sub> - Three-phase supply
a	Supply • 0 = single-phase 100 to 240 V <sub>AC</sub> or three-phase 200 to 480 V <sub>AC</sub>
b	Version • 0 = standard
c	Version • 0 = standard
d	Version • 0 = standard

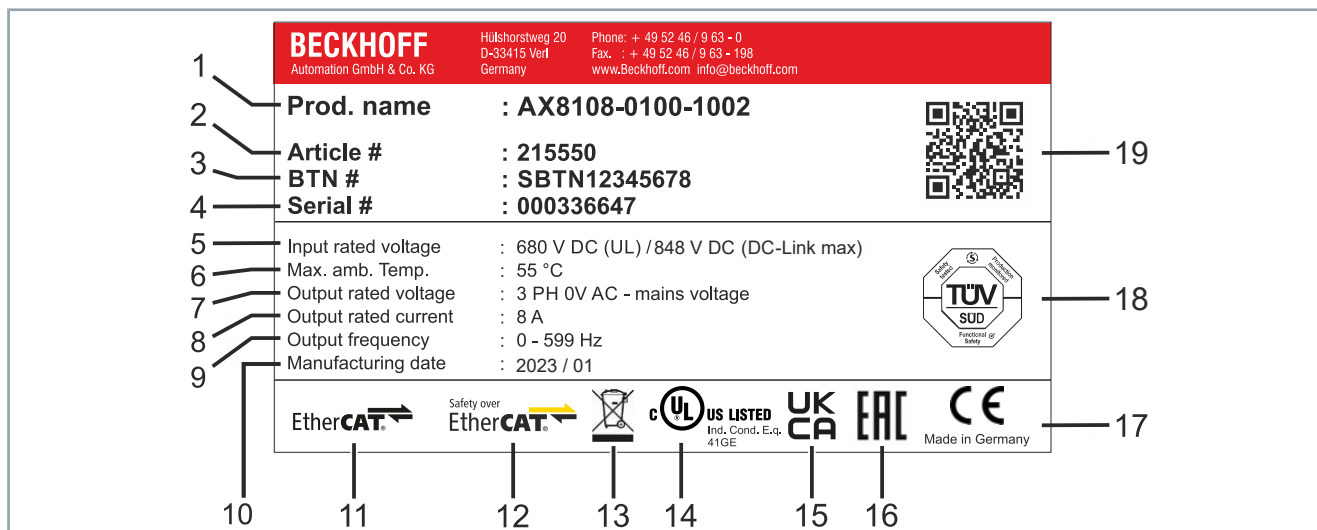
## 3.2 Axis modules AX81xx / AX82xx



Item number	AX8108 and AX8118	AX8206
1	Digital inputs X15 channel A	Digital inputs X15 channel A & X25 channel B
2	Feedback option -0x10: Feedback connection X11 and X12	Feedback option -0x10: Feedback connection X11 and X21
	Feedback option -0x20: Feedback connection X11	Feedback option -0x20: Not available
3	Quick coupling 24 V <sub>DC</sub> ; AX bridge	
4	EtherCAT connection	
5	Quick coupling, DC link and protective earth PE; AX bridge	
6	8-pin motor connector X13 Channel A; U, V, W, PE, T+ / OCT+, T- / OCT-, B+ and B-	8-pin motor connector X23 Channel A; U, V, W, PE, T+ / OCT+, T- / OCT-, B+ and B-
7	--	8-pin motor connector X13 Channel B; U, V, W, PE, T+ / OCT+, T- / OCT-, B+ and B-
8	AX bridge: DC link, FE	
9	AX bridge: 24 V <sub>DC</sub>	



### 3.2.1 Name plate

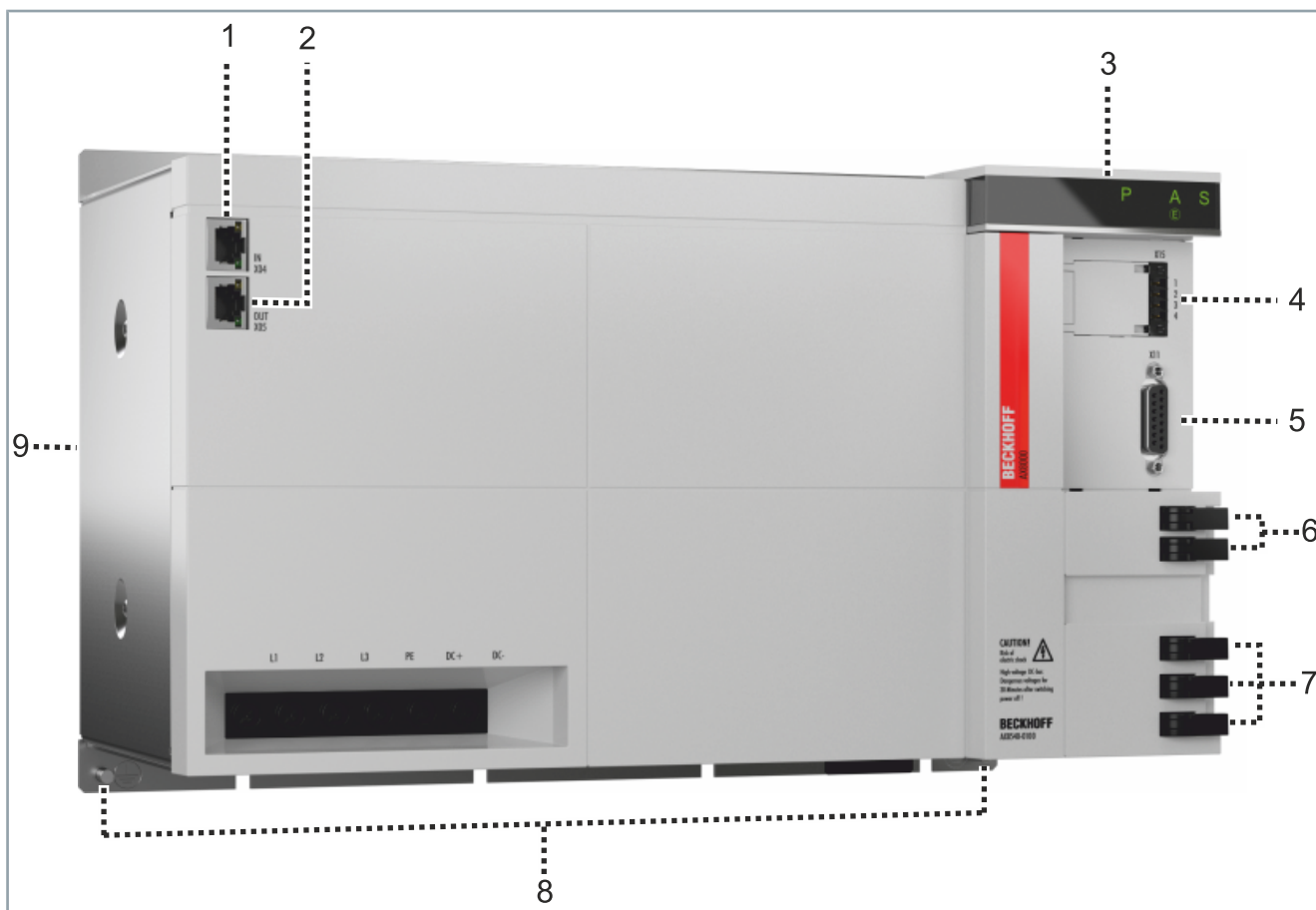


Item number	Explanation
1	Order number
2	Order number
3	Beckhoff traceability number
4	Serial number
5	Nominal input voltage
6	Maximum ambient temperature
7	Nominal output voltage
8	Nominal output current
9	Output frequency range
10	Date of manufacture
11	EtherCAT conformity
12	Safety over EtherCAT conformity • Order designations AX8xxx-x1xx and AX8xxx-x2xx only
13	Disposal according to WEEE directive
14	cULus approval
15	UKCA conformity
16	EAC approval
17	CE conformity
18	TÜV certification • Order designations AX8xxx-x1xx and AX8xxx-x2xx only
19	Data-Matrix Code

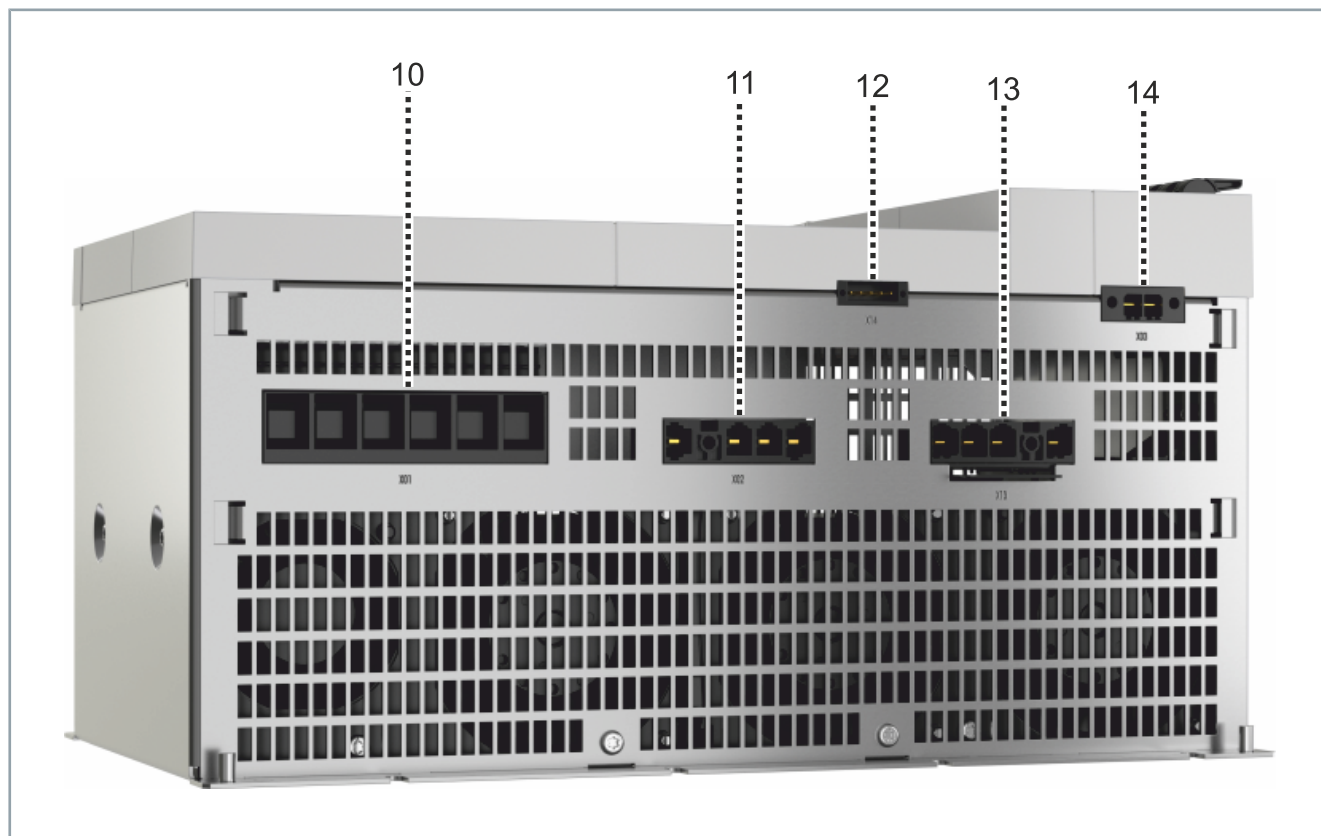
## 3.2.2 Type key

AX 8x yz - a b c d - e f g h	Explanation
AX	Product area • Servo drive
8	Series • AX8000
x	Axis module • 1 = single-channel axis module • 2 = two-channel axis module
yz	Channel nominal current • 08 = 1 x 8 A • 18 = 1 x 18 A • 06 = 2 x 6 A
a	DC link voltage • 0 = 0 to 848 V <sub>DC</sub>
b	Safety function • 0 = no safety function • 1 = safety functions TwinSAFE, STO/SS1 • 2 = safety functions TwinSAFE, 17 safety functions • All information on the safety functions integrated in the drive can be found in the chapter Ordering options.
c	Hardware features • 0 = OCT • 1 = EnDat 2.2 / 22, BiSS C • 2 = EnDat 2.2 / 22, BiSS C, Sin/Cos interface, TTL (RS422 diff.) interface; only available for single-channel devices!
d	Version • 0 = standard
e	Version • 0 = standard
f	Version • 0 = standard
g	Dual Use • 0 = Maximum rotary field frequency ≤ 599 Hz • 8 = Rotary field frequency ≥ 600 Hz • For further information, refer to the chapter Dual Use.
h	Version • 0 = standard

### 3.3 Combined modules AX85xx



Item number	Explanation
1	Fieldbus EtherCAT input X04
2	Fieldbus EtherCAT output X05
3	Display
4	X15 digital inputs / TwinSAFE STO connection
5	Optional: X11 encoder feedback connection
6	Quick coupling 24 V <sub>DC</sub> ; AX bridge
7	Quick coupling, DC link and protective earth PE; AX bridge
8	Grounding bolt
9	Housing



Item number	Explanation
10	X01 connection – mains supply and DC link
11	X02 connection – external braking resistor
12	X14 connection – holding brake, motor temperature / OCT
13	X13 plug – motor connection
14	X03 connection 24 V <sub>DC</sub>

## 3.3.1 Name plate

**BECKHOFF**  
Automation GmbH & CoKG  
Huelshorstweg 20  
D-33415 Verl  
Germany  
Phone: + 49 52 46 / 9 63 - 0  
Fax: + 49 52 46 / 9 63 - 198  
www.beckhoff.com info@beckhoff.com

**Cat. No. : AX85xx-0000-0000** **Serial No.: 123456789**

**Power supply** **Axis module AX8140**

Input rated voltage : 3 PH 200 - 480 V AC

Input rated current : 70 A AC --

Input frequency : 50 / 60 Hz --

Max. amb. temp. : 55 °C

Output rated voltage : 325 - 680 V DC (UL) 3 PH 0V AC - mains voltage

848 V DC (DC-Link max.)

Output rated current : 50 A DC (Bridge) 40 A AC (Motor)

Output frequency range : -- 0 - 599 Hz

QR Code

TUV SUD Functional safety

BTN No. : 87654321  
Article No. : 199809  
Manufacturing date : 2021 / 9

EtherCAT  
Safety over EtherCAT

Disposal according to WEEE directive

cULus LISTED Ind. Control, E.q. 41GE

UKCA

EAC

CE Made in Germany

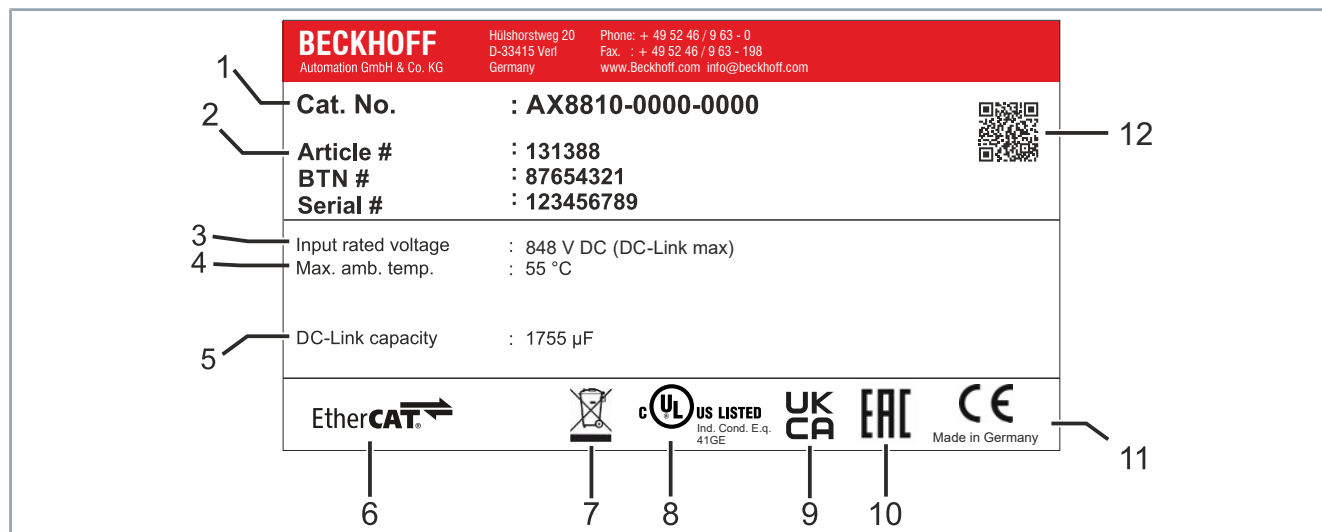
Item number	Explanation
1	Order number
2	Data for power supply module and axis module
3	Nominal input voltage
4	Nominal input current
5	Input frequency
6	Maximum ambient temperature
7	Nominal output voltage
8	Nominal output current
9	Output frequency range
10	Beckhoff traceability number
11	Order number
12	Date of manufacture
13	EtherCAT conformity Safety over EtherCAT conformity
14	Disposal according to WEEE directive
15	cULus approval
16	UKCA conformity
17	EAC conformity
18	CE approval
19	TÜV certification
20	Data-Matrix Code
21	Serial number

## 3.3.2 Type key

AX 85 yz - a b c d - e f g h	Explanation
AX	Product area • Servo drive
8	Series • AX8000
5	Combined power supply modules and axis modules
yz	Nominal DC link output current • 25 = up to 50 A <sub>DC</sub> 40 = $\geq 35$ A <sub>DC</sub> , depending on the connected nominal motor current  Channel nominal current • 25 = 1 x 25 A <sub>AC</sub> 40 = 1 x 40 A <sub>AC</sub>
a	Supply • 0 = 200 to 480 V <sub>AC</sub>  DC link voltage • 0 = 0 to 848 V <sub>DC</sub>
b	Safety function • 0 = no safety function 1 = safety functions TwinSAFE, STO/SS1 2 = safety functions TwinSAFE, 17 safety functions  • All information on the safety functions integrated in the drive can be found in the chapter Ordering options.
c	Hardware features • 0 = OCT 1 = Not available 2 = EnDat 2.2 / 22, BiSS C, Sin/Cos interface, TTL (RS422 diff.) interface
d	Version • 0 = standard
e	Version • 0 = standard
f	Version • 0 = standard
g	Dual Use • 0 = Maximum rotary field frequency $\leq 599$ Hz 8 = Rotary field frequency $\geq 600$ Hz  • For further information, refer to the chapter Dual Use.
h	Version • 0 = standard

## 3.4 Capacitor module AX8810

### 3.4.1 Name plate



Item number	Explanation
1	Order number
2	Order number Beckhoff Traceability Number Serial number
3	Nominal input voltage
4	Maximum ambient temperature
5	DC link capacitance
6	EtherCAT conformity
7	Disposal according to WEEE directive
8	cULus approval
9	UKCA conformity
10	EAC approval
11	CE conformity
12	Data-Matrix Code

## 3.4.2 Type key

AX 8 8 yz - a b c d - 0000	Explanation
AX	Product area • Servo drive
8	Series • AX8000
8	Option module
yz	Option modules • 10 = capacitor module
a	Supply • 0 = 0 to 848 V <sub>DC</sub>
b	Version • 0 = standard
c	Version • 0 = standard
d	Version • 0 = standard



## 3.5 Product characteristics

### Short cycle times

With the servo drive you can implement fast and highly dynamic positioning tasks through the integrated control technology. EtherCAT enables the ideal connection to the PC-based control technology. With EtherCAT and the AX8000 multi-axis servo system and distributed clocks you can achieve minimum cycle times of 62.5 µs, synchronicity and simultaneity in the drive technology.

### Scalable nominal motor power

With the axis modules you can operate different nominal motor powers through scalable motor current measurement. A nominal motor current of between 1 A and 8 A can be set on an 8 A module without influencing the quality of the resolution.

### Operation of different motor sizes

With a two-channel axis module you can connect two identical motor sizes or also different ones. The sum of the nominal currents of both servomotors is relevant for the selection of the axis module. The sum of the nominal currents of the axis modules is the most that can be provided at the same time here.

### Multi-feedback interface for third-party motors

The AX8000 multi-axis servo system provides a multi-feedback interface for connecting third-party motors that do not support OCT feedback.

### High-speed capture inputs

The digital high-speed capture inputs record binary control signals from the process level and make them available for "latching" / "capturing" an encoder position. The signal propagation time of these inputs is 15 µs. There are two digital inputs per axis.

### Diagnostics and parameter display

The display of the AX8000 multi-axis servo system shows error groups in various categories and is based on the 7-segment technology.

### Toolless connection

The simple and fast connection of the DC link of power supply modules and several axis modules is enabled by the AX bridge. The connection takes place without tools with spring-loaded terminals for DC link, control circuit and EtherCAT. The compact design of the AX8000 multi-axis servo system enables simple mounting inside the control cabinet.

## 3.6 Ordering options

Ordering options are defined via the type key and must be ordered separately. It is not possible to fit one at a later date.

### 3.6.1 Multi-feedback interface

Depending on the version, the "multi-feedback interface", [Page 94] supports the digital feedback system EnDat 2.2 / 22 or BiSS-C as well as the analog feedback systems Sin/Cos or TTL (RS422 diff.).

There is an additional D-Sub-15 plug for each axis channel behind the front cover of the axis module.

### 3.6.2 Drive-integrated safety technology



A servomotor from the AM8000 series with a G or H feedback system according to the type key is absolutely necessary for the operation of the axis modules with integrated safety technology. Prior to commissioning the axis modules with integrated safety technology, read the original operating instructions:

"AM8000 & AM8500 Synchronous Servomotors"

#### **Use a Beckhoff OCT motor cable**

An original Beckhoff OCT motor cable is absolutely necessary for the operation of the axis module with integrated safety technology. This is part of the safety certification.

#### **Observe the TwinSAFE documentation**

Before putting the axis module with integrated safety technology into operation, read the documentation:

"AX8911 TwinSAFE drive option for servo drives from the AX8xxx-xxxx series"

The axis modules are optionally available with integrated safety functions. These conform to IEC 61800-5-2 and fulfill the following safety standards:

- EN ISO 13849-1:2015, up to Cat 4, PL e
- EN 61508:2010, up to SIL 3
- EN 62061:2005 + A1:2013/A2:2015 up to SILCL3

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

Order identifier	Safety functions	
AX8xxx-x1xx STO device	<b>STO</b>	Safe Torque Off
	<b>SS1</b>	Safe Stop 1
AX8xxx-x2xx Safe Motion device	<b>STO</b>	Safe Torque Off
	<b>SOS</b>	Safe Operating Stop
	<b>SS1</b>	Safe Stop 1
	<b>SS2</b>	Safe Stop 2
	<b>SLP</b>	Safely Limited Position
	<b>SCA</b>	Safe Cam
	<b>SLI</b>	Safely Limited Increment
	<b>SDIp</b>	Safe Direction positive
	<b>SDIn</b>	Safe Direction negative
	<b>SLS</b>	Safely Limited Speed
	<b>SSR</b>	Safe Speed Range
	<b>SSM</b>	Safe Speed Monitor
	<b>SMS</b>	Safe Maximum Speed
	<b>SMA</b>	Safe Maximum Acceleration
	<b>SAR</b>	Safe Acceleration Range
	<b>SBC</b>	Safe Brake Control
	<b>SBT</b>	Safe Brake Test

## 3.7 Intended use

The modules of the AX8000 multi-axis servo system may be operated only for the intended activities defined in this documentation, taking into account the prescribed environmental conditions.

The components are to be installed only in closed control cabinets in electrical plants or machines and put into operation only as integrated components of the plant or machine.



### **Read the entire drive system documentation:**

- This translation of the original instructions
- Complete machine documentation provided by the machine manufacturer

### 3.7.1 Improper use

Any type of use that exceeds the permissible values from the technical data is regarded as inappropriate and is thus prohibited.

The modules of the AX8000 multi-axis servo system are not suitable for use in the following areas:

- ATEX zones without suitable housing
- Areas with aggressive environments, for example aggressive gases or chemicals

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

## 3.8 Dual Use

The EU Dual-Use Regulation defines in Annex I of Regulation (EU) No. 2021/821 under category 3A225 the technical parameters of commercially available frequency changers that are to be classified as dual-use articles and thus subject to approval.

For the AX8000 multi-axis servo system, this is the operating frequency:

- Dual Use  $\geq 600$  Hz
- Not Dual Use  $< 599$  Hz

This information can be found in the type codes (g):

- 8 = Dual Use
- 0 = not Dual Use

## 4 Technical data

### 4.1 Data for operation and environment

#### NOTICE

##### Operate servo drives only under the specified environmental conditions

Operate the servo drives only in accordance with the specifications for operation and the environment listed in this chapter. This ensures a long service life and proper operation.

*The lifetime of the servo drive may be shortened at temperatures above 40 °C and with encapsulated installation.*

Beckhoff products are designed for operation under certain environmental conditions, which vary according to the product. The following specifications must be observed for operation and environment in order to achieve the optimum service life of the products.

