

Operating instructions | EN

AF1000

Economy variable frequency drive



Table of contents

| | |
|---|----|
| 1 Documentation notes | 6 |
| 1.1 Disclaimer | 6 |
| 1.1.1 Trademarks | 6 |
| 1.1.2 Limitation of liability | 6 |
| 1.1.3 Copyright | 6 |
| 1.1.4 Third-party brands | 6 |
| 1.2 Version numbers | 7 |
| 1.3 Scope of the documentation | 7 |
| 1.4 Staff qualification | 8 |
| 1.5 Safety and instruction | 9 |
| 1.5.1 Notes on information security | 9 |
| 1.6 Explanation of symbols | 9 |
| 1.7 Beckhoff Services | 11 |
| 1.7.1 Support services | 11 |
| 1.7.2 Training offerings | 11 |
| 1.7.3 Service offerings | 11 |
| 1.7.4 Headquarters Germany | 12 |
| 1.7.5 Downloadfinder | 12 |
| 2 For your safety | 13 |
| 2.1 Safety pictograms | 13 |
| 2.1.1 Module front | 13 |
| 2.2 General safety instructions | 14 |
| 2.2.1 Before operation | 14 |
| 2.2.2 During operation | 14 |
| 2.2.3 After operation | 14 |
| 3 Product overview | 15 |
| 3.1 Name plate | 16 |
| 3.2 Type key | 17 |
| 3.3 BIC Beckhoff Identification Code | 18 |
| 3.3.1 BIC as DataMatrix code | 18 |
| 3.3.2 Scanning the DataMatrix code | 18 |
| 3.3.3 Coded information on the BIC | 19 |
| 3.4 Product characteristics | 19 |
| 3.5 Ordering options | 20 |
| 3.5.1 TwinSAFE Drive-integrated safety technology | 20 |
| 3.6 Intended use | 21 |
| 3.6.1 Improper use | 21 |
| 3.7 Dual Use | 22 |
| 4 Technical data | 23 |
| 4.1 Data for operation and environment | 23 |
| 4.2 AF1103-1xxx Economy variable frequency drive, single-phase, single-axis module, 0.37 kW | 25 |
| 4.3 AF1107-1xxx Economy variable frequency drive, single-phase, single-axis module, 0.75 kW | 26 |
| 4.4 AF1115-1xxx Economy variable frequency drive, single-phase, single-axis module, 1.5 kW | 27 |
| 4.5 AF1203-1xxx Economy variable frequency drive, single-phase, dual-axis module 0.37 kW | 28 |

| | | |
|----------|--|-----------|
| 4.6 | AF1207-1xxx Economy variable frequency drive, single-phase, dual-axis module 0.75 kW | 29 |
| 4.7 | AF1107-3xxx Economy variable frequency drive, three-phase, single-axis module, 0.75 kW | 30 |
| 4.8 | AF1115-3xxx Economy variable frequency drive, three-phase, single-axis module, 1.5 kW | 31 |
| 4.9 | AF1130-3xxx Economy variable frequency drive, three-phase, single-axis module, 3.0 kW | 32 |
| 4.10 | AF1207-3xxx Economy variable frequency drive, three-phase, dual-axis module 0.75 kW | 33 |
| 4.11 | AF1215-3xxx Economy variable frequency drive, three-phase, dual-axis module, 1.5 kW | 34 |
| 4.12 | AF1222-3xxx Economy variable frequency drive, three-phase, dual-axis module, 2.2 kW | 35 |
| 4.13 | Dimensional drawings | 36 |
| 4.13.1 | AF1xxx-1xxx | 36 |
| 4.13.2 | AF1xxx-3xxx | 37 |
| 5 | Scope of supply | 38 |
| 5.1 | Product packaging | 38 |
| 6 | Transport and storage | 40 |
| 6.1 | Conditions | 40 |
| 6.2 | Transport | 41 |
| 6.3 | Long-term storage | 41 |
| 6.3.1 | Forming the capacitors | 41 |
| 7 | Technical description | 42 |
| 7.1 | Installation location and position | 42 |
| 7.2 | Length of the motor cable | 42 |
| 7.3 | Braking resistor | 43 |
| 7.4 | Connections on the device | 44 |
| 7.4.1 | AF11xx-100x, AF11xx-110x | 44 |
| 7.4.2 | AF11xx-120x | 45 |
| 7.4.3 | AF12xx-100x, AF12xx-110x | 46 |
| 7.4.4 | AF12xx-120x | 47 |
| 7.4.5 | AF11xx-300x, AF11xx-310x | 48 |
| 7.4.6 | AF11xx-320x | 49 |
| 7.4.7 | AF12xx-300x, AF12xx-310x | 50 |
| 7.4.8 | AF12xx-320x | 51 |
| 7.5 | Display | 52 |
| 7.6 | Digital I/Os | 54 |
| 7.6.1 | Wiring X02 (1-channel) | 54 |
| 7.6.2 | Wiring X03 (2-channel) | 55 |
| 8 | Mechanical installation | 56 |
| 8.1 | Preparation | 56 |
| 8.2 | Control cabinet installation dimensions | 57 |
| 8.3 | Mounting in the control cabinet | 58 |
| 9 | Electrical installation | 59 |
| 9.1 | Project planning | 59 |
| 9.1.1 | Project planning of the drivetrain | 59 |
| 9.1.2 | Energy management | 59 |
| 9.1.3 | Supported third-party motors | 60 |
| 9.1.4 | Wiring instructions | 60 |
| 9.2 | EMC and grounding measures | 61 |

| | | |
|-----------|--|-----------|
| 9.2.1 | Electromagnetic interference emission | 61 |
| 9.2.2 | Measuring the insulation resistance | 63 |
| 9.2.3 | Protective earth | 63 |
| 9.3 | Supply networks | 65 |
| 9.3.1 | Direct connection to single-phase networks | 65 |
| 9.3.2 | Connection to single-phase networks with isolating transformer | 67 |
| 9.3.3 | Direct connection to three-phase networks | 69 |
| 9.3.4 | Connection to three-phase networks with isolating transformer | 70 |
| 9.3.5 | Connection to special network types | 71 |
| 9.4 | Fuse protection | 72 |
| 9.4.1 | CE conform | 72 |
| 9.5 | Mains connection | 73 |
| 9.5.1 | single-phase mains connection | 73 |
| 9.5.2 | three-phase mains connection | 74 |
| 9.6 | Description of connections | 75 |
| 9.6.1 | Mains connection X01 | 75 |
| 9.6.2 | EtherCAT slot IN X04, OUT X05 | 77 |
| 9.6.3 | I/O connection X02 | 78 |
| 9.6.4 | I/O connection X03 | 79 |
| 9.6.5 | TwinSAFE slot X09 | 80 |
| 9.6.6 | Motor slot X13 | 81 |
| 9.6.7 | Motor slot X23 | 83 |
| 10 | Commissioning | 85 |
| 10.1 | Before commissioning | 85 |
| 10.2 | Prerequisites during operation | 85 |
| 10.3 | After operation | 86 |
| 11 | Maintenance and cleaning | 87 |
| 11.1 | Intervals | 87 |
| 12 | Accessories | 88 |
| 12.1 | Mains filter | 88 |
| 12.2 | Shielding bracket | 92 |
| 12.3 | Braking resistor | 92 |
| 13 | Decommissioning | 93 |
| 13.1 | Disassembly | 93 |
| 13.2 | Disposal | 93 |
| 14 | Guidelines and Standards | 94 |
| 14.1 | Standards | 94 |
| 14.2 | Guidelines | 94 |
| 14.2.1 | Electrical isolation | 95 |
| 14.3 | Notified bodies | 95 |
| 14.4 | EU conformity | 95 |
| | Index | 96 |

1 Documentation notes

1.1 Disclaimer

Beckhoff products are subject to continuous further development. We reserve the right to revise the documentation at any time and without notice. No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams, and descriptions in this documentation.

1.1.1 Trademarks

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

The use by third parties of other brand names or trademarks contained in this documentation may lead to an infringement of the rights of the respective trademark owner.



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

1.1.2 Limitation of liability

All components of this product described in the original operating instructions are delivered in a hardware and software configuration, depending on the application requirements. 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 comply with this documentation
- Improper use
- Use of untrained personnel
- Use of unauthorized spare parts

1.1.3 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.

1.1.4 Third-party brands

Third-party trademarks and wordmarks are used in this documentation. The corresponding trademark endorsements can be found at

 www.beckhoff.com/trademarks

1.2 Version numbers

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

✉ motion-documentation@beckhoff.com

Origin of the document

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

Product features

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

1.3 Scope of the documentation

In addition to this documentation, the following documents are part of the complete documentation:

| Documentation | Definition |
|--------------------------|--|
| Short information AF1000 | Accompanying document with general notes on handling the economy variable frequency drive. Included with each product. |

1.4 Staff qualification

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

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

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

Instructed person

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

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

Trained person

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

- machine-specific or
- plant-specific

Trained specialists

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

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

Electricians

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

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

1.5 Safety and instruction

Read the contents that are related to the activities you will perform with the product. Always read the "For your safety", [Page 13] chapter in the documentation. Observe the warning notes in the chapters so that you can handle the product and work with it properly and safely.

1.5.1 Notes on information security

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

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

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

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

1.6 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 comply will result in serious or fatal injuries.

WARNING

Failure to comply may result in serious or fatal injuries.

CAUTION

Failure to comply 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:

- product malfunctions
- damage to the product
- damage to the environment



Information

This symbol indicates information, tips, and notes for handling the product or the software.



Examples

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



Required tool

This symbol indicates a tool that is required for the following steps.



Required accessories [+]

This symbol shows the accessories required for the following steps. The accessories are not included in the scope of delivery and can be ordered from Beckhoff.



Assembly material required

This symbol shows the assembly material required for the following steps. The assembly material is not included in the scope of delivery and must be purchased separately.



QR codes

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

1.7 Beckhoff Services

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

 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

 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

 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 963-460

 service@beckhoff.com

 www.beckhoff.com/en-en/support/our-service-offerings/

1.7.4 Headquarters Germany

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl, Germany

 +49 5246 963-0

 info@beckhoff.com

 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/

1.7.5 Downloadfinder

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

 www.beckhoff.com/documentations

2 For your safety

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

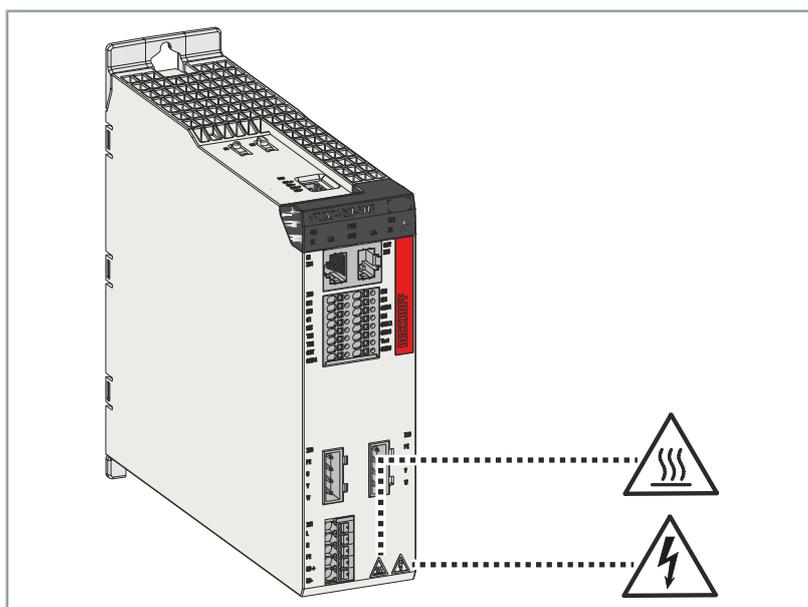
When working with control and automation products, many dangers can result from careless or incorrect use. Work particularly thoroughly, not under time pressure and responsibly towards other people.

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 pictograms may not be removed and must be legible for the user.

2.1.1 Module front

The following safety pictograms are affixed to the front of the Economy variable frequency drive:



Warning: High voltage

The DC link on the modules can have a life-threatening voltage of over 420 V_{DC} or 848 V_{DC}.



Warning: Hot surface

During and after operation, there is a risk of burns on the modules due to hot surfaces above 60 °C. Allow the module housing to cool down for at least 15 minutes.

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

Correctly ground electrical components or modules

Prevent electric shocks due to incorrect grounding of electrical components or modules. Ground all conductive components according to the specifications in the chapter "Electrical installation", [Page 59].

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

Do not touch hot surfaces

Check the temperature 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", [Page 23]. Provide for sufficient cooling. Switch the components off immediately if the temperature is too high.

2.2.3 After operation

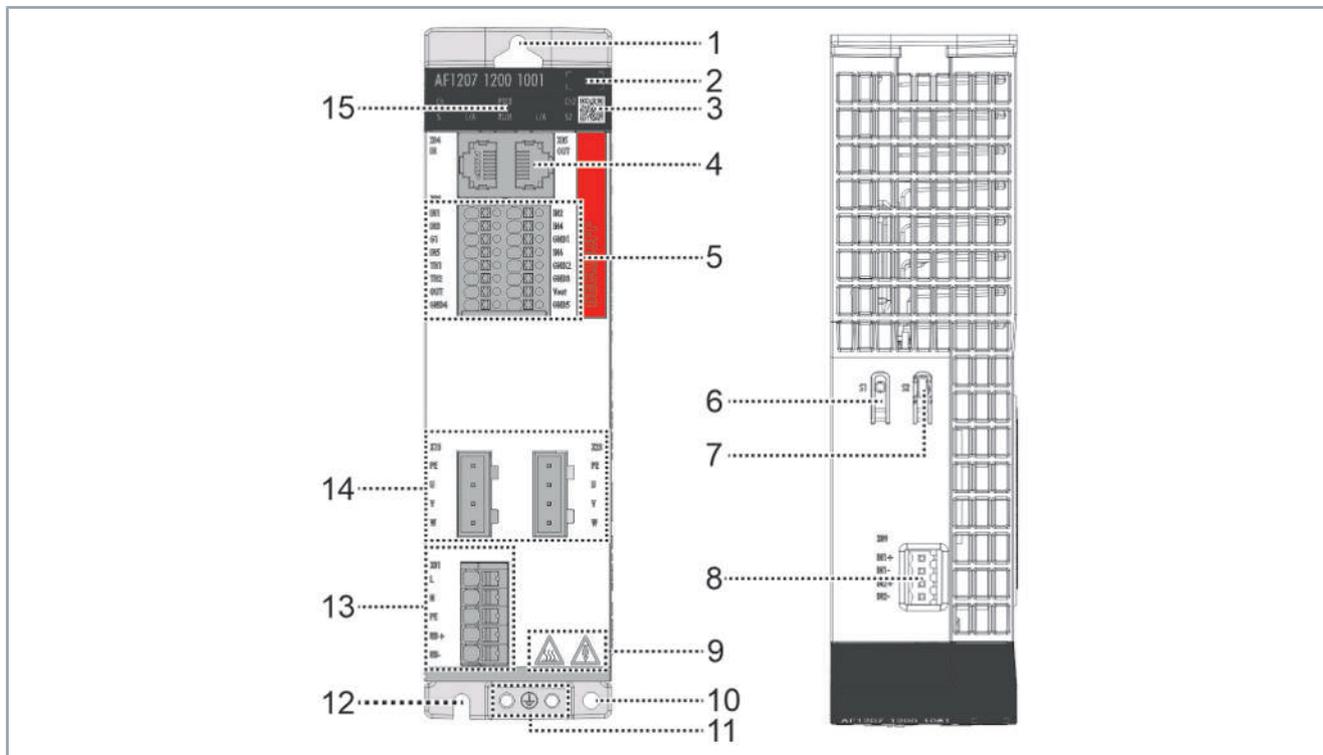
De-energize and switch off components before working on them

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", [Page 93].

3 Product overview

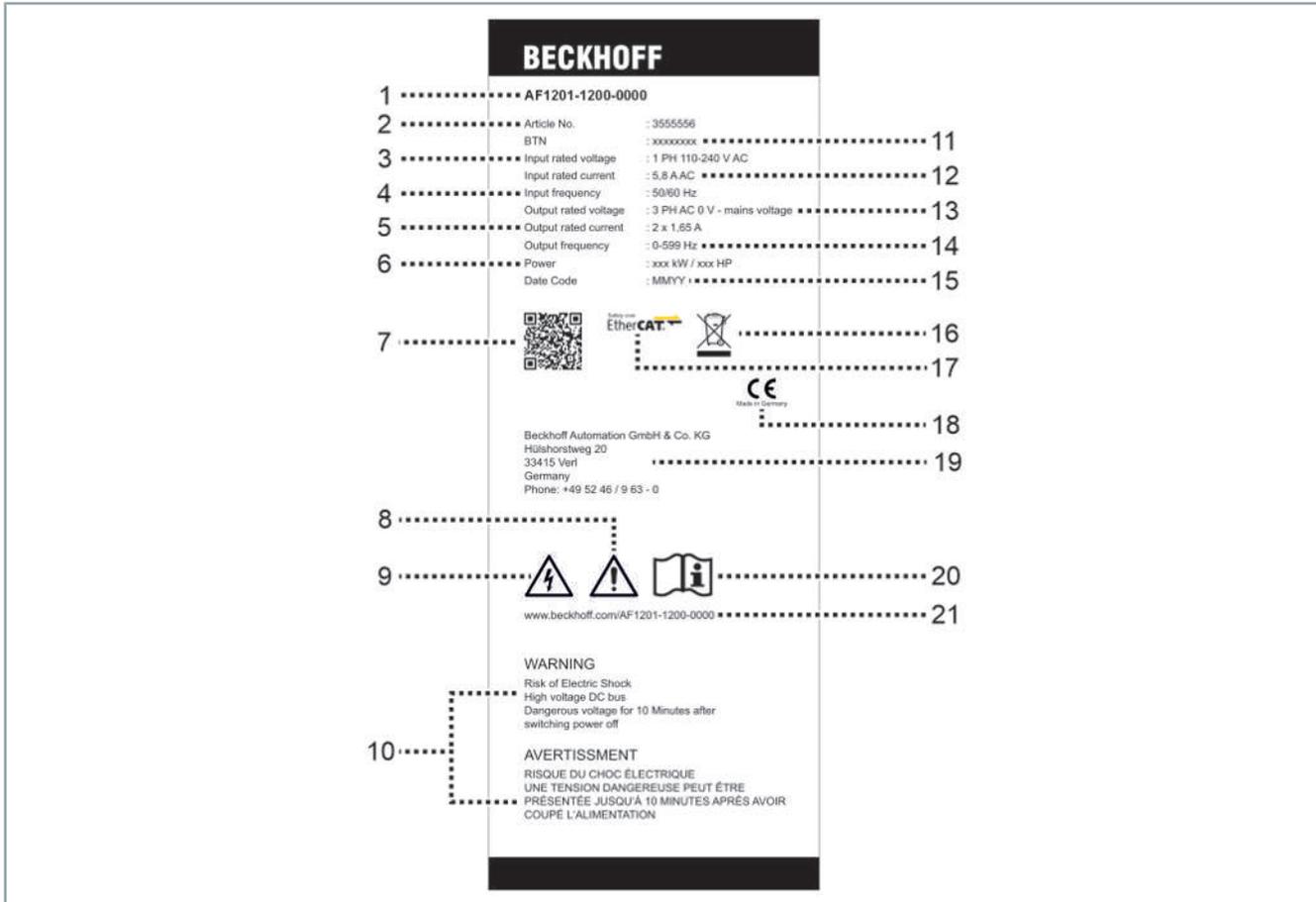


The areas, functions and slots shown in the figure may vary depending on the module version and are provided here for clarity.



| Position | Name | Explanation |
|----------|--------------------|--|
| 1 | Mounting hole | For mounting the variable frequency drive in the control cabinet |
| 2 | Position field | for equipment identification |
| 3 | DataMatrix code | contains BTN for identification, for further information see "name plate", [Page 16] |
| 4 | EtherCAT slot | For connecting the EtherCAT connector to "IN X4/OUT X5", [Page 77] |
| 5 | I/O connection | For connecting the I/O signals to "X02", [Page 78] and X03 X07 Use of internal field voltage 24 V |
| 6 | Push button S1 | for internal purposes |
| 7 | Push button S2 | TwinSAFE actuation button |
| 8 | TwinSAFE I/O slot | For connecting the TwinSAFE plug to "X09", [Page 80] |
| 9 | Safety pictograms | for further information, see "For your safety", [Page 13] |
| 10 | Mounting hole | For mounting the optional footprint filter to the economy variable frequency drive |
| 11 | Grounding | Grounding symbol and double connection point with pre-assembled grounding screws for connecting the protective conductor |
| 12 | Mounting hole | For mounting the variable frequency drive in the control cabinet |
| 13 | Network connection | For connecting the mains supply to "X01", [Page 75] |
| 14 | Motor slot | For connecting the motor connector to "X13/X23", [Page 81] |
| 15 | Display | Display for function and status display, see "Display", [Page 52] |

3.1 Name plate



| Item number | Explanation |
|-------------|------------------------------------|
| 1 | Product name |
| 2 | Order number |
| 3 | Nominal input voltage |
| 4 | Input frequency |
| 5 | Rated output current |
| 6 | Recommended motor power |
| 7 | BIC (Beckhoff Identification Code) |
| 8 | Warning signs |
| 9 | High voltage warning sign |
| 10 | Hazard warnings |
| 11 | Beckhoff Traceability Number, BTN |
| 12 | Rated input current |
| 13 | Nominal output voltage |
| 14 | Output frequency range |
| 15 | Date of manufacture |
| 16 | WEEE conformity |
| 17 | EtherCAT conformity |
| 18 | CE conformity |
| 19 | Manufacturer's address |
| 20 | Note: Read the documentation |
| 21 | Product URL |

3.2 Type key

| AF a b cd – e f g h – i j k l | Explanation |
|-------------------------------|---|
| AF | <i>Product area</i> • Variable frequency drive |
| a | <i>Series</i> • 1 = AF1000 |
| b | <i>Channels</i> • 1 = single-axis module • 2 = dual-axis module |
| cd | <i>Recommended motor power</i> • 03 = 0.37 kW • 07 = 0.75 kW • 15 = 1.5 kW • 22 = 2.2 kW • 30 = 3.0 kW |
| e | <i>Supply</i> • 1 = 1-phase • 3 = 3-phase |
| fg | <i>TwinSAFE</i> • 00 = without Safety • 10 = STO/SS1 (FSoE) • 20 = STO/SS1 (FSoE + I/O) |
| h | not used |
| i | <i>Version</i> • 0 = standard |
| j | not used |
| k | <i>Dual Use</i> • 0 = no Dual Use • 8 = Dual Use |
| l | not used |

3.3 BIC | Beckhoff Identification Code

The *Beckhoff Identification Code*, BIC for short, is used to uniquely identify the component. The BIC is represented as a DataMatrix code, or DMC for short, according to code scheme *ECC200*. The content of the DataMatrix code is based on the ANSI standard *MH10.8.2-2016*.

The BIC and its information can be scanned and read. You can use this information for your internal handling and administration of the products.

3.3.1 BIC as DataMatrix code

The Beckhoff Identification Code is displayed in the form of a DataMatrix code and can be read with a scanner or smartphone.

You will find the DataMatrix code on the product and the product packaging. If there is no BTN under the DataMatrix code, you can read it via the DataMatrix code.

