Bonfiglioli Vectron

AXIA AGILE

Operating Instructions

Frequency inverter 400 V
0.25 kW ... 15 kW

Bonfiglioli

TABLE OF CONTENTS

1 General Information about the documentation

1.1 Instruction manuals

For better clarity, the documentation is structured according to the customer-specific requirements made on the frequency inverter.

Quick Start Guide

The "Quick Start Guide" describes the basic steps required for the mechanical and electrical installation of the frequency inverter.

Operating Instructions

The operating instructions document the complete functionality of the frequency inverter. It describes the parameters required for special purposes, adjustment to the application, and the numerous additional functions in detail.

Application Manual

The application manual supplements the documentation for purposeful installation and commissioning of the frequency inverter. It provides information on various topics related to the use of the frequency inverter in the context of specific applications.

If you need a copy of the documentation or additional information, contact your local representative of BONFIGLIOLI.

The following instructions are available for the AXIA series:

AXIA Operating Instructions	Function of frequency inverter.
Quick Start Guide AXIA	Installation and commissioning supplied with the device.
Manuals Communication interfaces	
Manuals Extension modules	
Safety manual	Safety functions
Application manuals	Application-specific settings, best practices and preconditions
Graphical User Interface Manual	Description of intended use of the GUI

The products for CANopen® communication comply with the specifications of the user organization CiA® (CAN in Automation).

The products for EtherCAT® communication comply with the specifications of the user organization ETG (EtherCAT Technology Group).

The products for ProfiNET® communication comply with the specifications of the user organization "PROFIBUS Nutzerorganisation e. V.".

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Bluetooth® is a registered trademark of Bluetooth® SIG, Inc., USA and licensed to Panasonic Corporation.

The present documentation was prepared with great care, and it was subjected to extensive and repeated reviews. For reasons of clarity, it was not possible to include all details of all types of the product in the documentation. Neither was it possible to consider all conceivable installation, operation or maintenance situations. If you require further information or if you encounter specific problems, which are not dealt with in sufficient detail in the documentation, contact your local BONFIGLIOLI agent.

1.2 This document

This document is the first release. It is subject to being redrafted or changed to follow the ongoing development of the product.

This document describes the frequency inverters of the AXIA series.

The Operating Instructions contain important information on the installation and the use of the product in its specified application range. Comply with user documentation to avoid risks, to minimize repair cost and downtimes and to increase the reliability and service life of the frequency inverter.

For this reason, make sure you read the user manual and other relevant documents carefully.

IMPORTANT:

Compliance with the documentation is required to ensure safe operation of the frequency inverter. Bonfiglioli Deutschland GmbH shall not be held liable for any damage caused by any non-compliance with the documentation.

In case you encounter any problems not sufficiently covered by the documentation, please contact the manufacturer.

For safe commissioning and operation of the AXA (AXIA) series, comply with the following documentation:

- This Operating Instructions Document
- Co-applicable Safety manual

This document applies to the following frequency inverter series:

- AxiaAgile 20
- AxiaAgile 40

The AXA series is identified by its label on the case and by the type plate.

The present document has been created in English. Other language versions are translations thereof.

1.3 Warranty and liability

BONFIGLIOLI Deutschland GmbH (hereinafter referred to as "manufacturer") states that the contents of this Operating Instructions document do not form part of any previous or existing agreement, assurance or legal relationship between the manufacturer and the user of the Operating Instructions (hereinafter referred to as the "User"). Neither are they intended to supplement or replace such agreements, assurances or legal relationships. Any obligations of the manufacturer shall solely be based on the relevant purchase agreement which also includes the complete and solely valid warranty stipulations. These contractual warranty provisions are neither extended nor limited by the specifications contained in this documentation.

The manufacturer reserves the right to correct or amend the specifications, product information and omissions in these operating instructions without prior notice. The manufacturer assumes no responsibility to update these Operating Instructions. The manufacturer shall not be liable for any damage, injuries or costs which may be caused by the aforementioned reasons.