Environmental requirements	
Climate category - operation	2K3 according to EN 60721
Ambient temperature during operation	0 °C to +40 °C Extended temperature range up to +55 °C with power derating of 2 % / K
Ambient temperature during transport	-25 °C to +70 °C, maximum fluctuation 20 K per hour
Ambient temperature during storage	-25 °C to +55 °C, maximum fluctuation 20 K per hour
Power derating	No power derating up to 1000 m above sea level. Power derating of 1 % / 100 m from 1000 m up to maximally 3000 m above sea level.
Installation altitude	A reduction of the overvoltage category is necessary from an installation altitude of 2000 m up to maximally 3000 m above sea level. Observe derating.
Permissible humidity in operation	5 % to 95 % relative humidity, no condensation
Permissible humidity during transport and storage	5 % to 95 % relative humidity, no condensation
Corrosion protection	Not required: Special measures are to be taken in consultation with the vendor if the environmental conditions are extreme or if they differ from those described in this chapter.
Degree of pollution	2 according to EN 60204 and EN 50178

Specifications for intended use	
Ventilation	Integrated and temperature-controlled fan
Insulation material class	F according to IEC 60085 and UL1446 class F
Protection class	Devices IP 20 Terminals IP 00
Installation position	Vertical
Vibration resistance	1 g, 150 Hz according to EN 61800-5-1
Shock resistance	5 g, 30 ms according to EN 60068-2-27
EMC requirements	conforms to EN 61800-3:2004 + A1:2012
Approvals	CE cULus EAC UKCA See chapter: "Guidelines and Standards", [Page 123]

## 4.2 Power supply modules

### 4.2.1 DC power supply module

Electrical data	DC
	AX8600-0000
<b>Mains supply</b>	
• Nominal input current [ $A_{DC}$ ]	50
• Nominal supply voltage [ $V_{DC}$ ]	560 / 640
• 24 V system voltage and peripheral voltage [V]	24 V DC +6/-10 %
• 24 V current consumption [mA]	120
• SCCR value [kA]	5
<b>Nominal output power</b>	
• At 600 $V_{DC}$ supply voltage [kW]	30
<b>Basic power loss and power-dependent power loss</b>	
• Basic power loss [W]	8
• Power-dependent power loss [W/kW]	6
• Example: With a nominal output power of 5 kW, the total power loss is $8\text{ W} + (5\text{ kW} \times 6\text{ W/kW}) = 38\text{ W}$	
<b>DC link</b>	
• Maximum voltage [ $V_{DC}$ ]	848
• Capacitance [ $\mu\text{F}$ ]	405
• Maximum peak output current [ $A_{DC}$ ] for maximum 5 seconds	100
<b>External braking resistor</b> Dependent on the connected resistor	
• Continuous braking power [kW]	1.6
• Maximum braking power [kW]	21.8
• Minimum braking resistor [ $\Omega$ ]	33
Mechanical data	DC
	AX8600-0000
• Width [mm]	60
• Height without connectors [mm]	230
• Depth without connectors / accessories [mm]	192
• Weight [kg]	2.5

## 4.2.2 Power supply module 20 A

Electrical data	Single-phase
	AX8620-0000
<b>Mains supply</b>	
• Nominal input current [ $I_{AC}$ ]	10
• Maximum nominal input current [ $I_{AC}$ ]	20
• Nominal supply voltage [ $V_{AC}$ ]	1 x 100 / 240
• 24 V system voltage and peripheral voltage [V]	24 V DC +6/-10 %
• 24 V current consumption [mA]	120
• Mains filter	Integrated, category C3
• SCCR value [kA]	5
<b>Nominal output power</b>	
• 240 V <sub>AC</sub> mains connection voltage [kW]	2
<b>Basic power loss and power-dependent power loss</b>	
• Basic power loss [W]	8
• Power-dependent power loss [W/kW]	6
• Example: With a nominal output power of 5 kW, the total power loss is $8 \text{ W} + (5 \text{ kW} \times 6 \text{ W/kW}) = 38 \text{ W}$	
<b>DC link</b>	
• Maximum voltage [ $V_{DC}$ ]	848
• Capacitance [ $\mu\text{F}$ ]	405
• Nominal output current without mains choke [ $I_{DC}$ ]	5
• Nominal output current with mains choke [ $I_{DC}$ ]	7
• Peak output current [ $I_{DC}$ ] for maximum 5 seconds	14
<b>Internal braking resistor</b>	
• Continuous braking power [W]	75
• Maximum braking power [kW]	21.8
<b>External braking resistor</b> Dependent on the connected resistor	
• Continuous braking power [kW]	1.6
• Maximum braking power [kW]	21.8
• Minimum braking resistor [ $\Omega$ ]	33
Mechanical data	Single-phase
	AX8620
• Width [mm]	60
• Height without connectors [mm]	230
• Depth without connectors / accessories [mm]	192
• Weight [kg]	2.5



### 4.2.3 Power supply module 20 A / 40 A

Electrical data	Three-phase	
	AX8620-0000	AX8640-0000
Mains supply		
• Nominal input current [A <sub>AC</sub> ]	17.5	35
• Maximum nominal input current [A <sub>AC</sub> ]	35	70
• Nominal supply voltage [V <sub>AC</sub> ]	3 x 200/ 480	
• 24 V system voltage and peripheral voltage [V]	24 V DC +6/-10 %	
• 24 V current consumption [mA]	120	
• Mains filter	Integrated, category C3	
• SCCR value [kA]	5	
Nominal output power		
• 400 V <sub>AC</sub> mains connection voltage [kW]	10.7	21.4
Basic power loss and power-dependent power loss		
• Basic power loss [W]	8	
• Power-dependent power loss [W/kW]	6	
• Example: With a nominal output power of 5 kW, the total power loss is 8 W + (5 kW x 6 W/kW) = 38 W		
DC link		
• Maximum voltage [V <sub>DC</sub> ]	848	
• Capacitance [µF]	405	625
• Nominal output current without mains choke [A <sub>DC</sub> ]	20	40
• Nominal output current with mains choke [A <sub>DC</sub> ]	20	40
• Peak output current [A <sub>DC</sub> ] for maximum 5 seconds	40	80
Internal braking resistor		
• Continuous braking power [W]	75	125
• Maximum braking power [kW]	21.8	43.6
External braking resistor		
Dependent on the connected resistor		
• Continuous braking power [kW]	1.6	3.2
• Maximum braking power [kW]	21.8	40.1
• Minimum braking resistor [Ω]	33	18
Mechanical data	Three-phase	
	AX8620-0000	AX8640-0000
• Width [mm]	60	90
• Height without connectors [mm]	230	
• Depth without connectors / accessories [mm]	192	
• Weight [kg]	2.5	3.5

## 4.3 Axis modules

### 4.3.1 Single-channel

Electrical data	Single-axis module 8 A	Single-axis module 18 A
	AX8108-0000	AX8118-0000
• Nominal output current [A]; 8 / 16 kHz	8 / 4	18 / 9
• Minimum nominal output current with full current resolution [A]	1	5
• 24 V current consumption without holding brake [mA]	500	530
• Maximum current brake output [A]	1	2
<b>Basic power loss and power-dependent power loss</b>		
• Basic power loss [W]	12	
• Power-dependent power loss at 230 V <sub>AC</sub> [W/A]	9	8
• Power-dependent power loss at 400 V <sub>AC</sub> [W/A]	11	10
• Power-dependent power loss at 480 V <sub>AC</sub> [W/A]	12.5	11
• Example for AX8108: With a nominal output current of 5 A at 400 V, the total power dissipation is 12 W + (5 A x 11 W/A) = 67 W		
<b>DC link</b>		
• Voltage range [V <sub>DC</sub> ]	0 to 848	
• Capacitance [μF]	135	405
<b>Output current at 400 V<sub>AC</sub> mains connection voltage</b>		
• Nominal output current [A]; 8 / 16 kHz	8 / 4	18 / 9
• Peak output current [A] I <sub>rms</sub> for maximum 5 seconds; 8 / 16 kHz	20 / 10	40 / 20
<b>Output current at 480 V<sub>AC</sub> mains connection voltage</b>		
• Nominal output current [A]; 8 / 16 kHz	8 / 4	18 / 9
• Peak output current [A] I <sub>rms</sub> for maximum 5 seconds; 8 / 16 kHz	18 / 9	36 / 18
Mechanical data	Single-axis module 8 A	Single-axis module 18 A
	AX8108-0000	AX8118-0000
• Width [mm]	60	90
• Height without connectors [mm]	230	
• Depth without connectors / accessories [mm]	192	
• Weight [kg]	2	2.5

### 4.3.2 Two-channel

Electrical data	Dual-axis module 6 A
	AX8206-0000
• Nominal output current [A]	Per channel: 6
• Minimum nominal output current with full current resolution [A]	1
• 24 V current consumption without holding brake [mA]	570
• Maximum current brake output [A]	1
<b>Basic power loss and power-dependent power loss</b>	
• Basic power loss [W]	12
• Power-dependent power loss at 230 V <sub>AC</sub> [W/A]	9
• Power-dependent power loss at 400 V <sub>AC</sub> [W/A]	11
• Power-dependent power loss at 480 V <sub>AC</sub> [W/A]	12.5
• Example for AX8108: With a nominal output current of 5 A at 400 V, the total power dissipation is 12 W + (5 A x 11 W/A) = 67 W	
<b>DC link</b>	
• Voltage range [V <sub>DC</sub> ]	0 to 848
• Capacitance [μF]	135
<b>Output current at 400 V<sub>AC</sub> mains connection voltage</b>	
• Nominal output current [A]	Per channel: 6
• Maximum nominal output current [A] for channel A; 8 / 16 kHz	8 / 4 Up to FW 1.02: 6 / -
• Maximum nominal output current [A] for channel B; 8 / 16 kHz	8 / 4
• Nominal output current as total device current [A]; 8 / 16 kHz	12 / 5.3
• Peak output current [A] I <sub>rms</sub> for maximum 5 seconds for channel A; 8 / 16 kHz	20 / 10 Up to FW 1.02: 14 / -
• Peak output current [A] I <sub>rms</sub> for maximum 5 seconds for channel B; 8 / 16 kHz	20 / 10
• Peak output current I <sub>rms</sub> for maximum 5 seconds as total device current [A]; 8 / 16 kHz	28 / 14
<b>Output current at 480 V<sub>AC</sub> mains connection voltage</b>	
• Nominal output current [A]	Per channel: 6
• Maximum nominal output current [A] for channel A; 8 / 16 kHz	8 / 4 Up to FW 1.02: 6 / -
• Maximum nominal output current [A] for channel B; 8 / 16 kHz	8 / 4
• Nominal output current as total device current [A]; 8 / 16 kHz	12 / 5.3
• Peak output current [A] I <sub>rms</sub> for maximum 5 seconds for channel A; 8 / 16 kHz	18 / 9 Up to FW 1.02: 14 / -
• Peak output current [A] I <sub>rms</sub> for maximum 5 seconds for channel B; 8 / 16 kHz	18 / 9
• Peak output current I <sub>rms</sub> for maximum 5 seconds as total device current [A]; 8 / 16 kHz	28 / 14

Mechanical data	Dual-axis module 6 A
	AX8206-0000
• Width [mm]	60
• Height without connectors [mm]	230
• Depth without connectors / accessories [mm]	192
• Weight [kg]	2

## 4.4 Combined power supply modules and axis modules

Electrical data	Combined power supply modules and axis modules 25 A	Combined power supply modules and axis modules 40 A
	AX8525-0xx0	AX8540-0xx0
Mains supply		
• Nominal input current at 40 °C [A <sub>AC</sub> ]	70	
• Maximum nominal input current [A <sub>AC</sub> ]	140	
• Nominal supply voltage [V <sub>AC</sub> ]	3 x 200 / 480	
• 24 V system voltage and peripheral voltage [V]	24 +6/-10 %	
• 24 V current consumption [mA], without holding brake	750 mA	
• Maximum current brake output [A]	2	
• Mains filter	Integrated; category C3	
• SCCR value [kA]	10	
Nominal output power		
• At 400 V <sub>AC</sub> mains connection voltage [kW]	42.8	
Basic power loss and power-dependent power loss [Basic power loss of the power supply module + power-dependent power loss of the power supply module + power-dependent power loss of the integrated axis module]		
• Basic power loss [W]	18	
• Power-dependent power loss at 230 V <sub>AC</sub> [W/kW + W/A]	4 W/kW + 8 W/A	
• Power-dependent power loss at 400 V <sub>AC</sub> [W/kW + W/A]	4 W/kW + 10 W/A	
• Power-dependent power loss at 480 V <sub>AC</sub> [W/kW + W/A]	4 W/kW + 11 W/A	
• Example: With a nominal input power of 20 kW and a motor current from the directly connected motor of 8 A, the total power loss is 18 W + (4 W/kW x 20 kW + 10 W/A x 8 A) = 178 W The maximum power loss at 400 V <sub>AC</sub> , nominal output and highest nominal motor current is 18 W + (4 W/kW x 42.8 kW + 10 W/A x 40 A) = 590 W		
DC link		
• Maximum voltage [V <sub>DC</sub> ]	848	
• Capacitance [µF]	1520	
• Nominal output current [A <sub>DC</sub> ]	80; of which maximum 50 to the AX bridge	
• Maximum nominal output current [A <sub>DC</sub> ] for maximum 5 seconds	160; of which maximum 100 to the AX bridge	
Integrated axis module		
Output current at 400 V <sub>AC</sub> mains connection voltage		
• Nominal output current [A]; 8 / 16 kHz	25 / 14	40 / 23.5
• Peak output current I <sub>rms</sub> [A] for maximum 5 seconds; 8 / 16 kHz	50 / 23	80 / 37.5
Output current at 480 V <sub>AC</sub> mains connection voltage		
• Nominal output current [A]; 8 / 16 kHz	25 / 13	40 / 21
• Peak output current I <sub>rms</sub> [A] for maximum 5 seconds; 8 / 16 kHz	50 / 19	80 / 30.5
Internal braking resistor		
Continuous braking power [W]	200	
Maximum braking power [kW]	68	

Electrical data	Combined power supply modules and axis modules 25 A	Combined power supply modules and axis modules 40 A
	AX8525-0xx0	AX8540-0xx0
<b>External braking resistor</b>		
Minimum resistance value [ $\Omega$ ]	10	
Continuous braking power [kW]	6	
Maximum braking power [kW]	68	
Mechanical data	Combined power supply modules and axis modules 25 A	Combined power supply modules and axis modules 40 A
	AX8525-0xx0	AX8540-0xx0
• Width [mm]	360	
• Height [mm]	230	
• Depth [mm]	192	
• Weight [kg]	15	

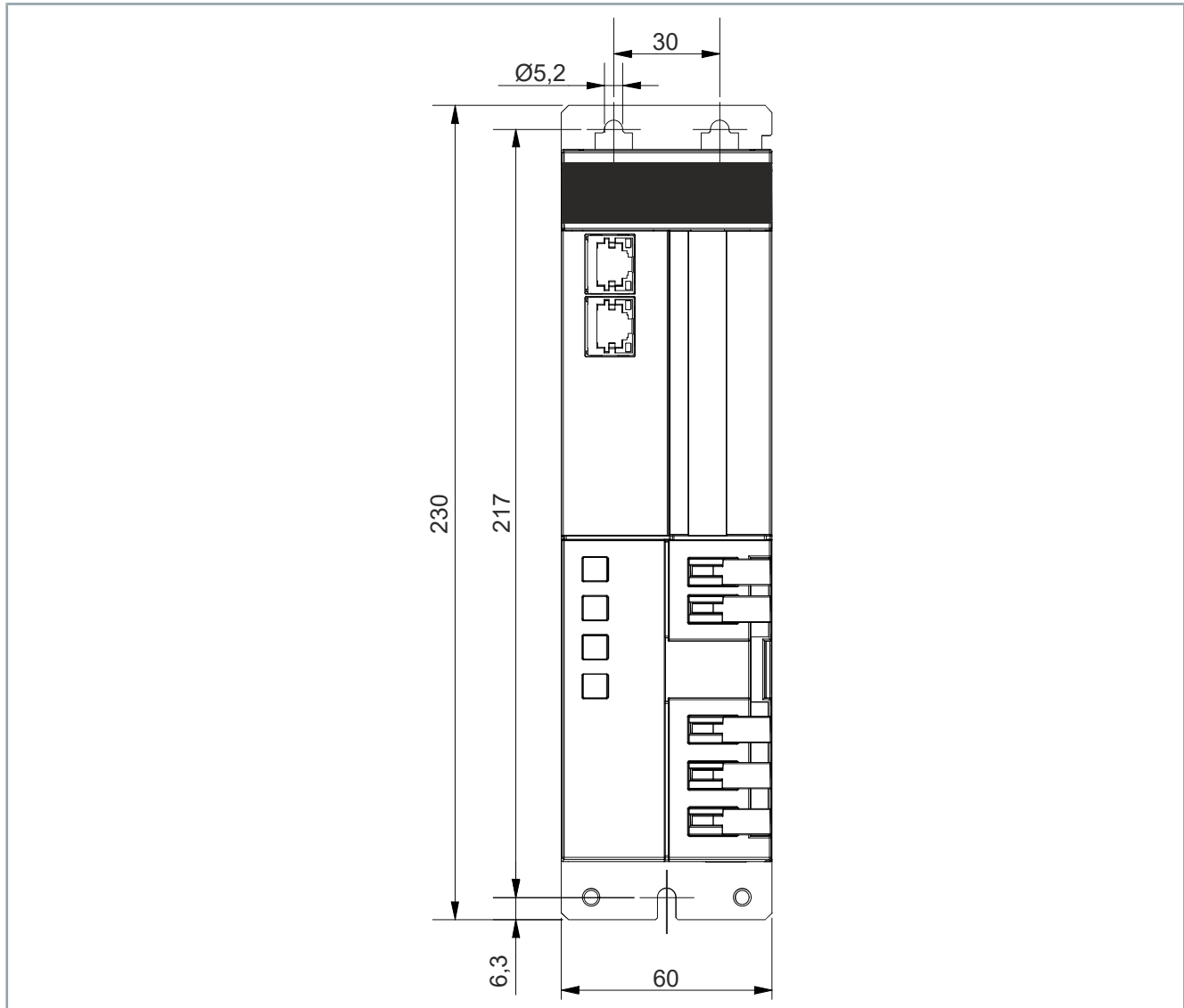
## 4.5 Capacitor module

Electrical data	AX8810-0000
<b>DC link</b>	
– Maximum voltage [V <sub>DC</sub> ]	848
– Capacitance [μF]	1755
Mechanical data	AX8810-0000
– Width [mm]	60
– Height without connectors [mm]	230
– Depth without connectors / accessories [mm]	192
– Weight [kg]	1.9

## 4.6 Dimensional drawings

- Dimensions without connectors and cables
- All figures in millimeters

### 4.6.1 Narrow modules



*Illustration:* Power supply modules AX8600, AX8620



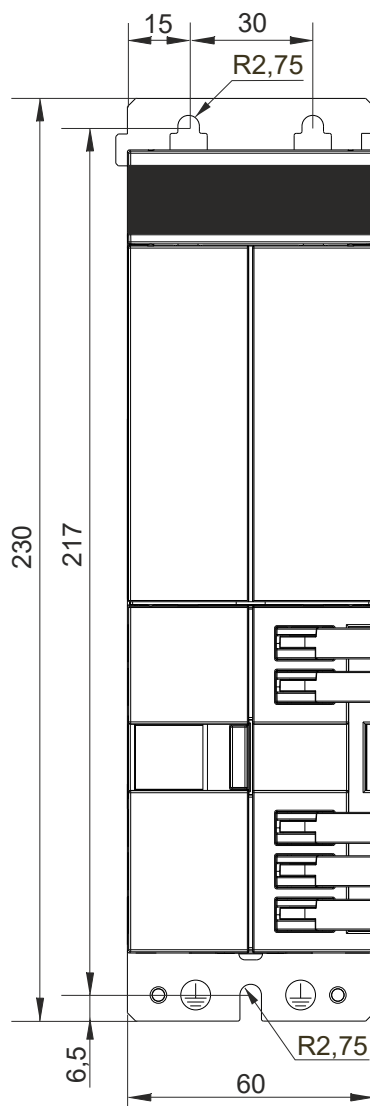


Illustration: Axis modules AX8108, AX8206 and Capacitor modules AX8810

## 4.6.2 Wide modules

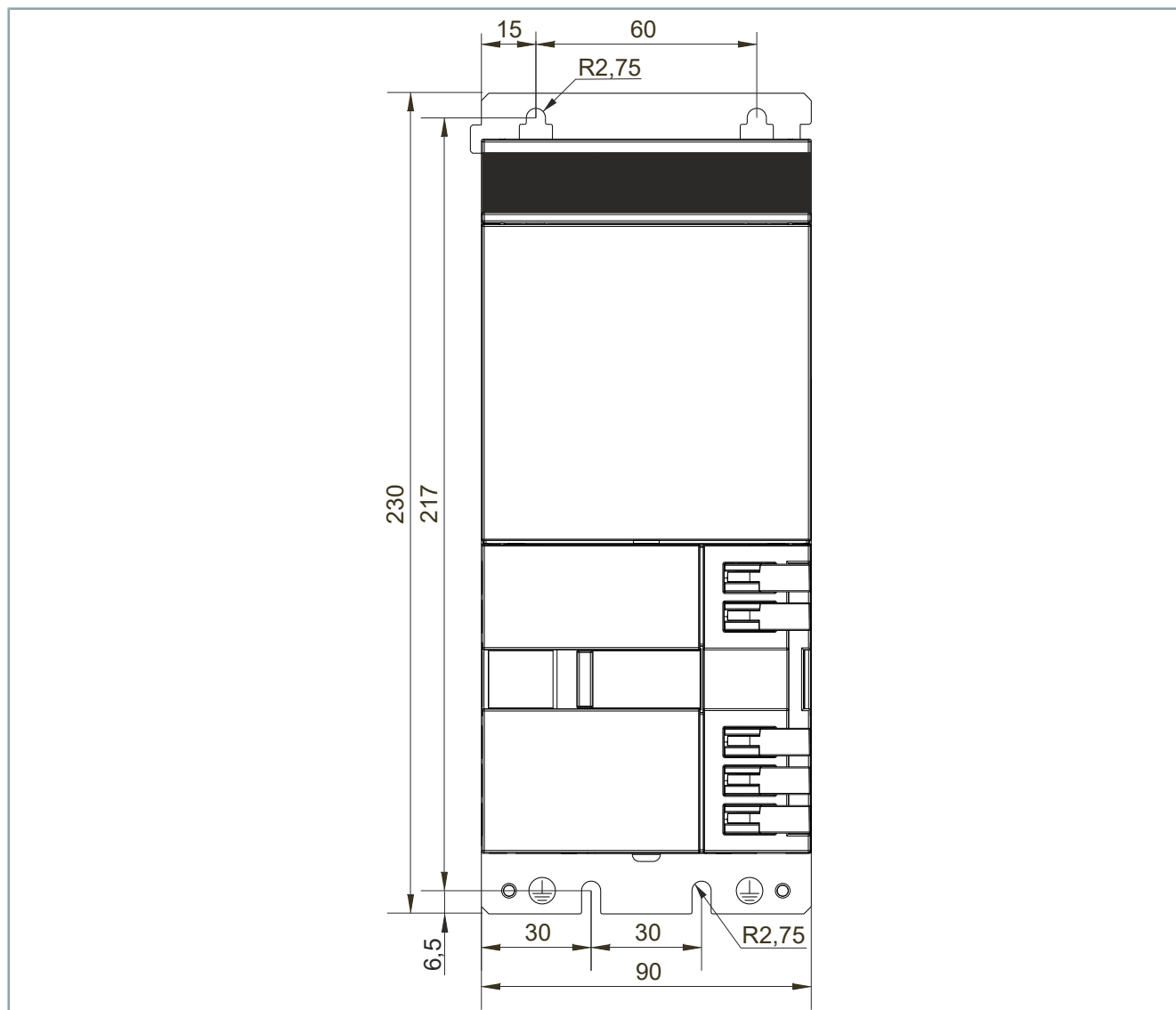


Illustration: Power supply modules AX8640 and Axis modules AX8118

### 4.6.3 Combined modules

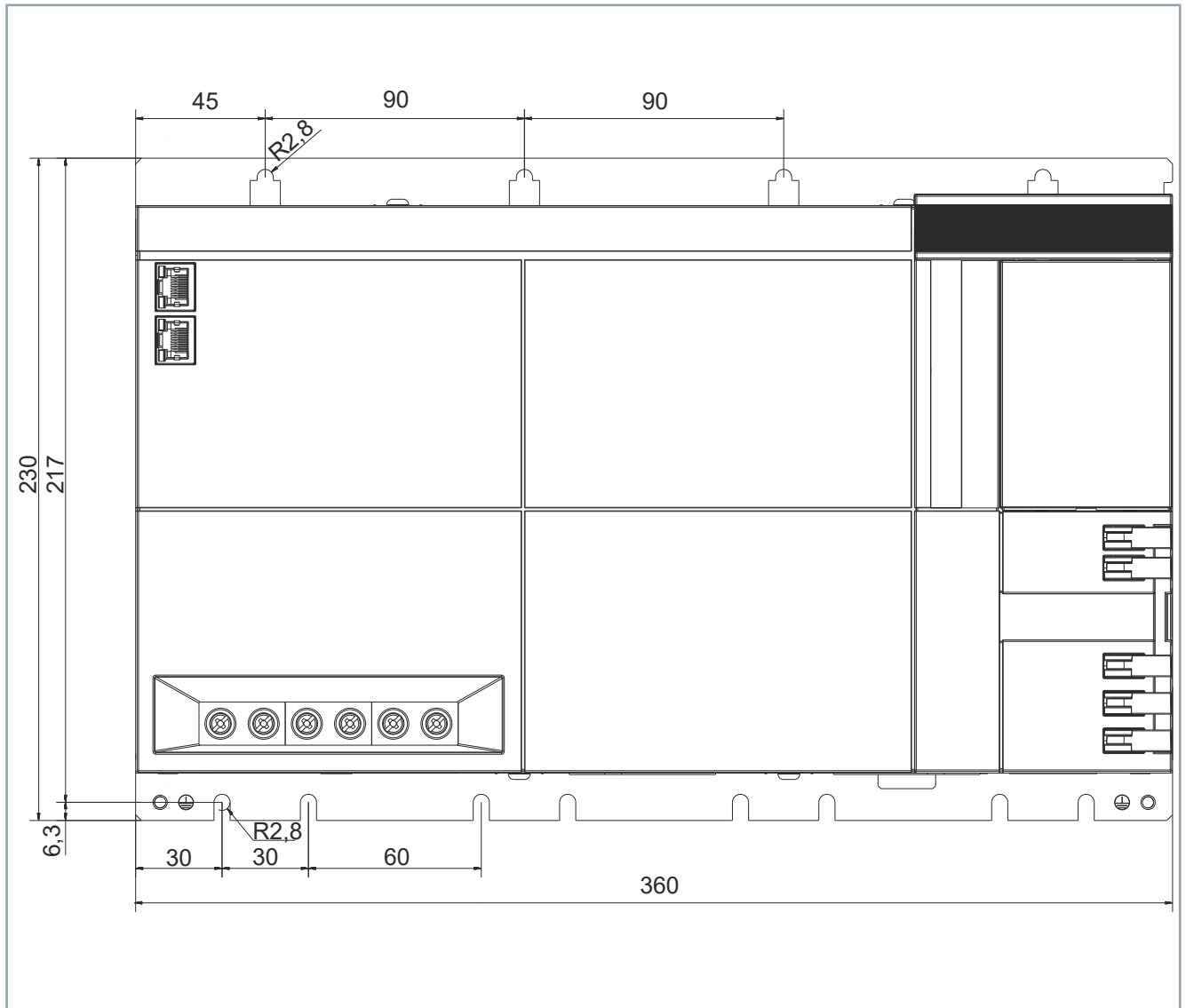


Illustration: Combined power supply modules and axis modules AX8525, AX8540

## 5 Scope of supply



### Check the scope of supply for missing or damaged parts

Check your delivery for completeness. If any parts are missing or became damaged during transport, contact the carrier, vendor or our service department immediately.