3.3.2 Scanning the DataMatrix code

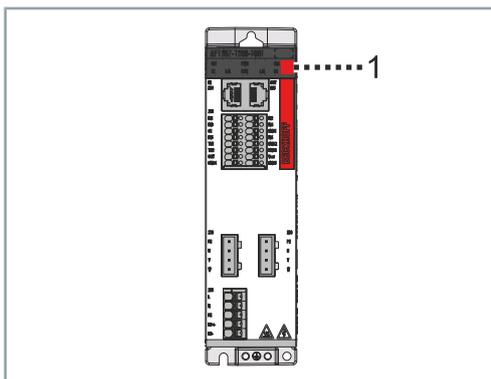
A scanner or smartphone is required to scan the DataMatrix code. Some smartphones support scanning the DataMatrix code with the camera. If scanning is not supported by your camera, Beckhoff recommends the following reader apps:

- *Qrafter* for IOS
- *QR Code Scanner* for Android



Example scan on a economy variable frequency drive

The scanning of the BTN is shown as an example on a economy variable frequency drive AF1000.

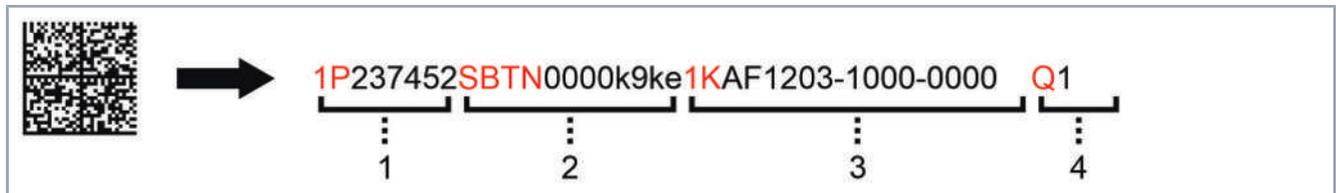


- ▶ Scan the DataMatrix code [1]
- ▶ Read the BTN from the screen of your end device via the camera or the reader app

Further information can be found in chapter "Coded information on the BIC", [Page 19].

3.3.3 Coded information on the BIC

Various information about the component is stored in the BIC. The example shows what information can be stored behind a DataMatrix code. For better clarity, the data identifiers of the BIC are shown in red.



| Position | Explanation | Data ID | Maximum digits | Example |
|----------|---|---------|----------------|--------------------|
| 1 | Beckhoff order number | 1P | 8 | 1P237452 |
| 2 | BTN Beckhoff Traceability Number Unique serial number | SBTN | 12 | SBTN0000k9ke |
| 3 | Product name | 1K | 32 | 1KAF1203-1000-0000 |
| 4 | Quantity Quantity in sales unit | Q | 6 | Q1 |

3.4 Product characteristics

Cost-efficient series

The economy variable frequency drive AF1000 series is a particularly cost-effective series that meets the highest technological standards. DC link capacitors and a braking resistor control are integrated.

Integrated 24 V DC power supply

An integrated 24 V DC power supply generates the control voltage from the DC link voltage.

Supply

Devices with a single-phase supply of 1 x 110...240 V AC are available for applications in the low power range. For higher power ranges, there are devices with 3-phase power supply 3 x 208...480 V AC.

Single-axis and dual-axis module

Both supply variants are available as single-axis and dual-axis modules. Asynchronous, synchronous and reluctance motors without motor feedback are supported.

Drive-integrated safety functions

The economy variable frequency drive AF1000 supports optional TwinSAFE for implementing the drive-integrated safety functions STO/SS1 in accordance with IEC 61800-5-2.

3.5 Ordering options

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

3.5.1 TwinSAFE Drive-integrated safety technology

Basic functions (TwinSAFE STO/SS1) can be implemented with the TwinSAFE safe drive technology. Depending on the product, the functionality can be implemented via safe FSoE communication and/or fixed wiring via fail-safe inputs on variable frequency drive.

AF1xxx-x0xx-xxxx

Axis module without safety

AF1xxx-x1xx-xxxx

Axis module with TwinSAFE STO/SS1 (FSoE)

| Technical data | |
|---------------------|---|
| Function | variable frequency drive with STO/SS1 |
| Implementation STO | through local TwinSAFE Logic or via FSoE |
| Safe stop functions | Safe Torque Off (STO), Safe Stop 1 (SS1) |
| Safety standard | EN ISO 13849-1:2023 (Cat 4, PL e), EN 61508:2010 (SIL 3) and EN 62061:2005 + A1:2013/A2:2015 (SIL CL3) |

AF1xxx-x2xx-xxxx

Axis module with TwinSAFE STO/SS1 (FSoE and I/O)

| Technical data | |
|---------------------|---|
| Function | variable frequency drive with STO/SS1 and I/O |
| Implementation STO | via local TwinSAFE Logic, via FSoE or fixed wiring via safe inputs |
| Safe stop functions | Safe Torque Off (STO), Safe Stop 1 (SS1) |
| Safety standard | EN ISO 13849-1:2023 (Cat 4, PL e), EN 61508:2010 (SIL 3) and EN 62061:2005 + A1:2013/A2:2015 (SIL CL3) |

3.6 Intended use

The modules of the economy variable frequency drive AF1000 may only be operated for the intended use defined in this documentation under the specified 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:

- These operating instructions
- Complete machine documentation provided by the machine manufacturer

3.6.1 Improper use

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



Non-approved areas of application

The economy variable frequency drive AF1000 is not approved for use in the following areas:

- Hazardous areas
- Areas with aggressive environments, for example aggressive gases or chemicals
- Areas with ionizing radiation and nuclear plants
- Aerospace industry

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

3.7 Dual Use

According to the published EU Regulation No. 2021/821, commercially available frequency converters are categorized as dual use items. This means that the Beckhoff economy variable frequency drive AF1000 belongs to the category of goods that could be included in a dual use listing.

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

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

Dual Use listing information

The type key of the economy variable frequency drive AF1000 determines whether export control in accordance with a dual use listing is required.

In the type key of the Beckhoff economy variable frequency drive AF1000, the dual use listing is indicated in the letter "k".

AF1abcd-efgh-ijkl

| Ordering information | Description |
|----------------------|---|
| k = | Dual Use |
| 0 | product not subject to authorization as the rotary field frequency is limited to 599 Hz |
| 8 | product may require an export license, as the maximum rotary field frequency exceeds 599 Hz |

4 Technical data

4.1 Data for operation and environment

NOTICE

Shorter service life due to high temperatures

Temperatures above 45 °C and encapsulated installation can shorten the service life of the product.

- Operate the economy variable frequency drive AF1000 only under the operating and environmental conditions specified in this chapter

NOTICE

Damage caused by conductive dusts

Penetration or deposition of conductive dust can lead to short circuits, malfunctions, fire or explosion hazards.

- Do not use in environments with conductive dusts

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 | |
|---|---|
| Ambient temperature during operation | 0 °C ... +45 °C Extended temperature range up to +55 °C with power derating of 2 % / K |
| Ambient temperature during transport | -25 °C ... +70 °C, maximum fluctuation 20 K per hour |
| Ambient temperature during storage | -25 °C ... +55 °C, maximum fluctuation 20 K per hour |
| Power derating | No power derating up to 1000 m above sea level From 1000 m up to a maximum of 3000 m above sea level with a power derating of 1 % / 100 m |
| 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. |
| Pollution degree | 2 according to EN 60204 and EN 50178 |
| Overvoltage category | 3 according to EN 61800-5-1 |

| Specifications for intended use | |
|--|---|
| Ventilation | <ul style="list-style-type: none">• Free convection• Integrated and temperature-controlled fan |
| Insulation material class | F according to IEC 60085 and UL1446 class F |
| Protection rating | Devices IP20 Terminals IP00 |
| Installation position | Vertical |
| Vibration resistance | 1 g, 150 Hz according to EN 60068-2-6 |
| Shock resistance | 5 g, 30 ms according to EN 60068-2-27 |
| EMC requirements | Conforms to EN 61800-3 |
| Approvals | CE See chapter "Guidelines and Standards", [Page 94] |

4.2 AF1103-1xxx | Economy variable frequency drive, single-phase, single-axis module, 0.37 kW

| Electrical data | | | | |
|--|--------|--|----------|-----------|
| Channels | | | | 1 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 1 x 110 _{-15%} ...240 ^{+10%} | | |
| Rated input current | [A AC] | 6.1 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [W] | 750 | | |
| Maximum braking power | [kW] | 5.0 | | |
| Minimum braking resistor | [Ω] | 35 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current | [A] | 3.0 | 3.0 | tbd |
| Peak output current I_{rms} for max. 3 s | [A] | 8.0 | 7.2 | tbd |
| Peak output current I_{rms} for max. 60 s | [A] | 6.0 | 5.4 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 0.37 | | |
| Recommended motor power | [hp] | 0.5 | | |
| Output apparent power 230 V AC | [kVA] | 1.2 | | |
| Peak output apparent power 230 V AC, for max. 60 s | [kVA] | 2.4 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...420 | | |
| Capacitance | [μF] | 660 | | |
| Output voltage 24 V DC (Vout) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 50 | | |
| Height without connectors | [mm] | 185 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.0 | | |

4.3 AF1107-1xxx | Economy variable frequency drive, single-phase, single-axis module, 0.75 kW

| Electrical data | | | | |
|--|--------|--|----------|-----------|
| Channels | | | | 1 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 1 x 110 _{-15%} ...240 ^{+10%} | | |
| Rated input current | [A AC] | 7.9 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [W] | 750 | | |
| Maximum braking power | [kW] | 5.0 | | |
| Minimum braking resistor | [Ω] | 35.0 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current | [A] | 4.0 | 3.6 | tbd |
| Peak output current I _{rms} for max. 3 s | [A] | 8.0 | 7.2 | tbd |
| Peak output current I _{rms} for max. 60 s | [A] | 6.0 | 5.4 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 0.75 | | |
| Recommended motor power | [hp] | 1.0 | | |
| Output apparent power 230 V AC | [kVA] | 1.6 | | |
| Peak output apparent power 230 V AC, for max. 60 s | [kVA] | 2.4 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...420 | | |
| Capacitance | [μF] | 660 | | |
| Output voltage 24 V DC (V _{out}) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 50 | | |
| Height without connectors | [mm] | 185 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.0 | | |

4.4 AF1115-1xxx | Economy variable frequency drive, single-phase, single-axis module, 1.5 kW

| Electrical data | | | | |
|--|--------|--|----------|-----------|
| Channels | | | | 1 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 1 x 110 _{-15%} ...240 ^{+10%} | | |
| Rated input current | [A AC] | 15.3 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [W] | 1000 | | |
| Maximum braking power | [kW] | 4.8 | | |
| Minimum braking resistor | [Ω] | 33.0 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current | [A] | 6.5 | 6.2 | tbd |
| Peak output current I_{rms} for max. 3 s | [A] | 13.0 | 12.4 | tbd |
| Peak output current I_{rms} for max. 60 s | [A] | 9.8 | 9.3 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 1.5 | | |
| Recommended motor power | [hp] | 2.0 | | |
| Output apparent power 230 V AC | [kVA] | 2.6 | | |
| Peak output apparent power 230 V AC, for max. 60 s | [kVA] | 3.9 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...400 | | |
| Capacitance | [μF] | 940 | | |
| Output voltage 24 V DC (Vout) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 50 | | |
| Height without connectors | [mm] | 185 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.0 | | |

4.5 AF1203-1xxx | Economy variable frequency drive, single-phase, dual-axis module 0.37 kW

| Electrical data | | | | |
|--|--------|--|----------|-----------|
| Channels | | | | 2 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 1 x 110 _{-15%} ...240 ^{+10%} | | |
| Rated input current | [A AC] | 8.1 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [W] | 750 | | |
| Maximum braking power | [kW] | 5.0 | | |
| Minimum braking resistor | [Ω] | 35 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current per channel | [A] | 2.0 | 1.6 | tbd |
| max. rated output current per channel | [A] | 3.0 | 3.0 | tbd |
| Rated output current as total device current | [A] | 4.0 | 3.2 | tbd |
| Peak output current I_{rms} for max. 3 s | [A] | 4.0 | 3.2 | tbd |
| Peak output current I_{rms} for max. 60 s | [A] | 3.0 | 2.4 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 0.37 | | |
| Recommended motor power | [hp] | 0.5 | | |
| Channel output apparent power 230 V AC | [kVA] | 0.8 | | |
| Peak output apparent power 230 V AC, for max. 60 s | [kVA] | 1.2 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...420 | | |
| Capacitance | [μF] | 660 | | |
| Output voltage 24 V DC (Vout) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 50 | | |
| Height without connectors | [mm] | 185 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.0 | | |

4.6 AF1207-1xxx | Economy variable frequency drive, single-phase, dual-axis module 0.75 kW

| Electrical data | | | | |
|--|--------|--|----------|-----------|
| Channels | | | 2 | |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 1 x 110 _{-15%} ...240 ^{+10%} | | |
| Rated input current | [A AC] | 14.5 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [W] | 1000 | | |
| Maximum braking power | [kW] | 4.8 | | |
| Minimum braking resistor | [Ω] | 33.0 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current per channel | [A] | 3.6 | 3.4 | tbd |
| max. rated output current per channel | [A] | 4.5 | 4.0 | tbd |
| Rated output current as total device current | [A] | 7.2 | 6.8 | tbd |
| Peak output current I_{rms} for max. 3 s | [A] | 7.2 | 6.8 | tbd |
| Peak output current I_{rms} for max. 60 s | [A] | 5.4 | 5.1 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 0.75 | | |
| Recommended motor power | [hp] | 1.0 | | |
| Channel output apparent power 230 V AC | [kVA] | 1.4 | | |
| Peak output apparent power 230 V AC, for max. 60 s | [kVA] | 2.2 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...400 | | |
| Capacitance | [μF] | 940 | | |
| Output voltage 24 V DC (Vout) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 50 | | |
| Height without connectors | [mm] | 185 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.0 | | |

4.7 AF1107-3xxx | Economy variable frequency drive, three-phase, single-axis module, 0.75 kW

| Electrical data | | | | |
|--|--------|---|----------|-----------|
| Channels | | | | 1 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 3 x 208 _{-15%} ...480 ^{+8%} | | |
| Rated input current | [A AC] | 2.5 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [kW] | 3.0 | | |
| Maximum braking power | [kW] | 14.2 | | |
| Minimum braking resistor | [Ω] | 45.0 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current | [A] | 2.5 | 2.5 | tbd |
| Peak output current I _{rms} for max. 3 s | [A] | 5.0 | 5.0 | tbd |
| Peak output current I _{rms} for max. 60 s | [A] | 3.8 | 3.8 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 0.75 | | |
| Recommended motor power | [hp] | 1.0 | | |
| Output apparent power 400 V AC | [kVA] | 1.7 | | |
| Peak output apparent power 400 V AC, for max. 60 s | [kVA] | 2.6 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...800 | | |
| Capacitance | [μF] | 235 | | |
| Output voltage 24 V DC (V _{out}) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 60 | | |
| Height without connectors | [mm] | 225 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.5 | | |

4.8 AF1115-3xxx | Economy variable frequency drive, three-phase, single-axis module, 1.5 kW

| Electrical data | | | | |
|--|--------|---|----------|-----------|
| Channels | | | | 1 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 3 x 208 _{-15 %} ...480 ^{+8 %} | | |
| Rated input current | [A AC] | 6.0 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [kW] | 3.0 | | |
| Maximum braking power | [kW] | 14.2 | | |
| Minimum braking resistor | [Ω] | 45.0 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current | [A] | 4.3 | 4.0 | tbd |
| Peak output current I_{rms} for max. 3 s | [A] | 8.6 | 8.0 | tbd |
| Peak output current I_{rms} for max. 60 s | [A] | 6.5 | 6.0 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 1.5 | | |
| Recommended motor power | [hp] | 2.0 | | |
| Output apparent power 400 V AC | [kVA] | 3.0 | | |
| Peak output apparent power 400 V AC, for max. 60 s | [kVA] | 4.5 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...800 | | |
| Capacitance | [μF] | 235 | | |
| Output voltage 24 V DC (Vout) | | | | |
| Voltage range | [V DC] | 24 _{-5 %} ...24 ^{+6 %} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 60 | | |
| Height without connectors | [mm] | 225 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.5 | | |

4.9 AF1130-3xxx | Economy variable frequency drive, three-phase, single-axis module, 3.0 kW

| Electrical data | | | | |
|--|--------|---|----------|-----------|
| Channels | | | | 1 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 3 x 208 _{-15%} ...480 ^{+8%} | | |
| Rated input current | [A AC] | 10.0 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [kW] | 6.0 | | |
| Maximum braking power | [kW] | 26.7 | | |
| Minimum braking resistor | [Ω] | 24.0 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current | [A] | 7.6 | 7.4 | tbd |
| Peak output current I _{rms} for max. 3 s | [A] | 15.2 | 14.8 | tbd |
| Peak output current I _{rms} for max. 60 s | [A] | 11.4 | 11.1 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 3.0 | | |
| Recommended motor power | [hp] | 4.0 | | |
| Output apparent power 400 V AC | [kVA] | 5.3 | | |
| Peak output apparent power 400 V AC, for max. 60 s | [kVA] | 7.9 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...800 | | |
| Capacitance | [μF] | 235 | | |
| Output voltage 24 V DC (Vout) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 60 | | |
| Height without connectors | [mm] | 225 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.5 | | |

4.10 AF1207-3xxx | Economy variable frequency drive, three-phase, dual-axis module 0.75 kW

| Electrical data | | | | |
|--|--------|---|----------|-----------|
| Channels | | | | 2 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 3 x 208 _{-15%} ...480 ^{+8%} | | |
| Rated input current | [A AC] | 6.0 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [kW] | 3.0 | | |
| Maximum braking power | [kW] | 14.2 | | |
| Minimum braking resistor | [Ω] | 45.0 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current per channel | [A] | 2.5 | 2.5 | tbd |
| max. rated output current per channel | [A] | 5.0 | 5.0 | tbd |
| Rated output current as total device current | [A] | 5.0 | 5.0 | tbd |
| Peak output current I_{rms} for max. 3 s | [A] | 8.6 | 8.0 | tbd |
| Peak output current I_{rms} for max. 60 s | [A] | 6.5 | 6.0 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 0.75 | | |
| Recommended motor power | [hp] | 1.0 | | |
| Channel output apparent power 3 x 400 V AC | [kVA] | 1.7 | | |
| Peak output apparent power 400 V AC, for max. 60 s | [kVA] | 4.5 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...800 | | |
| Capacitance | [μF] | 235 | | |
| Output voltage 24 V DC (Vout) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 60 | | |
| Height without connectors | [mm] | 225 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.5 | | |

4.11 AF1215-3xxx | Economy variable frequency drive, three-phase, dual-axis module, 1.5 kW

| Electrical data | | | | |
|--|--------|---|----------|-----------|
| Channels | | | | 2 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 3 x 208 _{-15%} ...480 ^{+8%} | | |
| Rated input current | [A AC] | 11.0 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [kW] | 3.0 | | |
| Maximum braking power | [kW] | 14.2 | | |
| Minimum braking resistor | [Ω] | 45.0 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current per channel | [A] | 4.3 | 4.0 | tbd |
| max. rated output current per channel | [A] | 6.5 | 6.2 | tbd |
| Rated output current as total device current | [A] | 8.6 | 8.0 | tbd |
| Peak output current I_{rms} for max. 3 s | [A] | 8.6 | 8.0 | tbd |
| Peak output current I_{rms} for max. 60 s | [A] | 6.5 | 6.0 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 1.5 | | |
| Recommended motor power | [hp] | 2.0 | | |
| Channel output apparent power 3 x 400 V AC | [kVA] | 3.0 | | |
| Peak output apparent power 400 V AC, for max. 60 s | [kVA] | 4.5 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...800 | | |
| Capacitance | [μF] | 235 | | |
| Output voltage 24 V DC (Vout) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 60 | | |
| Height without connectors | [mm] | 225 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.5 | | |

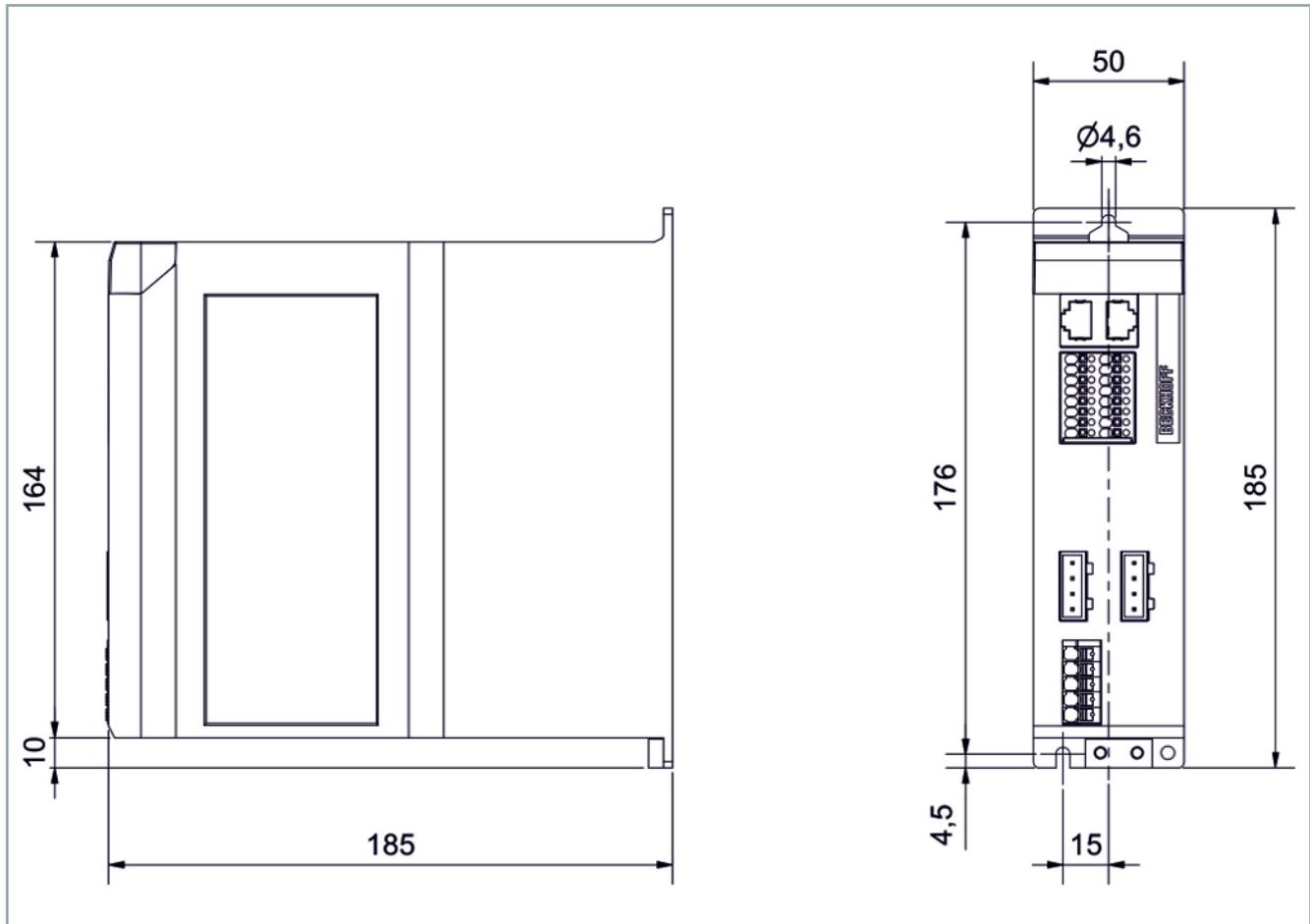
4.12 AF1222-3xxx | Economy variable frequency drive, three-phase, dual-axis module, 2.2 kW

| Electrical data | | | | |
|--|--------|---|----------|-----------|
| Channels | | | | 2 |
| Mains supply | | | | |
| Rated supply voltage | [V AC] | 3 x 208 _{-15%} ...480 ^{+8%} | | |
| Rated input current | [A AC] | 15.0 | | |
| Mains filter | | external | | |
| SCCR value | [kA] | 65 | | |
| External braking resistor - Values dependent on the connected resistor | | | | |
| Continuous braking power | [kW] | 6.0 | | |
| Maximum braking power | [kW] | 26.7 | | |
| Minimum braking resistor | [Ω] | 24.0 | | |
| Output current | | | | |
| Valid for a switching frequency of | [kHz] | 4 | 8 | 16 |
| Rated output current per channel | [A] | 6.0 | 5.6 | tbd |
| max. rated output current per channel | [A] | 9.0 | 8.6 | tbd |
| Rated output current as total device current | [A] | 12.0 | 11.2 | tbd |
| Peak output current I_{rms} for max. 3 s | [A] | 12.0 | 11.2 | tbd |
| Peak output current I_{rms} for max. 60 s | [A] | 9.0 | 8.4 | tbd |
| Power | | | | |
| Recommended motor power | [kW] | 2.2 | | |
| Recommended motor power | [hp] | 3 | | |
| Channel output apparent power 3 x 400 V AC | [kVA] | 4.2 | | |
| Peak output apparent power 400 V AC, for max. 60 s | [kVA] | 6.3 | | |
| DC link | | | | |
| Voltage range | [V DC] | 0...800 | | |
| Capacitance | [μF] | 470 | | |
| Output voltage 24 V DC (Vout) | | | | |
| Voltage range | [V DC] | 24 _{-5%} ...24 ^{+6%} | | |
| Max. output current | [A DC] | 1.0 | | |
| Output frequency | | | | |
| Limited frequency of the standard version | [Hz] | 0...599 | | |
| Frequency of the dual use version | [Hz] | 0...2000 | | |
| Mechanical data | | | | |
| Width | [mm] | 60 | | |
| Height without connectors | [mm] | 225 | | |
| Depth without connectors | [mm] | 185 | | |
| Weight | [kg] | 1.5 | | |