In addition, the manufacturer excludes any warranty and disclaims all liability, including without limitation direct, indirect, special, punitive, incidental, exemplary or consequential damages arising out of or in connection with one or more of the following causes:

- inappropriate use of the frequency inverter,
- non-compliance with the instructions, warnings and prohibitions contained in the documentation,
- unauthorized modifications of the frequency inverter,
- insufficient monitoring of parts of the machine/plant which are subject to wear,
- repair work at the machine/plant not carried out properly or in time,
- catastrophes by external impact and Force Majeure.

1.4 Obligation

These Operating Instructions must be read before commissioning and complied with. Anybody entrusted with tasks in connection with the

- transport,
- assembly,
- installation of the frequency inverter and
- operation of the frequency inverter

must have read and understood the Operating Instructions and, in particular, the safety instructions in order to prevent personal and material losses.

1.5 Copyright

In accordance with applicable law, any copyright relating to this document shall remain with

BONFIGLIOLI Deutschland GmbH
Europark Fichtenhain B6
47807 Krefeld
Germany

This document is intended for the operator of the frequency inverter. Any disclosure or copying of this document, exploitation and communication of its contents (as hardcopy or electronically) shall be forbidden, unless permitted expressly.

Any non-compliance will constitute an offense against copyright law, against law against unfair competition and the German Civil Code and may result in claims for damages. All rights relating to patent, utility model or design registration are reserved.

1.6 Licensing

1.6.1 lwIP (lightweight IP)

Firmware portions of the lwIP TCP/IP stack are subject to the following:

1.6.2 Mbed TLS

Firmware portions by Mbed TLS are subject to the following:

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   Unless required by applicable law or agreed to in writing, software
   distributed under the License is distributed on an "AS IS" BASIS,
   WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
   See the License for the specific language governing permissions and
   limitations under the License.
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1.7 Storage of documents

The documentation forms an integral part of the frequency inverter. It must be stored such that it is accessible to operating staff at all times. If the frequency inverter is sold on to other users, the documentation must also be handed over with it.

1.8 Final decommissioning

After the end of product service life, the user/operator must take the device out of operation.

Disposal requirements under European Union WEEE regulations

The product is marked with the WEEE symbol shown below.

This product cannot be disposed as general household waste. Users responsible for the final disposal must make sure that it is carried out in accordance with the European Directive 2012/19/EU, where required, as well as the relative national transposition rules. Fulfil disposal also in according with any other legal provisions applicable in the country.

2 General safety instructions and information on use

This chapter contains general safety instructions for the Operator and the Operating Staff. At the beginning of certain main chapters, some safety instructions are included which apply to all work described in the relevant chapter. Special work-specific safety instructions are provided before each safety-relevant work step.

2.1 Terminology

According to the documentation, different activities must be performed by certain persons with certain qualifications.

The groups of persons with the required qualification are defined as follows:

Operator

This is the entrepreneur/company who/which operates the frequency inverter and uses it as per the specifications or has it operated by qualified and instructed staff.

Operating staff

The term Operating Staff covers persons instructed by the Operator of the frequency inverter and assigned the task of operating the frequency inverter.

Skilled Personnel

The term Skilled Personnel covers staff that are assigned special tasks by the Operator of the frequency inverter, e.g. installation, maintenance and service/repair and troubleshooting. Based on their qualification and/or know-how, Skilled Personnel must be capable of identifying defects and assessing functions.

Qualified electrician

The term Qualified Electrician covers qualified and trained staff who have special technical know-how and experience with electrical installations. In addition, Qualified Electricians must be familiar with the applicable standards and regulations, they must be able to assess the assigned tasks properly and identify and eliminate potential hazards.

Instructed person

The term Instructed Person covers staff who were instructed and trained about/in the assigned tasks and the potential hazards that might result from inappropriate behavior. In addition, instructed persons must have been instructed in the required protection provisions, protective measures, the applicable directives, accident prevention regulations as well as the operating conditions and verified their qualification.