The scope of delivery always includes the following documents:

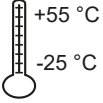



Product	Document
<ul style="list-style-type: none"> <li>• Power supply modules</li> <li>• Combined modules</li> </ul>	<ul style="list-style-type: none"> <li>• Short information</li> </ul>

Depending on the application, the scope of delivery may consist of different components. Please check the delivery:

Product	Connector plug	Slot
Power supply module AX8600	ZS4800-2002	X01
Power supply module AX8620	ZS4800-2001	<ul style="list-style-type: none"> <li>• Mains supply</li> <li>• DC link</li> <li>• 24 V<sub>DC</sub> supply</li> <li>• External braking resistor [+]</li> </ul>
Power supply module AX8640	ZS4800-2041	X01 <ul style="list-style-type: none"> <li>• Mains supply</li> </ul>
	ZS4800-2042	X02 <ul style="list-style-type: none"> <li>• DC link</li> <li>• 24 V<sub>DC</sub> supply</li> <li>• External braking resistor [+]</li> </ul>
Axis modules AX8108 / AX8118	ZS4800-2015	X15 <ul style="list-style-type: none"> <li>• Digital inputs and outputs</li> </ul>
Axis module AX8206	ZS4800-2015	X15 <ul style="list-style-type: none"> <li>• Digital inputs and outputs</li> </ul>
		X25 <ul style="list-style-type: none"> <li>• Digital inputs and outputs</li> </ul>
Combined AX85xx power supply modules and axis modules	ZS4500-2047	X02 <ul style="list-style-type: none"> <li>• External braking resistor [+]</li> </ul>
	ZS4800-2003	X03 <ul style="list-style-type: none"> <li>• 24 V<sub>DC</sub> supply</li> </ul>
	ZS4800-2015	X15 <ul style="list-style-type: none"> <li>• Digital inputs and outputs</li> </ul>
AX8810 capacitor module	---	---

## 5.1 Packaging

Instructions for handling are printed on the packaging:

Symbol	Explanation
	That is the highest and lowest temperature at which you may store.
	This is the correct position for the packaging.
	The packaging must be protected from moisture.
	The contents are fragile.

The table below shows the dimensions of the packages:

Dimension	AX8108	AX8206	AX8600	AX8620	AX8118	AX8640	AX8525	AX8540
Height [mm]		370			395		490	
Width [mm]		275			275		385	
Depth [mm]		130			170		290	

## 6 Transport and storage

### ⚠ WARNING

#### Protect the servo drive against damage

Protect the servo drive against damage during transport and storage and adhere to the conditions.

*Damage may result in hazardous voltages being present on the housing or exposed components and can lead to serious or even fatal injuries.*

### NOTICE

#### Avoid damage to the servo drive and loss of the guarantee

Observe the conditions and the following chapters on transport and storage.

*Disregarding the conditions can lead to damage to the servo drive and invalidation of the guarantee.*

### NOTICE

#### Avoid short-circuit due to moisture

Condensed water can form during transport in cold weather or in case of extreme temperature differences. Make sure that no moisture collects in the servo drive. Equalize room temperatures slowly. Switch the servo drive on only when it is dry.

*If the servo drive is not fully dry, condensed water can lead to a short circuit and damage to the servo drive when switching on.*

## 6.1 Conditions

Care must be taken that the servo drive and individual components are not damaged during transport and storage. Observe the specifications in the following chapters and comply with the following conditions:

- Avoid electrostatic charging
- Avoid contact with highly insulating materials
- Temperature: -25 °C to +55 °C, maximum fluctuation 20 K/hour
- Air humidity: Max. relative humidity 95 %, non-condensing
- Use of suitable means of transport
- Use of the vendor's original packaging

The table shows the maximum stacking height in which you may store and transport the servo drives in their original packaging on a pallet:

AX8000 multi-axis servo system	Stacking height [pieces]
Power supply modules, axis modules, capacitor modules	8
Combined modules	3

## 6.2 Transport

### NOTICE

#### **Avoid high mechanical stresses**

Use suitable means of transport and secure servo drives against high mechanical stress.

*High mechanical stresses damage the servo drive and individual components.*

All modules can be transported without aids.

## 6.3 Long-term storage

### NOTICE

#### **Observe the maximum storage time**

Do not exceed a maximum storage time of five years.

*Exceeding the specified maximum storage time can lead to a change in the properties of the servo drive used and may damage it in operation.*

### NOTICE

#### **Observe forming in case of a storage duration of one year**

The capacitors must be reformed before putting the servo drive into operation. To do this, release all electrical connections and supply up to 240 V<sub>AC</sub> single-phase for 30 minutes to the servo drive on terminal points L1 and L2 or L2 and L3.

*The connection of unformed capacitors to a supply network can damage the servo drive.*

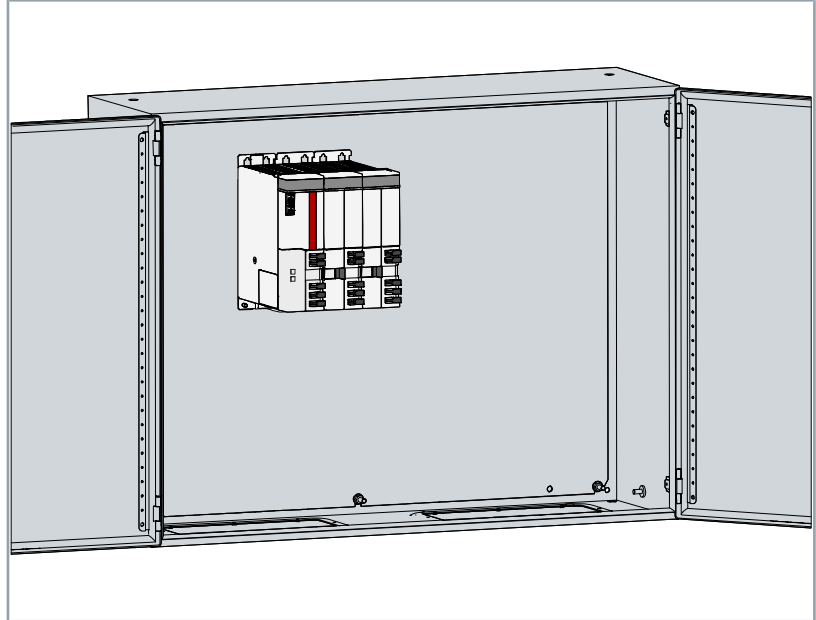
You have the option to store the servo drive over a short or longer period. For storage we always recommend the original packaging. Adhere to the conditions specified in the chapter: "Transport and storage", [Page 54].

Ensure the storage space is vibration-free.

## 7 Technical description

### 7.1 Installation position

The standard installation position of the servo drives in the control cabinet is the vertical installation position.



### 7.2 Residual current circuit breaker

Servo drives with a built-in mains filter may exhibit a small leakage current due to the capacitors in the filter. This fault current may cause malfunctions of standard residual current circuit breakers. Therefore, use so-called AC/DC-sensitive residual current circuit breakers type B, in which DC current is also accounted for. Beckhoff recommends residual current circuit breakers with switch-on delay.

### 7.3 Safe system stop

A power failure can lead to the uncontrolled run-out of the drive axes. Linear axes or lifting axes could then drive without braking against the end stop. Via the uninterruptible power supply in the Industrial PC, you have the possibility to buffer the supply voltage to the control electronics until all axes are safely stopped.



## 7.4 Wide voltage range

Due to the wide voltage range of the power supply modules, the AX8000 multi-axis servo system can be operated worldwide on different voltage systems.

All networks with a grounded center point are permitted; TT / TN.

Data are given below for the wide voltage range of the power supply modules for the different supply networks:

Single-phase supply networks	Three-phase supply networks
1 x 100 <sub>-10%</sub> V <sub>AC</sub> to 1 x 240 <sub>+10%</sub> V <sub>AC</sub>	3 x 200 <sub>-10%</sub> V <sub>AC</sub> to 3 x 480 <sub>+10%</sub> V <sub>AC</sub>



### Supply networks

Further information on all supply networks in the chapter:  
→ Electrical installation, "supply networks", [Page 104]



### Country-specific examples

The following table contains examples of different network systems in various countries:

Country	Single-phase supply networks	Three-phase supply networks
Japan	1 x 100 V <sub>AC</sub>	3 x 200 V <sub>AC</sub>
North America	1 x 115 V <sub>AC</sub>	3 x 480 V <sub>AC</sub>
Europe	1 x 230 V <sub>AC</sub>	3 x 400 V <sub>AC</sub>

## 7.5 Dimensioning

Important information on the DC link capacitance, the total motor cable lengths and the dimensioning of the 24 V<sub>DC</sub> control voltage can be found below. Subsequently, there is a practical example.

### 7.5.1 DC link capacitance



#### Observe the maximum chargeable DC link capacitance

The maximum chargeable DC link capacitance must be considered when designing the machine or plant:

- The capacitances can be taken from the table below.

The power supply modules charge up the entire DC link when the mains supply is first switched on.

#### Maximum chargeable DC link capacitance

- All data in  $\mu\text{F}$

Module	230 V <sub>AC</sub>	400 V <sub>AC</sub>	480 V <sub>AC</sub>
AX8600-0000	25000	8500	6000
AX8620-0000	25000	8500	6000
AX8640-0000	40000	13500	9500
AX8525-0000	70000	23000	13000
AX8540-0000	70000	23000	13000



#### Maximum chargeable DC link capacitance at 400 V<sub>AC</sub>

The system includes:

- 1 x AX8640-0000 with 625  $\mu\text{F}$
- 10 x AX8206-0000 with 1350  $\mu\text{F}$
- 1 x AX8810-0000 with 1755  $\mu\text{F}$

That makes a total capacitance of 3730  $\mu\text{F}$ .

The system is permissible, because a power supply module on the 400 V<sub>AC</sub> supply network can charge up a capacitance of 13500  $\mu\text{F}$ .



#### Charging time DC link capacitance

Charging time of the DC link when switched on the first time:

The charging time is calculated as follows:

- $\tau = R \times C$

After about 5  $\tau$  the charging time is completed.

#### Examples

AX8620 at 400 V<sub>AC</sub> with maximum number of axis modules:

- $\tau = 33 \text{ Ohm} \times 8500 \text{ } \mu\text{F} = 280 \text{ ms}$   
Charging time = 5 x 280 ms = 1.4 s

AX8540 at 400 V<sub>AC</sub> with maximum number of axis modules:

- $\tau = 10 \text{ Ohm} \times 23000 \text{ } \mu\text{F} = 230 \text{ ms}$   
Charging time = 5 x 230 ms = 1.15 s

## 7.5.2 Total motor cable length

In compliance with the EMC category C3, various total motor cable lengths apply to the AX8000 multi-axis servo system.

Without mains choke

Motor cable length	Total motor cable length	Number of axes per drive system
Maximum 25 m* per motor	Maximum 300 m per drive system	Limited by the maximum chargeable DC link capacitance and the 24 V <sub>DC</sub> supply with a maximum of 20 A <sub>DC</sub>  The requirement is determined via the module current and motor braking current.

With mains choke

• Mains choke to be used: AX2090-ND80-xxxx

Motor cable length	Total motor cable length	Number of axes per drive system
Maximum 50 m* per motor	Maximum 500 m per drive system	Limited by the maximum chargeable DC link capacitance and the 24 V <sub>DC</sub> supply with a maximum of 20 A <sub>DC</sub>  The requirement is determined via the module current and motor braking current.

\*) When using motor cable lengths of individual axes greater than 20 m (480 V<sub>AC</sub> power supply), please consult our Drive Technology Support: [support@beckhoff.de](mailto:support@beckhoff.de)

The total motor cable length of an AX8000 system remains unaffected.

EMC compliance

The following requirements apply for compliance with EMC category C2:

Power supply module	Category C2	Max. total motor cable length
AX8620 1-phase	AX2090-NF80-0010	up to 300 m
AX8620 3-phase	AX2090-NF80-0020 + AX2090-ND80-0020	up to 500 m
AX8640	AX2090-NF80-0040 + AX2090-ND80-0040	
AX8525 / AX8540	AX2090-NF80-0080 + AX2090-ND80-0080	

## 7.5.3 Control voltage



### Dimensioning the 24 V<sub>DC</sub> control voltage

The connected consumers must be summed in order to dimension the control voltage power supply unit:

- Power supply module
- Axis modules
- Capacitor module
- Motors with holding brake

### Data for 24 V<sub>DC</sub> power requirement

- "Technical data", [Page 37] or
- In the original operating instructions for the AM8000 & AM8500 Synchronous Servomotors

### 7.5.3.1 Practical example

The configured 480 V<sub>DC</sub> drive system consists of:

Number	Component
4	Servomotors from the AM8031-0D21 series with a cable length of 4 m, 10 m, 15 m and 22 m
4	Servomotors from the AM8051-0G21 series with a cable length of 16 m, 18 m, 21 m and 25 m
4	Dual-axis modules from the AX8206 series
1	Power supply modules from the AX8620 series

### Total standstill current I<sub>0</sub>

The total standstill current I<sub>0</sub> relates to all servomotors listed in the practical example and corresponds to:

- 4 x 1.95 A for the AM8031 + 4 x 4.75 A for the AM8051 = 26.8 A

The total standstill current I<sub>0</sub> is now multiplied by the simultaneity factor. In the case of a machine tool this is relatively high, e.g. 0.9, because all axes can drive into the material at the same time. In the case of a handling system the factor is more likely to be 0.7.

This then corresponds to:

- 26.8 A x 0.7 = 18.76 A

The AX8620 power supply module was selected on the basis of the calculations.

### 24 V<sub>DC</sub> current consumption

The 24 V<sub>DC</sub> current consumption relates to all the components listed in the practical example and corresponds to:

- 0.12 A for the AX8620 + 4 x 0.57 A for the AX8206 + 4 x 0.33 A for the holding brake with the AM8031 + 4 x 0.54 A for the holding brake with the AM8051 = 5.88 A<sub>DC</sub>

## Result

The maximum single cable length for the AM8051-0G21 is 25 m and is thus  $\leq 25$  m

The total cable length of all servomotors is 131 m and is thus  $\leq 300$  m

- No AX2090-ND80-xxxx mains choke required

The 24 V<sub>DC</sub> current consumption of all components is 5.88 A<sub>DC</sub> and is thus  $\leq 20$  A<sub>DC</sub>

- 24 V<sub>DC</sub> power supply unit with a rated current of at least 6 A

The maximum DC link capacitance is always related to the connection to a common AX86x0 power supply module with 945  $\mu$ F and is thus  $\leq 6000$   $\mu$ F

## 7.6 Display

Information about the states of the individual modules is shown on the display of the AX8000 multi-axis servo system. There are different symbols for each module.

### Display black:

The module is switched off.



### 7.6.1 Power supply module

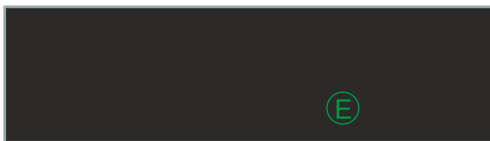
Information about the meaning of the different symbols on the display of the power supply module is given below:

#### 7.6.1.1 EtherCAT

E = EtherCAT

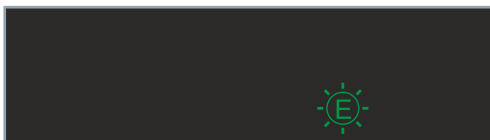
#### EtherCAT symbol lights up green:

The EtherCAT master is active.



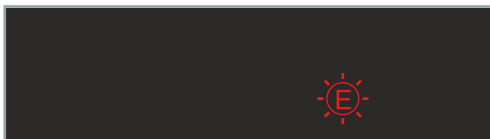
#### EtherCAT symbol flashes green:

The EtherCAT master is active, the configuration is inactive.



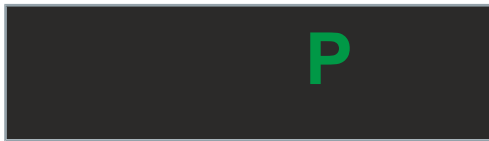
#### EtherCAT symbol flashes red:

EtherCAT error.



## 7.6.1.2 Mains voltage

P = Power supply



### Power symbol lights up green:

The mains voltage is connected, and the DC link is charged.



### Symbol flashes green:

The DC link is being charged / discharged.

Fast blinking: DC link voltage > 48 V

Slow flashing: DC link voltage ≤ 48 V



### Power symbol lights up red:

Error.

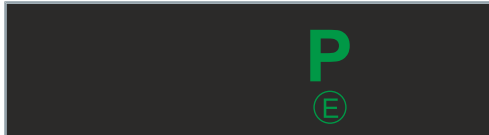


### Power symbol flashes red:

An error has occurred, but the DC link is being charged/discharged:

Fast blinking: DC link voltage > 48 V

Slow flashing: DC link voltage ≤ 48 V



### EtherCAT and power symbol light up green:

The power supply module is ready to operate.

## 7.6.1.3 Debug firmware

D = Debug firmware



### Debug firmware symbol flashes green:

a preliminary test version, debug firmware, is installed. Replace the version as soon as possible by a released firmware.

## 7.6.2 Axis module

In the case of a two-channel axis module, the display is vertically divided. The left column shows the symbols for channel A, the right column shows the symbols for channel B. The EtherCAT symbol is shown in the center.

Information on the meaning of the different symbols on the display of the single-channel axis module is given below:

### 7.6.2.1 EtherCAT

E = EtherCAT

Corresponds to the description for the power supply module:  
See chapter "Power supply module display", [Page 62]

### 7.6.2.2 Axis module

A = axis module

**Axis symbol lights up green:**

The axis is enabled and free from errors.

**Axis symbol flashes green:**

Fast blinking: The axis is disabled and is being initialized.

Slow flashing: The axis is disabled and free from errors.

**Axis symbol lights up red:**

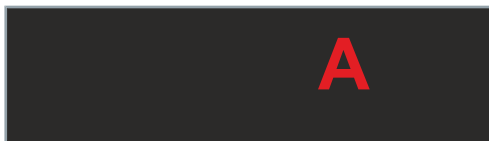
The module is in EtherCAT INIT state.

**Axis symbol flashes red:**

Error.

**Axis symbol flashes green-red:**

The error reaction of the axis is active.

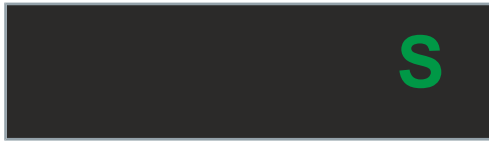




## 7.6.2.3 Safety

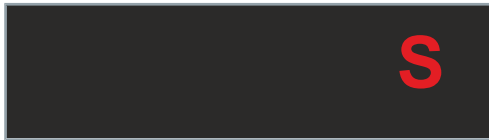
Information on the meaning of the different symbols on the display of the safety axis module is given below:

S = Safety



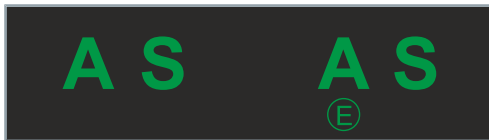
**Safety symbol lights up green:**

No safety error.



**Safety symbol lights up red:**

The axis is in state "STO".



**Symbols of EtherCAT, axis module and safety light up green:**

The safety axis module is in the normal operating state.

These symbols are only visible when the two-channel safety axis module has reached its operating state.

## 7.6.2.4 Debug firmware

D = Debug firmware



**Debug firmware symbol flashes green:**

a preliminary test version, debug firmware, is installed. Replace the version as soon as possible by a released firmware.

## 7.6.3 Combined module

The display of the combined module contains the information from the display of the "power supply module", [Page 62] and the "axis module", [Page 64]:

- EtherCAT
- Mains voltage
- Axis module
- Safety
- Debug firmware

## 7.7 Capacitor module

You can extend the DC link capacitance with the capacitor module. Use in combination with the single-phase supply to the AX8620-0000 is particularly suitable for supporting the DC link. Voltage peaks during motor braking are absorbed and stored. This provides you with the possibility to largely avoid switching in a brake resistor and to achieve a reduction in the power loss.

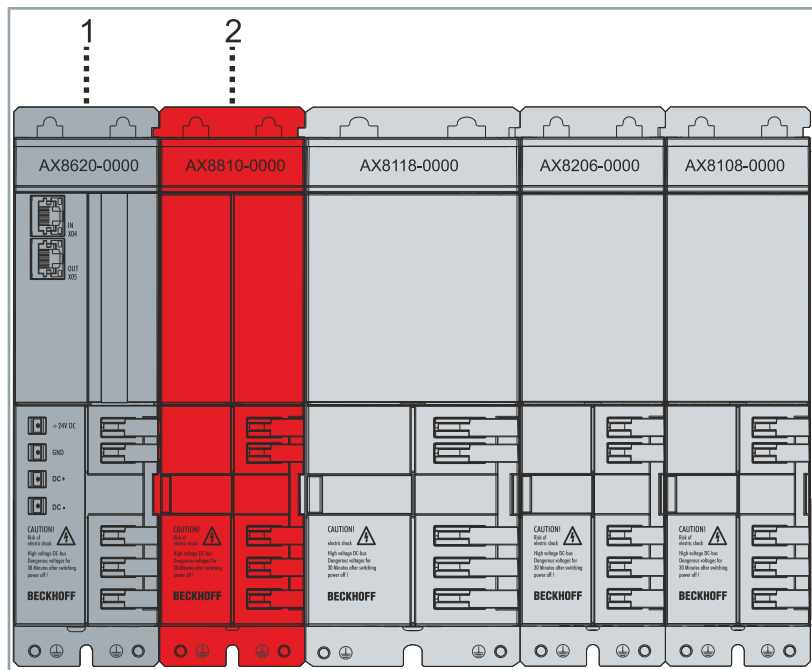
### 7.7.1 Placement in the group



#### Example: system group with capacitor module

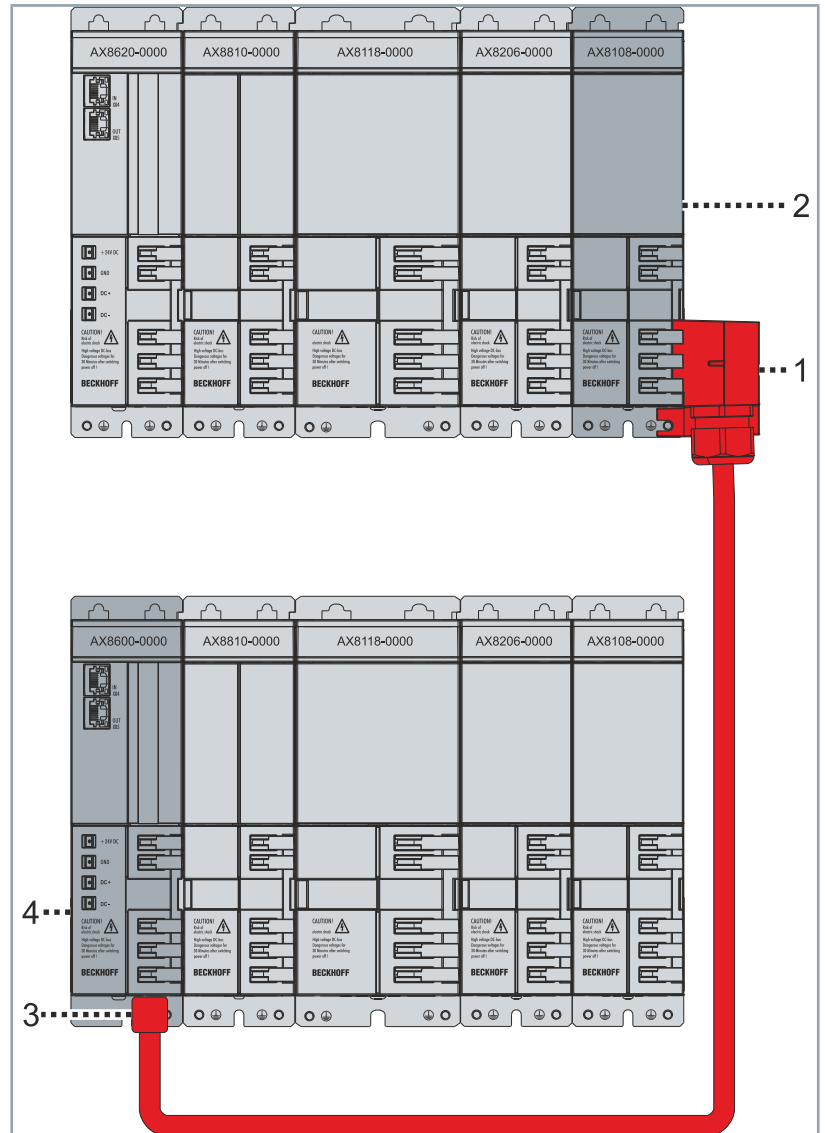
- Power supply module AX8620
- AX8810 capacitor module
- AX8118 axis module; 18 A
- AX8206 axis module; 2 x 6 A
- AX8108; 8 A

Beckhoff recommends that you place the optional capacitor module [2] directly adjacent to the power supply module [1]. Construct the AX8000 multi-axis servo system in decreasing order from the highest to the lowest rated output current.



## 7.8 AX8600 Power supply module DC

If, for example, an AX8000 multi-axis servo system is to be coupled with another system in the DC link in a multi-row configuration, you can implement this case using a ZK4875-900x-zzzzz DC link connection cable and an AX8600 DC power supply module. The plug of the DC link connection cable [1] is connected to the AX-Bridge of the last AX8000 axis module [2] and the plug [3] in the next row is connected to the AX8600 [4].



### **⚠ DANGER**

#### **Warning of high voltage!**

Even after switching off the mains voltage, a life-threatening DC link voltage can be present at the contacts of the AX8000 system for up to 30 minutes. Before removing the connector [1] of the ZK4875-900x DC link connection cable, the following steps must be observed:

- Check the DC voltage
- First disconnect the opposite side of the DC connection cable on the AX8600 DC power supply module

## NOTICE

### Possible loss of IEC and UL approval

The AX8600 DC power supply module and the DC link connection cable may only be used within the AX8000 system. Connecting third-party equipment to the line or feeding DC voltage from an external source is not covered by the IEC and UL approval of the components.

## 7.9 Third-party motors

The AX8000 axis modules also support the connection of third-party motors. This includes, for example, asynchronous motors, synchronous motors, linear motors and torque motors.

- Asynchronous motors can be operated in U/f mode without feedback.
- Synchronous motors can be operated without feedback in the "sensorless vector control" mode.
- For "closed loop vector control", an EnDat 2.2/22, BiSS C, Sin/Cos or TTL (RS422 diff.) can be connected via the multi-feedback interface.



**The insulation system of the motor must comply with the stress category IVIC C (Impulse Voltage Insulation Class C).**

### 7.9.1 Third-party motors and TwinSAFE

Safe Motion functions are also supported for third-party motors.

- STO / SS1 can be used for every third-party motor, because the feedback is not important.
- For all other TwinSAFE Safe Motion functions, either a Hiperface DSL (FS)\*, an EnDat 2.2/22 (FS)\* or an EnDat 3 (FS)\* encoder must be used.