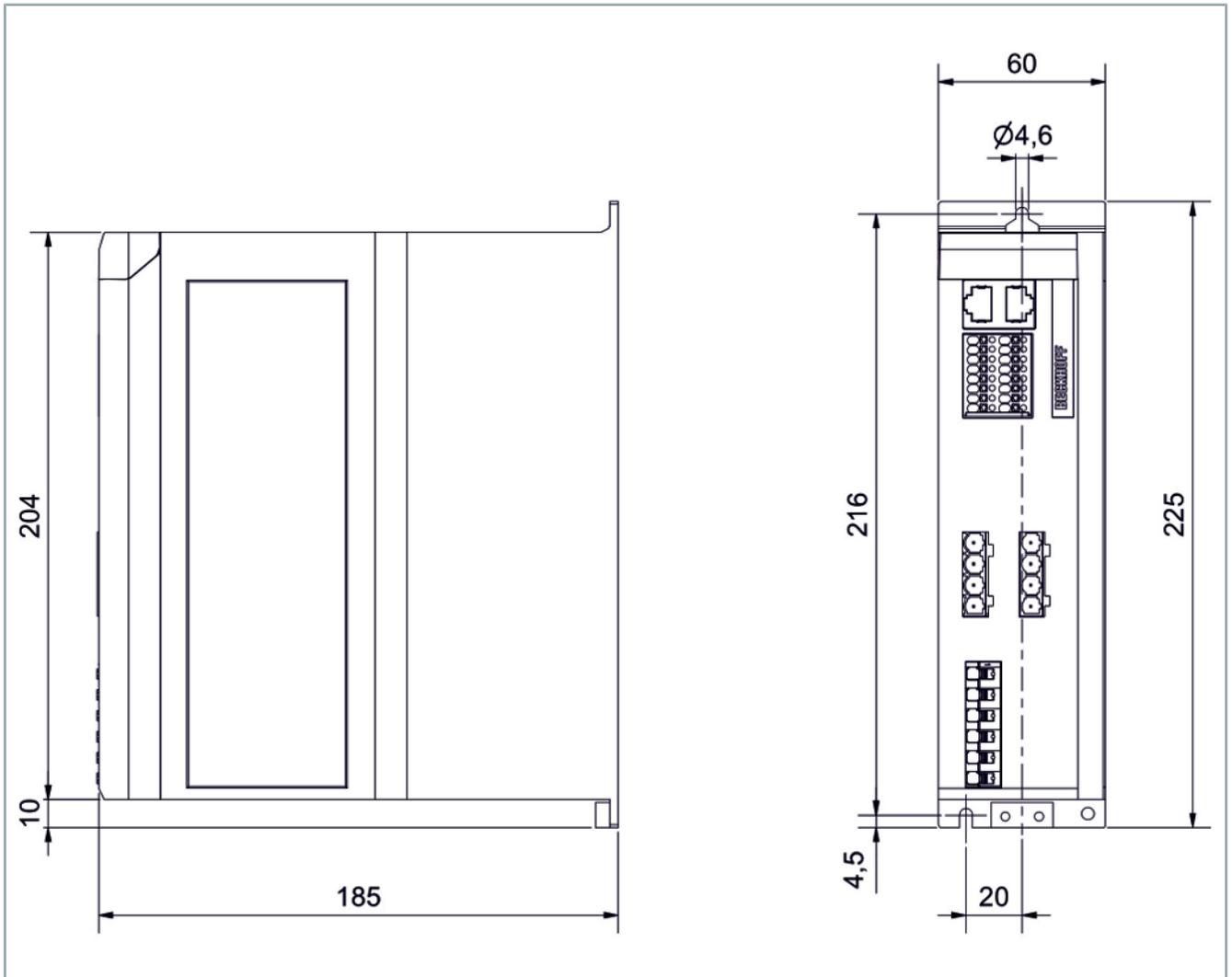
4.13 Dimensional drawings

All dimensions in mm

4.13.1 AF1xxx-1xxx



4.13.2 AF1xxx-3xxx



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.

Depending on the application, the scope of supply may consist of different components and documents. Please check the delivery.

The connector for motor connection via socket X13/X23 is not included in the scope of delivery and must be ordered separately.

AF1xxx-x0xx-xxx

Axis module without TwinSAFE

| Name | Function |
|-----------------------|---------------------------|
| Quick reference guide | • Information |
| Grounding screws | • 2 pieces, pre-assembled |

AF1xxx-x1xx-xxx

Axis module with TwinSAFE STO/SS1 (FSoE)

| Name | Function |
|-----------------------|---------------------------|
| Quick reference guide | • Information |
| Grounding screws | • 2 pieces, pre-assembled |

AF1xxx-x2xx-xxx

Axis module with TwinSAFE STO/SS1 (FSoE and I/O)

| Name | Function |
|---------------------------------|--|
| Quick reference guide | • Information |
| Grounding screws | • 2 pieces, pre-assembled |
| Mating connector for X09 | • TwinSAFE safe digital inputs "slot X09", [Page 80] |

5.1 Product packaging

Instructions for handling are printed on the packaging:



The product packaging is not suitable for transporting the product. It is used to show important information such as the storage temperature range, stacking direction and information for transport in shipping packaging. Shipping packaging is required to transport the product safely. There is a note on the product packaging.

Shipping instructions

| Symbol | Explanation |
|--|---|
|  +55 °C -25 °C | Highest and lowest temperature to store the product safely. |
|  | This is the correct position for the packaging. |
|  | The packaging must be protected from moisture. |
|  | The contents are fragile. |

6 Transport and storage

⚠ WARNING

Serious injuries due to damaged economy variable frequency drive

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

- Protect the economy variable frequency drive from damage during transport and storage
- Comply with the conditions for transport and storage

NOTICE

Loss of warranty due to disregard of transport and storage conditions

Failure to observe the conditions may result in damage to the economy variable frequency drive and void the warranty.

- Observe the conditions in the following chapter for transport and storage

NOTICE

Damage due to moisture in the economy variable frequency drive

Condensed water can form during transport in cold weather or in case of extreme temperature differences. If the economy variable frequency drive is not completely dry, condensed water can lead to a short circuit when switching on and damage the economy variable frequency drive.

- Make sure that no moisture accumulates in the economy variable frequency drive
- Equalize the room temperature slowly
- Only switch on the economy variable frequency drive when it is in a dry state

6.1 Conditions

During transport and storage ensure that the economy variable frequency drive and individual components are not damaged. Observe the following chapters, comply with the "specifications for operation and environment", [Page 23] and observe the following instructions:

- ▶ Avoid electrostatic charging.
- ▶ Avoid contact with highly insulating materials.
- ▶ Use of suitable means of transport.
- ▶ Use the vendor's original packaging.

The table shows the maximum stacking height at which you may store and transport the economy variable frequency drive on a pallet in its original packaging:

| economy variable frequency drive AF1000 | Stacking height [pieces] |
|--|--------------------------|
| Without interlayer | 5 |
| With interlayer every 5 boxes | 15 |

6.2 Transport

NOTICE

Damage due to high mechanical load

High mechanical loads will damage the economy variable frequency drive and individual components.

- Use suitable means of transport
- Protect the economy variable frequency drive from high mechanical loads

All modules can be transported without aids.

6.3 Long-term storage

The economy variable frequency drive can be stored for shorter or longer periods.

- ▶ Store the product in its original packaging
- ▶ Adhere to the conditions specified in the chapter: Transport and storage
- ▶ Ensure the storage space is vibration-free

6.3.1 Forming the capacitors

During long storage periods, the installed DC link capacitors must be reformed. The following steps must be carried out:

- ▶ Connecting the mains voltage to the drive system
- ▶ Leave the drive system connected to the mains voltage for 60 minutes and do not operate under load

The device can then be used as usual.

The time interval at which the capacitors must be formed varies depending on the storage temperature.

| Storage temperature | Forming interval |
|---------------------|------------------|
| < 25 °C | 5 years |
| > 25 °C | 3 years |

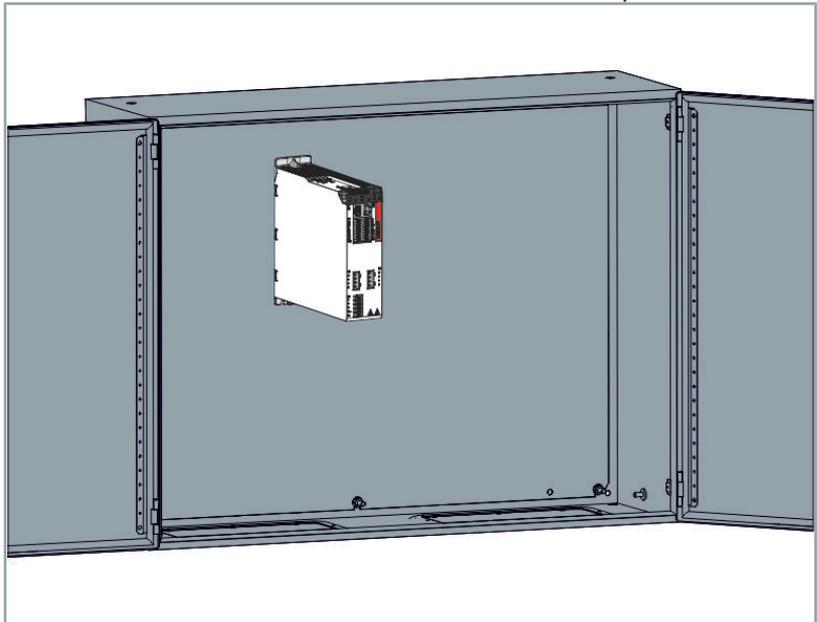
7 Technical description

7.1 Installation location and position

Install the variable frequency drive in an enclosure, e.g. a control cabinet, that complies with the required protection class for the installation environment. The installation location must be free of conductive and aggressive material.

Observe the required clearances above and below the economy variable frequency drive at "Control cabinet installation dimensions", [Page 57].

The standard installation position of the economy variable frequency drive in the control cabinet is the vertical installation position.



7.2 Length of the motor cable

For the variable frequency drive AF1000, a total motor cable length of max. 25 m per motor applies in industrial applications.



Requirements for CE

To comply with CE, the use of mains filters is mandatory. Please refer to the information in chapter "Electromagnetic interference emission", [Page 61].

7.3 Braking resistor

The economy variable frequency drive AF1000 offers the option of converting braking energy into heat via the external braking resistor. The external braking resistor is connected to "Mains connection | X01", [Page 75].

External braking resistor

The following table shows an overview of the available braking resistors for the minimum permissible braking resistors.

AF1xxx-1xxx* with 35 Ω min. braking resistor

| Braking resistor | available braking power |
|------------------|-------------------------|
| AX2090-BW10-1001 | 0.10 kW |
| AX2090-BW10-1002 | 0.15 kW |

*for 1 x 100...240 V AC

AF1xxx-3xxx* with 45 Ω min. braking resistor

| Braking resistor | available braking power |
|------------------|-------------------------|
| AX2090-BW10-3003 | 0.30 kW |
| AX2090-BW10-3005 | 0.48 kW |

*for 3 x 200...480 V AC



Check braking resistor power

Check the braking resistor power with the TE5910 | TwinCAT 3 Motion Designer design software.

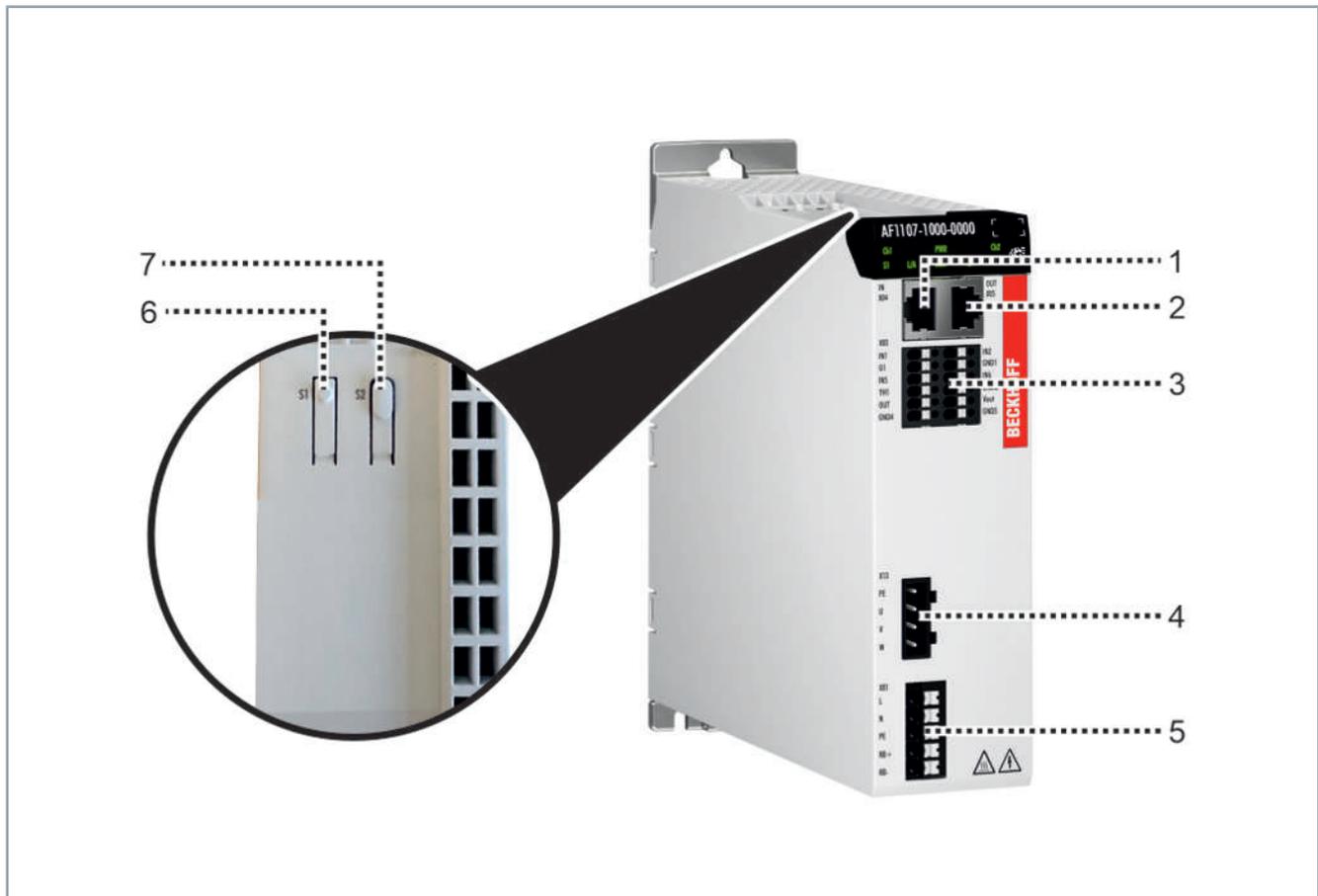
- Install TE5910 from the Beckhoff homepage.
- Enter the data for your configuration.
- Check your configuration.
- Select the braking resistor according to the result.



[TE5910 | TwinCAT 3 Motion Designer](#)

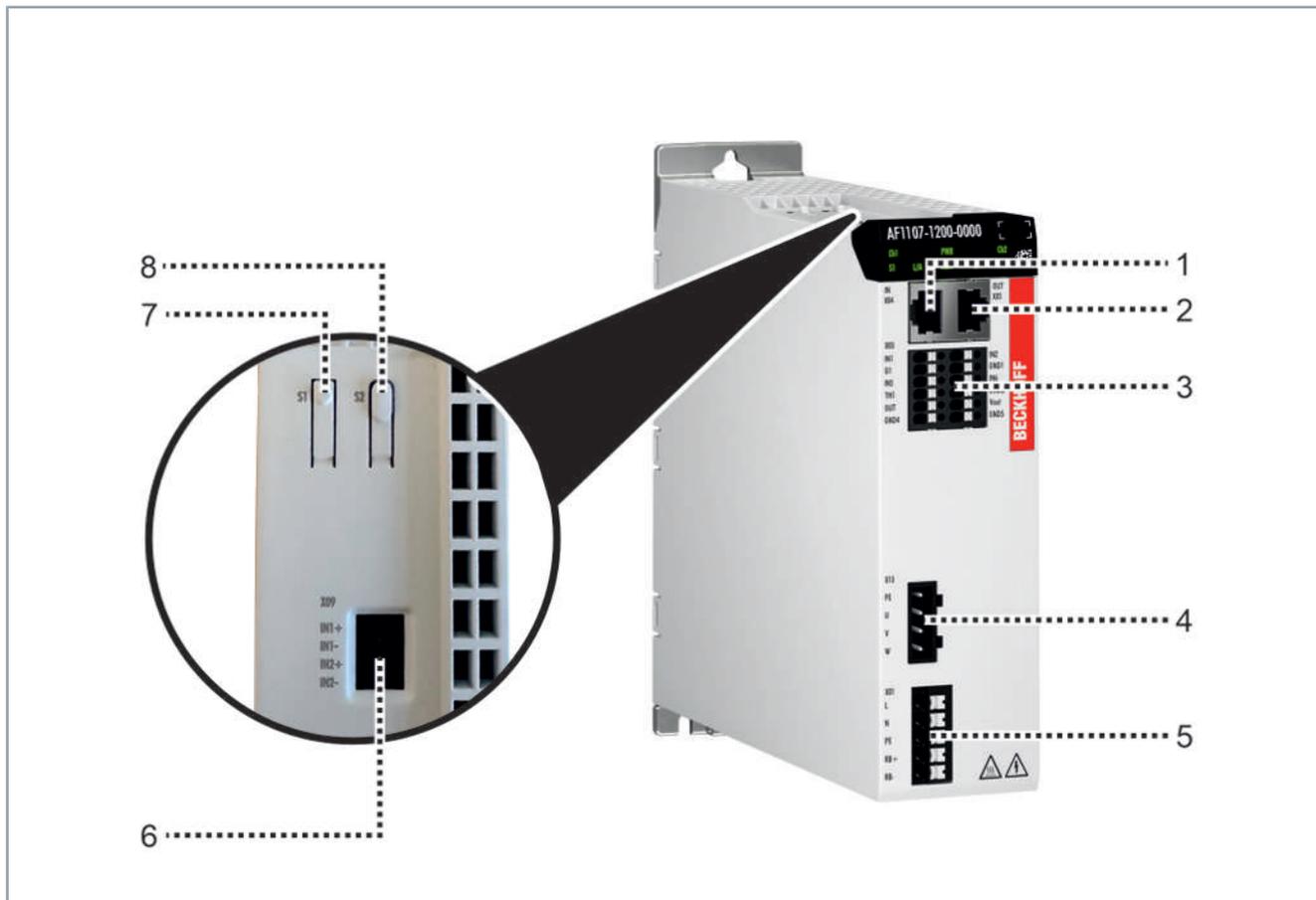
7.4 Connections on the device

7.4.1 AF11xx-100x, AF11xx-110x



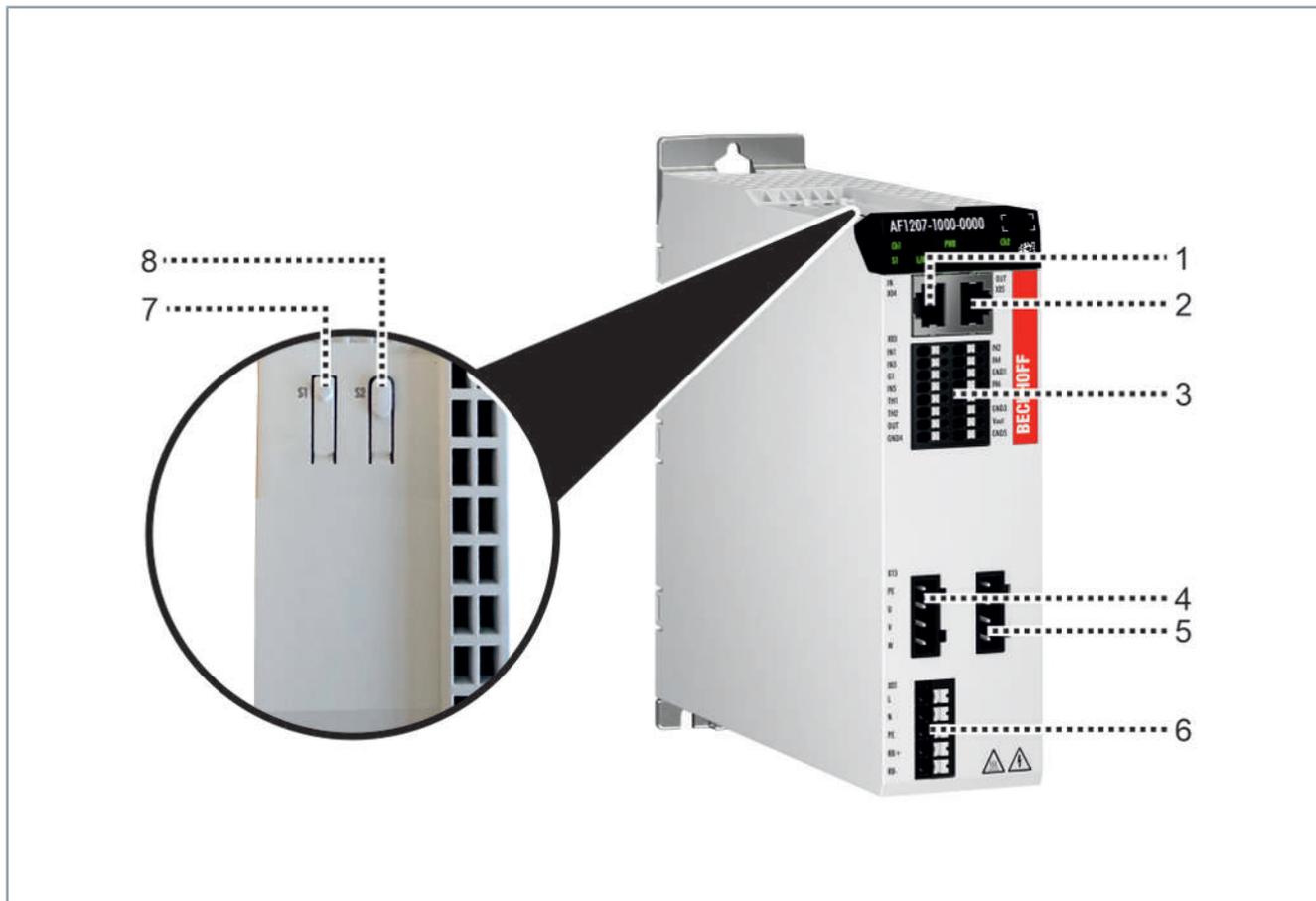
| Position | Labeling | Explanation |
|----------|----------|---|
| 1 | IN X04 | RJ45 socket for the incoming EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 2 | OUT X05 | RJ45 socket for the downstream EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 3 | X02 | Connection I/O: 12-pin terminal point for digital input/output signals, see "I/O connection X02", [Page 78] |
| 4 | X13 | Slot motor channel 1, see "Motor slot X13", [Page 81] |
| 5 | X01 | Single-phase network connection, see "Mains connection X01", [Page 75] |
| 6 | S1 | Push button for internal purposes |
| 7 | S2 | TwinSAFE actuation button |