Expert

The term Expert covers qualified and trained staff who have special technical know-how and experience relating to frequency inverter. Experts must be familiar with the applicable government work safety directives, accident prevention regulations, guidelines and generally accepted rules of technology to assess the operationally safe condition of the frequency inverter.

2.2 Designated use

The frequency inverter is designed according to the state of the art and recognized safety regulations.

The frequency inverters are electrical drive components intended for installation in industrial plants or machines. Commissioning and start of operation is not allowed until it has been verified that the machine meets the requirements of the EC Machinery Directive 2006/42/EC and DIN EN 60204-1.

The frequency inverters meet the requirements of the low voltage directive 2014/35/EU and DIN EN 61800-5-1. CE-labelling is based on these standards. Responsibility for compliance with the EMC Directive 2014/30/EU lies with the operator. Frequency inverters are only available at specialized dealers and are exclusively intended for commercial use as per EN 61000-3-2.

No capacitive loads may be connected to the frequency inverter.

The technical data, connection specifications and information on ambient conditions are indicated on the rating plate and in the documentation and must be complied with in any case.

2.3 Misuse

Any use other than that described in "Designated use" shall not be permissible and shall be considered as misuse.

For example, the machine/plant must not be operated

- by uninstructed staff,
- while it is not in perfect condition,
- without protection enclosure (e.g. covers),
- without safety equipment or with safety equipment deactivated,
- when general requirements, such as operating conditions and technical data, are not met.

The manufacturer shall not be held liable for any damage resulting from such misuse. The sole risk shall be borne by the operator.

Explosion protection

The frequency inverter is an IP 20 ingress protection rating device. For this reason, use of the device in explosive atmospheres is not permitted.

2.4 Residual risks

Residual risks are special hazards involved in handling of the frequency inverter which cannot be eliminated despite the safety-compliant design of the device. Residual risks are not obviously identifiable and can be a potential source of injury or a health hazard.

Typical residual hazards include:

- Electrical hazard
- Danger of contact with energized components due to a defect, open covers or enclosures or improper working on electrical equipment.
- Danger of contact with energized components in frequency inverter if no external disconnection device was installed by the operator.

To minimize electrical hazards, install all covers correctly and close all electrical cabinet doors during operation.

When LEDs and/or other indicating elements on the frequency inverter are not active, the inverter still may be energized.

Before carrying out any work with the device, where contact with energized parts might be possible, always check if the device is deenergized, irrespective of the status of any installed indicating elements.

Charged capacitors in DC link

The DC-link may have dangerous voltage levels for up to 3 minutes after shutdown.

Electrostatic charging

Touching electronic components entails the risk of electrostatic discharges.

Thermal hazards

Risk of accidents by hot machine/plant surfaces, e.g. heat sink, transformer, fuse or sine filter.

Danger of equipment falling down/over, e.g. during transport

Center of gravity is not at the center of the device.

2.5 Safety and warning signs on frequency inverter

- Comply with all safety instructions and danger information provided on the frequency inverter.
- Safety information and warnings on the frequency inverter must not be removed.

2.6 Warning information and symbols

Hazard classes

The following hazard identifications and symbols are used to mark particularly important information:

DANGER

Identification of immediate threat holding a **high** risk of death or serious injury if not avoided.

WARNING

Identification of immediate threat holding a **medium** risk of death or serious injury if not avoided.

CAUTION

Identification of immediate threat holding a **low** risk of minor or moderate physical injury if not avoided.

NOTICE

Identification of a threat holding a risk of material damage if not avoided.

Hazard symbols

Symbol	Meaning	Symbol	Meaning
	General hazard		Suspended load
	Electrical voltage		Hot surfaces
	Danger of crushing		

Prohibition signs

Symbol	Meaning
	No switching; it is forbidden to switch the machine/plant, assembly on

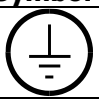
Personal safety equipment

Symbol	Meaning
	Wear body protection
	Wear ear protectors

Recycling

Symbol	Meaning
	Recycling, to avoid waste, collect all materials for reuse

Grounding symbol

Symbol	Meaning
	Ground connection

ESD symbol

Symbol	Meaning
	ESD: Electrostatic Sensitive Devices, i.e. components and assemblies sensitive to electrostatic energy

Information signs

Symbol	Meaning
	Tips and information making using the frequency inverter easier.