\*) FS = Fail Safe = Safe Motion Encoder



**The machine builder is responsible for the correct selection of components, assembly in accordance with the encoder operating instructions and FMEA (Failure Mode and Effects Analysis).**

## 8 Mechanical installation

### 8.1 Preparation

#### WARNING

**Establish voltage-free and de-energized condition**

Remove all fuses in the supply network and turn off the main switch on the control cabinet. Secure the control cabinet against being switched on again.

*Although a motor is no longer rotating, voltage on the control and power connections or a residual voltage in the capacitors of the servo drive can lead to serious injuries.*

#### NOTICE

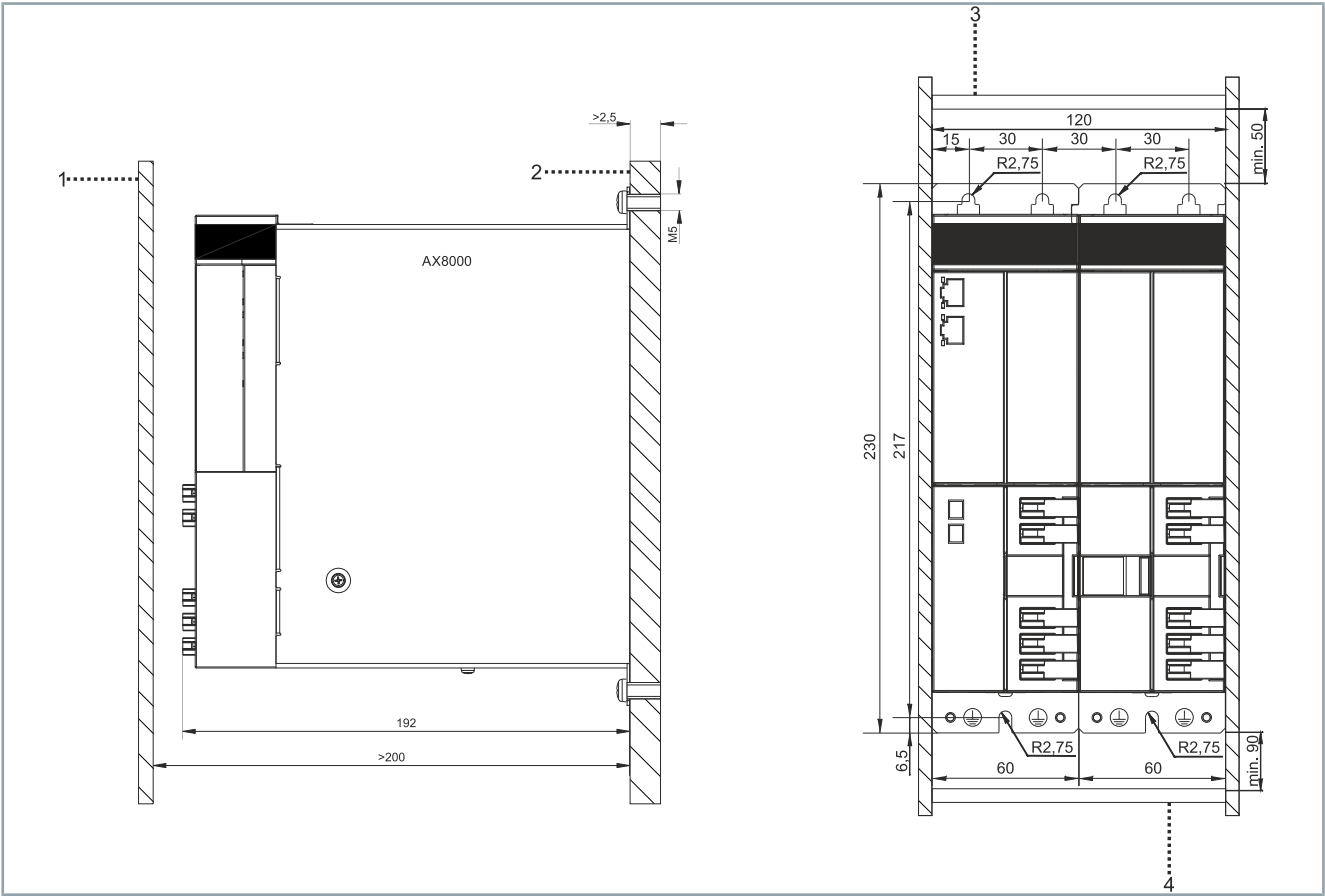
**Mount servo drives vertically and with sufficient ventilation**

Observe the permissible data for operation and environment as well as the notes in this chapter.

*Inadequate ventilation and incorrect installation can lead to damage to the servo drive and its components due to heat development.*

Note that when dimensioning the control cabinet you may have to mount input filters, mains chokes and braking resistors for your application. Allow sufficient space in the control cabinet for these components so that cooling air circulation is ensured.

The following illustration contains recommended dimensions that you should observe when mounting the servo drive in the control cabinet:



Number	Explanation
1	Control cabinet door
2	Conductive and galvanized mounting plate
3	Control cabinet roof, cable channel or anything that disturbs the convection
4	Control cabinet floor, cable channel or anything that disturbs the convection

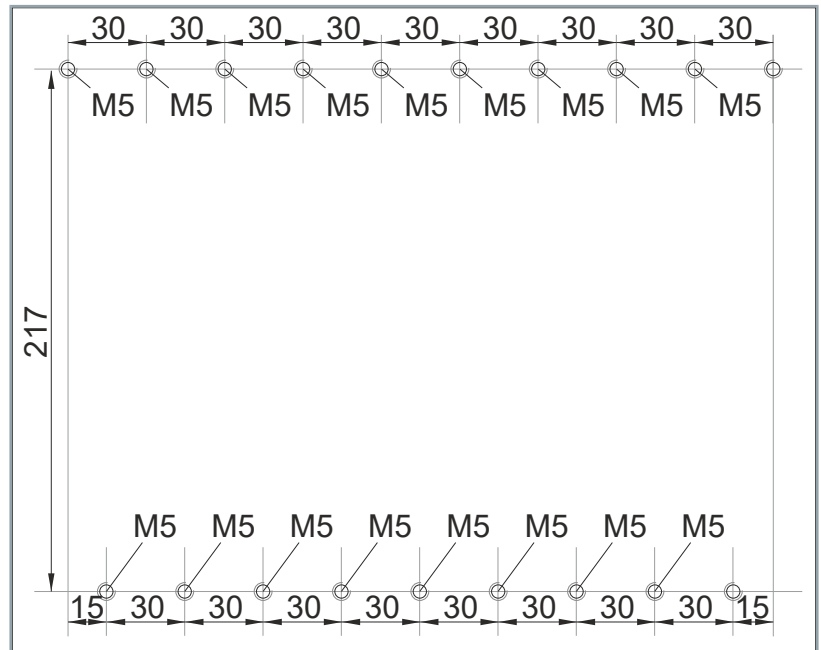
## 8.1.1 Drilling pattern



### Beckhoff universal drilling pattern

You have the possibility – at any time and without having to drill new holes – to change the configuration of the servo drive modules if you provide the mounting plate with the universal drilling pattern.

Information is given in the illustration below on how to make tapped holes in the mounting plate in accordance with the drilling pattern.



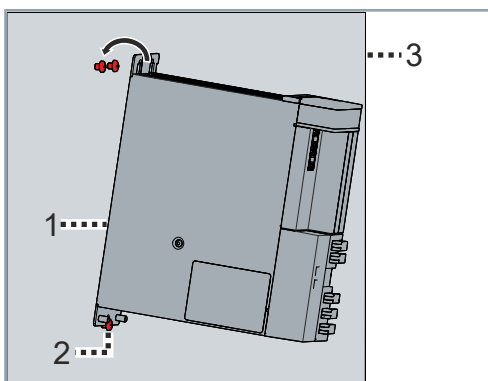
## 8.2 Modules



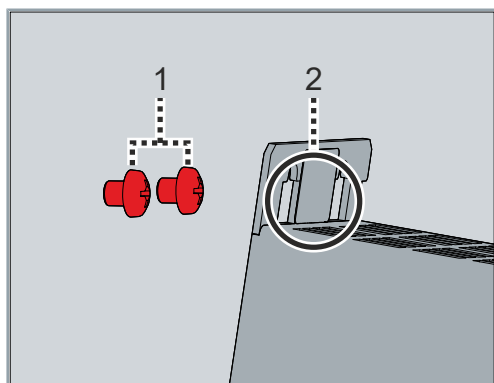
### Mounting example

This chapter provides information on the mounting of power supply modules and other modules. A power supply module and other axis modules are bayed as an example.

### 8.2.1 Power supply modules



- Screw screws into the control cabinet mounting plate in accordance with the drilling pattern
- Place the power supply module [1] onto the screw [2] and carefully press against the mounting plate [3]

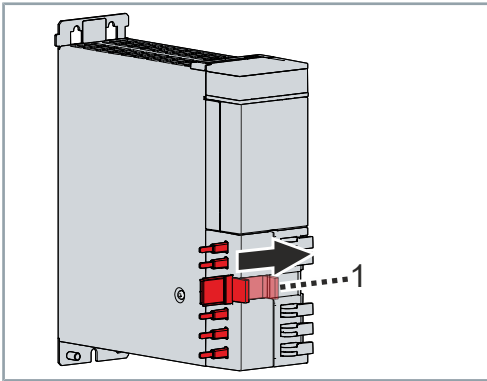


- ▶ Guide the screws [1] through the rectangular cut-outs in the module housing [2]
- ▶ Screw all the screws tight in the elongated holes in the module housing
- ▶ Observe tightening torques:

Components	Tightening torque [Nm]
Screws M5 x 5 Strength class 8.8	6



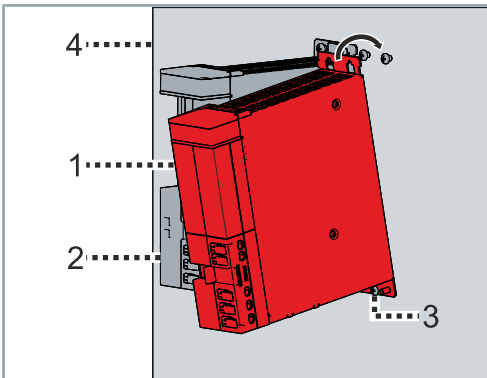
## 8.2.2 Axis modules and capacitor modules



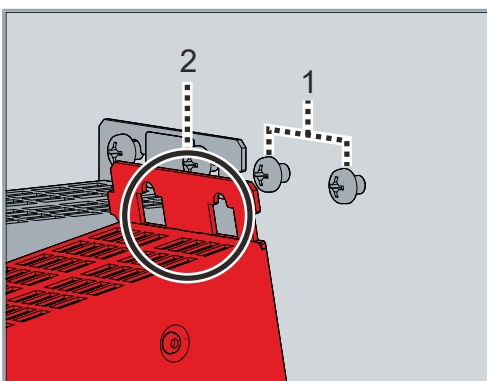
- On all relevant modules, slide the bar for the AX bridge [1] to the right

The contacts can then no longer be seen.

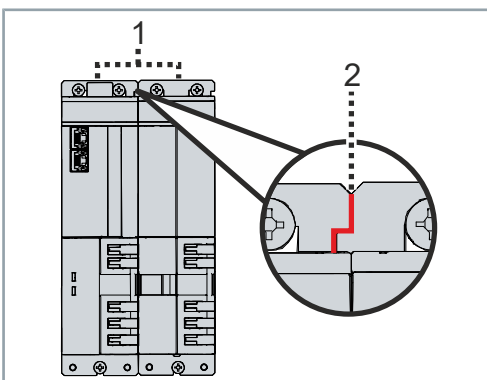
- Screw screws once again into the control cabinet mounting plate in accordance with the drilling pattern



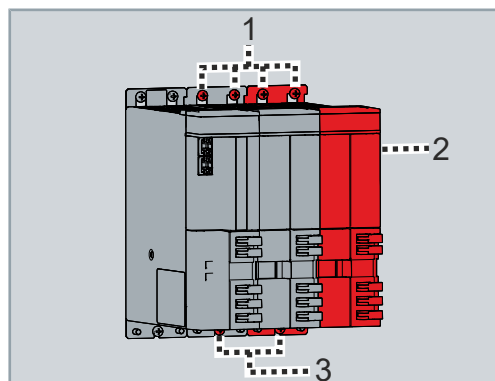
- Place the axis module [1] at the right side of the power supply module [2] onto the screw [3] and carefully press against the mounting plate [4]



- Once again, guide the screws [1] through the rectangular cut-outs in the module housing [2]

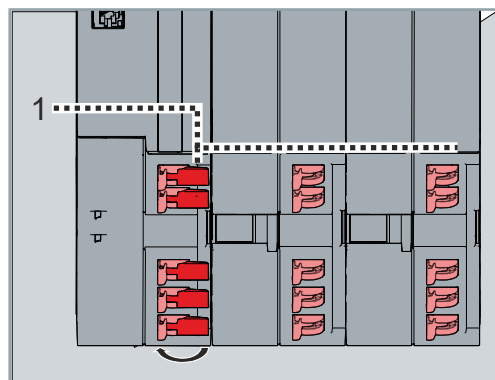


- Make sure that the plates of the rear panel of Module [1] are not overlapping and that the modules are sitting flush in cut-out [2].

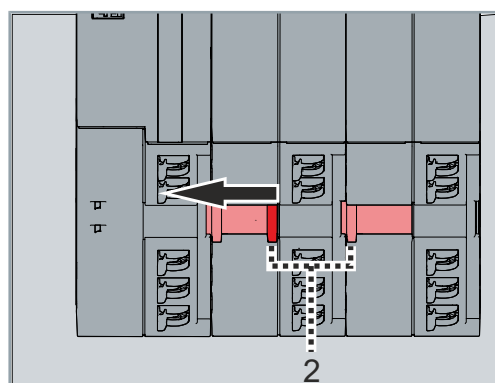


- Bay further modules [2] and screw all remaining screws [1] and [3] tight on the module housings
- Observe tightening torques:

Components	Tightening torque [Nm]
Screws M5 x 5 Strength class 8.8	6



- On all modules that you wish to connect, open the quick connectors [1] and place them in the 90° position



- Slide all bars [2] for the AX bridge to the left
- Close all quick connectors again

The modules are now connected to one another.

## 9 Electrical installation

### ⚠ WARNING

#### **Avoid contact with DC link DC+ and DC-**

Measure the voltage on the DC link test contacts DC+ und DC-. After disconnection from the supply network, observe a waiting time of 30 minutes.

*There is still a life-threatening voltage of  $> 848 V_{DC}$  on the capacitors after disconnection from the supply network. Serious or even fatal injuries may result if this is ignored.*

### NOTICE

#### **Electromagnetic compatibility**

Connect all components and use only shielded cables. Ground the shields of the assembled cables via the mounting plate and place the star point centrally on the unpainted mounting plate.

In the case of larger applications, implement the potential equalization via PE rails.

*Improper grounding or faulty contacting can lead to damage to the multi-axis servo system or to EMC interference emissions.*

*The minimum cross-sections of separate protective conductors can be found in EN 61439-1.*

### 9.1 Project planning

The project planning is the detailed planning of your drivetrain. Taking into account various views, you can design your drive system with the help of the following information. Please note that this support is only an example.

## 9.1.1 Energy management

If the supply network is impaired due to high voltage fluctuations, you must consider the specifications of the servo drive and the speed range of the servomotor. Observe the upper limit value of the wide voltage input on the AX8000.

Check whether the lowering of the speed due to lacking voltage is permissible.

If the supply network does not correspond to the specification for the operation of the servo drive, then isolating transformers, mains chokes, mains filters or other measures must be added.

This system operates in a drive system with a common DC link and a commonly used internal or external brake resistor. In the case of already existing drive systems, you can determine the utilization rate of the brake resistor with the aid of the diagnostic system and transfer the values. The Beckhoff software "[TE5910 | TwinCAT 3 Motion Designer](#)" is available for energy management purposes.

## 9.1.2 Control cabinet structure



### **Observe the voltage tolerances for safe operation**

When connecting servomotors with a holding brake, observe the prescribed voltage tolerances.

### **Observe the order of connection**

The nominal current of the device should reduce from the power supply module. Beckhoff recommends the following order of connection of the modules:

- AX8640 – AX8118 – AX8206 – AX8108

You must dimension the control cabinet in such a way that you can install all components with the prescribed spacing.

Forced cooling must be used in case of high temperatures. Place the control cabinet as close as possible to the machine. Dimension the motor cables as short as possible. Apart from that, the control cabinet must have a metallic, grounded rear panel, to which the AX8000 and the peripherals are attached. This makes secure grounding possible.

## 9.1.3 Drivetrain

The application, servo drives, motors and gear units must be matched to one another so that sufficient safety is ensured for all components. Mechanical stiffness can occur after a while due to wear.

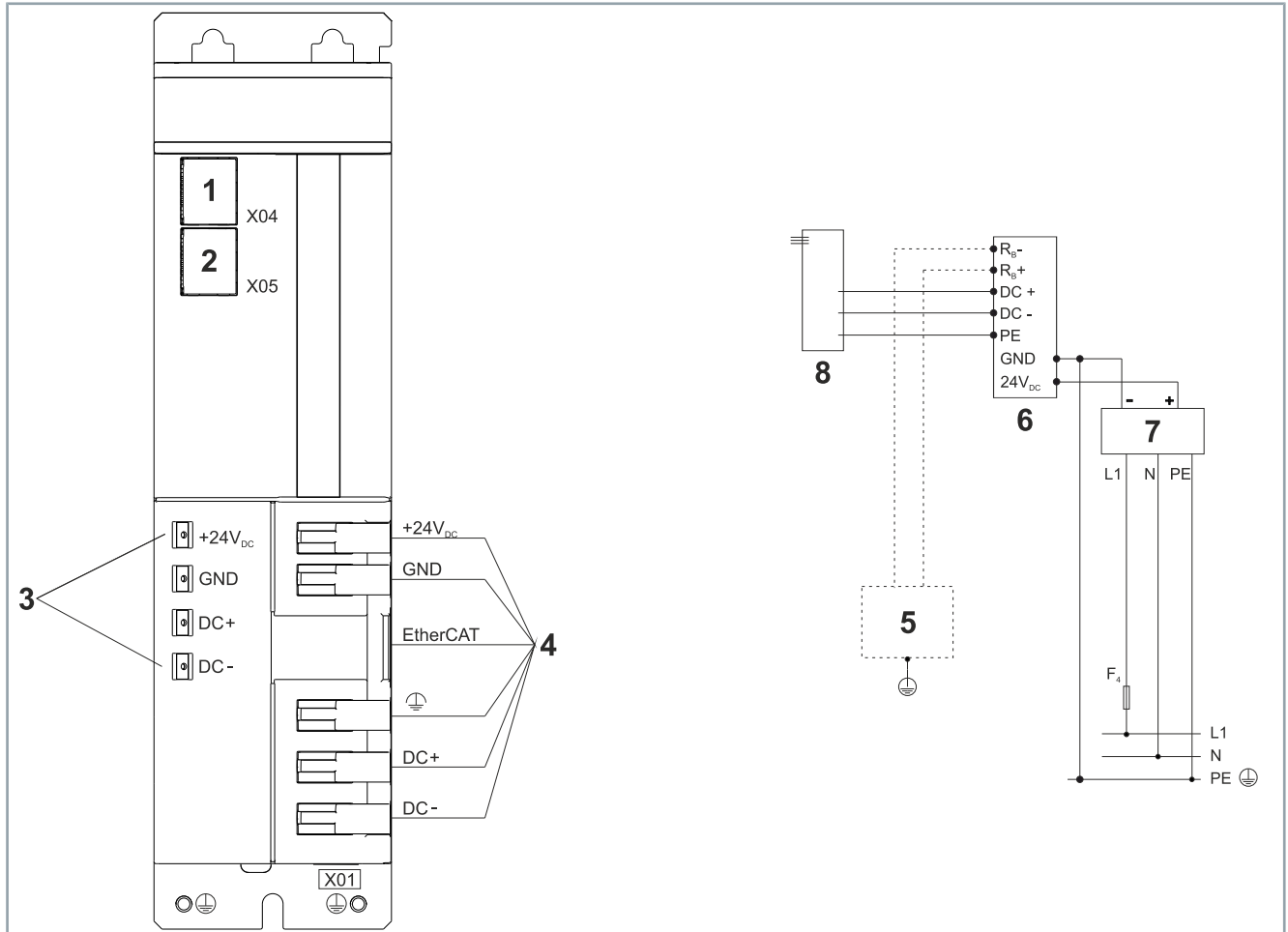
Make sure that the components in the working area of the system have adequate reserves so that the working life is not impaired and the necessary control quality can be maintained.

The Beckhoff software "[TE5910 | TwinCAT 3 Motion Designer](#)" is available for configuration of the drivetrain and selection of suitable components.

## 9.2 Block diagrams

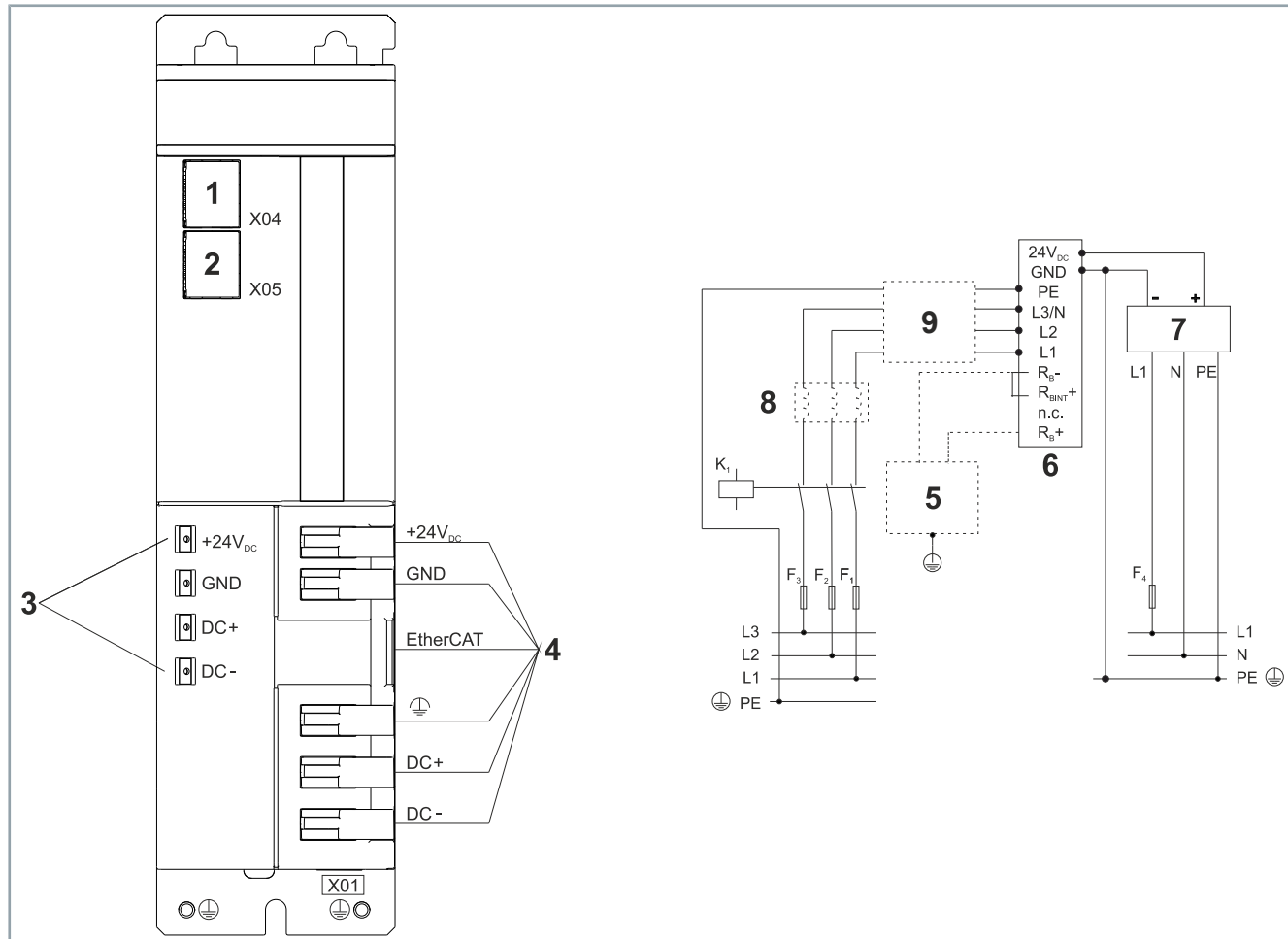
Sample connection scenarios are presented below using schematic connection diagrams for the power supply modules and axis modules.