7.4.2 AF11xx-120x



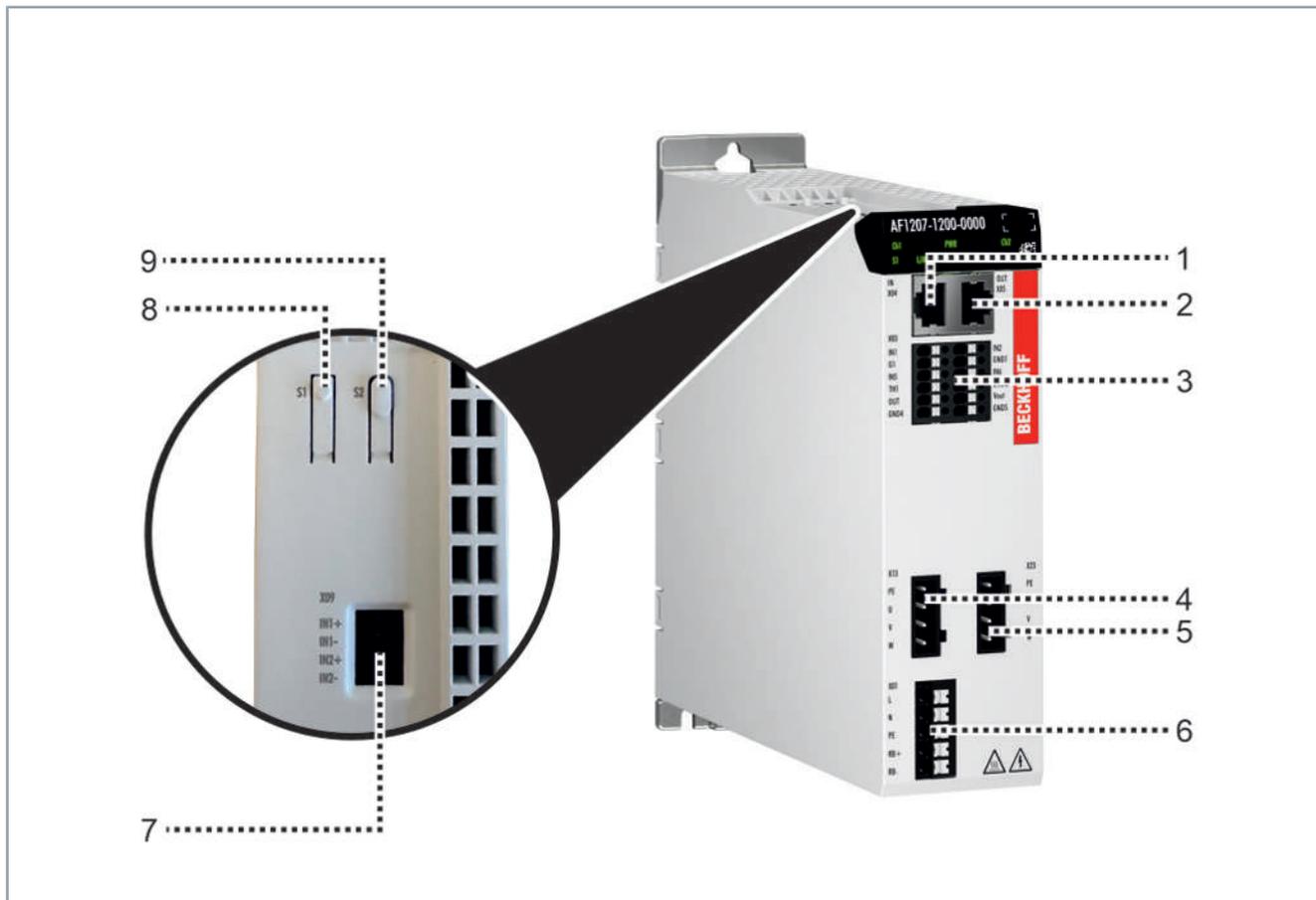
| Position | Labeling | Explanation |
|----------|----------|---|
| 1 | IN X04 | RJ45 socket for the incoming EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 2 | OUT X05 | RJ45 socket for the downstream EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 3 | X02 | Connection I/O: 12-pin terminal point for digital input/output signals, see "I/O connection X02", [Page 78] |
| 4 | X13 | Slot motor channel 1, see "Motor slot X13", [Page 81] |
| 5 | X01 | Single-phase network connection, see "Mains connection X01", [Page 75] |
| 6 | X09 | TwinSAFE slot: safe inputs, see "TwinSAFE slot X09", [Page 80] |
| 7 | S1 | Push button for internal purposes |
| 8 | S2 | TwinSAFE actuation button |

7.4.3 AF12xx-100x, AF12xx-110x



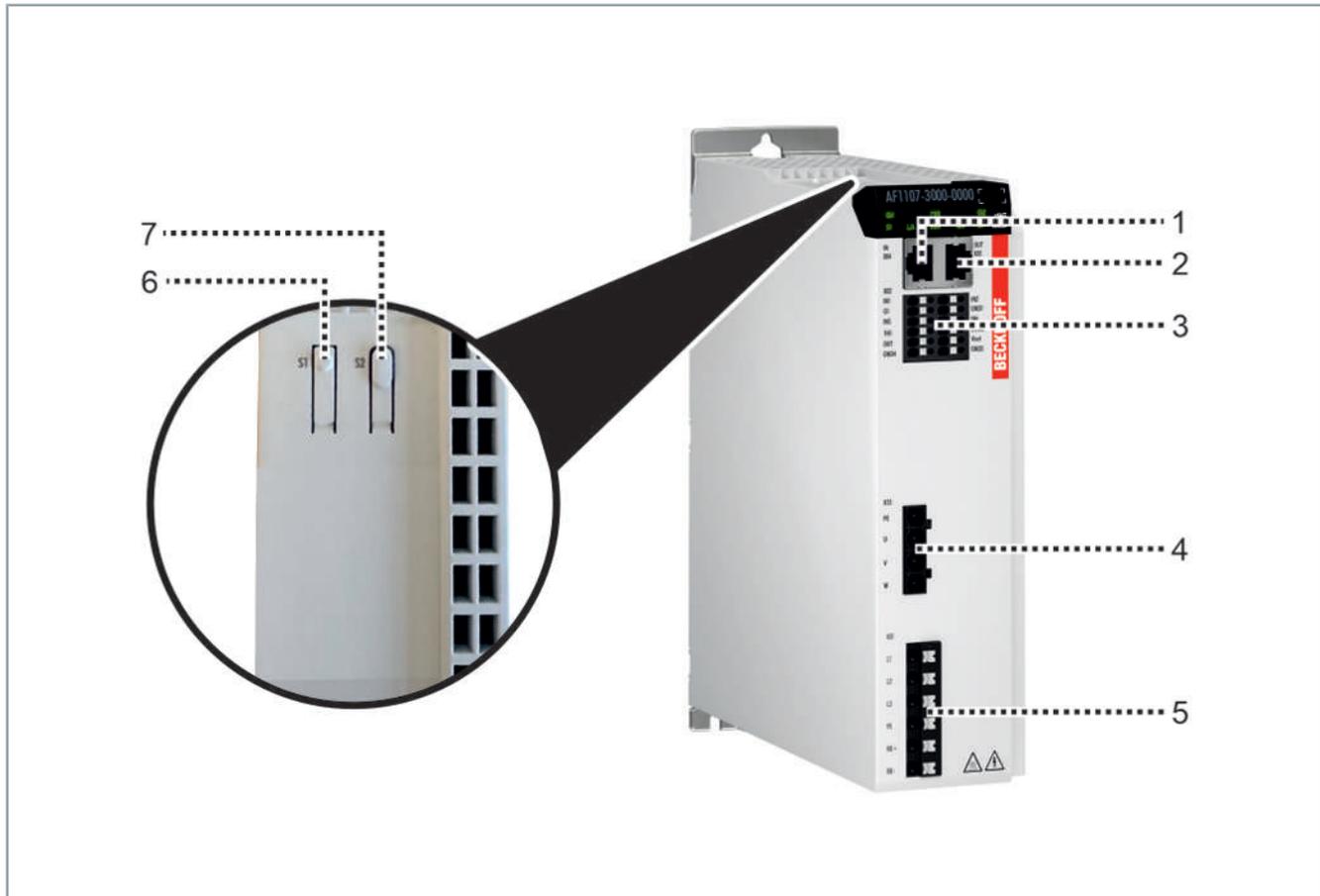
| Position | Labeling | Explanation |
|----------|----------|---|
| 1 | IN X04 | RJ45 socket for the incoming EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 2 | OUT X05 | RJ45 socket for the downstream EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 3 | X03 | Connection I/O: 16-pin terminal point for digital input/output signals, see "I/O connection X03", [Page 79] |
| 4 | X13 | Slot motor channel 1, see "Motor slot X13", [Page 81] |
| 5 | X23 | Slot motor channel 2, see "Motor slot X23", [Page 83] |
| 6 | X01 | Single-phase network connection, see "Mains connection X01", [Page 75] |
| 7 | S1 | Push button for internal purposes |
| 8 | S2 | TwinSAFE actuation button |

7.4.4 AF12xx-120x



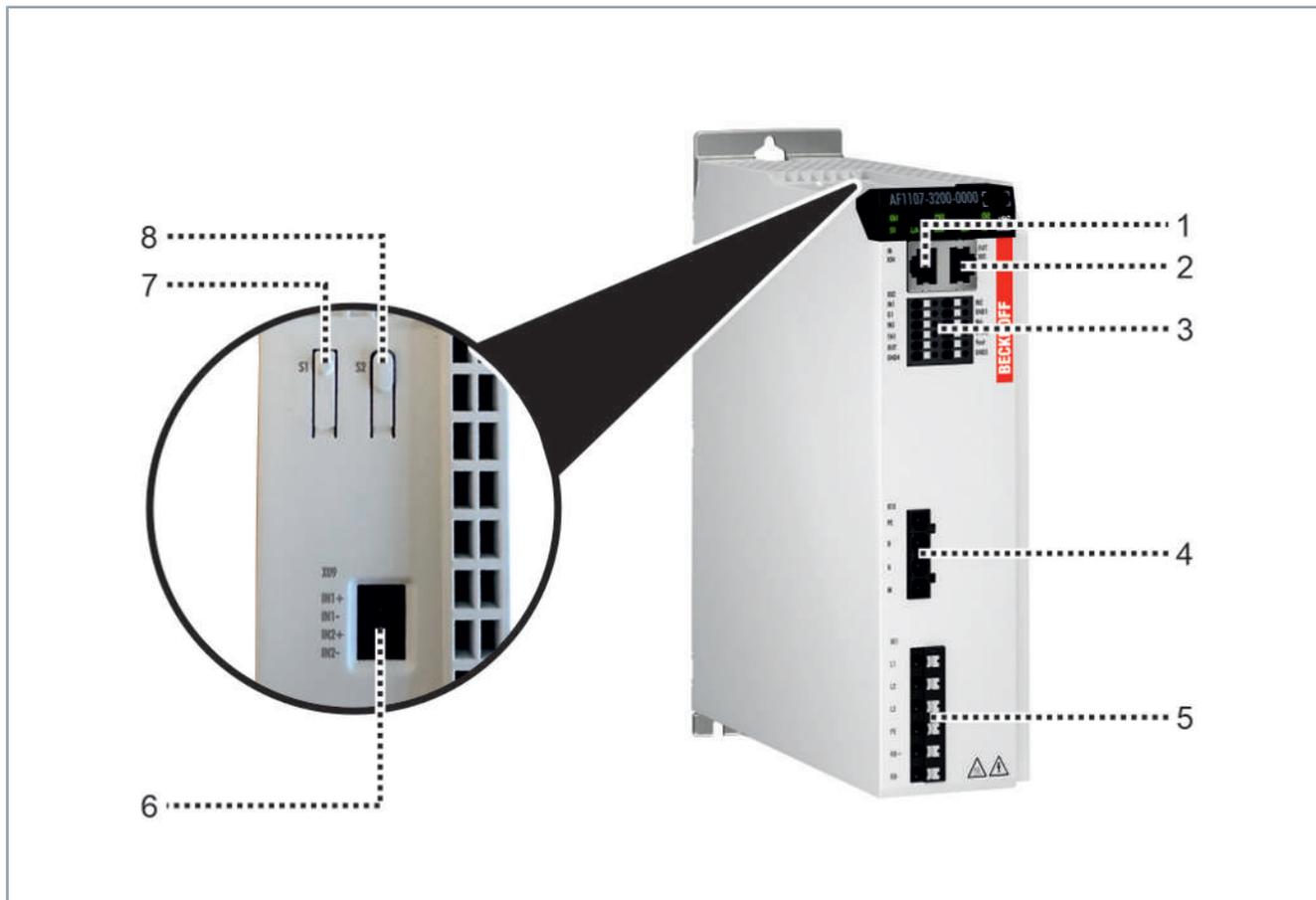
| Position | Labeling | Explanation |
|----------|----------|---|
| 1 | IN X04 | RJ45 socket for the incoming EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 2 | OUT X05 | RJ45 socket for the downstream EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 3 | X03 | Connection I/O: 16-pin terminal point for digital input/output signals, see "I/O connection X03", [Page 79] |
| 4 | X13 | Slot motor channel 1, see "Motor slot X13", [Page 81] |
| 5 | X23 | Slot motor channel 2, see "Motor slot X23", [Page 83] |
| 6 | X01 | Single-phase network connection, see "Mains connection X01", [Page 75] |
| 7 | X09 | TwinSAFE slot: safe inputs see "TwinSAFE slot X09", [Page 80] |
| 8 | S1 | Push button for internal purposes |
| 9 | S2 | TwinSAFE actuation button |

7.4.5 AF11xx-300x, AF11xx-310x



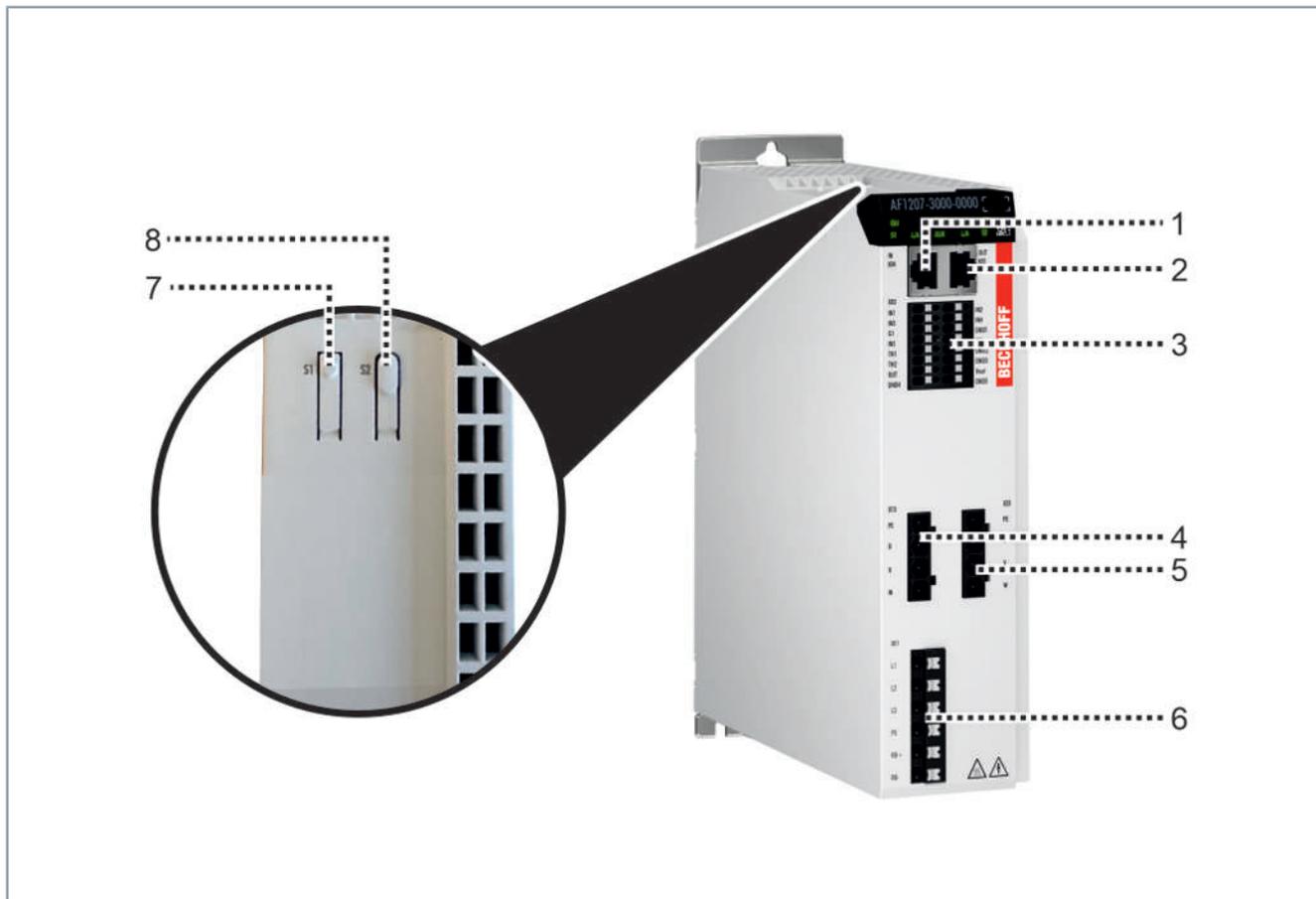
| Position | Labeling | Explanation |
|----------|----------|---|
| 1 | IN X04 | RJ45 socket for the incoming EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 2 | OUT X05 | RJ45 socket for the downstream EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 3 | X02 | Connection I/O: 12-pin terminal point for digital input/output signals, see "I/O connection X02", [Page 78] |
| 4 | X13 | Slot motor channel 1, see "Motor slot X13", [Page 81] |
| 5 | X01 | Three-phase network connection, see "Mains connection X01", [Page 75] |
| 6 | S1 | Push button for internal purposes |
| 7 | S2 | TwinSAFE actuation button |

7.4.6 AF11xx-320x



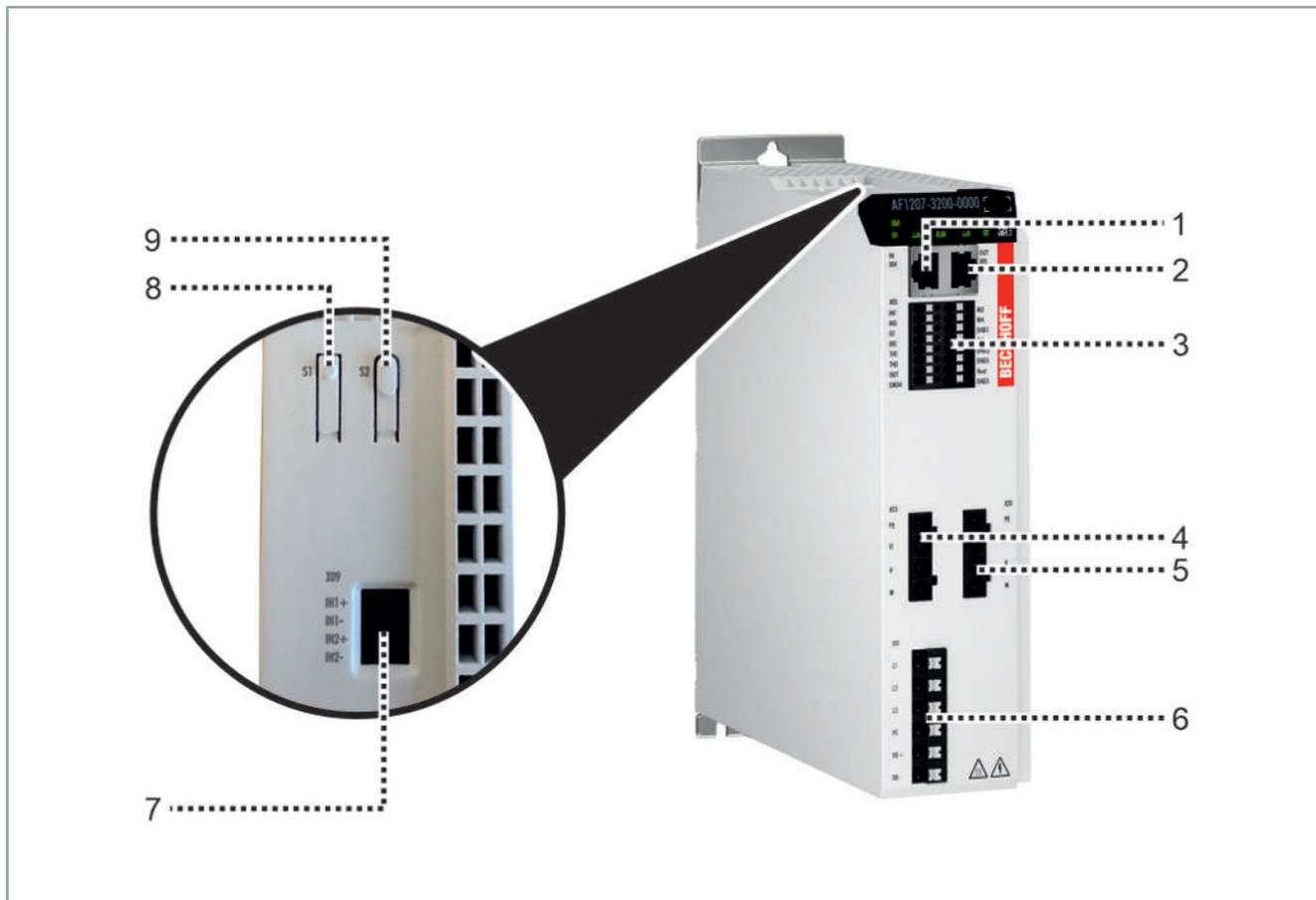
| Position | Labeling | Explanation |
|----------|----------|---|
| 1 | IN X04 | RJ45 socket for the incoming EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 2 | OUT X05 | RJ45 socket for the downstream EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 3 | X02 | Connection I/O: 12-pin terminal point for digital input/output signals, see "I/O connection X02", [Page 78] |
| 4 | X13 | Slot motor channel 1, see "Motor slot X13", [Page 81] |
| 5 | X01 | Three-phase network connection, see "Mains connection X01", [Page 75] |
| 6 | X09 | TwinSAFE slot: safe inputs see "TwinSAFE slot X09", [Page 80] |
| 7 | S1 | Push button for internal purposes |
| 8 | S2 | TwinSAFE actuation button |