Font style in documentation

Example	Font style	Use
0x1234	bold	Representation of object index numbers / object numbers
/12	Bold & underlined	Representation of object sub-index numbers. In the software AxiaManager: ".12"
Object	inclined, font: Times New Roman	Representation of object names / designations
01234	Courier new	Representation of parameter values / object settings

Object properties table

Abbreviations used	
Access: r/w: ro: wo: Rng. Default:	Access type Read/Write Read only Write only Value Range Default value

2.7 Directives and guidelines to be adhered to by the operator

The operator must adhere to the following directives and regulations:

- Ensure that the applicable workplace-related accident prevention regulations as well as other applicable national regulations are accessible to the staff.
- An authorized person must ensure, before using the frequency inverter, that the device is used in compliance with its designated use and that all safety requirements are met.
- Additionally, comply with the applicable laws, regulations and directives of the country in which the frequency inverter is used.
- For liquid cooled frequency inverters, comply with the cooling water guideline VGB-R 455 P.
- Any guidelines and directives that may be required additionally shall be defined by the operator of the machine/plant considering the operating environment.

2.8 Operator's general plant documentation

- In addition to the Operating Instructions, the operator should issue separate internal user manuals for the frequency inverter. The Operating Instructions of the frequency inverter must be included in the Operating Instructions of the whole plant.

2.9 Operator's/operating staff's responsibilities

2.9.1 Selection and qualification of staff

- Any work on the frequency inverter may only be carried out by skilled personnel. The staff must not be under the influence of any drugs. Note the minimum age required by law. Define the staff's responsibility pertaining to all work on the frequency inverter clearly.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering.
- The operating staff must be trained for the relevant work to be performed.

2.9.2 General work safety

- In addition to the Operating Instructions of the machine/plant, any applicable legal or other regulations relating to accident prevention and environmental protection must be complied with. The staff must be instructed accordingly.
  Such regulations and/or requirements may include, for example, handling of hazardous media and materials or provision/use of personal protective equipment.
- In addition to this Operating Instructions, issue any additional directives that may be required to meet specific operating requirements, including supervision and reporting requirements, e.g. directives relating to work organization, workflow and employed staff.
- Unless approved expressly by the manufacturer, do not modify the frequency inverter in any way, including addition of attachments or retrofits.
- Only use the frequency inverter if the rated connection and setup values specified by the manufacturer are met.
- Provide appropriate tools as may be required for performing all work on the frequency inverter properly.

2.9.3 Ear protectors

- The frequency inverter produces noise. Due to noise development, frequency inverters should only be installed in normally unstaffed areas.
- Noise emission in operation is < 85 dB(A) in the case of sizes 1 through 4.

2.10 Organizational measures

2.10.1 General

- Train your staff in the handling and use of the frequency inverter and the machine/plant as well as the risks involved.
- Use of any individual parts or components of the frequency inverter in other parts of the operator's machine/plant is prohibited.
- Optional components for the frequency inverter must be used in accordance with their designated use and in compliance with the relevant documentation.

2.10.2 Use in combination with third-party products

- Please note that Bonfiglioli Deutschland GmbH will not accept any responsibility for compatibility with third-party products (e.g. motors, cables or filters).
- In order to enable optimum system compatibility Bonfiglioli Deutschland GmbH offers components facilitating commissioning and providing optimum synchronization of the machine/plant parts in operation.
- If you use the frequency inverter in combination with third-party products, you do so at your own risk.

2.10.3 Handling and installation

- Do not commission any damaged or destroyed components.
- Prevent any mechanical overloading of the frequency inverter. Do not bend any components and never change the isolation distances.
- Do not touch any electronic construction elements and contacts. The frequency inverter is equipped with components which are sensitive to electrostatic energy and can be damaged if handled improperly. Any use of damaged or destroyed components will endanger the machine/plant safety and shall be considered as non-compliance with the applicable standards.
- Only install the frequency inverter in a suitable operating environment. The frequency inverter is exclusively designed for installation in industrial environments.
- If seals are removed from the case, this can result in the warranty becoming null and void.