### 9.2.1 AX8600 DC Power supply module



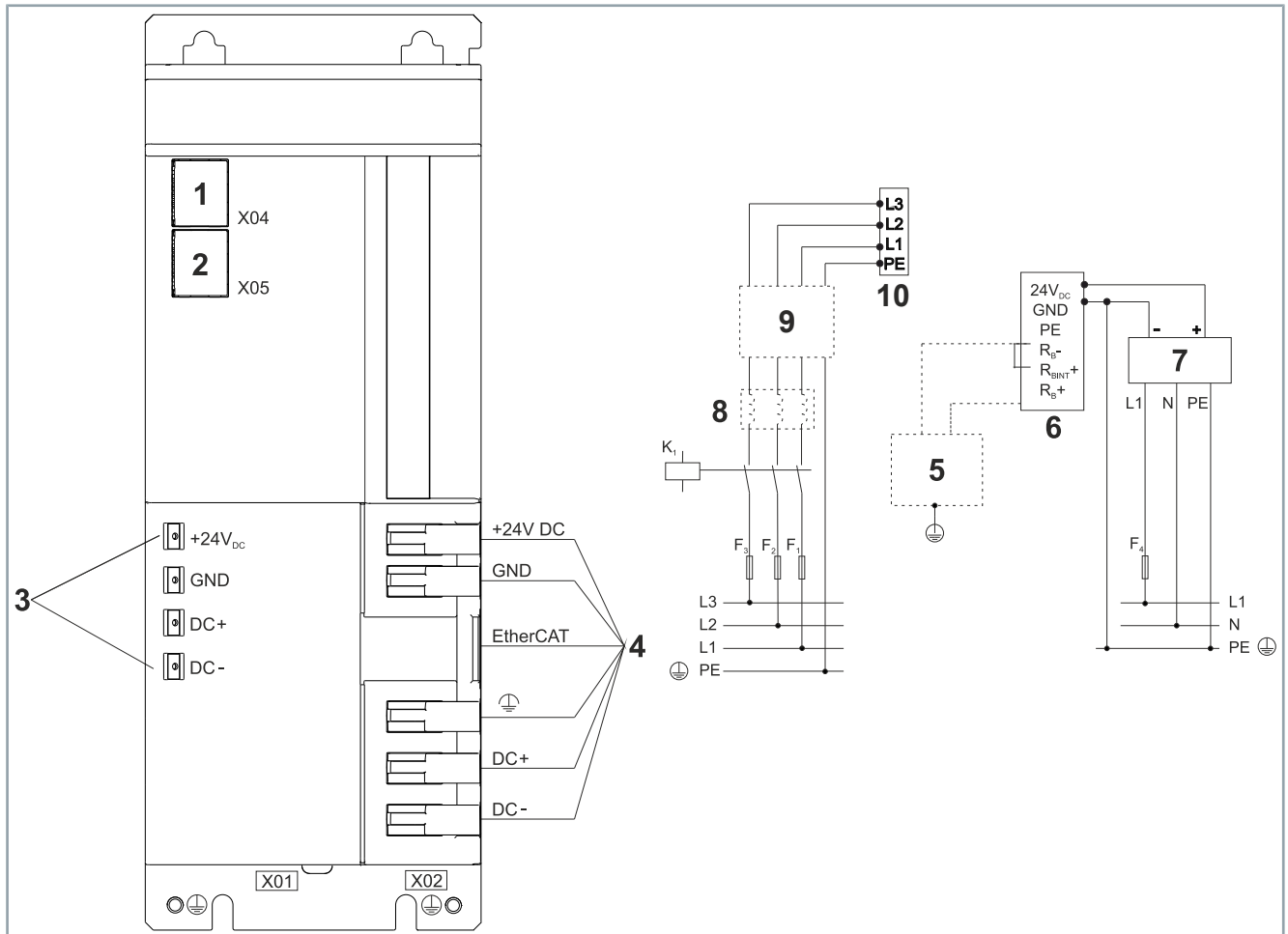
Item number	Explanation
1	Connection socket for incoming EtherCAT cable
2	Connection socket for outgoing EtherCAT cable
3	Measuring and test contacts on the devices
4	Quick coupling of the AX8000 multi-axis servo system; AX bridge
5	Optional braking resistor
6	Schematic contacts on the 7-pin supply plug "X01"
7	Power supply unit with 24 V <sub>DC</sub> supply voltage
8	ZK4875-900x-zzzz; DC link connection

## 9.2.2 AX8620 Power supply module 20 A



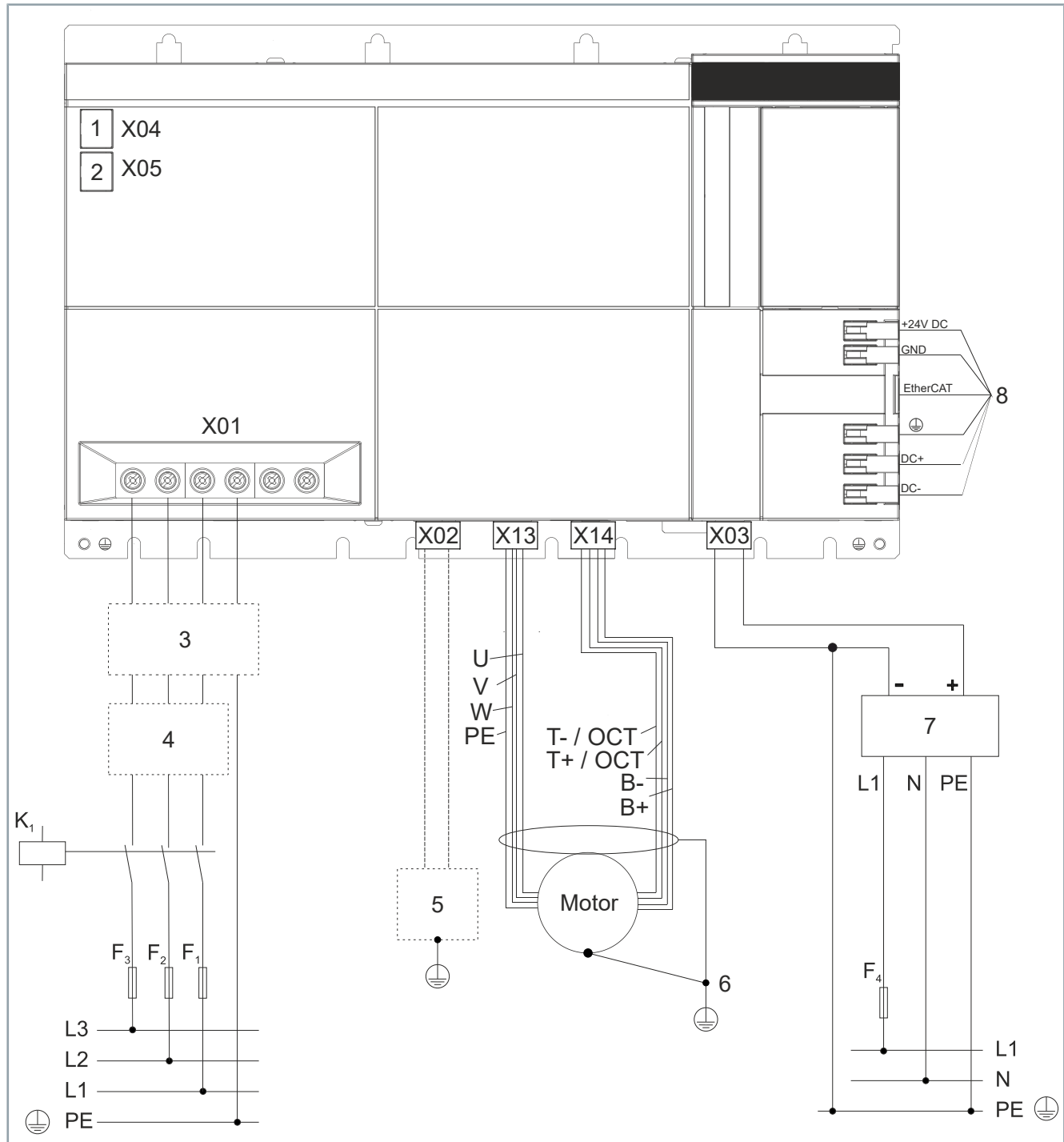
Number	Explanation
1	Connection socket for incoming EtherCAT cable
2	Connection socket for outgoing EtherCAT cable
3	Measuring and test contacts on the devices
4	Quick coupling of the AX8000 multi-axis servo system; AX bridge
5	Optional braking resistor When using an optional braking resistor on the AX8000 multi-axis 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 <sub>DC</sub> supply voltage
8	Optional mains choke
9	Optional mains filter

## 9.2.3 AX8640 Power supply module 40 A



Item number	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 braking resistor When using an optional braking resistor with the AX8000 multi-axis servo system, the bridge of the 6-pin supply plug "X02" between $R_{B-}$ and $R_{BINT+}$ must be removed
6	Schematic contacts on the 6-pin supply plug "X02"
7	Power supply unit with 24 V <sub>DC</sub> supply voltage
8	Optional mains choke
9	Optional mains filter
10	Schematic contacts on the 4-pin supply plug "X01"

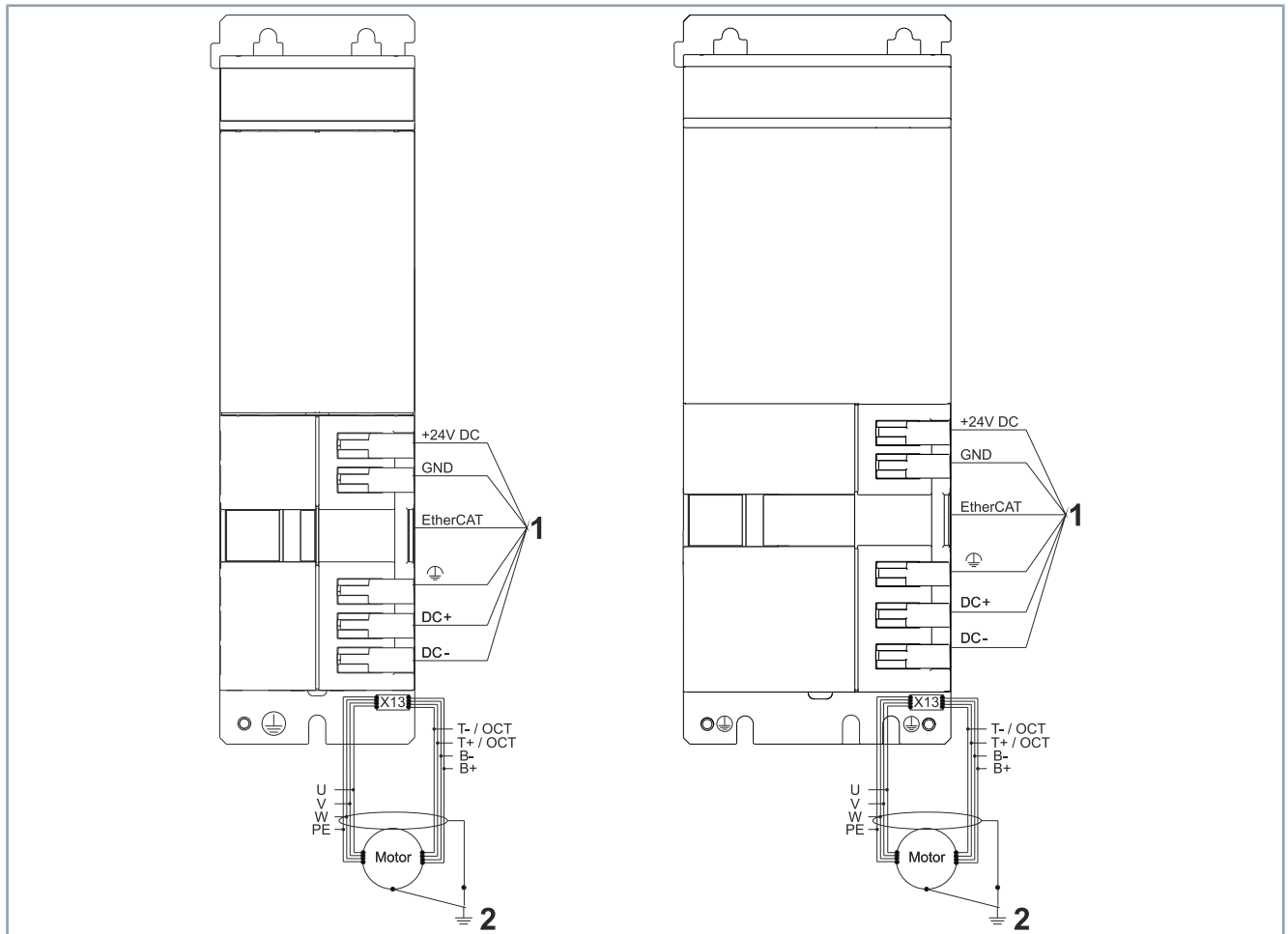
## 9.2.4 AX85xx combined power supply modules and axis modules 25 A / 40 A



Number	Explanation
1	Connection socket for incoming EtherCAT cable
2	Connection socket for outgoing EtherCAT cable
3	Optional mains filter
4	Optional mains choke
5	Optional braking resistor When using an optional braking resistor on the AX8000 multi-axis servo system, the bridge of the 10-pin supply plug "X01" between $R_B$ and $R_{Bint}$ must be removed
6	ZK4800-85xx motor cable; including OCT
7	Power supply unit with 24 V <sub>DC</sub> supply voltage
8	Quick coupling of the AX8000 multi-axis servo system; AX bridge

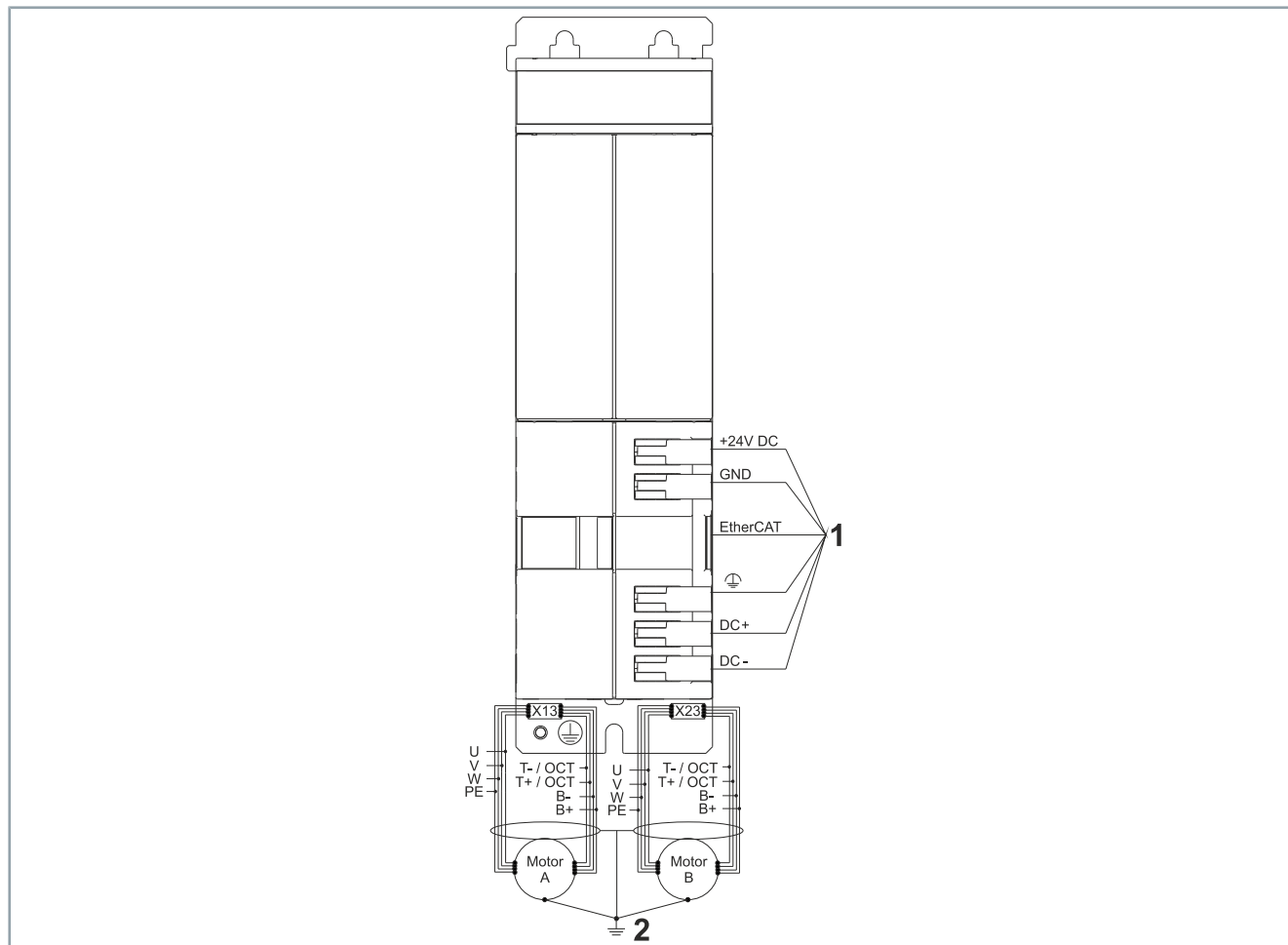


## 9.2.5 AX81x8 Single-axis module 8 A / 18 A



Number	Explanation
1	Quick coupling of the AX8000 multi-axis servo system; AX bridge
2	ZK4800-80xx-xxxx motor cable; including OCT

## 9.2.6 AX8206 Dual-axis module 6 A



Number	Explanation
1	Quick coupling of the AX8000 multi-axis servo system; AX bridge
2	ZK4800-80xx-xxxx motor cable; including OCT

## 9.3 Grounding

The ground connection of all relevant components must be made with the largest possible cross-section, with a low impedance, over a wide area and via a short connection to a conductive fastener with a wide area. The shields have to be applied with a sufficiently large contact area on both sides.

The shield of the AX8000 multi-axis servo system is connected via the grounding hangers and hexagonal nuts, similar to DIN 6923 with flange and serrations class 8 with the galvanized surface. These components are included in the scope of supply of all AX8206, AX8118 and AX8108 axis modules as well as AX8810 option modules.

### Use of components of a higher EMC category

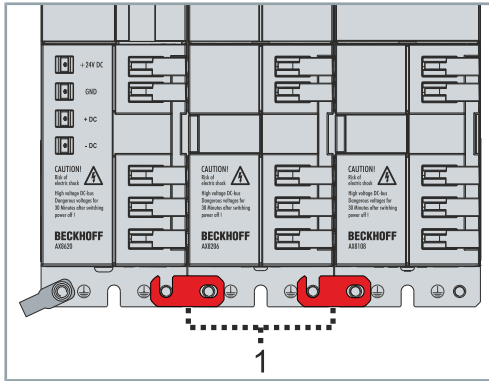
The AX8000 multi-axis servo system conforms to EMC category C3 for industrial areas with respect to conducted interference emissions. If you wish to use components that conform to a higher category, you can limit the conducted interference emissions using additional filters to the extent that the EMC category C2 for residential and industrial areas is complied with.



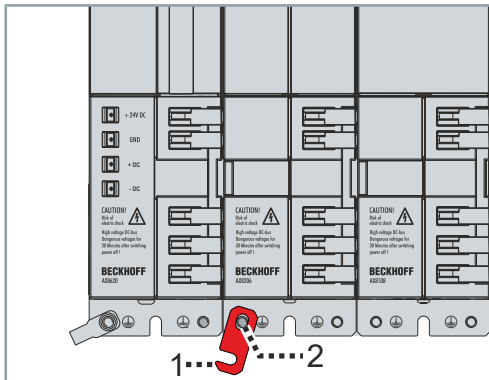
### Example drive system

In this chapter, the device connection is shown by the example of a multi-axis drive system consisting of an AX8620 power supply module and two AX8206 and AX8108 axis modules.

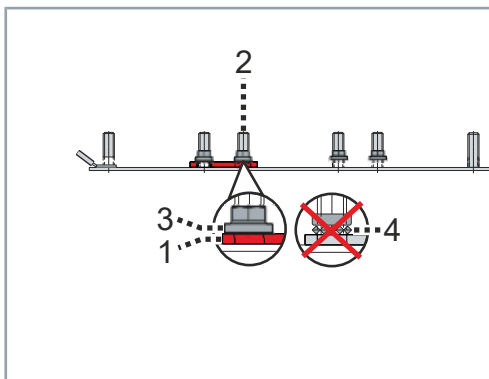
## 9.3.1 Module connection



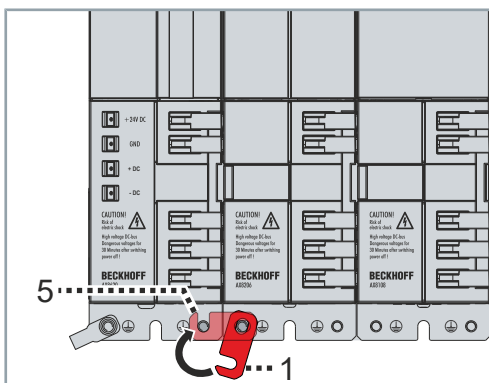
The connection of the individual modules in a drive system takes place via the grounding hangers [1]. These are each mechanically locked to the right-hand earthing bolt of the module and swiveled onto the left-hand earthing bolt of the adjacent module, where they are mechanically locked by the nuts and serrations.



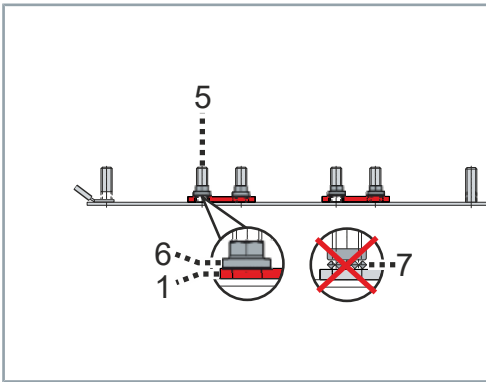
- Push the grounding hanger [1] onto the earthing bolt [2] of the right-hand module
- Make sure that the opening in the grounding hanger [1] is facing upwards



- Screw the nut [3] onto the earthing bolt [2] on top of the grounding hanger [1]
- Do not use a spring washer [4]

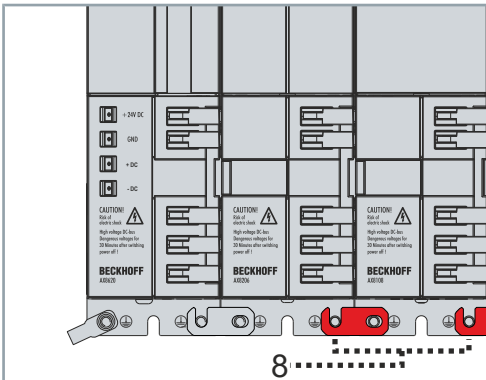


- Swivel the grounding hanger [1] onto the earthing bolt [5] of the left-hand module



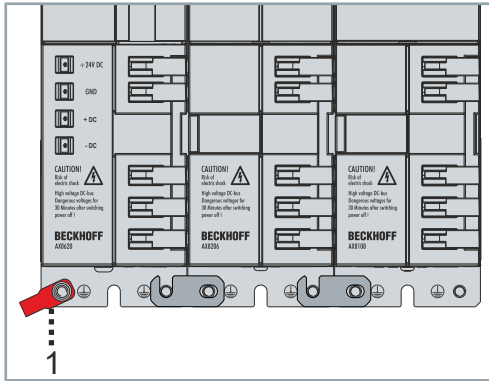
- Screw the nut [6] onto the earthing bolt [5] on top of the ground-hanger [1]
- Do not use a spring washer [7]
- Tighten both nuts firmly
- Observe tightening torques:

Components	Tightening torque [Nm]
Serrated hexagonal nut M5, strength class A2-50	2.7



- Mount [8] further grounding hangers

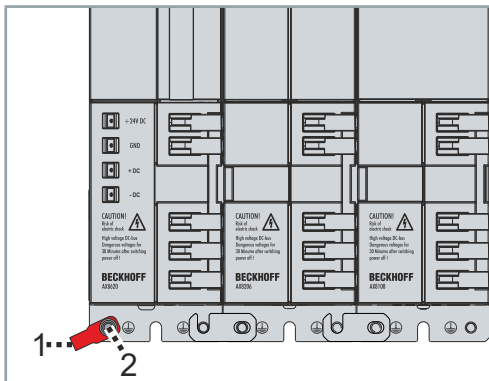
## 9.3.2 Protective earth



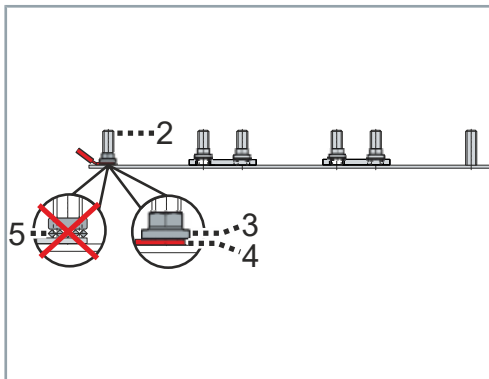
The protective earth is established via the left-hand earthing bolt on the power supply module and the mounting plate on the control cabinet. The connection is made via a cable with a ring-shaped cable lug [1]. Use a cable with a cross-section of at least 10 mm<sup>2</sup> for a protective conductor.

Optionally, an additional protective earth can be attached via the right-hand earthing bolt of the last module.

- Make up a cable with a ring-shaped cable lug and a cross-section of at least 10 mm<sup>2</sup>



- Plug the cable with the cable lug [1] onto the left-hand earthing bolt [2] of the first module in the drive system



- Place nut [3] on the earthing bolt [2] on top of the cable lug [4] and screw it tight
- Do not use a spring washer [5]
- Observe tightening torques:

Components	Tightening torque [Nm]
Serrated hexagonal nut M5, strength class A2-50	2.7

- Attach the assembled cable properly to the control cabinet mounting plate. Clean the contact surfaces prior to the assembly and ensure that the mounting plate is not painted.

## 9.4 Connector power supply 24 V

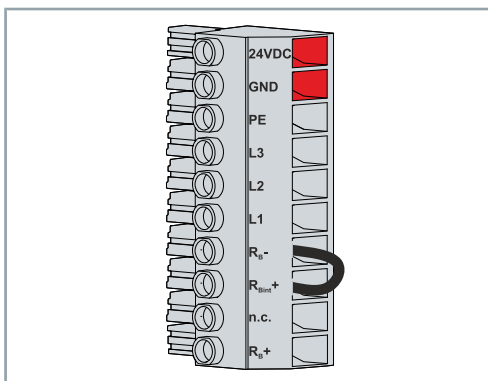
Supply connections are available on the AX86xx power supply modules and the AX85xx combined modules for the 24 V<sub>DC</sub> power supply.

Connect the components of the AX8000 multi-axis servo system according to standard EN 60204-1:2006 Protective Extra Low Voltage; PELV:

- The PE and 0 V conductors of the voltage source must be on the same potential and connected in the control cabinet.
- Standard EN 60204-1:2006, section 6.4.1:b stipulates that one side of the circuit, or a point of the energy source for this circuit must be connected to the protective conductor system.