7.4.7 AF12xx-300x, AF12xx-310x



| Position | Labeling | Explanation |
|----------|----------|---|
| 1 | IN X04 | RJ45 socket for the incoming EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 2 | OUT X05 | RJ45 socket for the downstream EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 3 | X03 | Connection I/O: 16-pin terminal point for digital input/output signals, see "I/O connection X03", [Page 79] |
| 4 | X13 | Slot motor channel 1, see "Motor slot X13", [Page 81] |
| 5 | X23 | Slot motor channel 2, see "Motor slot X23", [Page 83] |
| 6 | X01 | Three-phase network connection, see "Mains connection X01", [Page 75] |
| 7 | S1 | Push button for internal purposes |
| 8 | S2 | TwinSAFE actuation button |

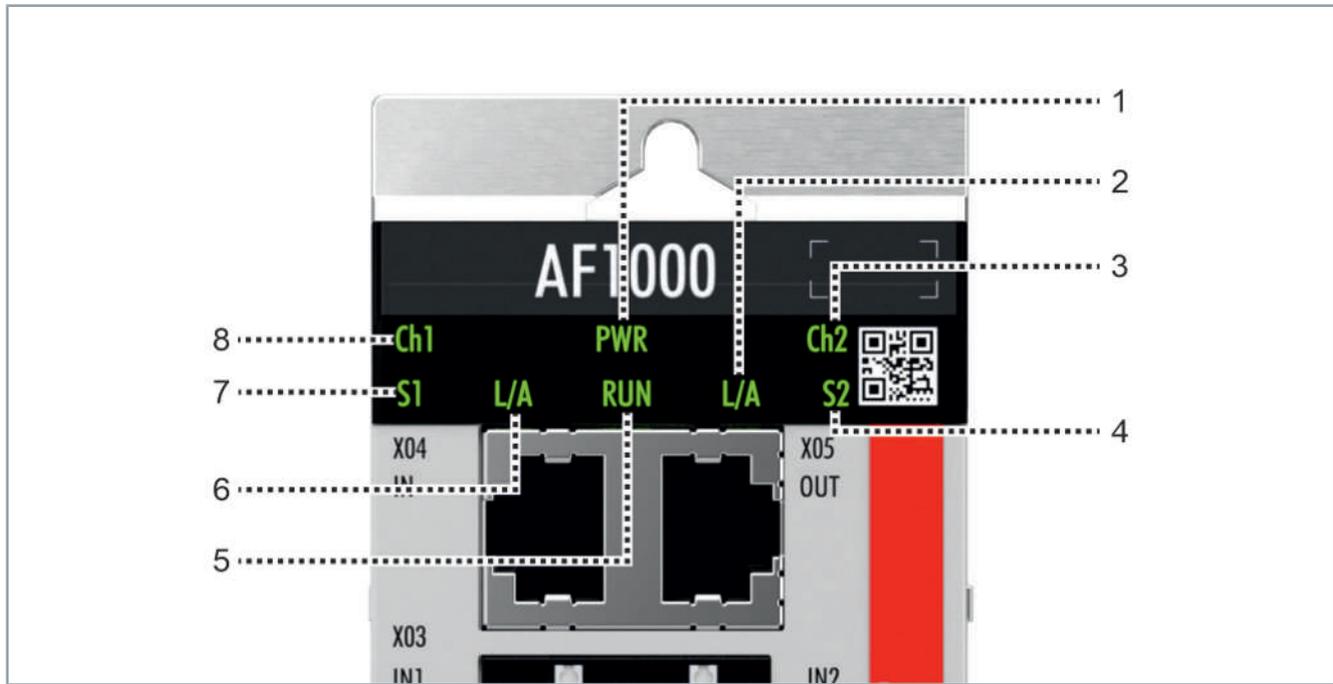
7.4.8 AF12xx-320x



| Position | Labeling | Explanation |
|----------|----------|---|
| 1 | IN X04 | RJ45 socket for the incoming EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 2 | OUT X05 | RJ45 socket for the downstream EtherCAT cable, see "EtherCAT slot IN X04, OUT X05", [Page 77] |
| 3 | X03 | Connection I/O: 16-pin terminal point for digital input/output signals, see "I/O connection X03", [Page 79] |
| 4 | X13 | Slot motor channel 1, see "Motor slot X13", [Page 81] |
| 5 | X23 | Slot motor channel 2, see "Motor slot X23", [Page 83] |
| 6 | X01 | Three-phase network connection, see "Mains connection X01", [Page 75] |
| 7 | X09 | TwinSAFE slot: safe inputs, see "TwinSAFE slot X09", [Page 80] |
| 8 | S1 | Push button for internal purposes |
| 9 | S2 | TwinSAFE actuation button |

7.5 Display

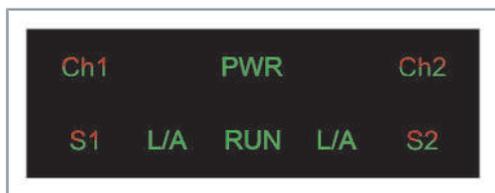
The economy variable frequency drive AF1000 display provides information about the state of the module.



| Item number | Function - designation | Explanation |
|-------------|------------------------|--------------------------------------|
| 1 | PWR | DC link |
| 2 | L/A | Communication OUT X05 |
| 3 | Ch2 | Operating state axis 2 ¹⁾ |
| 4 | S2 | Safety status axis 2 ¹⁾²⁾ |
| 5 | RUN | EtherCAT operating state |
| 6 | L/A | Communication IN X04 |
| 7 | S1 | Safety status axis 1 ²⁾ |
| 8 | Ch1 | Operating state axis 1 |

¹⁾ for 2-channel modules

²⁾ for modules with TwinSAFE



DC link status | PWR symbol

| LED/status | Status |
|-----------------|----------------------------|
| Off | The module is switched off |
| Lights up green | DC link charged |
| Flashes green | DC link is charging |

Axis operating state | Ch1 symbol / Ch2 symbol

| LED/status | Status |
|------------------------------------|---|
| Off | The axis is not active |
| Lights up red | The variable frequency drive is in EtherCAT INIT status |
| Flashes red | There is an error |
| Flashing red and green alternately | An error reaction of the axis is active |
| Lights up green | The axis is enabled and free from errors |
| Flashes green quickly | The axis is disabled and is being initialized |
| Flashes green slowly | The axis is disabled and free from errors |

Safety status axis | S1 symbol / S2 symbol

| LED/status | Status |
|-----------------|----------------------------|
| Off | Safety is not active |
| Lights up red | The axis is in "STO" state |
| Lights up green | There is no safety error |

Communication state | L/A symbol

| LED/status | Status |
|-----------------|--|
| Off | No connection to the connected EtherCAT module |
| Lights up green | Connection to the connected EtherCAT module (LINK) |
| Flashes green | Communication with connected EtherCAT module (ACT) |

EtherCAT operating state | RUN symbol

| LED/status | Status |
|---------------------------|---|
| Off | The module is in EtherCAT INIT status |
| Lights up green | The module is in EtherCAT Operational status |
| Flashes green steadily | The module is in EtherCAT Pre-Operational status |
| Flashes green irregularly | The module is in EtherCAT Safe-Operational status |

7.6 Digital I/Os

Wiring of digital inputs with internal power supply and external power supply

7.6.1 Wiring X02 (1-channel)

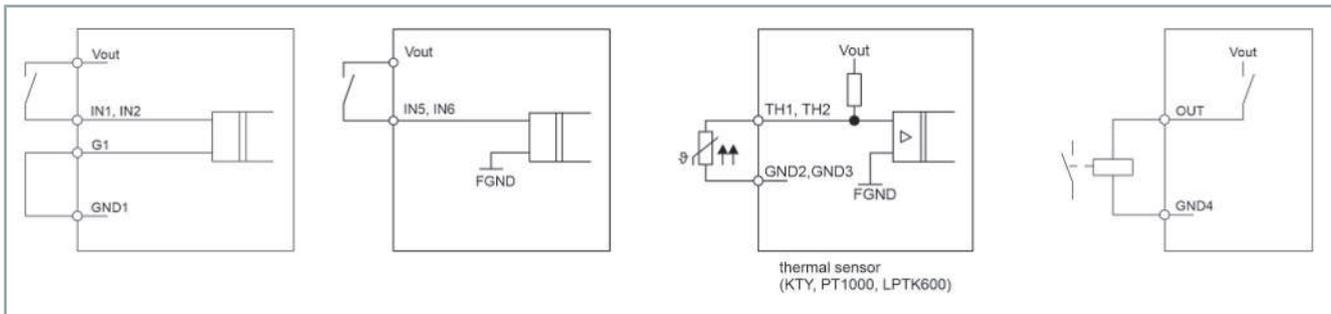
NOTICE

Damage due to improper connection of external 24 V

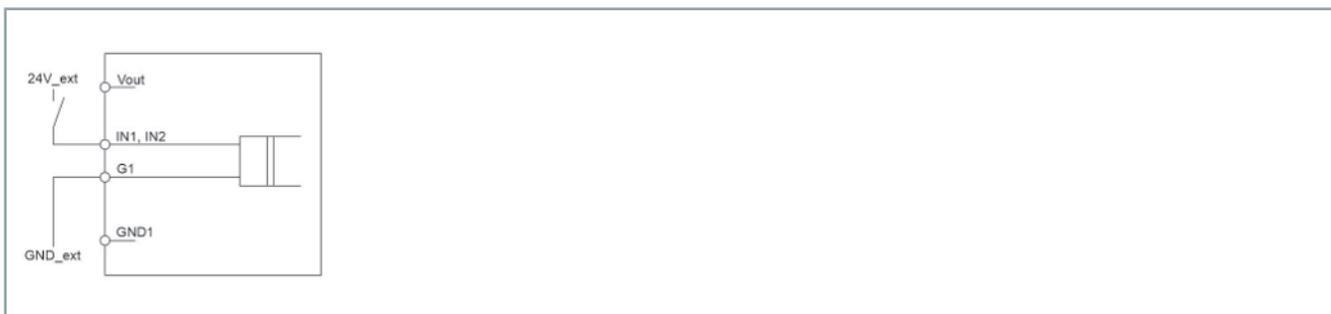
Connecting an external 24 V power supply to the internal 24 V power supply Vout can lead to excess voltage and instability of the internal voltage control. This can damage electronic components and circuit breakers, trigger short circuits or thermal overheating and cause fire or electric shock hazards.

- Never connect the internal power supply to an external power supply
- Only use supply points approved by the manufacturer

Use of the internal 24 V power supply Vout



Use of an external 24 V power supply



7.6.2 Wiring X03 (2-channel)

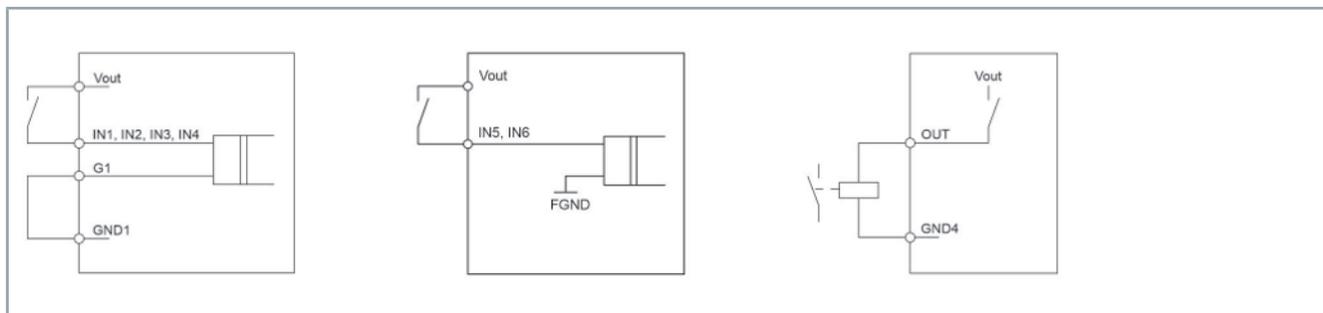
NOTICE

Damage due to improper connection of external 24 V

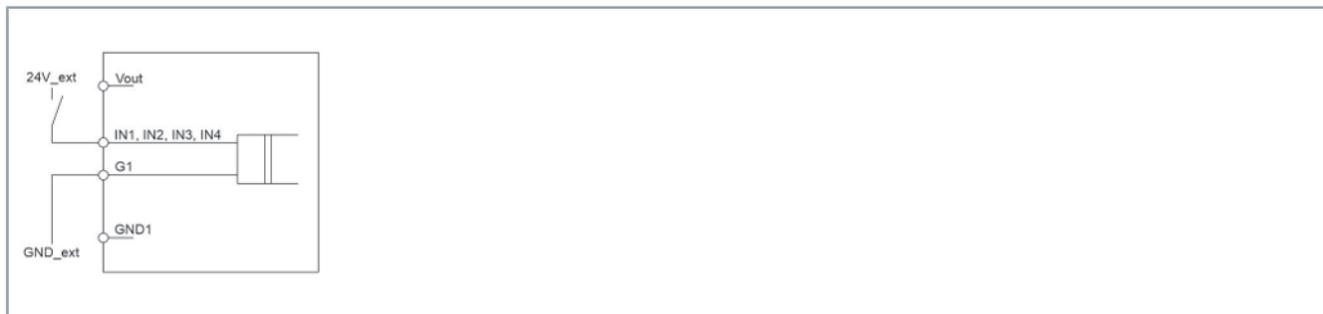
Connecting an external 24 V power supply to the internal 24 V power supply Vout can lead to excess voltage and instability of the internal voltage control. This can damage electronic components and circuit breakers, trigger short circuits or thermal overheating and cause fire or electric shock hazards.

- Never connect the internal power supply to an external power supply
- Only use supply points approved by the manufacturer

Use of the internal 24 V power supply Vout



Use of an external 24 V power supply



8 Mechanical installation

8.1 Preparation

NOTICE

Damage due to high heat development

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

- Observe the permissible "data for operation and environment", [Page 23] as well as the notes in this chapter.



Provide sufficient space in the control cabinet

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.

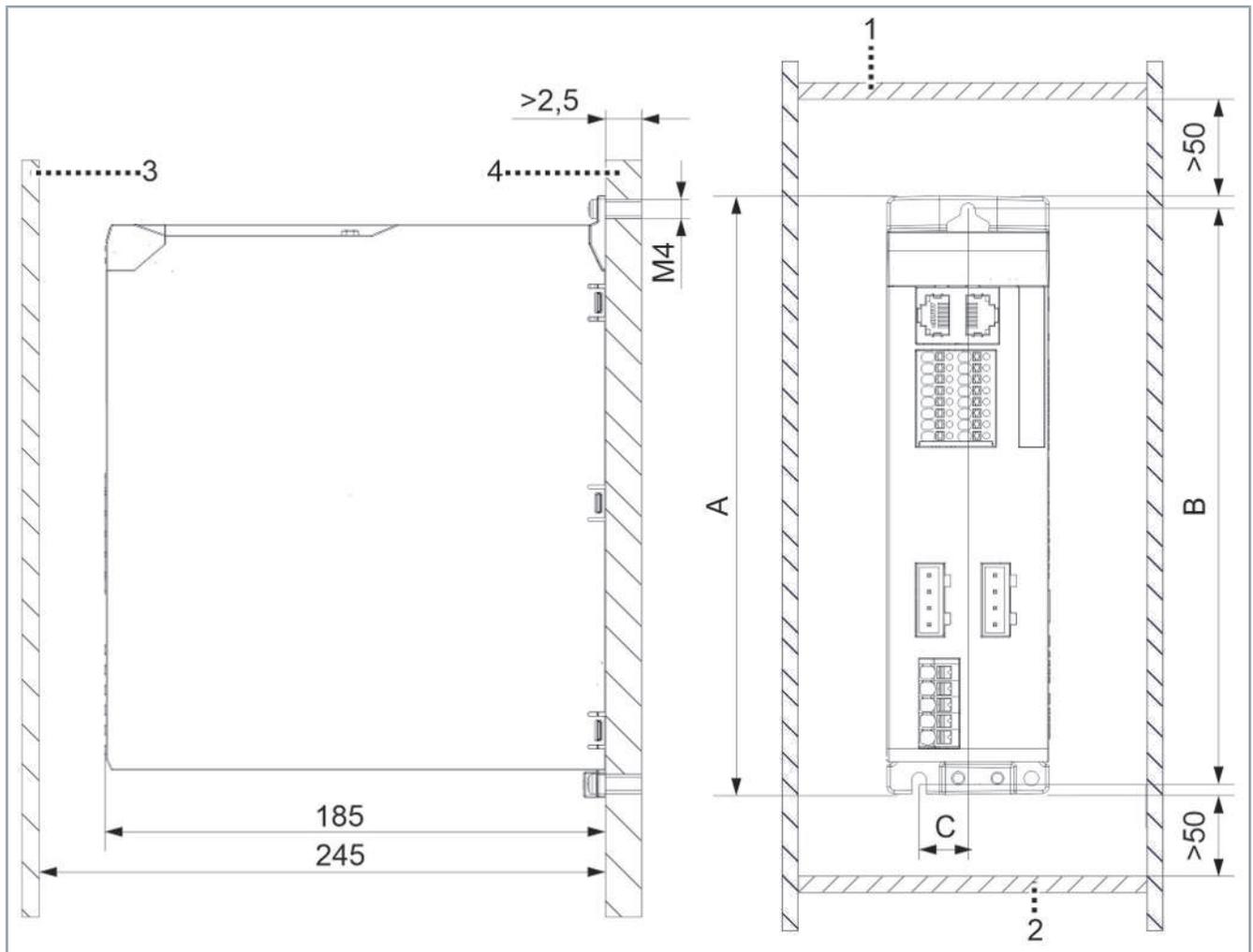
8.2 Control cabinet installation dimensions

Installation in the control cabinet

The following illustration contains recommended dimensions that you should observe when mounting the economy variable frequency drive in the control cabinet.



The areas, functions and slots shown in the figure may vary depending on the module version and are provided here for clarity.



| Position | Explanation |
|----------|--|
| 1 | Control cabinet top side |
| 2 | Control cabinet base |
| 3 | Control cabinet door |
| 4 | Conductive and galvanized mounting plate |

| Position | Dimensions AF1xxx-1xxx [mm] | Dimensions AF1xxx-3xxx [mm] |
|----------|-----------------------------|-----------------------------|
| A | 185 | 225 |
| B | 176 | 216 |
| C | 15 | 20 |

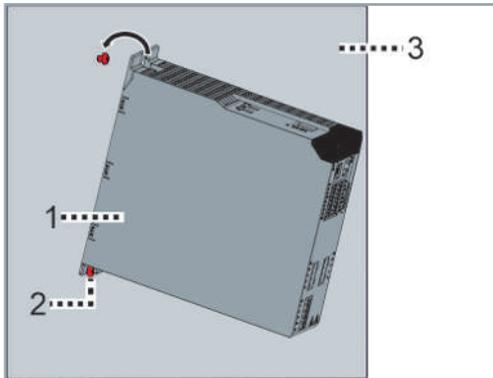
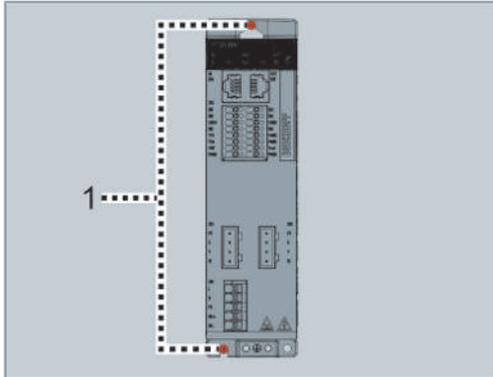
8.3 Mounting in the control cabinet



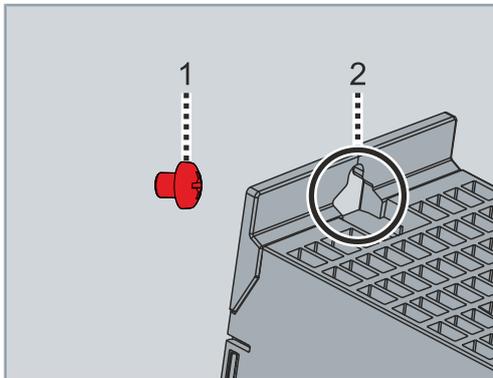
Mounting example

This chapter provides information on mounting the economy variable frequency drive AF1000. A single device is mounted as an example.

The economy variable frequency drive AF1000 has two mounting points [1] where it is fixed to the mounting plate with screws.



- ▶ Insert the screws into the control cabinet mounting plate
- ▶ Place product [1] on the lower screw [2] and carefully press it against the mounting plate [3]



- ▶ Guide the upper screw [1] through the large recess on the upper flange of the housing [2]
- ▶ Tighten all the screws in the elongated holes in the module housing
- ▶ Observe tightening torques

| Components | Tightening torque [Nm] |
|--|------------------------|
| M4x12 screws with washer Strength class 8.8 | 3 |

9 Electrical installation

NOTICE

Damage caused by faulty grounding

Improper grounding or faulty contact can lead to damage to the product or EMC interference emissions.

- Establish a conductive connection of all components
- Place the star point centrally on the unpainted mounting plate
- For larger applications, implement the potential equalization via PE rails
- Observe the minimum cross-sections of separate protective conductors in DIN 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 Project planning of the drivetrain

The application, variable frequency drive, 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.

- ▶ Ensure sufficient reserves in the design of the components involved in the working area of the system so that the service life is not impaired and the required control quality can be maintained.

The following software is available for designing the drivetrain and selecting the appropriate components:

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

9.1.2 Energy management

If the supply network is impaired due to high voltage fluctuations, you must consider the specifications of the economy variable frequency drive and the speed range of the connected motor.

- ▶ Observe the upper limit value of the tolerance of the rated supply voltage.
- ▶ Check whether a reduction in speed is permissible due to a lack of voltage.
- ▶ If the supply network does not meet the specifications for operating a economy variable frequency drive, use isolating transformers, mains chokes, mains filters and other measures to achieve the required specifications.

The economy variable frequency drive AF1000 stores energy in the internal DC link. If the regenerative energy generated when braking a connected motor is higher than the energy that can be stored in the DC link, an external braking resistor is required.

For existing drive systems, you can determine the utilization of the braking resistor using the measuring and diagnostic functions available in the drive system and transfer the values.

The following software is available for energy management:

 [TE5910 | TwinCAT 3 Motion Designer](#)

9.1.3 Supported third-party motors

The AF1000 Economy variable frequency drives support the connection of third-party motors. These include, for example, asynchronous motors, reluctance motors and synchronous motors.

- Asynchronous motors can be operated in U/f mode without feedback.
- Reluctance motors and synchronous motors can be operated without feedback in "sensorless vector control" mode.

9.1.4 Wiring instructions

Performance data

- ▶ Check the assignment of variable frequency drive and motor. Compare the mains voltage and rated current of the devices.
- ▶ Make sure that the maximum rated voltage at the connections does not exceed the tolerance limits. Otherwise, the variable frequency drive may be destroyed.

Protection

- ▶ Ensure that the mains voltage is adequately protected with fuses. Please also note the information in the chapter "Protection", [Page 72].

Cable routing

- ▶ Route the power and control cables separately. A distance greater than 20 cm improves the EMC interference immunity.
- ▶ Keep the cable from the mains filter to the mains connection X01 as short as possible. When using single wires or strands, twist the wires or strands.

Shielding

- ▶ Apply shielding over a large area (low resistance). Use metalized connector housings or shield terminals. Information about the connection technology can be found in section "Description of connections", [Page 75].
- ▶ In the case of shielded cables, the shield must be continuous. Interruptions must be bridged over a large area.

Connection cables

- ▶ Lay all power cables with a sufficient cross-section. Use cable material of the quality required in the "Description of connections", [Page 75] section to achieve the maximum cable length.

9.2 EMC and grounding measures

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

Grounding measures are essential to ensure effective electromagnetic compatibility (EMC). The following points should be observed:

- ▶ Connect all grounding points directly to the central grounding bar or mounting plate.
- ▶ Ensure that the connections have low resistance and good conductivity.
- ▶ Use the shortest possible connections.
- ▶ Design the connections to the grounding bar in a star configuration.
- ▶ Ensure that the connections are protected against corrosion.
- ▶ Use flexible ground straps for moving parts such as machine parts or doors. These straps should be as short and large as possible.

9.2.1 Electromagnetic interference emission

The products described in the present manual meet the EMC requirements as per IEC 61800-3 if the EMC measures described in the present manual are implemented.

⚠ WARNING

ELECTROMAGNETIC DISTURBANCES OF SIGNALS AND DEVICES

Failure to follow these instructions can result in death, serious injury, or equipment damage.

- Use proper EMC shielding techniques to help prevent unintended device operation in accordance with the standard IEC 61800-3.

These types of devices are not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if used in such a network.

WARNING

RADIO INTERFERENCE

Failure to follow these instructions can result in death, serious injury, or equipment damage.

- Do not operate this equipment in a first environment as defined in IEC 61800-3.

EMC categories with external mains filter

For the economy variable frequency drive AF1000, the following categories for emission as per IEC 61800-3 are reached with a motor cable length ≤ 25 m if the EMC measures described in the present manual are implemented and if the external mains filters offered as accessories are used.

| Emission type | Category |
|----------------------|-----------------|
| Conducted emission | Category C2 |
| Radiated emission | Category C3 |

Motor cable length ≤ 25 m

External mains filters as sum filters

Several devices can be connected to a common external mains filter.

The following mains filters are available for this purpose:

- AX2090-NF12-1020
- AX2090-NF12-3020

Prerequisites:

- Single-phase devices may only be connected to single-phase mains filters; three-phase devices may only be connected to three-phase devices.
- The total input current of the connected devices must be smaller than or equal to the permissible rated current of the mains filter.

9.2.2 Measuring the insulation resistance

NOTICE

Damage to the variable frequency drive due to dielectric strength or insulation resistance tests

Dielectric strength or insulation tests at variable frequency drive can destroy internal components or protective components. Induced voltages can cause insulation breakdowns, partial discharges or latent damage leading to malfunctions, fire or electric shock risks.

- Do not carry out any dielectric strength or insulation tests on variable frequency drive
- When measuring the insulation resistance of the servomotor, disconnect the motor cable from the output terminals of the Economy variable frequency drive



For variable frequency drive, the insulation between the main circuit and the housing was tested at the factory. The variable frequency drive is equipped with voltage-limiting circuits that automatically limit the test voltage.

Insulation resistance measurement of the motor and motor cable

Check the insulation of the mains cable before connecting it to the variable frequency drive. Follow the local regulations. The following points must be observed when measuring the motor and motor cable:

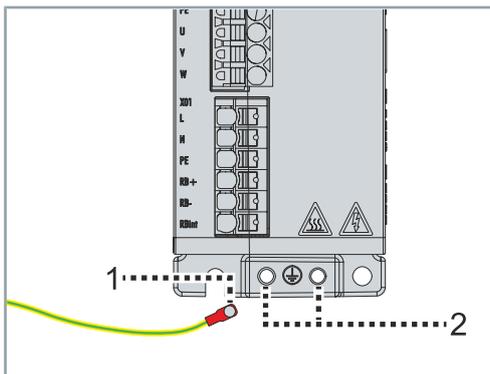
- ▶ Check that the motor cable is connected to the motor and disconnected from the output terminals U, V and W of the economy variable frequency drive.
- ▶ Test the insulation resistance between each phase conductor and the protective earth (PE) with a voltage of 1000 V DC.
 - The insulation resistance of a motor must be more than 100 MOhm (at 25 °C / 77 °F).
 - Moisture in the motor housing reduces the insulation resistance.
- ▶ If the motor is damp, dry it and then measure it again.

9.2.3 Protective earth



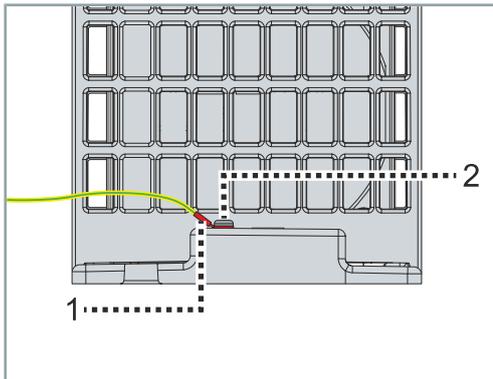
Mounting material required for proper installation of the protective earth

- Ring cable lug for M4



The protective earth is established via the connection between the ground connection of the device and the mounting plate on the control cabinet. The economy variable frequency drive has two ground connections [2] on the bottom flange of the device. The connection is made via a cable with a ring-shaped cable lug [1]. Use the same cross-section of the supply cable to connect the second protective earth conductor.

Single device

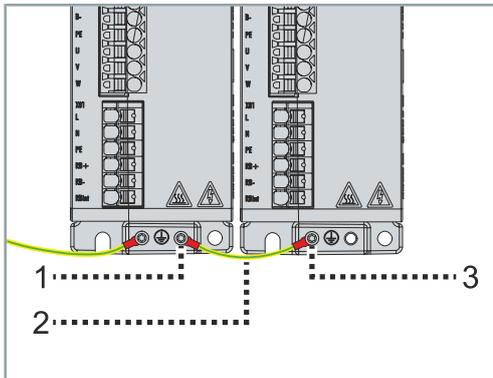


- ▶ Assemble cables with a sufficient cross-section using a ring-shaped cable lug [1]
- ▶ Align cable with cable lug [1] to one of the two ground connections [2] of the economy variable frequency drive
- ▶ Fix the cable lug [1] to the economy variable frequency drive with the pre-assembled screw [2]
- ▶ Observe tightening torques

| Components | Tightening torque [Nm] |
|-----------------------------------|------------------------|
| Screws M4x8 Strength class 8.8 | 2 |

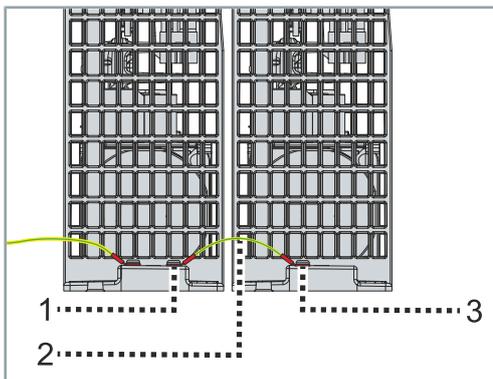
- ▶ Clean the contact surfaces
- ▶ Ensure that the mounting plate is not painted.
- ▶ Attach the ready-made cable properly to the control cabinet mounting plate.

Drive system



In a drive system, multiple devices can be grounded by connecting the grounding terminals.

- ▶ Align the cable lugs of the connection cable [2] so that they can be connected to the ground connection output of a economy variable frequency drive [1] and a ground connection input of the next device [3]



- ▶ Secure the cable lugs to the devices using the pre-assembled fixing screws [1] [3]
- ▶ Observe tightening torques

| Components | Tightening torque [Nm] |
|-----------------------------------|------------------------|
| Screws M4x8 Strength class 8.8 | 2 |

9.3 Supply networks

The economy variable frequency drive AF1000 is suitable for operation on grounded single-phase or three-phase networks with the following voltage systems:

- Single-phase: 1 x 110 V AC_{-15%}...240 V AC^{+10%}
- Three-phase: 3 x 208 V AC_{-15%}...480 V AC^{+8%}

The economy variable frequency drive AF1000 can be operated on the following supply networks without any additional measures:

- TN network
- TT network

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

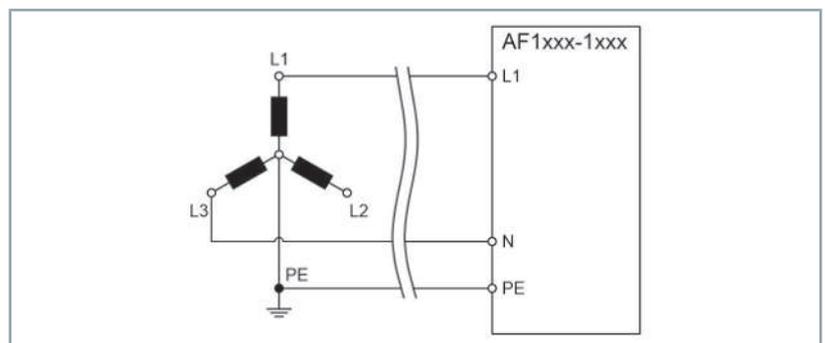
Network types

The supply networks differ in the type of ground connection. For a better understanding, the table below contains examples with the associated meaning:

| Network configuration | 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 |

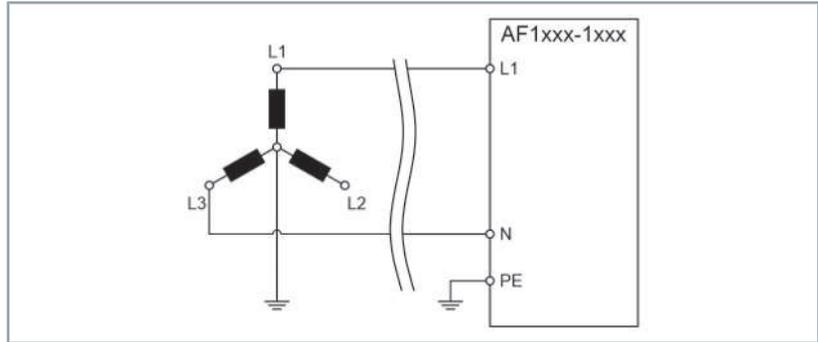
9.3.1 Direct connection to single-phase networks

TN network

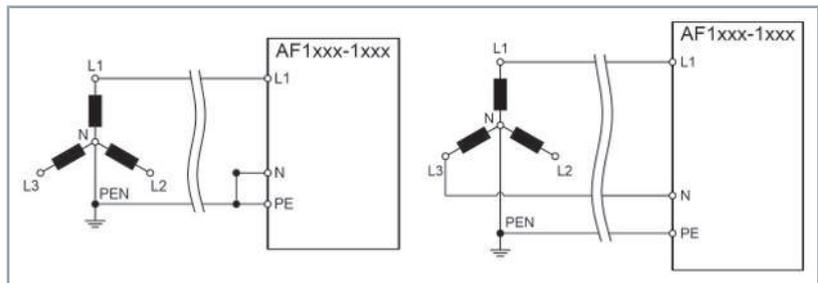


Electrical installation

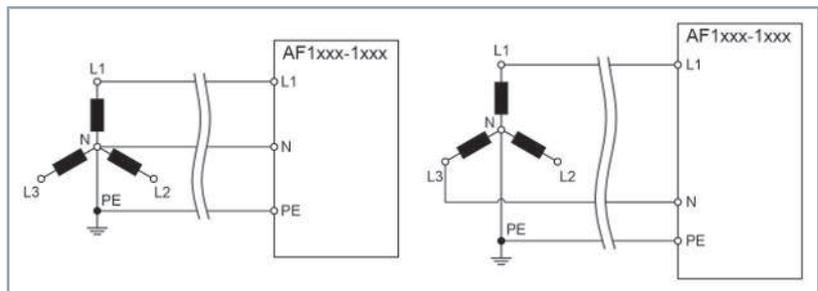
TT network



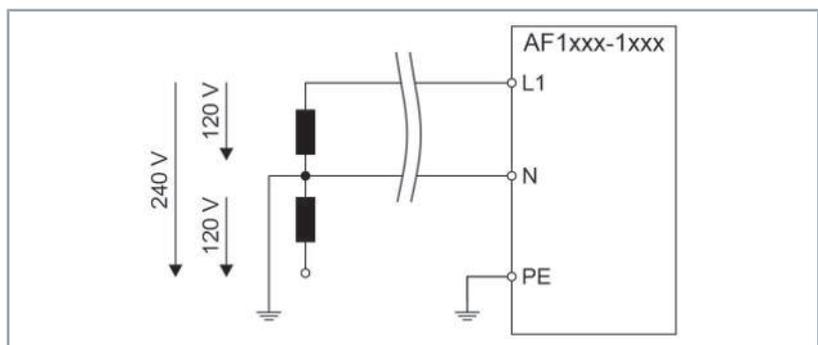
TN-C network



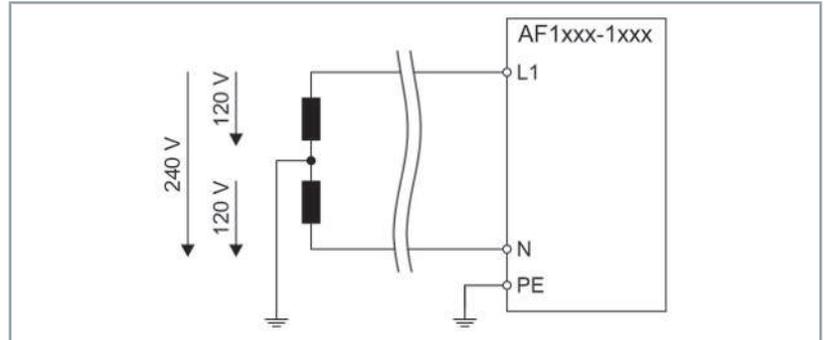
TN-S network



Split-phase with grounded center tap 120 V



Split-phase with grounded center tap 240 V



9.3.2 Connection to single-phase networks with isolating transformer

NOTICE

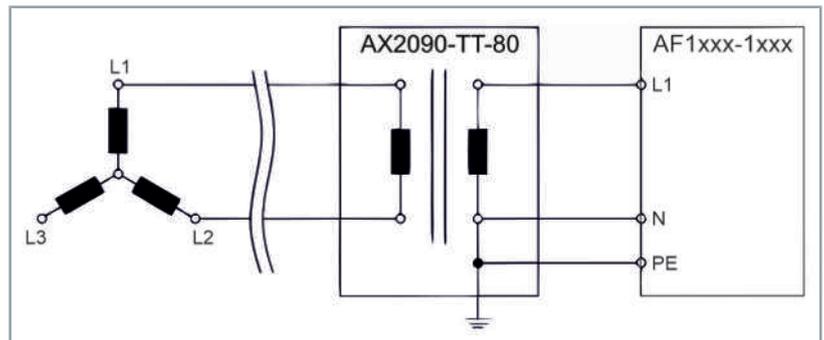
Damage to the product possible

Use an upstream isolating transformer with the following networks.

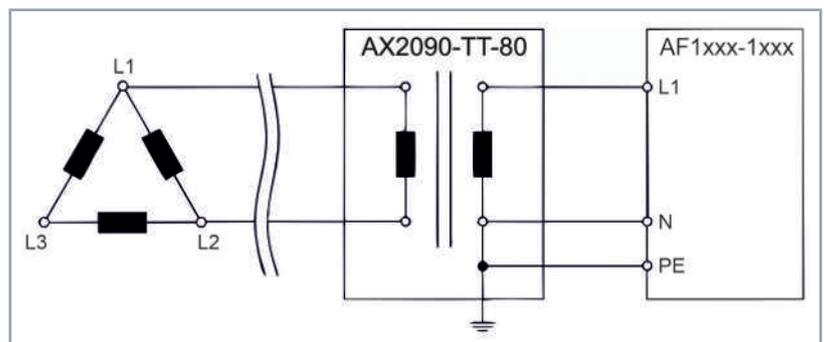
Non-compliance may damage the economy variable frequency drive AF1000 and the components.

- Connection only with upstream isolating transformer

IT network with star point

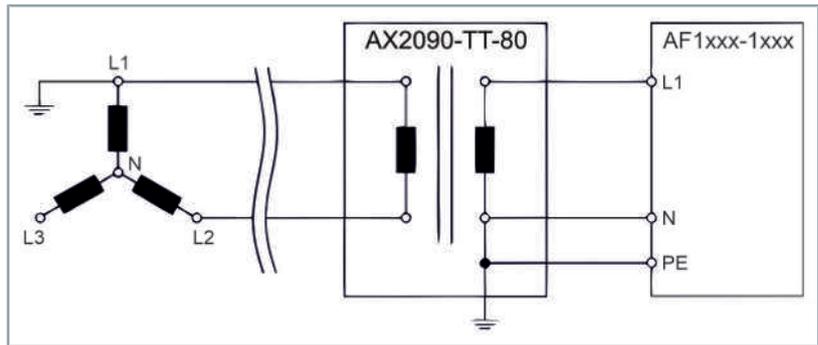


IT delta network

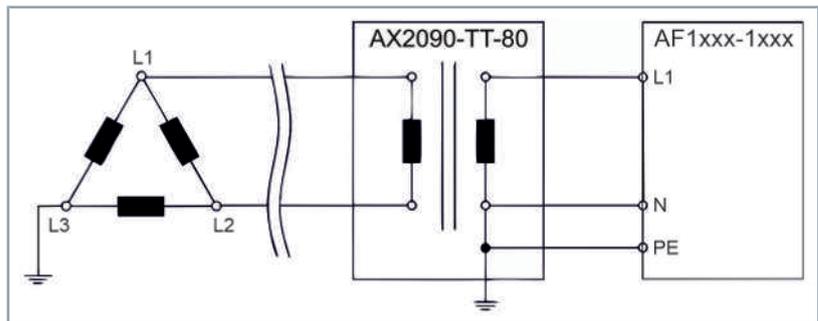


Electrical installation

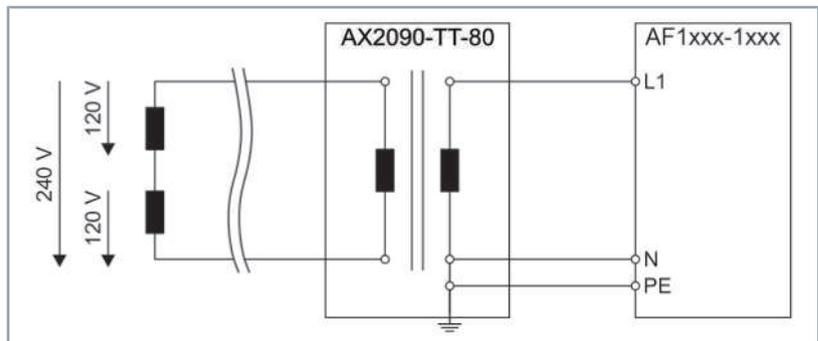
Asymmetrically grounded network with star point



Asymmetrically grounded delta network

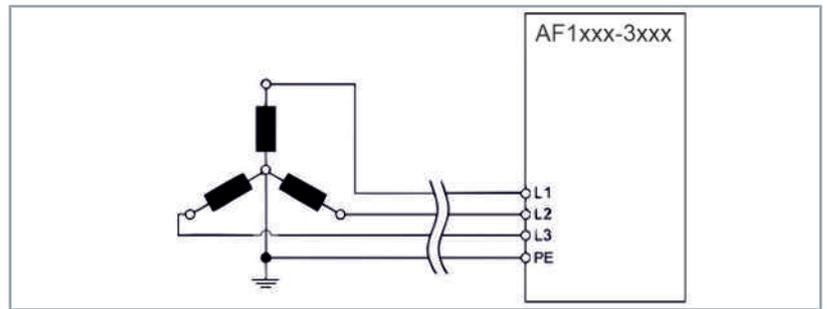


Split-phase ungrounded networks

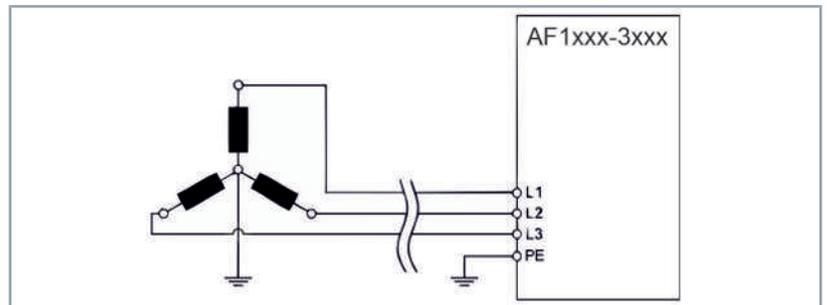


9.3.3 Direct connection to three-phase networks

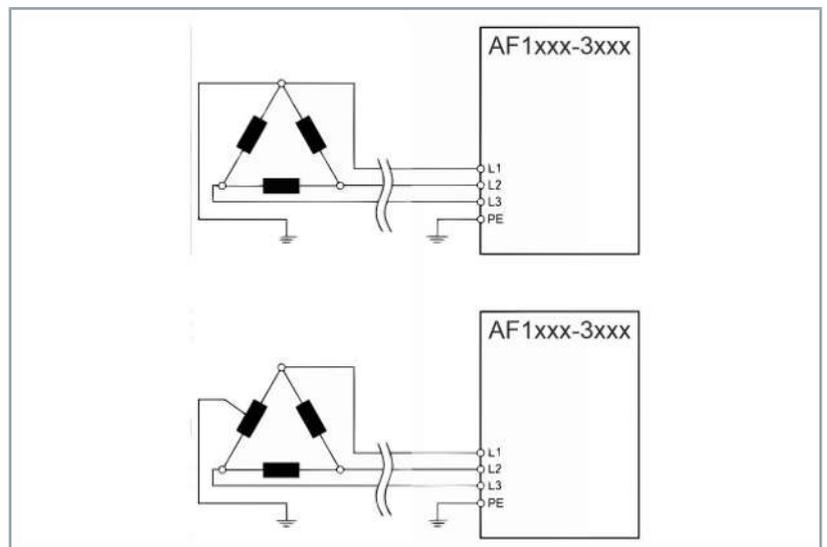
TN network



TT network



Asymmetrically grounded delta network 200...240 V AC



9.3.4 Connection to three-phase networks with isolating transformer

NOTICE

Connection only with upstream isolating transformer

The use of an isolating transformer is generally required for the following network forms.