### 9.4.1 ZS4800-2001 / Connector power supply modules AX8620

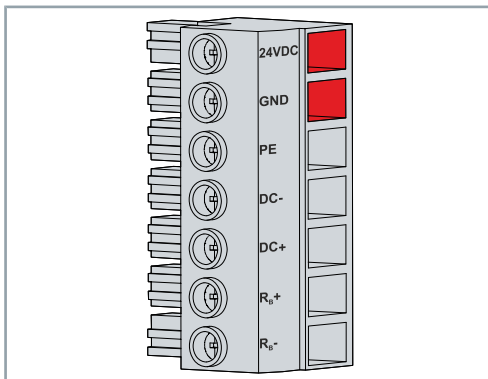
- X01 slot on AX8620 power supply modules



Terminal point	Connection
24 V <sub>DC</sub>	24 V <sub>DC</sub> +6/-10 % system voltage and peripheral voltage
GND	GND
<b>Wire cross-section</b>	
Maximum 6 mm <sup>2</sup> AWG 8	
<b>Mounting</b>	
Screws with tightening torque 0.5 Nm – 0.6 Nm / 4.4 lbf in – 5.3 lbf in	

### 9.4.2 ZS4800-2002 / Connector power supply modules AX8600

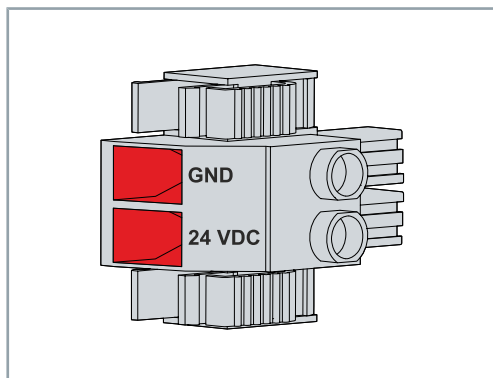
- X01 connection on AX8600 power supply modules



Terminal point	Connection
24 V <sub>DC</sub>	24 V <sub>DC</sub> +6/-10 % system voltage and peripheral voltage
GND	GND
<b>Wire cross-section</b>	
Maximum 16 mm <sup>2</sup> AWG 6	
<b>Mounting</b>	
Screws with tightening torque 1.2 Nm – 1.5 Nm / 10.6 lbf in – 13.3 lbf in	

## 9.4.3 ZS4800-2003 / Connector combined modules AX85xx

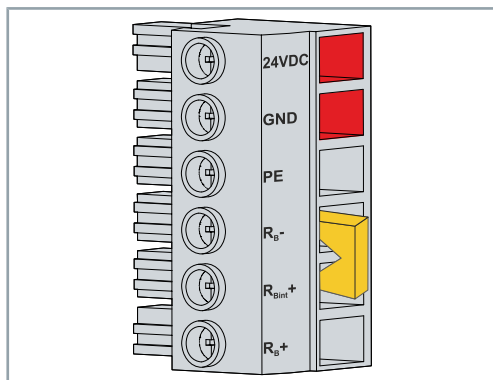
- X03 connection on AX85xx combined modules



Terminal point	Connection
GND	GND
24 V <sub>DC</sub>	24 V <sub>DC</sub> +6/-10 % system voltage and peripheral voltage
<b>Wire cross-section</b>	
Maximum 6 mm <sup>2</sup> AWG 8	
<b>Mounting</b>	
Screws with tightening torque 0.5 Nm – 0.6 Nm / 4.4 lbf in – 5.3 lbf in	

## 9.4.4 ZS4800-2042 / Connector power supply modules AX8640

- X02 slot on AX8640 power supply modules



Terminal point	Connection
24 V <sub>DC</sub>	24 V <sub>DC</sub> +6/-10 % system voltage and peripheral voltage
GND	GND
<b>Wire cross-section</b>	
Maximum 16 mm <sup>2</sup> AWG 6	
<b>Mounting</b>	
Screws with tightening torque 1.2 Nm – 1.5 Nm / 10.6 lbf in – 13.3 lbf in	



## 9.5 Connector voltage input

### NOTICE

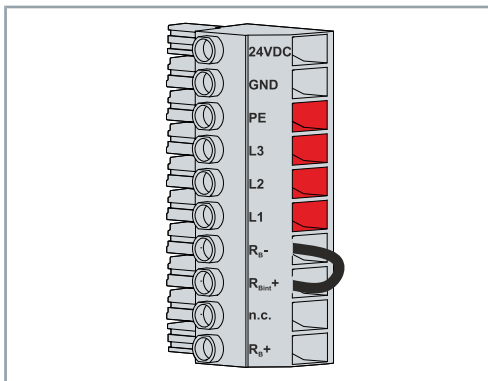
**Do not remove the bridge between  $R_{Bint+}$  and  $R_B$ .**

Proper commissioning is only possible if the bridge between the terminal points  $R_{Bint+}$  and  $R_B$  is not removed. Alternatively, an external brake resistor can be connected.

*Without this measure the AX8000 multi-axis servo system will be shut down with an error message.*

### 9.5.1 ZS4800-2001 / Connector power supply modules AX8620

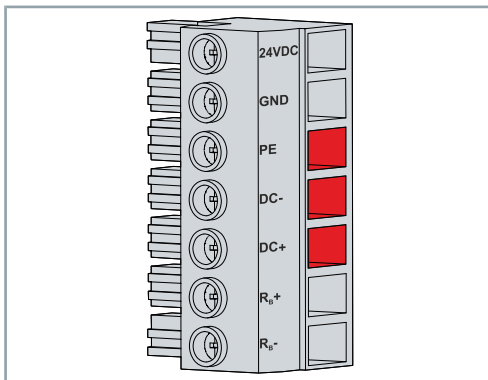
- X01 slot on AX8620 power supply modules



Terminal point	Connection
PE	Protective conductor
L3 / N	Phase L3 / N
L2	Phase L2
L1	Phase L1
<b>Wire cross-section</b>	
Maximum 6 mm <sup>2</sup> AWG 8	
<b>Mounting</b>	
Screws with tightening torque 0.5 Nm – 0.6 Nm / 4.4 lbf in – 5.3 lbf in	

### 9.5.2 ZS4800-2002 / Connector power supply modules AX8600

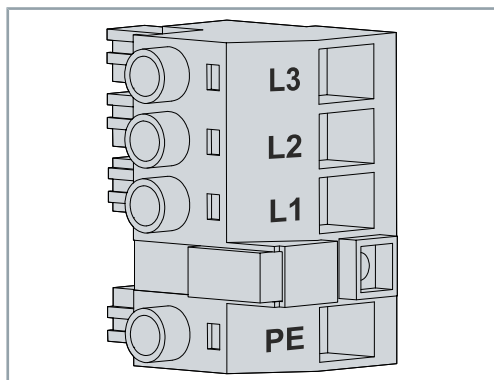
- X02 connection on AX8600 power supply modules



Terminal point	Connection
PE	Protective conductor
DC -	DC link -
DC +	DC link +
<b>Wire cross-section</b>	
Maximum 16 mm <sup>2</sup> AWG 6	
<b>Mounting</b>	
Screws with tightening torque 1.2 Nm – 1.5 Nm / 10.6 lbf in – 13.3 lbf in	

## 9.5.3 ZS4800-2041 / Connector power supply modules AX8640

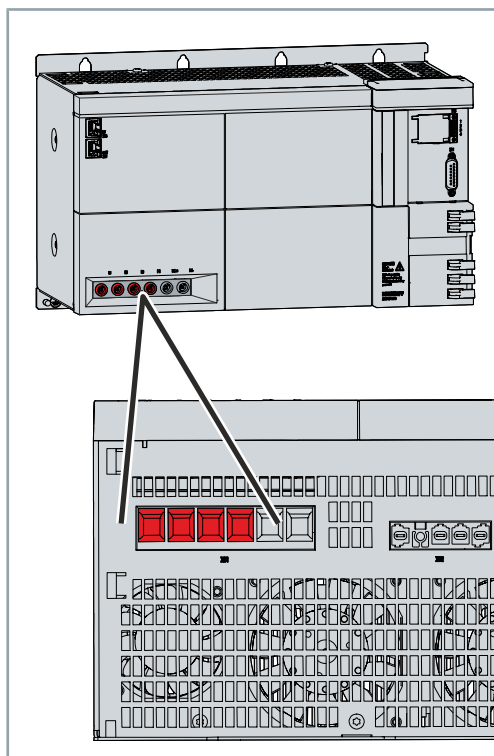
- X01 slot on AX8640 power supply modules



Terminal point	Connection
L3 / N	Phase L3
L2	Phase L2
L1	Phase L1
PE	Protective conductor
<b>Wire cross-section</b>	
Maximum 16 mm <sup>2</sup> AWG 6	
<b>Mounting</b>	
Screws with tightening torque 1.2 Nm – 1.5 Nm / 10.6 lbf in – 5.3 lbf in	

## 9.5.4 Terminal strip on AX85xx

- X01 connection on AX8525 combined modules



Terminal point	Connection
L1	Phase L1
L2	Phase L2
L3	Phase L3
PE	Protective conductor
<b>Wire cross-section</b>	
Maximum 35 mm <sup>2</sup> AWG 2	
<b>Mounting</b>	
Screws with tightening torque 1.2 Nm – 1.5 Nm / 10.6 lbf in – 5.3 lbf in ≤ 25 mm <sup>2</sup> = 2.5 Nm, 35 mm <sup>2</sup> = 4.5 Nm	

## 9.6 Connector external brake resistor



### Remove the bridge between contact points $R_{B-}$ and $R_{Bint+}$

Before you can connect the external braking resistor, remove the bridge between the contacts  $R_{B-}$  and  $R_{Bint+}$ .

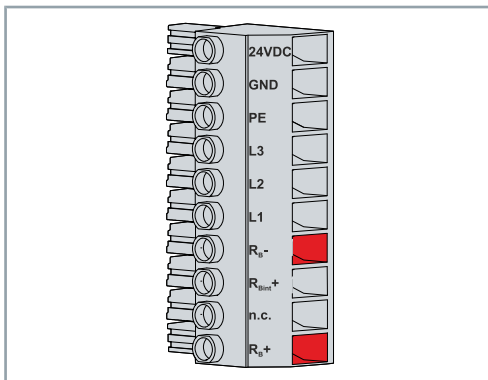
### Establish protective earth via connector X02

Connect the "Protective Earth" of the external braking resistor to the PE connection of connector X02.

Various outputs are available on the AX86xx power supply modules and AX85xx combined modules for the connection of an external braking resistor:

### 9.6.1 ZS4800-2001 / Connector power supply modules AX8620

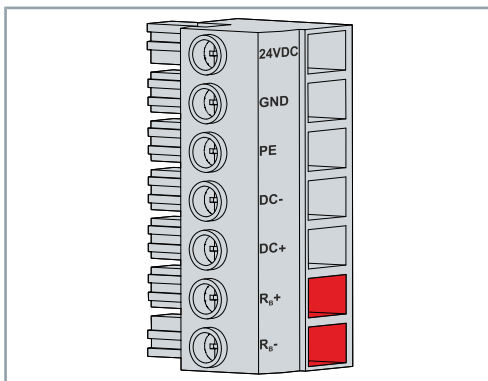
- X01 slot on AX8620 power supply modules



Terminal point	Connection
$R_{B-}$	Brake resistor -
$R_{B+}$	Brake resistor +
<b>Wire cross-section</b>	
Maximum 6 mm <sup>2</sup> AWG 8	
<b>Mounting</b>	
Screws with tightening torque 0.5 Nm – 0.6 Nm / 4.4 lbf in – 5.3 lbf in	

### 9.6.2 ZS4800-2002 / Connector combined modules AX8600

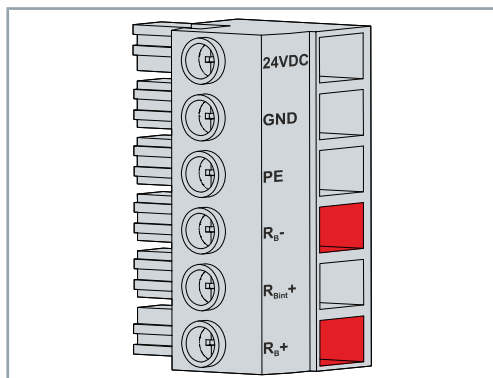
- X01 connection on AX8600x combined modules



Terminal point	Connection
$R_{B-}$	Braking resistor -
$R_{B+}$	Braking resistor +
<b>Wire cross-section</b>	
Maximum 16 mm <sup>2</sup> AWG 6	
<b>Mounting</b>	
Screws with tightening torque 1.2 Nm – 1.5 Nm / 10.6 lbf in – 13.3 lbf in	

## 9.6.3 ZS4800-2042 / Connector power supply modules AX8640

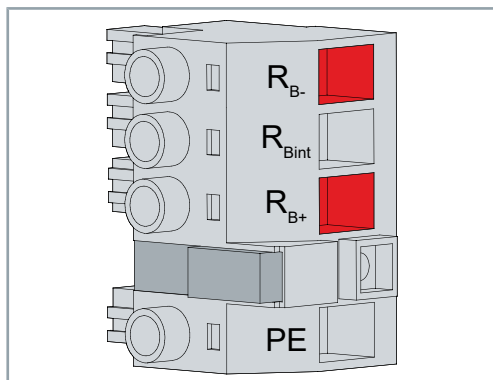
- X02 slot on AX8640 power supply modules



Terminal point	Connection
R <sub>B-</sub>	Brake resistor -
R <sub>B+</sub>	Brake resistor +
<b>Wire cross-section</b>	
Maximum 16 mm <sup>2</sup> AWG 6	
<b>Mounting</b>	
Screws with tightening torque 1.2 Nm – 1.5 Nm / 10.6 lbf in – 13.3 lbf in	

## 9.6.4 ZS4500-2047 / Connector combined modules AX85xx

- X02 connection on AX85xx combined modules



Terminal point	Connection
R <sub>B-</sub>	External braking resistor GND
R <sub>Bint</sub>	Internal braking resistor +
R <sub>B+</sub>	External braking resistor +
PE	Protective conductor
<b>Wire cross-section</b>	
Maximum 16 mm <sup>2</sup> AWG 6	
<b>Mounting</b>	
Screws with tightening torque 1.2 Nm – 1.5 Nm / 10.6 lbf in – 13.3 lbf in	

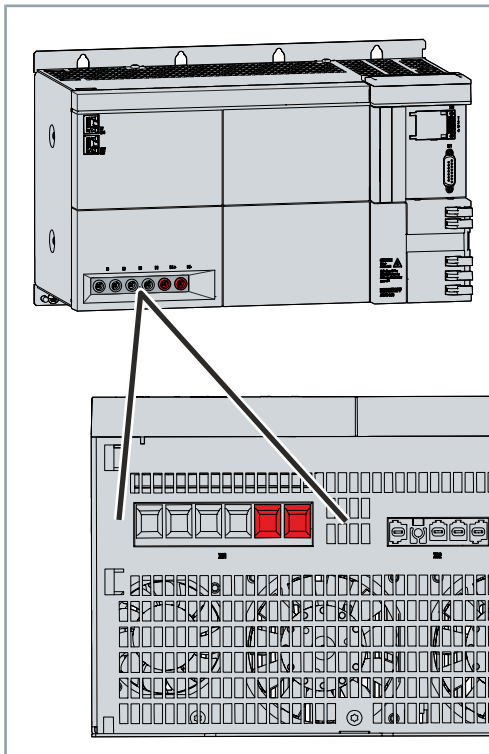
## 9.7 DC link



### No external DC link group possible

In order to avoid damaging the AX8000 multi-axis servo system, an external DC link group with a servo drive from the AX5000 series is not permissible.

### 9.7.1 Terminal strip

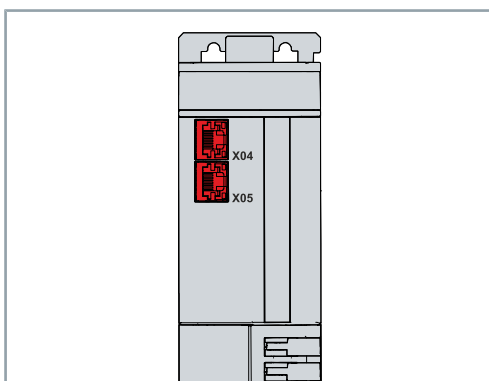


- X01 connection on AX8525 combined modules

Terminal point	Connection
DC+	DC link +
DC-	DC link -
<b>Wire cross-section</b>	
Maximum 35 mm <sup>2</sup> AWG 2	
<b>Mounting</b>	
Screws with tightening torque 1.2 Nm – 1.5 Nm / 10.6 lbf in – 5.3 lbf in ≤ 25 mm <sup>2</sup> = 2.5 Nm, 35 mm <sup>2</sup> = 4.5 Nm	

## 9.8 Fieldbus system

The EtherCAT real-time Ethernet fieldbus is available in the AX8000 multi-axis servo system.



- X04 connection and X05 connection in case of AX8620 and AX8640 power supply modules

Terminal point	Connection
X04 IN	Incoming EtherCAT line
X05 OUT	Outgoing EtherCAT line

## 9.9 Multi-feedback

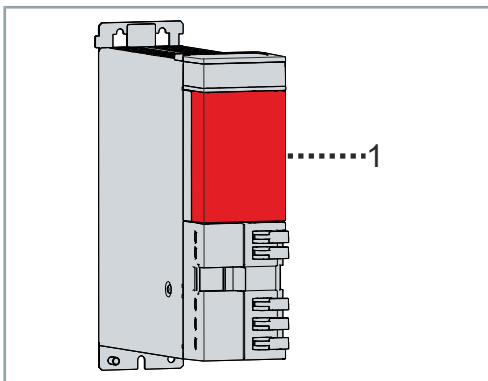
Two versions of the multi-feedback interface are available for the combination and axis modules:

- Order code AX8xxx-0x10 supports EnDat 2.2 or Biss C
- Order code AX8xxx-0x20 supports EnDat 2.2, Biss C, Sin/Cos or TTL (diff.)

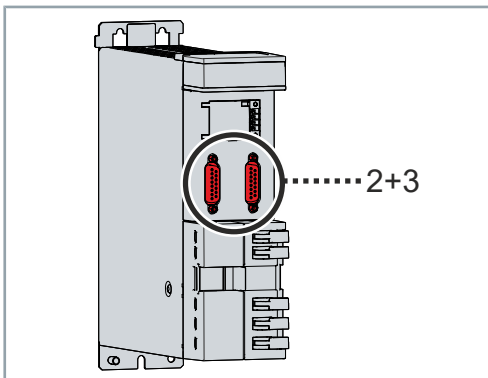
### 9.9.1 EnDat 2.2 / 22 or BiSS C

You have the option to use encoders with EnDat 2.2 / 22 or BiSS C:

- As a commutation encoder, for example with linear motors
- As a second feedback for position optimization

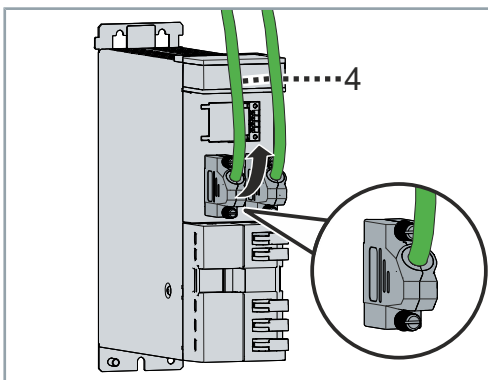


► Remove cover [1]



The D-sub connectors [2] and [3] are exposed.

► Connect feedback



The connectors are angled upwards. If the connectors are connected correctly, the cables can only be guided upwards.

► Guide cables [4] upwards

## Cables

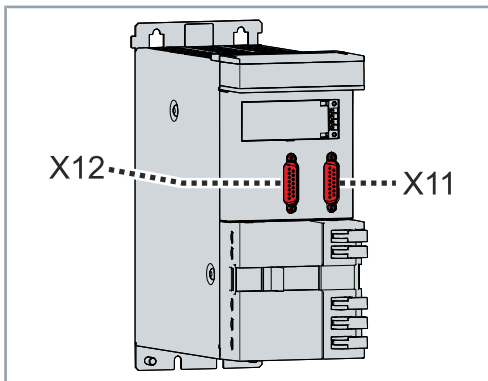
The following cable is available for the feedback system EnDat 2.2 / 22 with M12 connection:

- ZK4810-0020-zzzz Encoder cable, EnDat 2.2

## Definition connections

X a b	Explanation
X	Designation Connector
a	Channel 1 = channel 1 2 = channel 2
b	Number of the connector 1 = First connector 2 = Second connector

## AX81xx-0x10 Device with multi-feedback option

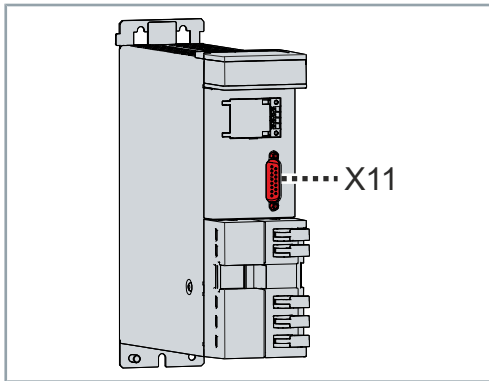


Two D-sub connectors are available for the AX81xx-0x10 single-axis module:

- Right connector X11: Primary connection, for example as commutation encoder with third-party motors
- Left connector X12: In addition, for example, as secondary feedback

Pin	EnDat 2.2 / 22	BiSS C
1	n.c.	n.c.
2	GND	GND
3	n.c.	n.c.
4	5 V <sub>DC</sub> ± 10%	5 V <sub>DC</sub> ± 10%
5	Data; DX+ Data	Data+ / SLO+
6	Us 11 V <sub>DC</sub>	Us 11 V <sub>DC</sub>
7	n.c.	n.c.
8	Clock; CLK+	CLK+ / MA+
9	n.c.	n.c.
10	GND sense	GND sense
11	n.c.	n.c.
12	5V sense	5V sense
13	Data; DX-	Data- / SLO-
14	n.c.	n.c.
15	Clock; CLK-	CLK- / MA-
<b>Output current</b>		
Maximum 250 mA per D-sub connector		

## AX81xx-0x20 Device with multi-feedback option



A D-sub connector is available for the AX81xx-0x20 single-axis modules. The connector of the AX81xx-0x20 can optionally support one of the four feedback systems:

Pin	Sin/Cos	TTL	EnDat 2.2 / 22	BiSS C
1	SIN	n.c.	n.c.	n.c.
2	GND_5 V	GND_5 V	GND	GND
3	COS	n.c.	n.c.	n.c.
4	5 V <sub>DC</sub> ± 10%	5 V <sub>DC</sub> ± 10%	5 V <sub>DC</sub> ± 10%	5 V <sub>DC</sub> ± 10%
5	n.c.	B+	Data; DX+	Data+ / SLO+
6	n.c.	n.c.	Us 11 V <sub>DC</sub>	Us 11 V <sub>DC</sub>
7	REF Z	REF Z	n.c.	n.c.
8	n.c.	A+	Clock; CLK+	CLK+ / MA+
9	REFSIN	n.c.	n.c.	n.c.
10	GND sense	GND sense	GND sense	GND sense
11	REFCOS	n.c.	n.c.	n.c.
12	5 V sense	5 V sense	5 V sense	5 V sense
13	n.c.	B-	Data; DX-	Data- / SLO-
14	Z	Z	n.c.	n.c.
15	n.c.	A-	Clock; CLK-	CLK- / MA-

### Output current

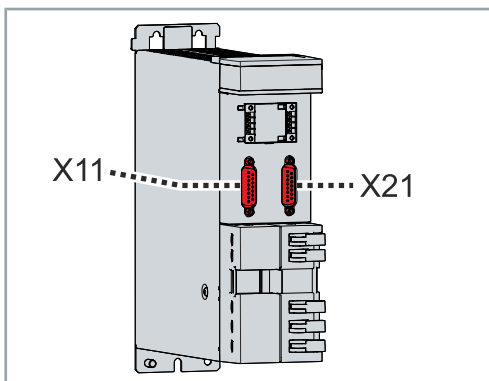
Maximum 250 mA per D-sub connector

### Cut-off frequency

1 V<sub>pp</sub> = 270 kHz

TTL = 10 MHz

## AX82xx-0x10 dual-axis module with multi-feedback option



A D-sub connector is available in each case for the AX82xx-0x10 dual-axis module:

- Left connector X11: Assignment to left axis channel 1
- Right connector X21: Assignment to right axis channel 2

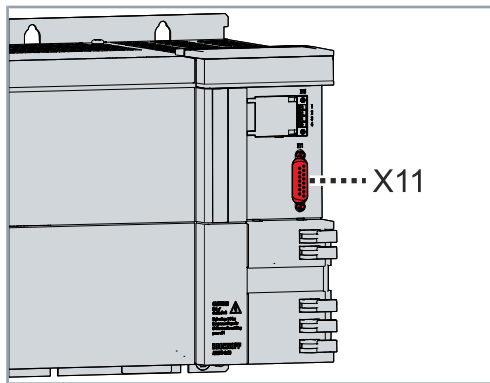
Pin	EnDat 2.2 / 22	BiSS C
1	n.c.	n.c.
2	GND	GND
3	n.c.	n.c.
4	5 V <sub>DC</sub> ± 10%	5 V <sub>DC</sub> ± 10%
5	Data; DX+	Data+ / SLO+
6	Us 11 V <sub>DC</sub>	Us 11 V <sub>DC</sub>
7	n.c.	n.c.
8	Clock; CLK+	CLK+ / MA+
9	n.c.	n.c.
10	GND sense	GND sense
11	n.c.	n.c.
12	5 V sense	5 V sense
13	Data; DX-	Data- / SLO-
14	n.c.	n.c.
15	Clock; CLK-	CLK- / MA-

### Output current

Maximum 250 mA per D-sub connector



## AX85xx-0x20



A D-Sub connector is available for the combined AX85xx-0x20 modules. The connector of the AX85xx-0x20 can all four feedback systems:

Pin	Sin/Cos	TTL	EnDat 2.2 / 22	BiSS C
1	SIN	n.c.	n.c.	n.c.
2	GND_5 V	GND_5 V	GND	GND
3	COS	n.c.	n.c.	n.c.
4	5 V <sub>DC</sub> ± 10%	5 V <sub>DC</sub> ± 10%	5 V <sub>DC</sub> ± 10%	5 V <sub>DC</sub> ± 10%
5	n.c.	B+	Data; DX+	Data+ / SLO+
6	n.c.	n.c.	Us 11 V <sub>DC</sub>	Us 11 V <sub>DC</sub>
7	REF Z	REF Z	n.c.	n.c.
8	n.c.	A+	Clock; CLK+	CLK+ / MA+
9	REFSIN	n.c.	n.c.	n.c.
10	GND sense	GND sense	GND sense	GND sense
11	REFCOS	n.c.	n.c.	n.c.
12	5 V sense	5 V sense	5 V sense	5 V sense
13	n.c.	B-	Data; DX-	Data- / SLO-
14	Z	Z	n.c.	n.c.
15	n.c.	A-	Clock; CLK-	CLK- / MA-

**Output current**  
Maximum 250 mA per D-sub connector

**Cut-off frequency**  
1 V<sub>pp</sub> = 270 kHz  
TTL = 10 MHz

## 9.9.2 Sin/Cos or TTL (diff.)

For single-axis modules, a sine/cosine or TTL interface is also available with the order code -0x20:

- As a commutation encoder, for example with linear motors
- As a second feedback for position optimization



The AL8200-000z-0000 magnetic encoder system is currently not supported due to its low resolution (one sine period per revolution)

## 9.10 Motor feedback OCT

For the axis modules AX81xx and AX8206 you need a combined motor connector and feedback connector. The connector is part of the preassembled Beckhoff motor cable.