Non-compliance may damage the economy variable frequency drive AF1000 and the components.

NOTICE

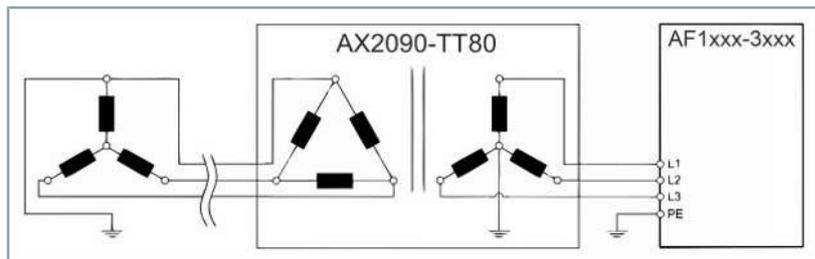
Damage to the product possible

Use an upstream isolating transformer with the following networks.

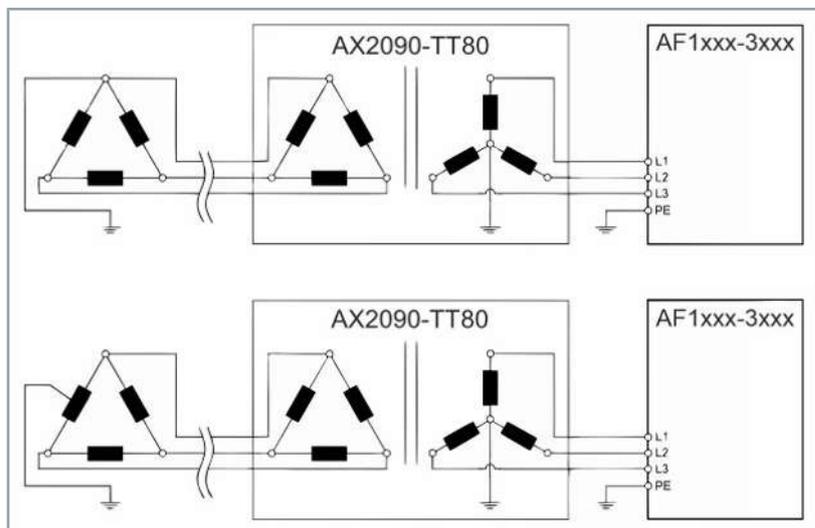
Non-compliance may damage the economy variable frequency drive AF1000 and the components.

- Connection only with upstream isolating transformer

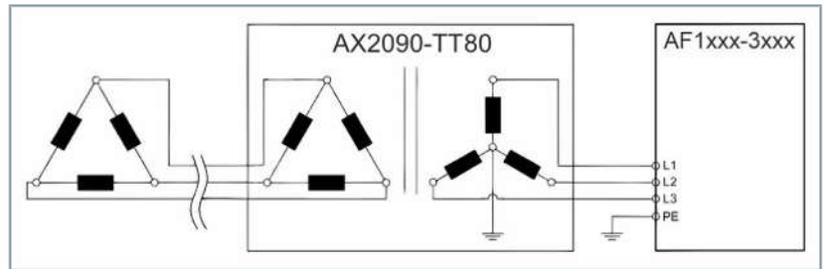
Asymmetrically grounded network with star point



Asymmetrically grounded delta network 400...480 V AC



IT delta network



9.3.5 Connection to special network types

For special mains forms, an upstream isolating transformer is required that can provide the full peak current for a short time. If the maximum feed-in power is not required in the application, isolating transformers with lower power 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](#)
- Select the isolating transformer according to the result.

Isolating transformers

The following table shows an overview of the available isolating transformers for the corresponding feed-in power.

Supply 1 x 230 V AC for AF1xxx-1xxx

| Isolating transformer | Rated power |
|-------------------------|-------------|
| AX2090-TT80-0002; 230 V | 1.6 kVA |

Supply 3 x 400...480 V AC for AF1xxx-3xxx

| Isolating transformer | Rated power |
|-------------------------|-------------|
| AX2090-TT80-0016; 400 V | 16 kVA |
| AX2090-TT80-0030; 400 V | 30 kVA |

9.4 Fuse protection

NOTICE

Damage to the device due to inadequate line protection

The economy variable frequency drive AF1000 are equipped with integrated self-protection. The drive system requires additional line protection.

- Provide additional fuses as line protection.
- Use the recommended fuse types.
- Adhere to the dimensioning according to the prescribed data for operation and environment.

9.4.1 CE conform

Depending on the achievable SCCR level, various fuse protection options are available:

9.4.1.1 External fuse protection

Fuse type gG

Use mains fuses of the operating class “gG” according to IEC 60269 or automatic circuit-breakers with the characteristic “C”.

| Device | Fuse type | Breaking capacity |
|-------------|--------------|-------------------|
| AF1xxx-xxxx | gG max. 20 A | 500 V / 120 kA |

9.4.1.2 Internal fuse protection

| Fuse protection | Fuse |
|---------------------------|--|
| 24 V power supply Vout | electronic |
| External braking resistor | electronic Requirements: <ul style="list-style-type: none"> • Active thermal model for selected braking resistor • Correct braking resistor line |

9.5 Mains connection

The following are examples of connection scenarios for economy variable frequency drive AF1000.

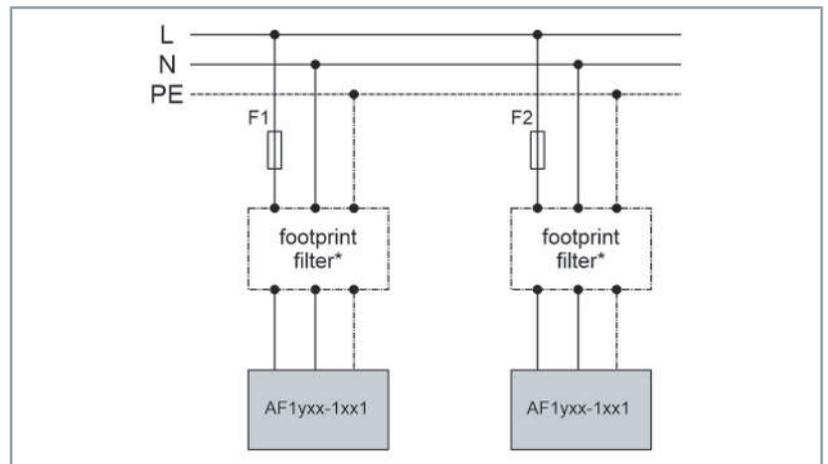
9.5.1 single-phase mains connection

A mains filter is required for CE compliance.

To improve EMC, the wiring distance from the filter to the mains connection of the device should be kept as short as possible.

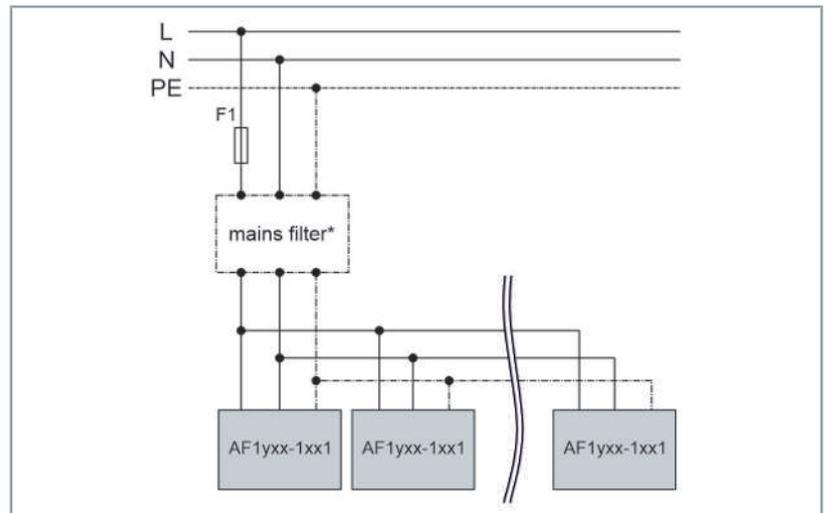
If single wires or strands are used, the wiring route from the filter to the mains connection must be realized with twisted wires or strands.

Use of footprint filters



* Required for compliance with CE

Use of sum mains filters



* Required for compliance with CE

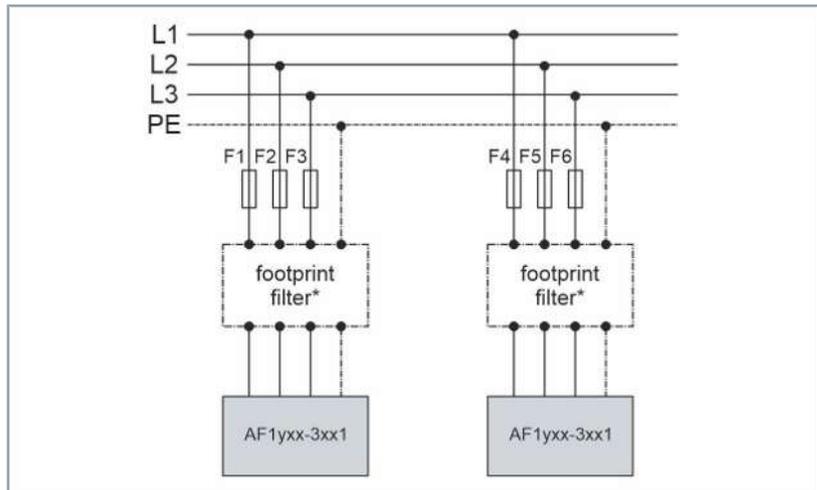
9.5.2 three-phase mains connection

A mains filter is required for CE compliance.

To improve EMC, the wiring distance from the filter to the mains connection of the device should be kept as short as possible.

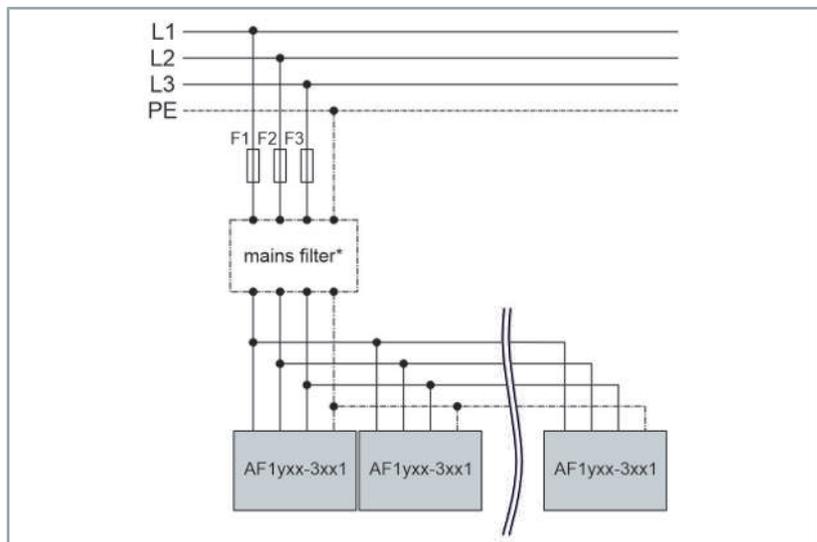
If single wires or strands are used, the wiring route from the filter to the mains connection must be realized with twisted wires or strands.

Use of footprint filters



* Required for compliance with CE

Use of sum mains filters



* Required for compliance with CE

9.6 Description of connections

9.6.1 Mains connection | X01

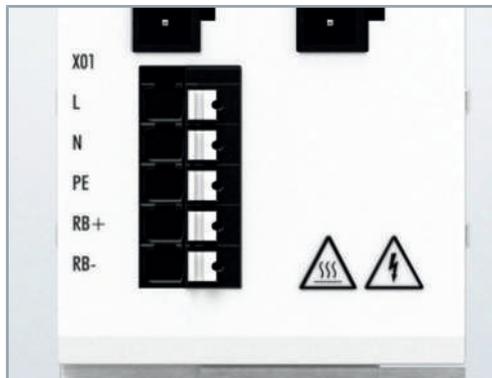
The power supply and the braking resistor are connected to the X01 connection strip. The connection differs according to the number of phases of the network input and depends on the device type:

9.6.1.1 X01 for single-phase devices

Valid for:

- All single-phase devices in the AF1000 series
 - AF11xx-1xxx
 - AF12xx-1xxx

Network connection on connection strip X01



| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 5-pin |

Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.34 | 4 |
| Conductor connection cross-section AWG | AWG | 12 | 20 |
| solid wire H05(07) V-U | mm ² | 0.5 | 2.5 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 4 |
| with AEH with collar DIN46 228/4 | mm ² | 0.34 | 2.5 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.5 | 2.5 |

If single wires or strands are used, the wiring route from the filter to the mains connection must be realized with twisted wires or strands.

Contact assignment at this connection

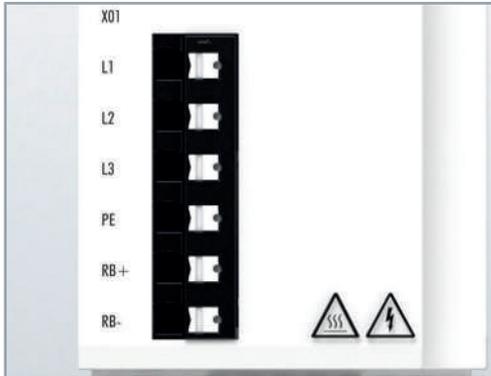
| Terminal point | Connection |
|----------------|-----------------------------|
| L | Phase L |
| N | Neutral conductor N |
| PE | Protective conductor, PE |
| RB+ | External braking resistor + |
| RB- | External braking resistor - |

9.6.1.2 X01 for three-phase devices

Valid for:

- All three-phase devices in the AF1000 series
 - AF11xx-3xxx
 - AF12xx-3xxx

Network connection on connection strip X01



| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 6-pin |

Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.34 | 4 |
| Conductor connection cross-section AWG | AWG | 12 | 20 |
| solid wire H05(07) V-U | mm ² | 0.5 | 2.5 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 4 |
| with AEH with collar DIN46 228/4 | mm ² | 0.34 | 2.5 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.5 | 2.5 |

If single wires or strands are used, the wiring route from the filter to the mains connection must be realized with twisted wires or strands.

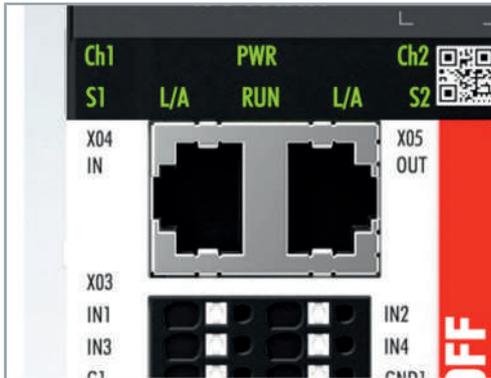
Contact assignment at this connection

| Terminal point | Connection |
|----------------|-----------------------------|
| L1 | Phase L1 |
| L2 | Phase L2 |
| L3 | Phase L3 |
| PE | Protective conductor, PE |
| RB+ | External braking resistor + |
| RB- | External braking resistor - |

9.6.2 EtherCAT slot | IN X04, OUT X05

Valid for:

- all devices in the series AF1000

Fieldbus connection to EtherCAT slot

| Feature | Implementation |
|--------------------------------|--|
| Connection type | RJ45 socket |
| Cable type | Industrial Ethernet/EtherCAT patch cable |
| Suitable cable (pre-assembled) | ZK1090-9191-xxxx, green |
| Configuration | RJ45, plug, 8-pin - RJ45, plug, 8-pin |
| Topology structure | continuously shielded transmission lines recommended, e.g. SF/FTP, S/FTP, SF/UTP |

Contact assignment at this connection

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



Thanks to automatic line detection (auto-crossing), Beckhoff EtherCAT devices can be operated both with straight through (1:1) cables and with cross-over cables.

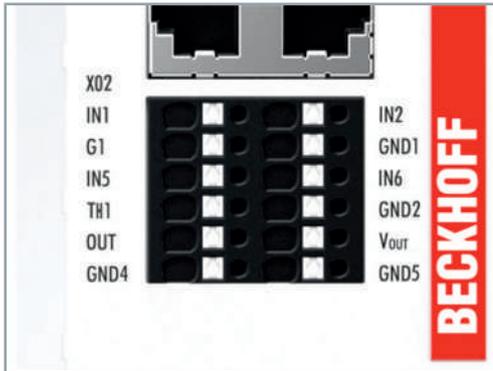


Observe the conditions for wiring the 1-channel modules from the chapter "Wiring X02 (1-channel)", [Page 54]

Valid for:

- All 1-channel devices in the AF1000 series
 - AF11xx-1xxx
 - AF11xx-3xxx

Digital I/Os on X02 connection strip



| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 12-pin |

Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.2 | 1.5 |
| Conductor connection cross-section AWG | AWG | 26 | 16 |
| solid wire H05(07) V-U | mm ² | 0.2 | 1.5 |
| stranded wire H05(07) V-U | mm ² | 0.2 | 1.5 |
| with AEH with collar DIN46 228/4 | mm ² | 0.2 | 0.75 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.2 | 1.5 |

Contact assignment at this connection

| Terminal point | Function | Reference potential | Input filter/ switching times |
|----------------|--|---------------------|---|
| IN1 | Digital input 1, type 3 | G1 | 2 ms |
| IN2 | Digital input 2, type 3 | G1 | 2 ms |
| G1 | Reference potential for input 1 and 2 | G1 | |
| GND1 | Reference potential of the 24 V DC supply voltage V_{out} | FGND | |
| IN5 | Digital input 5, type 3 | FGND | 2 ms |
| IN6 | Digital input 6, type 3 | FGND | 2 ms |
| TH1 | Input temperature sensor 1 | FGND | |
| GND2 | Reference potential temperature sensor 1 | FGND | |
| OUT | Digital output | FGND | $t_{on} = 100 \mu s$ $t_{off} = 150 \mu s$ |
| V_{out} | Output 24 V DC supply voltage | FGND | |
| GND4 | Reference potential of the 24 V DC supply voltage V_{out} | FGND | |
| GND5 | Reference potential of the 24 V DC supply voltage V_{out} | FGND | |

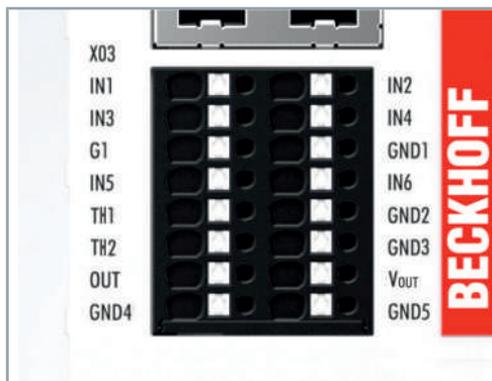
9.6.4 I/O connection | X03



Observe the conditions for wiring the 2-channel modules from chapter "Wiring X03 (2-channel)", [Page 55]

Valid for:

- All 2-channel devices in the AF1000 series
 - AF12xx-1xxx
 - AF12xx-3xxx

Digital I/Os on X03 connection strip

| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 16-pin |

Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.2 | 1.5 |
| Conductor connection cross-section AWG | AWG | 26 | 16 |
| solid wire H05(07) V-U | mm ² | 0.2 | 1.5 |
| stranded wire H05(07) V-U | mm ² | 0.2 | 1.5 |
| with AEH with collar DIN46 228/4 | mm ² | 0.2 | 0.75 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.2 | 1.5 |

Contact assignment at this connection

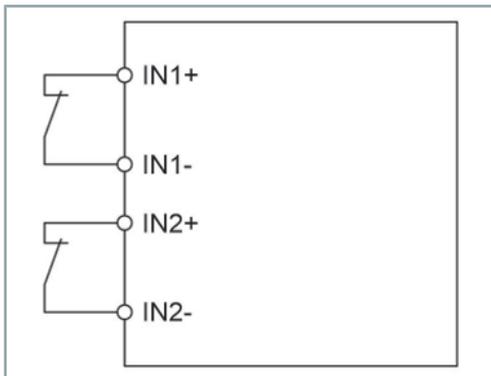
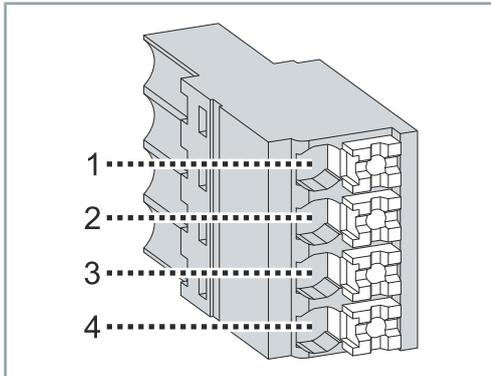
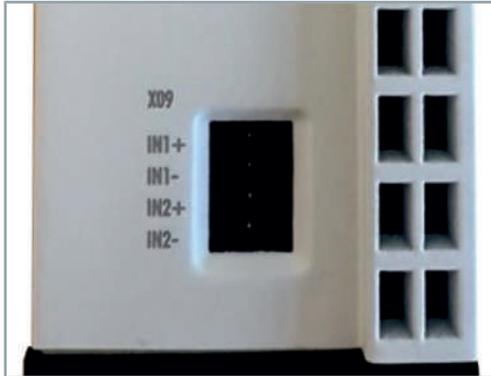
| Terminal point | Function | Reference potential | Input filter/ switching times |
|----------------|--|---------------------|---|
| IN1 | Digital input 1, type 3 | G1 | 2 ms |
| IN2 | Digital input 2, type 3 | G1 | 2 ms |
| IN3 | Digital input 3, type 3 | G1 | 2 ms |
| IN4 | Digital input 4, type 3 | G1 | 2 ms |
| G1 | Reference potential for input 1 to 4 | G1 | |
| GND1 | Reference potential of the 24 V DC supply voltage V _{out} | FGND | |
| IN5 | Digital input 5, type 3 | FGND | 2 ms |
| IN6 | Digital input 6, type 3 | FGND | 2 ms |
| TH1 | Input temperature sensor 1 | FGND | |
| GND2 | Reference potential temperature sensor 1 | FGND | |
| TH2 | Input temperature sensor 2 | FGND | |
| GND3 | Reference potential temperature sensor 2 | FGND | |
| OUT | Digital output | FGND | t _{on} = 100 μs t _{off} = 150 μs |
| Vout | Output 24 V DC supply voltage | FGND | |
| GND4 | Reference potential of the 24 V DC supply voltage Vout | FGND | |
| GND5 | Reference potential of the 24 V DC supply voltage Vout | FGND | |

9.6.5 TwinSAFE slot | X09

Valid for:

- All devices in the AF1000 series with TwinSAFE STO/SS1 via FSoE and I/O
 - AF1xxx-x2xx

Safe inputs at the TwinSAFE slot



| Feature | Implementation |
|------------------------------------|------------------------------------|
| Connection type | Slot |
| Plug connector | 4-pin, included in scope of supply |
| Contact type of the plug connector | Direct plug-in technique |
| Replacement part | ZS4010-xxxx |

Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.14 | 1.5 |
| Conductor connection cross-section AWG | AWG | 26 | 16 |
| solid wire H05(07) V-U | mm ² | 0.14 | 1.5 |
| stranded wire H05(07) V-U | mm ² | 0.14 | 1.5 |
| with AEH with collar DIN46 228/4 | mm ² | 0.28 | 1 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.25 | 1 |

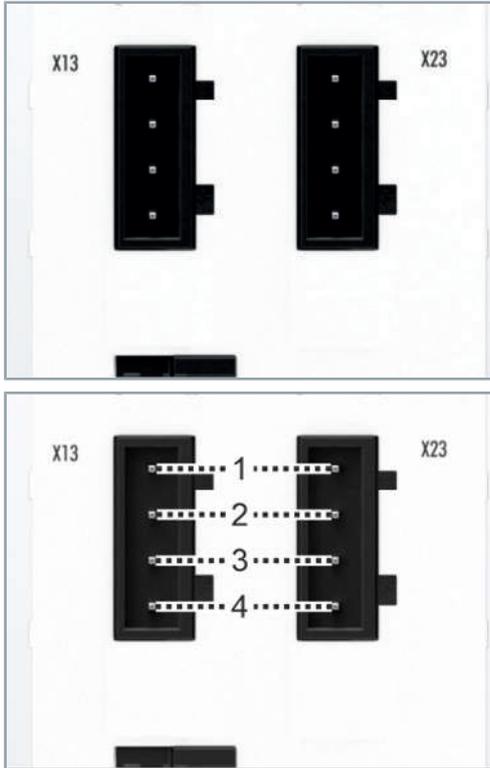
Contact assignment at this connection

| Position | Terminal point | Signal | Reference potential |
|----------|----------------|--------------------|---------------------|
| 1 | IN1+ | Fail-safe input 1+ | FGND |
| 2 | IN1- | Fail-safe input 1- | FGND |
| 3 | IN2+ | Fail-safe input 2+ | FGND |
| 4 | IN2- | Fail-safe input 2- | FGND |

9.6.6 Motor slot | X13

Valid for:

- All devices in the AF1000 series
 - AF11xx-xxxx
 - AF12xx-xxxx

Motor connection for channel 1 to connection X13

| Feature | Implementation |
|--|--|
| Connection type | Socket, 4-pin |
| Connector | Accessory component, not included in scope of delivery |
| Contact type of the connector | Direct plug-in technique |
| Connectors for devices with an AF1xxx-1xxx single-phase supply | Order information ZS4100-1013 (PU 1 pc.) ZS4100-1113 (PU 10 pcs.) |
| Connectors for devices with an AF1xxx-3xxx three-phase supply | Order information ZS4100-3013 (PU 1 pc.) ZS4100-3113 (PU 10 pcs.) |

Contact assignment at this connection

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | PE | Protective conductor, PE |
| 2 | U | Phase U |
| 3 | V | Phase V |
| 4 | W | Phase W |

Accessories | Connectors for the motor connectors

The connector for the motor socket is not included in the scope of delivery. Order information can be found in the following tables.