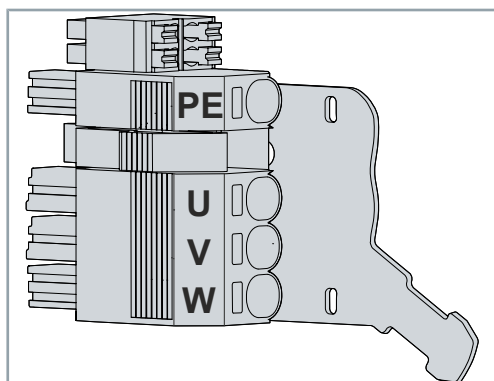
### 9.10.1 ZS4800-2013 / Connector axis modules AX81xx / AX8206



#### Maximum output current for the motor brake B- and B+

AX8108 and AX8206 = 1 A  
 AX8118 = 2 A  
 AX8525 and AX8540 = 2 A

- X13 slot and X23 slot on AX81xx and AX8206 axis modules



Terminal point	Connection
PE	Protective conductor
U	Motor connection U
V	Motor connection V
W	Motor connection W
T-	OCT- or Temperature - Possible temperature sensors: KTY 83-1xx, KTY 84-1xx, KTY 21-6 or PT1000
T+	OCT+ or Temperature + Possible temperature sensors: KTY 83-1xx, KTY 84-1xx, KTY 21-6 or PT1000
B-	Motor brake GND
B+	Motor brake +
<b>Wire cross-section</b>	
Maximum 6 mm <sup>2</sup> AWG 8	
<b>Mounting</b>	
Push in	

## NOTICE

### Connection of third-party motors

A temperature sensor with double insulation or reinforced insulation is required for the operation of a third-party motor with a temperature sensor on the AX8000.

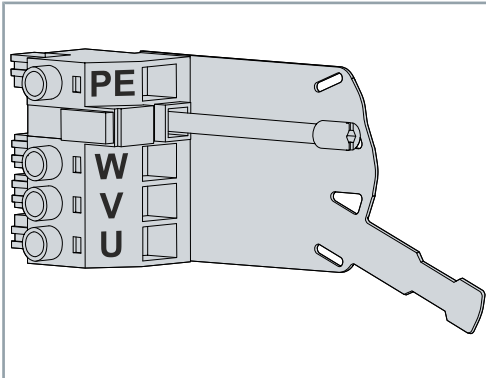
*The AX8000 multi-axis servo system and further components can be damaged if this is ignored.*

## 9.11 Motor connector AX85xx

A motor connector is required for the AX85xx combined modules. The connector is part of the preassembled Beckhoff motor cable.

### 9.11.1 ZS4800-2043 / Connector combined modules AX85xx

- X13 connection on AX85xx combined modules



Terminal point	Connection
PE	Protective conductor
W	Motor connection W
V	Motor connection V
U	Motor connection U
<b>Wire cross-section</b>	
Maximum 16 mm <sup>2</sup>	
AWG 6	
<b>Mounting</b>	
Push in	

### NOTICE

#### Connection of third-party motors

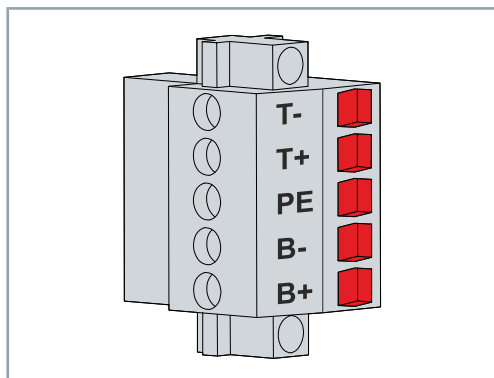
A temperature sensor with double insulation or reinforced insulation is required for the operation of a third-party motor with a temperature sensor on the AX8000.

*The AX8000 multi-axis servo system and further components can be damaged if this is ignored.*

## 9.12 Holding brake OCT

### 9.12.1 ZS4500-2014 / Connector combined modules AX85xx

- X13 connection on AX85xx combined modules



Terminal point	Connection
PE	Protective conductor
U	Motor connection U
V	Motor connection V
W	Motor connection W
T-	OCT- or Temperature - Possible temperature sensors: KTY 83-1xx, KTY 84-1xx, KTY 21-6 or PT1000
T+	OCT+ or Temperature + Possible temperature sensors: KTY 83-1xx, KTY 84-1xx, KTY 21-6 or PT1000
B-	Motor brake GND
B+	Motor brake +
<b>Wire cross-section</b>	
Maximum 6 mm <sup>2</sup> AWG 8	
<b>Mounting</b>	
Push in	

## NOTICE

### Connection of third-party motors

A temperature sensor with double insulation or reinforced insulation is required for the operation of a third-party motor with a temperature sensor on the AX8000.

*The AX8000 multi-axis servo system and further components can be damaged if this is ignored.*

## 9.13 Digital inputs

The axis modules have 4 digital I/O per axis. The I/O can be found on slot X15 for single-axis modules and slot X15 & X25 for dual-axis modules. The I/O characteristics depend on whether the TwinSAFE drive option is installed or not.

Devices with  
TwinSAFE drive option



### Support for safety functions

Before putting the axis modules with TwinSafe drive option and the order identifier AX8xx-x1xx into operation, read the documentation for:

- AX8911 TwinSAFE Drive Option

Terminal point	Connection
1	TwinSAFE input: Reaction time 4 ms typ. (read input, write to E-bus)
2	TwinSAFE input: Reaction time 4 ms typ. (read input, write to E-bus)
3	Input: Input filter 15 µs typ.  <b>AX8525 / AX8540 only:</b> Output: Switchover times TON: 60 µs typ.; TOFF: 300 µs typ.
4	Input: Input filter 15 µs typ.  <b>AX8525 / AX8540 only:</b> Output: Switchover times TON: 60 µs typ.; TOFF: 300 µs typ.
<b>Wire cross-section</b> With ferrule and collar according to DIN 46 228/4 maximum 1 mm <sup>2</sup> AWG 17	
<b>Mounting</b> Push in	

Devices without  
TwinSAFE drive option

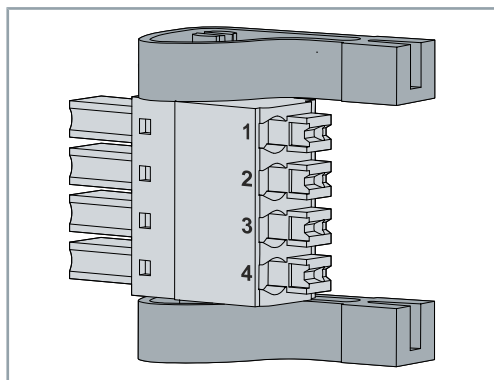
Terminal point	Connection
1	Input: Input filter 30 $\mu$ s typ.
2	Input: Input filter 30 $\mu$ s typ.
3	Input: Input filter 15 $\mu$ s typ.  <b>AX8525 / AX8540 only:</b> Output: Switchover times TON: 60 $\mu$ s typ.; TOFF: 300 $\mu$ s typ.
4	Input: Input filter 15 $\mu$ s typ.  <b>AX8525 / AX8540 only:</b> Output: Switchover times TON: 60 $\mu$ s typ.; TOFF: 300 $\mu$ s typ.
<b>Wire cross-section</b> With ferrule according to DIN 46 228/1 maximum 1.5 mm <sup>2</sup> AWG 16	
<b>Mounting</b> Push in	

## 9.13.1 ZS4800-2015 / Connector I/O

ZS4800-2015 I/O connector plug is required to connect signals to X15 / X25.

**For AX8525 and AX8540:**

On the devices, either an input or an output is available on terminal points 3 and 4.



## 9.14 Leakage currents

When operating servo drives, operationally related leakage currents occur in various frequency ranges. In addition, it is possible for a smooth DC residual current (ohmic) to be produced after the rectifier. These currents would prevent a residual current circuit breaker (RCCB or RCD) of the type A or AC from tripping. In the event of a fault, therefore, it would be possible for dangerous voltages to be present on the housing parts. The legal regulations in various countries demand the use of AC/DC-sensitive RCDs in three-phase applications. These should have a rated residual current of  $\leq 300$  mA.



### Calculation bases for leakage currents

Note that no exact value is calculated for the leakage currents, but rather the maximum expected value, with associated variance.

The leakage current values given in the table are based on the following:

- original Beckhoff motor cables are used
- shielding and grounding concepts are adhered to

### Composition of the maximum total leakage current

The maximum total leakage current is composed of:

- device-dependent fixed part with 50 Hz; single-phase supply or 150 Hz; three-phase feed
- variable part that depends on the motor cable length and clock frequency. If no other specifications are applied, the clock frequency is around 8 kHz.

The leakage currents of the individual modules add up.

Leakage currents $I_{ABFix}$ [mA]				
Servo drive	1x 230 V <sub>AC</sub> ; 50 Hz	1x 240 V <sub>AC</sub> ; 60 Hz	3x 400 V <sub>AC</sub> ; 50 Hz	3x 480 V <sub>AC</sub> ; 60 Hz
AX8108	4.1	4.6	3.5	4.4
AX8118	---	---	4.5	5.6
AX8206	4.1	4.6	3.5	4.4
AX8620	7	7.9	4.5	4.4
AX8640	---	---	4.5	4.4

## 9.15 Supply networks

The AX8000 multi-axis servo system is suitable for operation on grounded single-phase or three-phase networks. The respective network configurations differ by the type of ground connection. For a better understanding, the table below contains examples with the associated meaning:

Net form	French term	Meaning
TN	Terre Neutre	Neutral grounding of a point
TT	Terre Terre	Direct grounding of a point
TN-C	Terre Neutre Combiné	Combined neutral grounding: Neutral conductor and protective conductor combined to form PEN conductor
TN-S	Terre Neutre Combiné Séparé	Separate neutral grounding: Separate neutral conductor and protective conductor
IT	Isolé Terre	Isolation of all active parts from ground

Connection to TN or TT networks is possible without further measures.

For all other networks, operation is only possible on isolating transformers. An isolating transformer is a mains transformer that transfers the mains voltage to the secondary winding via an electrical isolation. A star point grounded network is made available with the help of this protective isolation.

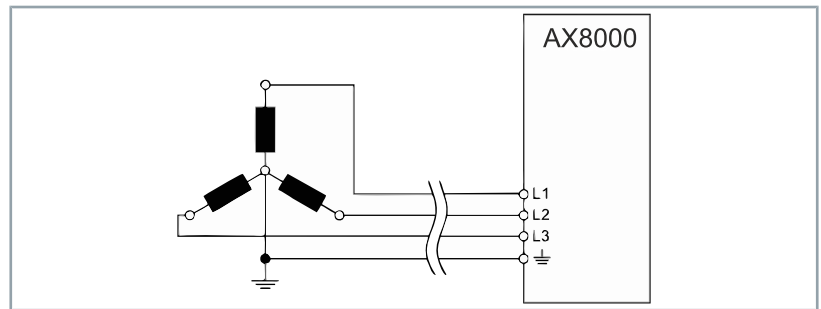
The AX8000 power supply modules are equipped with a wide-range voltage input on terminal point X01 and can be connected to the following voltage systems:

- Three-phase 200 V<sub>AC</sub> to 480 V<sub>AC</sub>
- Single-phase 100 V<sub>AC</sub> to 240 V<sub>AC</sub>

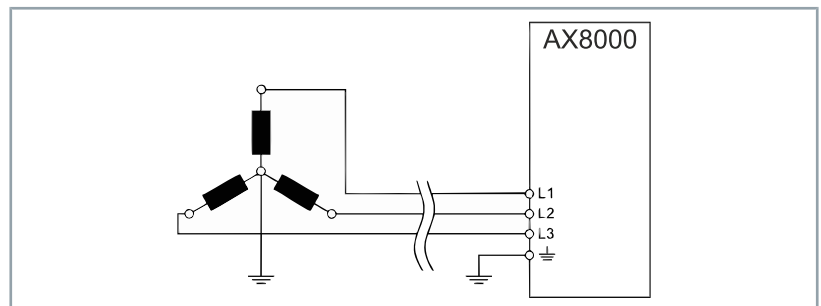


## 9.15.1 Three-phase connection

### 9.15.1.1 TN network



### 9.15.1.2 TT network



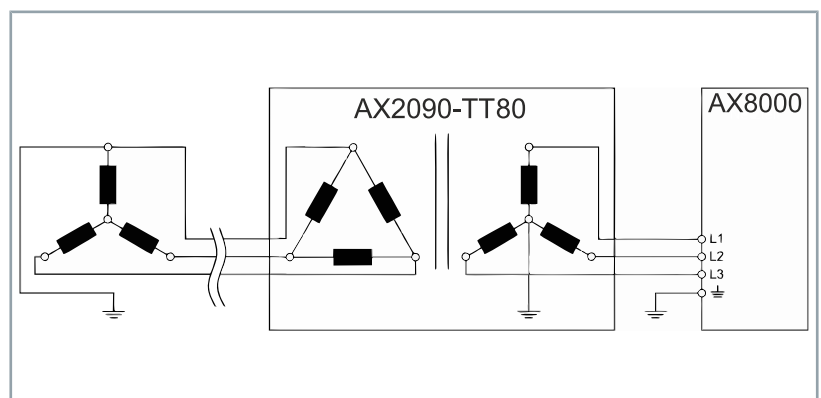
## NOTICE

### Connection only with upstream isolating transformer

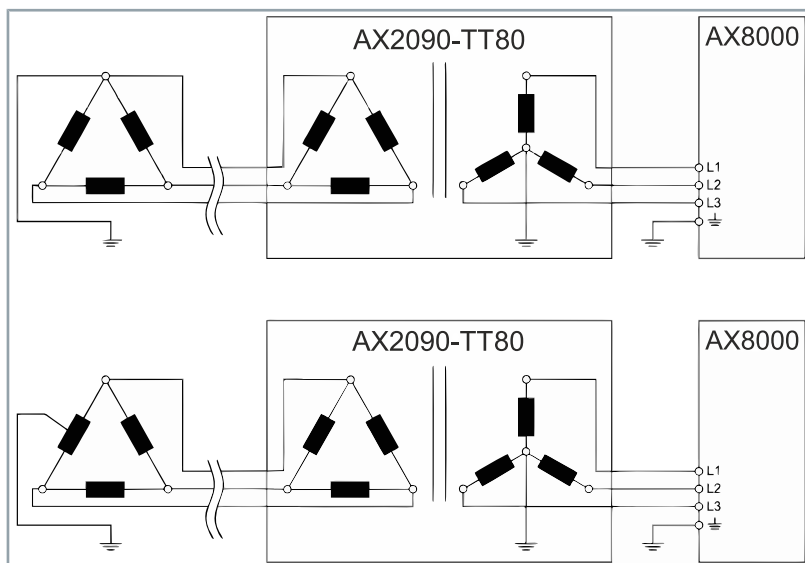
Use an upstream isolating transformer with the following networks.

*The AX8000 multi-axis servo system and the components can be damaged if this is ignored.*

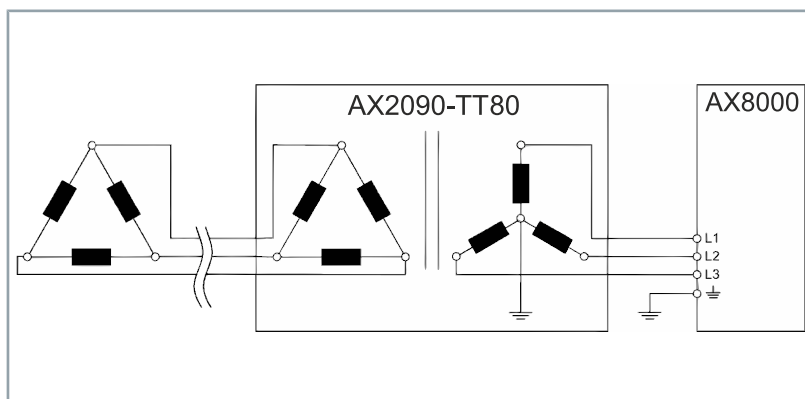
### 9.15.1.3 Asymmetrically grounded network with star point



## 9.15.1.4 Asymmetrically grounded delta network

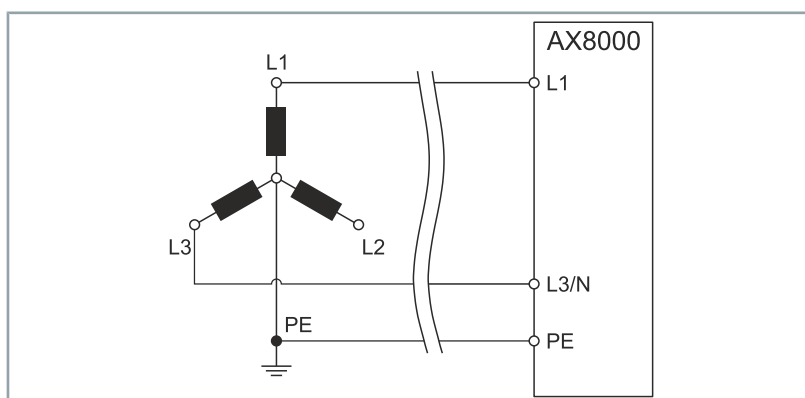


## 9.15.1.5 IT delta network

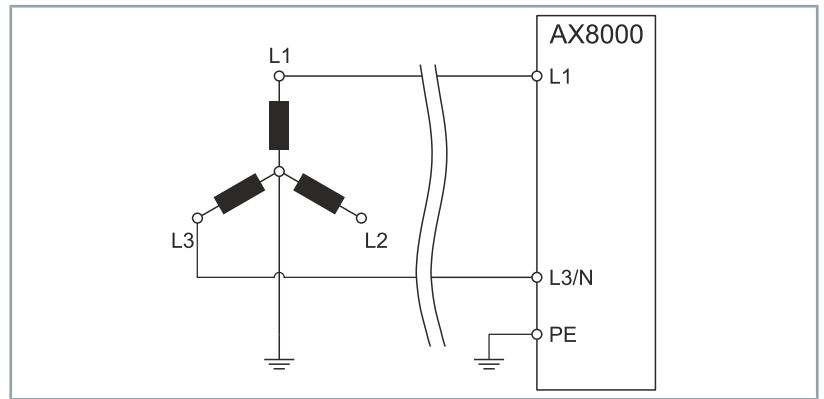


## 9.15.2 Single-phase connection

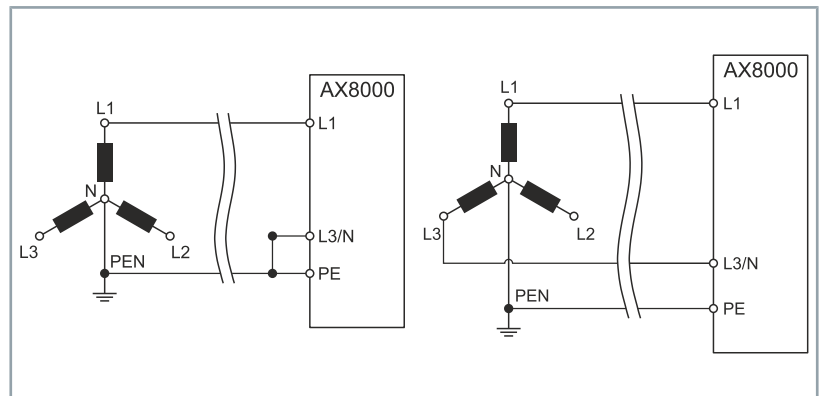
### 9.15.2.1 TN network



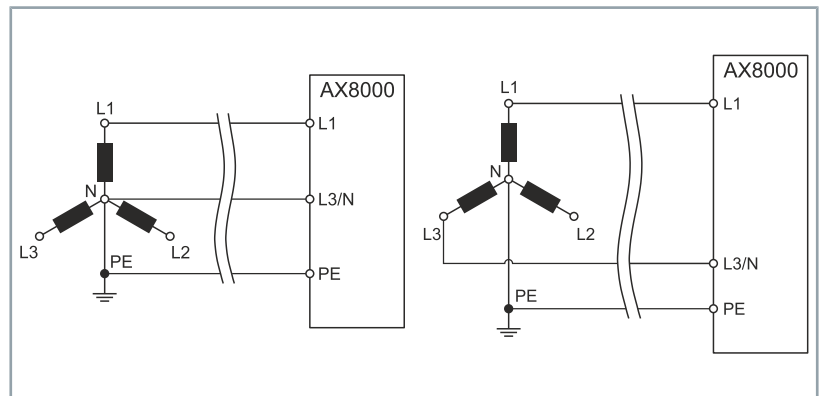
## 9.15.2.2 TT network



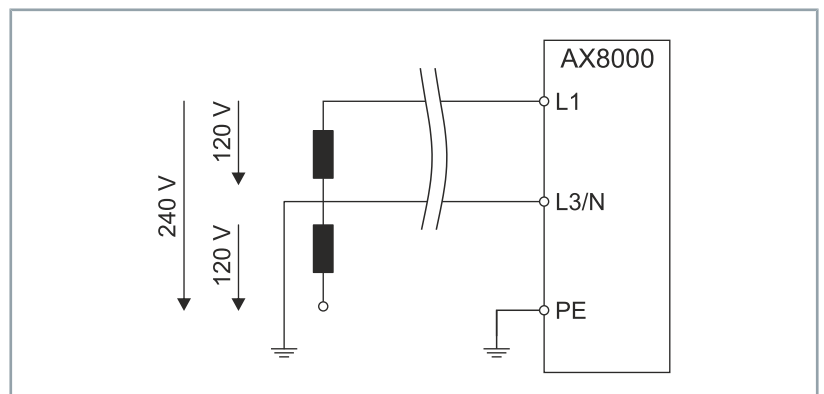
## 9.15.2.3 TN-C network



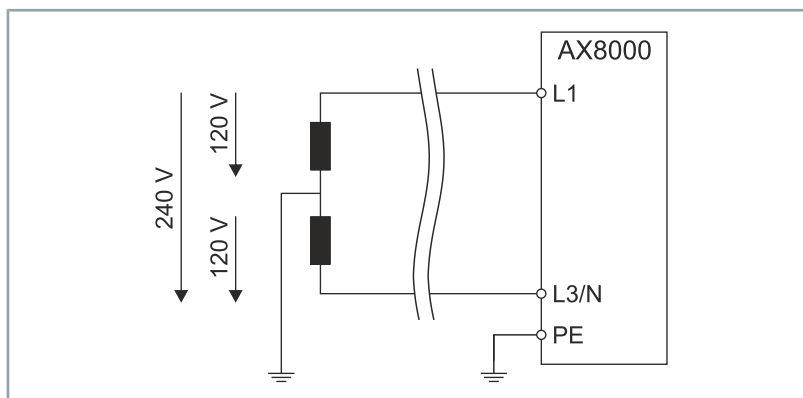
## 9.15.2.4 TN-S network



## 9.15.2.5 Split-phase with grounded center tap 120 V



## 9.15.2.6 Split-phase with grounded center tap 240 V



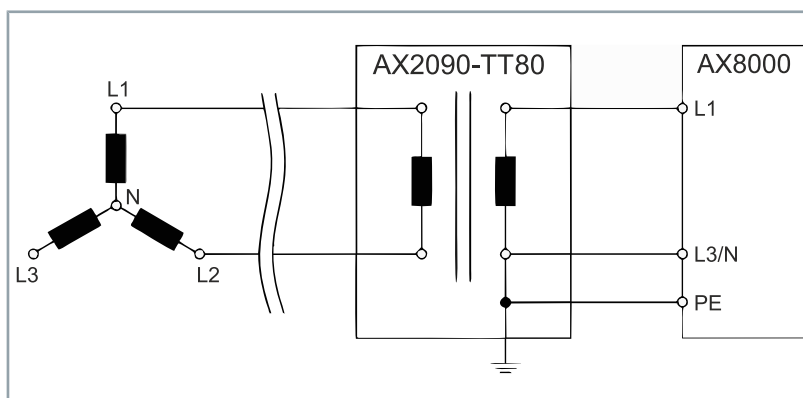
### NOTICE

#### Connection only with upstream isolating transformer

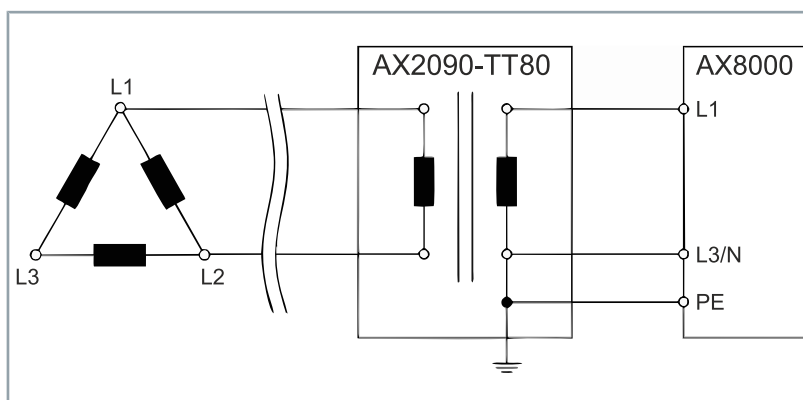
Use an upstream isolating transformer with the following networks.

*The AX8000 multi-axis servo system and the components can be damaged if this is ignored.*

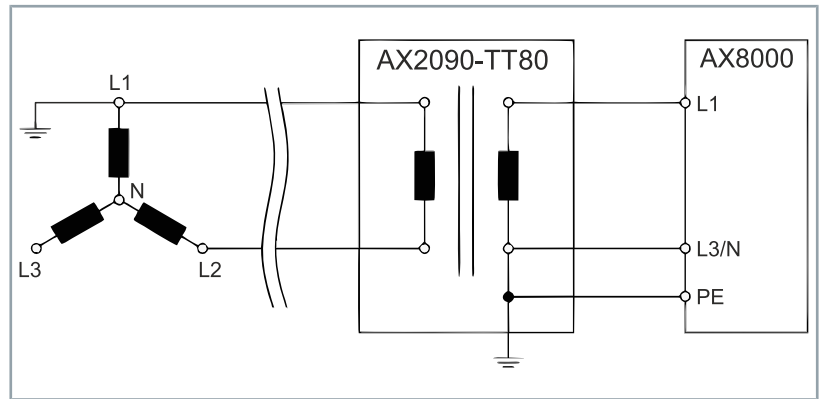
## 9.15.2.7 IT network with star point



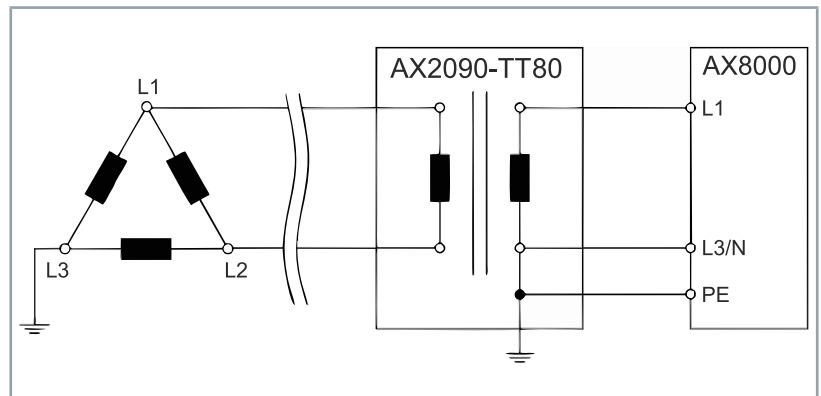
## 9.15.2.8 IT delta network



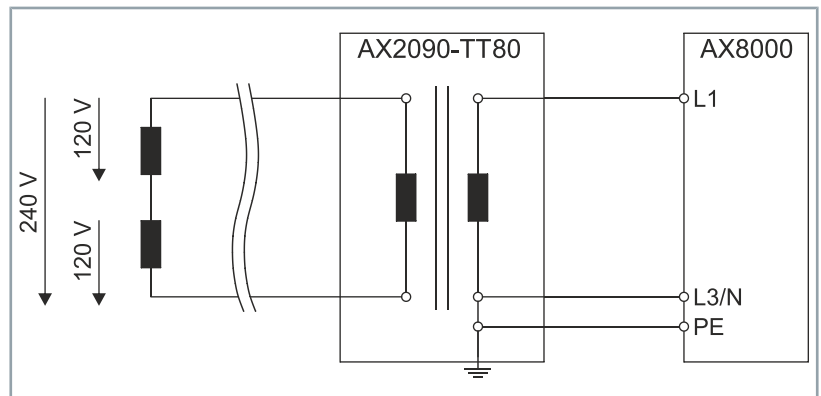
## 9.15.2.9 Asymmetrically grounded network with star point



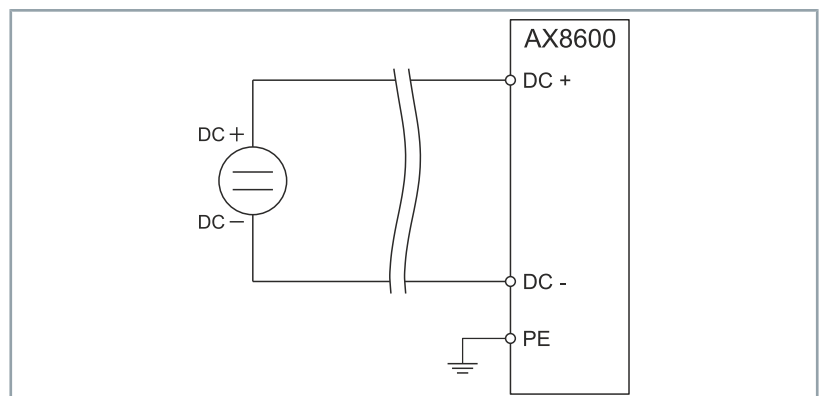
## 9.15.2.10 Asymmetrically grounded delta network



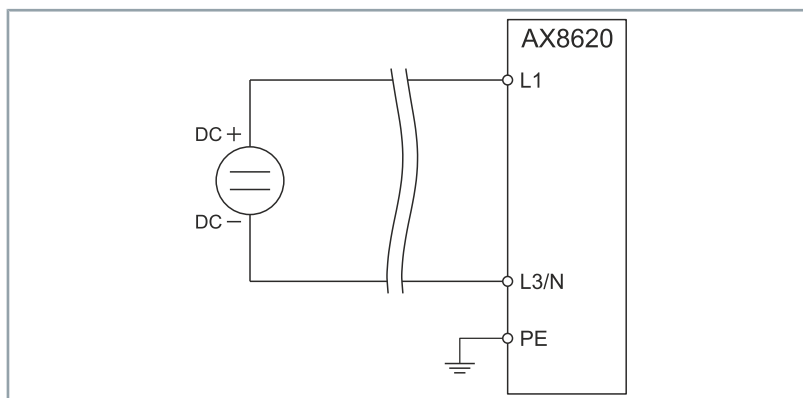
## 9.15.2.11 Split-phase ungrounded networks



## 9.15.2.12 DC power supply AX8600



## 9.15.2.13 DC power supply AX8620



Important: Observe derating!

### 9.15.3 Isolating transformers

Special network configurations require an upstream isolating transformer. Like the power supply modules of the AX8000, this supplies a short-term peak current of 100%. Full input power is not required for many applications. If this is the case, isolating transformers with a lower power rating can also be used.



#### Checking the isolating transformer power rating with the TwinCAT 3 Motion Designer

Check the isolating transformer power rating with the design software TE5910 | TwinCAT 3 Motion Designer.

This can be found on the Beckhoff homepage:

- [TE5910 | TwinCAT 3 Motion Designer](#)

The power supply modules are assigned to the isolating transformers in the following tables.

#### Single-phase supply

Module	Nominal current [A]	Isolating transformer	Nominal current [A]
AX8620	7	AX2090-TT80-0002; 230 V, 1.6 kVA	7

#### Three-phase supply

Module	Nominal current [A]	Isolating transformer	Nominal current [A]
AX8620	17.5	AX2090-TT80-0010; 400 V, 10 kVA	14.4
AX8640	35	AX2090-TT80-0020; 400 V, 20 kVA	28.9
<b>Full input power</b>			
AX8620	17.5	AX2090-TT80-0016; 400 V, 16 kVA	23.1
AX8640	35	AX2090-TT80-0030; 400 V, 30 kVA	43.4

## 9.16 Fuse protection

### NOTICE

#### Observe fuses and data for operation and environment

The servo drives are equipped with integrated self-protection. The recommended fuses are used for line protection. Adhere to the dimensioning according to the prescribed data for operation and environment.

*The system may be damaged if this is ignored.*

### 9.16.1 CE conform

Use mains fuses of the operating class "gG(A)" according to IEC60269 or automatic circuit-breakers with the characteristic "C".

#### External fuse protection

Fuse protection	AX8620	AX8640	AX8525	AX8540
Maximum AC supply	25 A	50 A	100 A	
Maximum 24 V supply	20 A			

#### Internal fuse protection

Fuse protection	Fuse
24 V system voltage / periphery	electronic
Internal braking resistor	electronic
External braking resistor	electronic <b>Requirements:</b> <ul style="list-style-type: none"> <li>• Active thermal model for selected braking resistor</li> <li>• Correct braking resistor line</li> </ul>



## 9.16.2 UL-compliant

**Circuit breakers are not permitted**

Circuit breakers are not permitted for external fusing of the UL network.

*Use exclusively the UL mains fuses specified in this chapter.*

**Fuse holders with UL approval**

Before implementing a UL configuration, it is mandatory that you contact your UL certificate authority and discuss the necessary boundary conditions. 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 certificate authority.

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

Use UL mains fuses of the class "J".

For alternatives to the UL fuses of the class "J", be sure to refer to the UL standard "UL 508A, chapter SB4.2.3, exception no.1".

## External fuse protection

Fuse protection	AX8620	AX8640	AX8525	AX8540
Maximum AC supply	25 A	50 A	100 A	
Maximum 24 V supply	20 A			

## Internal fuse protection

Fuse protection	Fuse
24 V system voltage / periphery	electronic
Internal braking resistor	electronic
External braking resistor	electronic <b>Requirements:</b> <ul style="list-style-type: none"> <li>• Active thermal model for selected braking resistor</li> <li>• Correct braking resistor line</li> </ul>

## 9.16.3 Device fusing

### Conservative

The device fusing can be selected according to various methods:

Select the fusing in accordance with the maximum device fusing of the corresponding power supply module.

Power supply modules	Fuse
AX8620-0000	Maximum 25 A
AX8640-0000	Maximum 50 A
AX8525-0000	Maximum 100 A
AX8540-0000	Maximum 100 A

### Application-oriented

Add together the motor currents of all connected servomotors. Multiply the sum by the application-typical simultaneity factor. In the case of a machine tool this is relatively high, e.g. 0.9, because all axes can drive into the material at the same time. In the case of a handling system the factor is more likely to be 0.7.



#### Example: handling system with three axes:

In the following sample, a typical use case with a three-axis handling system is described.

*The use case is only an example and does not offer the basis for a planned application.*

	X	Y	Z
Servomotor	AM8042-0JH0	AM8031-0DH0	AM8021-0BH1
Current	6.90 A	1.95 A	0.85 A

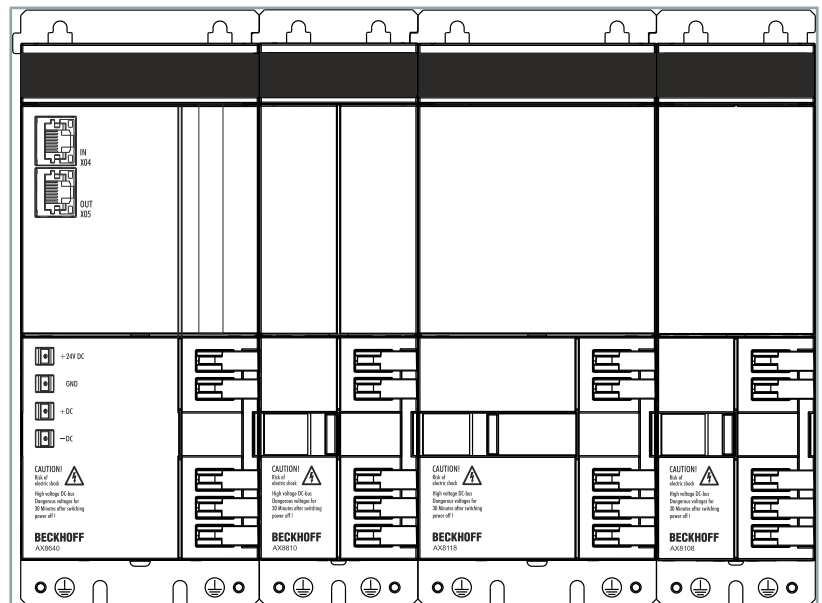
Total sum current: 9.70 A x simultaneity factor 0.7 = 6.8 A

Selected power supply module: AX8620-0000

Selected fusing: 10 A



## Example of the design of the current-limiting circuit breakers in the system group



Rated output current of the axis modules is 18 A for AX8118-0000 and 8 A for AX8108-0000 = 26 A

Total rated output current = 26 A

The system group must be fused with at least 26 A. Select the next higher standard level for this according to UL 508A, Tab. SB4.2. This corresponds to class "J" with 40 A.

## 10 Commissioning



### Exemplary commissioning

The procedure for commissioning is described as an example. A different method may be appropriate or necessary, depending on the application of the components.

### 10.1 Before commissioning

Pay attention to the following points before commissioning:

- ▶ Make sure that an emergency stop switch complying with the valid regulations is fitted to the control station
- ▶ Check components for damage
- ▶ Check mounting and alignment
- ▶ Check correct seating of the modules in the control cabinet and on the machine
- ▶ Tighten screw connections correctly
- ▶ Mount mechanical and electrical protective devices
- ▶ Check the wiring, connection and proper grounding

### 10.2 During commissioning

Pay attention to the following points during commissioning:

- ▶ Check function and adjustment of attachments
- ▶ Observe information for environment and operation
- ▶ Check protective measures against moving and live parts

#### Configuration

Beckhoff recommends the use of the latest TwinCAT version and the TwinCAT Drive Manager 2 for the configuration of new projects.

- ▶ Create a new TwinCAT project and select the target system
- ▶ Add modules to the I/O devices via the Scan function
- ▶ Create a TwinCAT Drive Manager 2 project
- ▶ Scan components or manually insert a configuration
- ▶ Configure components inserted in the I/O devices
- ▶ Check the state and activate TwinCAT

## 10.3 Prerequisites during operation

Pay attention to the following points during operation:

- ▶ Listen for atypical noises
- ▶ Check for unusual smoke formation
- ▶ Always check drive surfaces and cables for dirt or dust
- ▶ Check temperature development
- ▶ Observe recommended maintenance intervals
- ▶ Check function of safety devices

## 10.4 After operation

### **WARNING**

#### **Ensure safe condition of the machine / system**

Make sure that all moving parts on the machine come completely to a standstill.

*After switching off the power supply, the components of the AX8000 multi-axis servo system may perform uncontrolled movements and cause serious injuries.*

## 11 Maintenance and cleaning

### **WARNING**

#### **Ensure safe condition for cleaning work**

Basically, electronic devices are not fail-safe. The condition is always safe when the unit is switched off and not energized. For cleaning work, place the connected servo drives and the machine in a safe state.

*Carrying cleaning work during operation can lead to serious or fatal injuries.*

### **NOTICE**

#### **Do not immerse or spray the servo drives**

Clean the servo drive carefully using only a cloth.

*Cleaning by immersion will destroy the servo drive. Impermissible solutions will damage the servo drives and surfaces.*

The components of the AX8000 multi-axis servo system are maintenance-free. However, dirt, dust or swarf can negatively affect the function of the components. In the worst case, contamination can lead to failure. Therefore, clean the components regularly and carefully with a cloth or brush.

### 11.1 Intervals



#### **All modules are maintenance-free**

The modules from the AX8000 multi-axis servo system are subject to protection class IP20 and may only be installed and operated in accordance with the "specifications for operation and environment", [Page 37].

Operation beyond the permissible environmental conditions and operating states will shorten the service life of the components of the AX8000 multi-axis servo system.

The service life of consumables may be shortened depending on the mechanical dynamics due to mounted devices and movements.

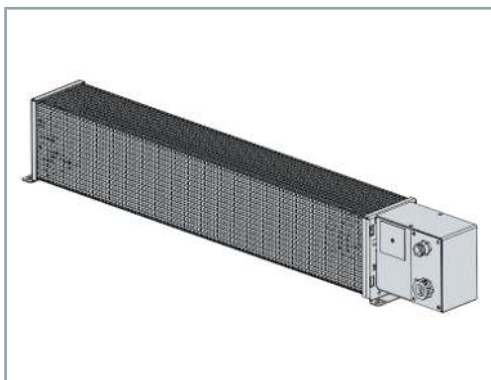
## 12 Accessories



### Use accessories with UL approval

Accessories with UL approval are also required for the operation of the AX8000 in the USA or Canada.

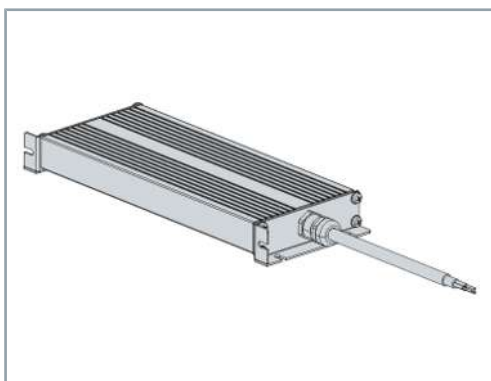
### 12.1 Brake resistor



Regenerative energy is converted into heat via the brake resistors of the AX2090-BW80 series when braking a servomotor.

For further information, read the original operating instructions for the brake resistors from the AX2090-BW80-xxxx series.

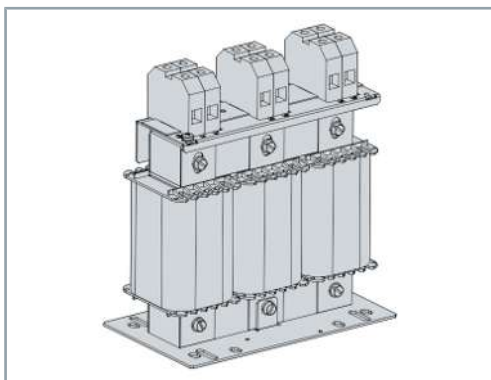
### 12.2 Brake resistor IP65



When braking a decentralized servo drive, the energy generated is converted into heat by the brake resistors from the AX2090-BW65 series. As components with the protection class IP65, the brake resistors feature full contact hazard protection and are protected against dust or water jets from any direction.

For further information, read the original operating instructions for the brake resistors from the AX2090-BW65-xxxx series.

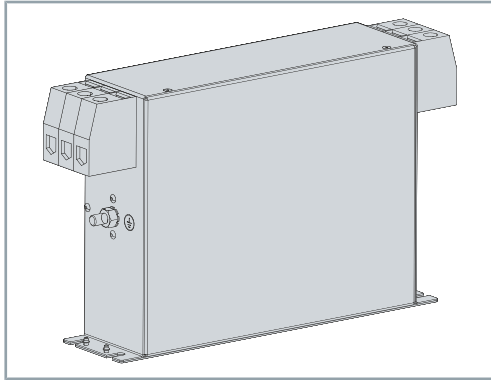
### 12.3 Mains choke



With the help of the mains chokes, current peaks and recharging currents can be limited, for example, for larger servo drives and drive systems.

For further information, read the original operating instructions for the mains chokes from the AX2090-ND80-0xxx series.

## 12.4 Mains filter



Mains filters are used to comply with the EMC requirements for variable speed drive systems. The requirements are defined in the product standard EN 61800-3. The standard differentiates the requirements according to the installation site:

- First environment
  - Residential buildings and sites where the control cabinet is connected directly, without a transformer, to the public low-voltage network.
- Second environment
  - Industrial areas connected to the medium voltage network via a transformer.

The required category is then derived from this:

- Category C2
  - Stationary drive systems for operation in the first and second environments.
- Category C3
  - Drive systems for operation in the second environment.

The power supply modules of the AX8000 servo system are designed with integrated mains filters for compliance with category C3. Optional mains filters are available for use in the first environment. In addition, a mains choke must be used. The following dependencies on the total motor cable length must be observed:

Power supply module	Category C3	Max. total motor cable length
AX8620 1-phase	Integrated mains filter	up to 300 m without mains choke up to 500 m with optional mains choke AX2090-ND80-00xx
AX8620 3-phase	Integrated mains filter	
AX8640	Integrated mains filter	
AX8525 / AX8540	Integrated mains filter	

Power supply module	Category C2	Max. total motor cable length
AX8620 1-phase	AX2090-NF80-0010	up to 300 m
AX8620 3-phase	AX2090-NF80-0020 + AX2090-ND80-0020	up to 500 m
AX8640	AX2090-NF80-0040 + AX2090-ND80-0040	
AX8525 / AX8540	AX2090-NF80-0080 + AX2090-ND80-0080	



## 13 Decommissioning

Disassembly may only be carried out by qualified and trained personnel.

Read the section Documentation notes.

When disposing of electronic waste, make sure that you dispose of it in accordance with the regulations applicable in your country. Read and follow the instructions for proper disposal.

### 13.1 Disassembly

#### WARNING

##### **Avoid contact with DC link DC+ and DC-**

Measure the voltage on the DC link test contacts DC+ und DC-. Keep to the waiting times after disconnection from the supply network:

- 30 minutes for AX8620 and AX8640
- 30 minutes for AX8108, AX8118 and AX8206

*There is still a life-threatening voltage of  $> 848 V_{DC}$  on the capacitors after disconnection from the supply network. Serious or even fatal injuries may result if this is ignored.*



##### **Do not remove components from the products**

Only

Beckhoff Automation GmbH & Co. KG is permitted to remove components.

Contact Beckhoff Service for further information.

##### **Removal of the servo drive from the machine**

- Remove cables and electrical connections
- Loosen and remove the servo drive fixing screws

## 13.2 Disposal

Depending on your application and the products used, ensure the professional disposal of the respective components:

### **Cast iron and metal**

Dispose of cast and metal parts as scrap metal for recycling.

### **Cardboard, wood and foam polystyrene**

Dispose of packaging materials made of cardboard, wood or foam polystyrene in accordance with the regulations.

### **Plastics and hard plastics**

You can recycle parts made of plastic and hard plastic via the recycling depot or re-use them depending on the component designations and markings.

### **Oils and lubricants**

Dispose of oils and lubricants in separate containers. Hand over the containers at the used oil collection station.

### **Batteries and rechargeable batteries**

Batteries and rechargeable batteries may also be marked with the crossed-out trash can symbol. You must separate these components from the waste and are legally obliged to return used batteries and rechargeable batteries within the EU. Observe the relevant provisions outside the area of validity of the EU Directive 2006/66/EC.



### **Electronic components**

Products marked with a crossed-out waste bin must not be disposed of with general waste. Electronic components and device are considered as waste electrical and electronic equipment for disposal. Observe the national regulations for the disposal of old electrical and electronic equipment.

### 13.2.1 Returning to the vendor

In accordance with the WEEE-2012/19/EU directives, you can return used devices and accessories for professional disposal. The transport costs are borne by the sender.

Send the used devices with the note "For disposal" to:

Beckhoff Automation GmbH & Co. KG  
"Service" Building  
Stahlstrasse 31  
D-33415 Verl

In addition, you have the option to contact a local certified specialist company for the disposal of used electrical and electronic appliances. Dispose of the old components in accordance with the regulations applicable in your country.

## 14 Guidelines and Standards

### 14.1 Standards

**EN 61000-6-2:2005**

*"Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments"*

**EN 61000-6-4:2007+A1:2011**

*"Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments"*

**Product standard EN 61800-3:2004+A1:2012**

*"Adjustable speed electrical power drive systems. EMC requirements and specific test methods"*

**Product standard EN 61800-5-1:2007+A1:2017**

*"Adjustable speed electrical power drive systems. Safety requirements"*

**RoHS: EN 50581:2012**

*"Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances"*

**IEC 61800-5-3**

*"Adjustable speed electrical power drive systems"*

Part 5-3: Safety requirements - Functional, electrical and environmental requirements for encoders

## 14.2 Guidelines

### 2014/35/EU

Low Voltage Directive

### 2011/65/EU

RoHS Directive

### 2014/30/EU

EMC Directive



#### Installation with protective conductor connection

When installing electrical systems and components, the protective conductors must be connected first. They must be disconnected last when uninstalling.

Depending on the magnitude of the leakage currents, observe the following regulations for the implementation of the protective conductor connection:

- Minimum requirement for protective conductor: KU value of 4.5
- Minimum requirement for leakage currents:  $I_L < 10 \text{ mA}$ ; KU = 6 for  $I_L > 10 \text{ mA}$

Value	Explanation
KU	Variable for the classification of safety-related types of failure for protection against dangerous shock current and excessive heating
KU = 4.5	Achieved in relation to interruption: With permanently connected protective conductor connection $\geq 1.5 \text{ mm}^2$ With a protective conductor connection of $\geq 2.5 \text{ mm}^2$ via a plug connector for industrial plants according to IEC 60309-2
KU = 6	Achieved in relation to interruption: With permanently connected conductors $\geq 10 \text{ mm}^2$ ; type of connection and laying must conform to the applicable standards for PE cables

### 14.2.1 Electrical isolation

The power section, consisting of motor connection, DC link connection and mains connection, as well as the control unit are to be double-insulated against each other. This guarantees secure shock protection on all terminals in the control unit, even without further measures. The air gaps and creepage distances conform to EN 50178 / VDE 0160.

### 14.3 Test centers

	<p>The AX8000 multi-axis servo system does not fall within the area of applicability of the Machinery Directive.</p> <p>However, Beckhoff products are designed and evaluated in full compliance with all relevant regulations for personal safety and use in a machine or system.</p>
	<p>The AX8000 multi-axis servo system meets all the requirements of the UK economic area. These include England, Wales and Scotland.</p>
	<p>The AX8000 multi-axis servo system meets all requirements of the Eurasian Economic Union. These include Russia, Belarus, Armenia, Kazakhstan and Kyrgyzstan.</p> <p>The EAC logo can be found on the name plate.</p>
	<p>The AX8000 multi-axis servo system meets the requirements according to UL and is UL-listed. This applies to the US and Canadian market in accordance with the standards applicable to the USA and Canada.</p> <p>The cURus logo can be found on the name plate.</p>

### 14.4 EU conformity



#### Provision

Beckhoff Automation GmbH & Co KG will be pleased to provide you with EU declarations of conformity and manufacturer's declarations for all products on request.

Please send your request to: [info@beckhoff.com](mailto:info@beckhoff.com)

## 14.5 UL certification

The modules may be used as components in a system with a UL-Listing test mark.

### 14.5.1 USA and Canada



#### **The English translation is binding**

Note that all statements made in this chapter on UL certification are binding only in the English version.

*The German version of this chapter is purely informative.*

A UL certificate is necessary for the operation of the AX8000 multi-axis servo system in the economic area of the USA or Canada. The devices have been certified according to the standards of the UL test laboratory and are permitted to bear the cULus logo on the name plate. The test number is: E195162.

#### 14.5.1.1 Canada



#### **Approval in Canada only with transient suppression**

In Canada the devices are only approved with a transient suppression on the input side.

The technical requirements are:

- Three-phase networks with 240 V and 480 V, as well as three-wire systems and four-wire systems with 277 V / 480 Y
- Surge arrester type 2; for example: Allen Bradley 4983-DS277-404
- Protection against a rated surge voltage peak of 4 kV

#### 14.5.1.2 Specifications

- 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 to 75 °C.
- The AX8000 multi-axis servo system does not offer an overheating sensor for the connected motor.
- You have the option to operate motors of various sizes. You can adjust the level of the internal overload protection of the motor.

## 15 Notes

## 16 Notes



# Index

## A

Accessories	
Brake resistor	119
Brake resistor IP65	119
Mains chokes	119

## B

Brake resistor [+]	
Documentation	119
Brake resistor IP65 [+]	
Documentation	119

## C

Cable lengths	59
Cleaning	118
Commissioning	116
Connection	
Braking resistor	91
Mechanics	69
Modules	71
Control voltage	60

## D

DC link capacitance	58
Dimensional drawings	48
Display	62
Disposal	122

## E

Environmental conditions	37
--------------------------	----

## F

Features	33
Fuses	112
Fast discharge DC link	19

## G

General safety instructions	18
Grounding	83

## I

Installation position	56
Instruction	13
Intended use	36

## L

Label, see Safety symbols	17
---------------------------	----

## M

Mains choke [+]	
Documentation	119
Maintenance	118
Intervals	118
Motor feedback	98
Multi-feedback	94

## O

Operating Conditions	37
Ordering options	34
Drive-integrated safety technology	34
Multi-feedback interface	34

## P

Pictograms	13
Power derating	37

## S

Safety	17
DC link capacitors	19
De-energized and voltage-free condition	19
Grounding	18
Hot surfaces	19
Intended use	36
Keep the environment clean	18
Overheating	19
Protective equipment	18
Safety pictograms	18
Shut down and secure the machine or plant	18
Tightening torques	18
Safety symbols	17
Safety technology	
OCT motor cable	34
Safety	34
STO; safe torque off	35
TwinSAFE	34
Scope of supply	52
Security	
General safety instructions	18
Servo drive	
Commissioning	116
Dimensioning	58
Dismantling	121
Disposal	121
Electrical installation	75, 121
Mechanical installation	69
Storage	54
Transport	54
Signal words	13
Storage	54
Support	15
Symbols	13

## T

Target group	11
Technical data	37
Total motor cable length	59
Transport	54

## U

UL	126
----	-----



More Information:  
**[www.beckhoff.com/ax8000](http://www.beckhoff.com/ax8000)**

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