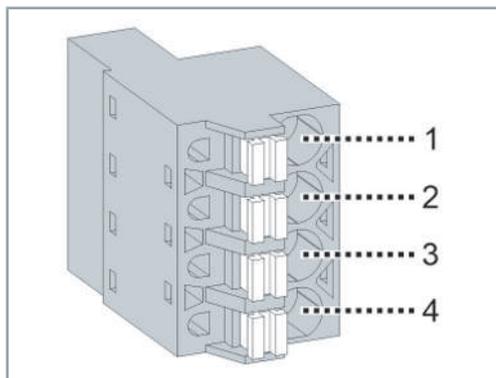
| Single-phase devices | PU [pieces] | Ordering information |
|--|-------------|----------------------|
| 4-pin motor connector for AF1000 single-phase devices, socket X13/X23, wire cross-section max. 2.5 mm ² | 1 | ZS4100-1013 |
| | 10 | ZS4100-1113 |

| Three-phase devices | PU [pieces] | Ordering information |
|---|-------------|----------------------|
| 4-pin motor connector for AF1000 three-phase devices, socket X13/X23, wire cross-section max. 2.5 mm ² | 1 | ZS4100-3013 |
| | 10 | ZS4100-3113 |

Connectable conductors for this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.08 | 2.5 |
| Conductor connection cross-section AWG | AWG | 20 | 12 |
| solid wire H05(07) V-U | mm ² | 0.5 | 1.5 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 2.5 |
| with AEH with collar DIN46 228/4 | mm ² | 0.5 | 2.5 |

| Technical parameter | Unit | min. | max. |
|----------------------------------|-----------------|------|------|
| with wire end sleeve DIN46 228/1 | mm ² | 0.5 | 2.5 |



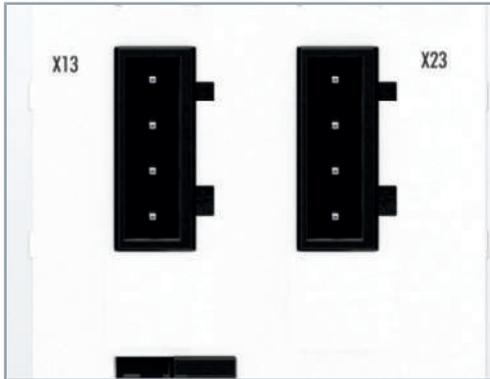
Contact assignment at this connection

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | PE | Protective conductor, PE |
| 2 | U | Phase U |
| 3 | V | Phase V |
| 4 | W | Phase W |

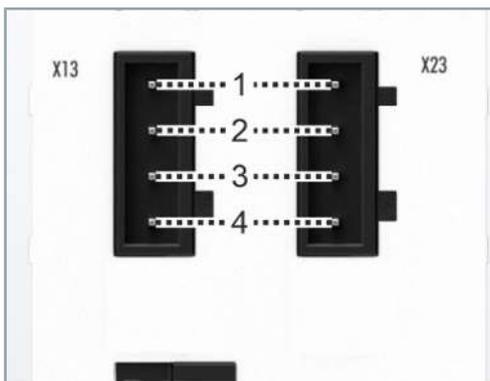
9.6.7 Motor slot | X23

Valid for:

- All 2-channel devices in the AF1000 series
 - AF12xx-xxxx

Motor connection for channel 2 to connection X23

| Feature | Implementation |
|--|--|
| Connection type | Socket, 4-pin |
| Connector | Accessory component, not included in scope of delivery |
| Contact type of the connector | Direct plug-in technique |
| Connectors for devices with an AF1xxx-1xxx single-phase supply | Order information ZS4100-1013 (PU 1 pc.) ZS4100-1113 (PU 10 pcs.) |
| Connectors for devices with an AF1xxx-3xxx three-phase supply | Order information ZS4100-3013 (PU 1 pc.) ZS4100-3113 (PU 10 pcs.) |

**Contact assignment at this connection**

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | PE | Protective conductor, PE |
| 2 | U | Phase U |
| 3 | V | Phase V |
| 4 | W | Phase W |

Accessories | Connectors for the motor connectors

The connector for the motor socket is not included in the scope of delivery. Order information can be found in the following tables.

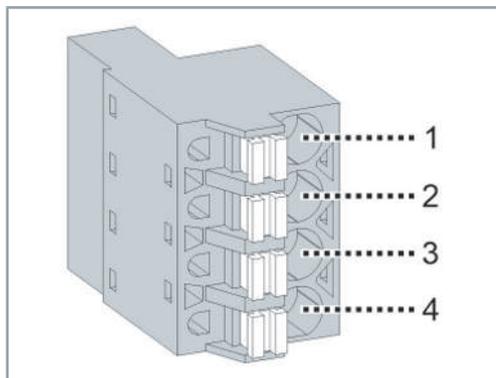
| Single-phase devices | PU [pieces] | Ordering information |
|--|-------------|----------------------|
| 4-pin motor connector for AF1000 single-phase devices, socket X13/X23, wire cross-section max. 2.5 mm ² | 1 | ZS4100-1013 |
| | 10 | ZS4100-1113 |

| Three-phase devices | PU [pieces] | Ordering information |
|---|-------------|----------------------|
| 4-pin motor connector for AF1000 three-phase devices, socket X13/X23, wire cross-section max. 2.5 mm ² | 1 | ZS4100-3013 |
| | 10 | ZS4100-3113 |

Connectable conductors for this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.08 | 2.5 |
| Conductor connection cross-section AWG | AWG | 20 | 12 |
| solid wire H05(07) V-U | mm ² | 0.5 | 1.5 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 2.5 |

| Technical parameter | Unit | min. | max. |
|----------------------------------|-----------------|------|------|
| with AEH with collar DIN46 228/4 | mm ² | 0.5 | 2.5 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.5 | 2.5 |



Contact assignment at this connection

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | PE | Protective conductor, PE |
| 2 | U | Phase U |
| 3 | V | Phase V |
| 4 | W | Phase W |

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 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 Prerequisites during operation

Pay attention to the following points during operation:

- ▶ Atypical noise development
- ▶ Smoke development
- ▶ Always check drive surfaces and cables for dirt or dust
- ▶ Check temperature development
- ▶ Check function of safety devices

10.3 After operation

WARNING

Risk of injury due to uncontrolled movement of components

The components of the drive system may perform uncontrolled movements after the power supply has been switched off and cause serious injury.

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

DANGER

Serious injuries due to electrical voltage!

Even after the mains voltage has been switched off, a life-threatening DC link voltage may remain present for up to 30 minutes. The following steps must be taken before removing the supply line:

- Wait until the DC link is discharged

CAUTION

Increased attention in the case of vertical axes!

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

WARNING

Caution – Risk of injury!

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

11 Maintenance and cleaning

⚠ WARNING

Serious injuries due to cleaning work during operation

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

- Bring the connected motors and the machine into a safe state for cleaning work.
- De-energize the connected motors and the machine.
- Secure the connected motors and the machine against unauthorized restarting.

NOTICE

Damage to the economy variable frequency drive due to liquid

Cleaning fluid entering the variable frequency drive through immersion or spraying may cause damage to the product.

- Wipe the variable frequency drive with cleaning agent and a cloth only
- Do not immerse variable frequency drive

The components of the economy variable frequency drive 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 of the economy variable frequency drive AF1000 are subject to protection rating IP20 and may only be installed and operated in accordance with the data for operation and environment.

Operation beyond the permissible environmental conditions and operating states will shorten the service life of the components of the economy variable frequency drive AF1000.

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 AF1000 in the USA or Canada.

12.1 Mains filter

In the accessories

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 following products are available:

- Footprint filter for protection of individual devices with single-phase or three-phase mains connection
- Central mains filter as a sum filter for protection of several devices with single-phase or three-phase mains connection

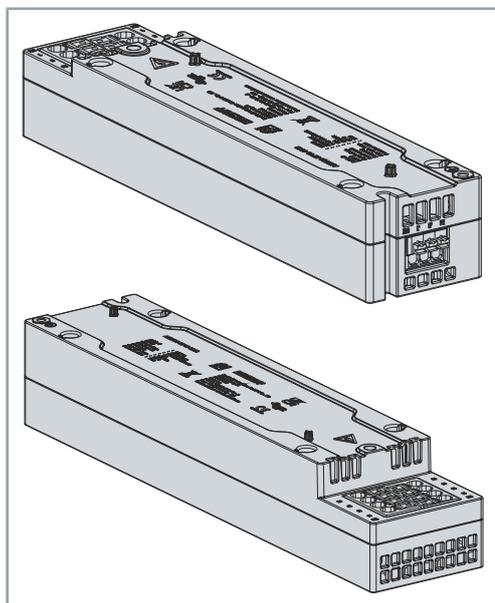
Supply 1 x 230 V AC for AF1xxx-1xxx

| Mains filter, category C2 | Rated current |
|-----------------------------|---------------|
| AX2090-NF10-1012, footprint | 12 A |
| AX2090-NF12-1020, central | 20 A |

Supply 3 x 400...480 V AC for AF1xxx-3xxx

| Mains filter, category C2 | Rated current |
|-----------------------------|---------------|
| AX2090-NF10-3012, footprint | 12 A |
| AX2090-NF12-3020, central | 20 A |

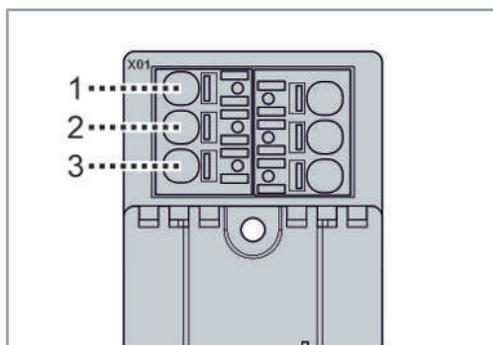
12.1.1 AX2090-NF10-x012 footprint filter



The footprint filter is a compact mains filter that is mounted directly on the AF1000. It is designed for the operating current of the respective economy variable frequency drive and reduces cable-related interference locally.

AX2090-NF10-1012 connection technology

Connection X01



X01 | Mains input for single-phase devices

| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 3-pin |

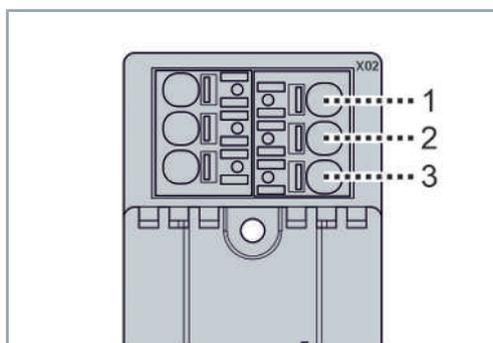
Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.25 | 6 |
| Conductor connection cross-section AWG | AWG | 24 | 8 |
| solid wire H05(07) V-U | mm ² | 0.5 | 6 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 6 |
| with AEH with collar DIN46 228/4 | mm ² | 0.25 | 6 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.25 | 6 |

Contact assignment at this connection

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | L | Phase L |
| 2 | N | Neutral conductor N |
| 3 | PE | Protective conductor, PE |

Connection X02



X02 | Mains forwarding for single-phase devices

| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 3-pin |

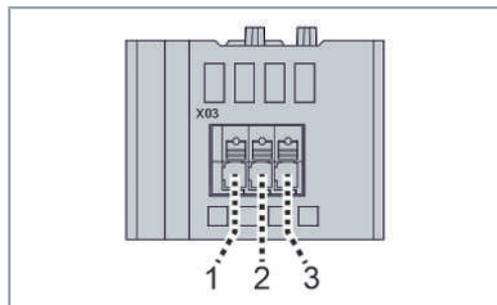
Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.25 | 6 |
| Conductor connection cross-section AWG | AWG | 24 | 8 |
| solid wire H05(07) V-U | mm ² | 0.5 | 6 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 6 |
| with AEH with collar DIN46 228/4 | mm ² | 0.25 | 6 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.25 | 6 |

Contact assignment at this connection

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | L | Phase L |
| 2 | N | Neutral conductor N |
| 3 | PE | Protective conductor, PE |

Connection X03



X03 | Mains output for single-phase devices

| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 3-pin |

Connectable conductors at this connection

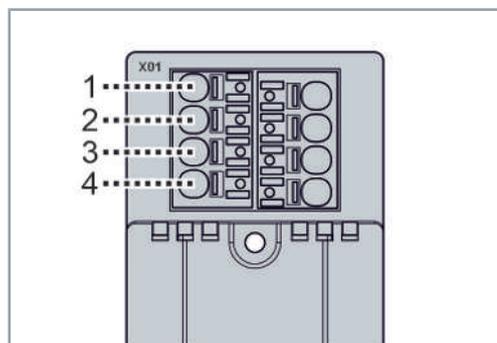
| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.34 | 4 |
| Conductor connection cross-section AWG | AWG | 12 | 20 |
| solid wire H05(07) V-U | mm ² | 0.5 | 2.5 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 4 |
| with AEH with collar DIN46 228/4 | mm ² | 0.34 | 2.5 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.5 | 2.5 |

Contact assignment at this connection

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | L' | Forwarding L |
| 2 | N' | Forwarding N |
| 3 | PE | Protective conductor, PE |

AX2090-NF10-3012 connection technology

Connection X01



X01 | Mains input for three-phase devices

| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 4-pin |

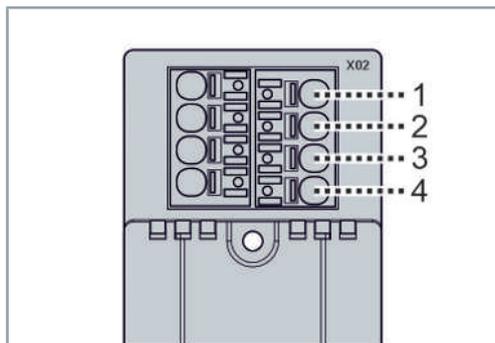
Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.25 | 6 |
| Conductor connection cross-section AWG | AWG | 24 | 8 |
| solid wire H05(07) V-U | mm ² | 0.5 | 6 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 6 |
| with AEH with collar DIN46 228/4 | mm ² | 0.25 | 6 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.25 | 6 |

Contact assignment at this connection

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | L1 | Phase L1 |
| 2 | L2 | Phase L2 |
| 3 | L3 | Phase L3 |
| 4 | PE | Protective conductor, PE |

Connection X02



X02 | Mains forwarding for three-phase devices

| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 4-pin |

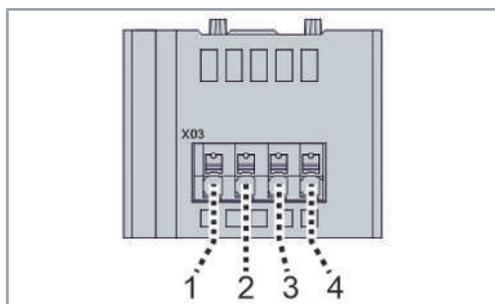
Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.25 | 6 |
| Conductor connection cross-section AWG | AWG | 24 | 8 |
| solid wire H05(07) V-U | mm ² | 0.5 | 6 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 6 |
| with AEH with collar DIN46 228/4 | mm ² | 0.25 | 6 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.25 | 6 |

Contact assignment at this connection

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | L1 | Phase L1 |
| 2 | L2 | Phase L2 |
| 3 | L3 | Phase L3 |
| 4 | PE | Protective conductor, PE |

Connection X03



X03 | Mains output for three-phase devices

| Feature | Implementation |
|--------------------|--------------------------|
| Connection type | Connection strip |
| Contact type | Direct plug-in technique |
| Number of contacts | 4-pin |

Connectable conductors at this connection

| Technical parameter | Unit | min. | max. |
|--|-----------------|------|------|
| Clamping range | mm ² | 0.34 | 4 |
| Conductor connection cross-section AWG | AWG | 12 | 20 |
| solid wire H05(07) V-U | mm ² | 0.5 | 2.5 |
| stranded wire H05(07) V-U | mm ² | 0.5 | 4 |
| with AEH with collar DIN46 228/4 | mm ² | 0.34 | 2.5 |
| with wire end sleeve DIN46 228/1 | mm ² | 0.5 | 2.5 |

Contact assignment at this connection

| Position | Terminal point | Connection |
|----------|----------------|--------------------------|
| 1 | L1' | Forwarding L1 |
| 2 | L2' | Forwarding L2 |
| 3 | L3' | Forwarding L3 |
| 4 | PE | Protective conductor, PE |

12.1.2 AX2090-NF10-x020 central mains filter

Missing content

The mains filter is a central mains filter that is installed in the power supply upstream of several economy variable frequency drives and is designed for the sum of the currents.

| Economy variable frequency drive | Mains filter, category C2 |
|----------------------------------|---------------------------|
| AF1xxx-1xxx, single-phase | AX2090-NF12-1020, 20 A |
| AF1xxx-3xxx, three-phase | AX2090-NF12-3020, 20 A |

Prerequisites:

- Single-phase devices may only be connected to single-phase mains filters; three-phase devices may only be connected to three-phase devices.
- The total input current of the connected devices must be smaller than or equal to the permissible rated current of the mains filter.

12.2 Shielding bracket

Missing content

When using a shielded motor cable, the shield of the motor cable can be connected and safely contacted using the shielding bracket.

12.3 Braking resistor

Missing content

When braking a drive, the energy generated is converted into heat by the braking resistors from the AX2090-BW65 series. As components with the protection rating IP65, the braking resistors feature full contact hazard protection and are protected against dust or water jets from any direction. For further information, read the operating instructions for the braking resistors from the [AX2090-BW65](#) series.

13 Decommissioning

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

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



Do not remove components from the products

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

Contact Beckhoff Service for further information.

Removing the economy variable frequency drive from the machine

- ▶ Remove cables and electrical connections
- ▶ Loosen and remove the fixing screws of the economy variable frequency drive

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.

14 Guidelines and Standards

14.1 Standards

Generic standards EN IEC 61000-6-2

"Immunity standard for industrial environments"

EN IEC 61800-5-1

"Adjustable speed electrical power drive systems"

Part 5-1: Safety requirements - Electrical, thermal and energy

Generic standards EN IEC 61000-6-4

"Emission standard for industrial environments"

Product standard EN IEC 61800-3

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

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
- The 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 protective conductor connections $\geq 2.5 \text{ mm}^2$ via connector for industrial plants according to IEC 60309-2 |
| KU = 6 | Achieved in relation to interruption: With permanently connected conductors $\geq 10 \text{ mm}^2$; the type of connection and routing must comply with the standards applicable to PE conductors |

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 Notified bodies

 The product does not fall within the scope of the Machinery Directive. However, Beckhoff products are designed and evaluated for personal safety and use in a machine or system in full compliance with all relevant regulations.

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.

Send your request to:

✉ info@beckhoff.com

Index

| | | | |
|-------------------------------------|----|----------------|----|
| B | | Support | 11 |
| BIC Beckhoff Identification Code | 18 | Symbols | 9 |
| DataMatrix code | 18 | | |
| BTN Beckhoff Traceability Number | 18 | T | |
| Product packaging | 18 | Target group | 8 |
| | | Technical data | 23 |
| C | | | |
| Commissioning | 85 | | |
| D | | | |
| DataMatrix code | | | |
| Position | 18 | | |
| Reader apps | 18 | | |
| Scanning | 18 | | |
| Declaration of conformity | 95 | | |
| Disposal | 93 | | |
| Dual Use | 22 | | |
| E | | | |
| Environmental conditions | 23 | | |
| F | | | |
| Fuses | 72 | | |
| G | | | |
| General safety instructions | 14 | | |
| I | | | |
| Instruction | 9 | | |
| Intended use | 21 | | |
| L | | | |
| Label, see Safety pictograms | 13 | | |
| O | | | |
| Operating Conditions | 23 | | |
| Ordering options | 20 | | |
| P | | | |
| Pictograms | 9 | | |
| Power derating | 23 | | |
| S | | | |
| Safety | 13 | | |
| De-energized and voltage-free state | 14 | | |
| Grounding | 14 | | |
| Hot surfaces | 14 | | |
| Intended use | 21 | | |
| Keep the environment clean | 14 | | |
| Overheating | 14 | | |
| Safety pictograms | 14 | | |
| Tightening torques | 14 | | |
| Safety pictograms | 13 | | |
| Scope of supply | 38 | | |
| Security | | | |
| General safety instructions | 14 | | |
| Signal words | 9 | | |

Trademark statements

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

More Information:
www.beckhoff.com/af1000

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