2.10.4 Electrical connections

- The five safety rules must be complied with.
- Never touch live terminals. In sizes 1 through 4, the DC-link may have dangerous voltage levels for up to 3 minutes after shutdown.
- When performing any work on/with the frequency inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants of the country in which the frequency inverter is used.
- The cables connected to the frequency inverters may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.
- Only connect the frequency inverter to suitable supply mains. The frequency inverter may be operated in TN, TT and IT grid types. Precautions must be taken for operation in IT grids, ☞ "Electrical installation". Operation in a corner-grounded TN grid shall not be permissible.

The five safety rules

When working on/in electrical plants, always follow the five safety rules:

- Disconnect
- Secure to prevent restarting
- check for absence of voltage,
- carry out earthing and short-circuiting
- cover or shield neighboring live parts

2.10.5 Safe operation

- During operation of the frequency inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants.
- Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to the applicable national and international safety directives.
- During operation, all covers must be installed correctly, and all electrical cabinet doors must be closed. During operation, never open the machine/plant.
- No connection work shall be carried out while power supply is on.
- The machine/plant holds high voltage levels during operation, is equipped with rotating parts (fan) and has hot surfaces. Any unauthorized removal of covers, improper use, wrong installation or operation may result in serious injuries or material damage.
- Some components, e.g. the heat sink or braking resistor, may be hot even some time after the machine/plant was shut down. Don't touch any surfaces directly after shutdown. Wear safety gloves where necessary.
- The frequency inverter may hold dangerous voltage levels until the capacitor in the DC link is discharged. After shutdown, wait for at least 3 minutes before starting any electrical or mechanical work on the frequency inverter. Even after this waiting time, make sure that the equipment is deenergized in accordance with the safety rules before starting the work.
- To avoid accidents or damage, only skilled personnel and electricians may carry out the work such as installation, commissioning or setup.
- In the case of a defect of terminals and/or cables, immediately disconnect the frequency inverter from mains supply.
- People who are not familiar with the operation of the frequency inverter and children must not have access to the device.
- Do not bypass nor decommission any protective devices.
- The frequency inverter may be connected to power supply every 60 s. This must be considered when operating a mains contactor in jog operation mode. For commissioning or after an emergency switch-off, a non-recurrent, direct restart is permissible.
- After a failure and restoration of the power supply, the motor may start unexpectedly if the Auto-start function is activated.
  If staff are endangered, a restart of the motor must be prevented by means of external circuitry.
- Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to EN 60204 and applicable safety directives (e.g. Working Machines Act or Accident Prevention Directives).

2.10.6 Maintenance and service/troubleshooting

- Visually inspect the frequency inverter when carrying out the required maintenance work and inspections at the machine/plant.
- Perform the maintenance work and inspections prescribed for the machine carefully, including the specifications on parts/equipment replacement.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering. Only use original spare parts.
- Unauthorized opening and improper interventions in the machine/plant can lead to personal injury or material damage. Any repair work may only be carried out by the manufacturer or personnel approved/licensed by the manufacturer. Any repair work must be carried out by qualified electricians. Check protective equipment regularly.
- Before performing any maintenance work, the machine/plant must be disconnected from mains supply and secured against restarting. The five safety rules must be complied with.

2.10.7 Final decommissioning

Unless separate return or disposal agreements were made, recycle the disassembled frequency inverter components:

- Scrap metal materials
- Recycle plastic elements
- Sort and dispose of other component materials

Electric scrap, electronic components, lubricants and other utility materials must be treated as special waste and may only be disposed of by specialized companies.

In any case, comply with any applicable national disposal regulations regarding environmentally compatible disposal of the frequency inverter. For more details, contact the competent local authorities.

2.11 Safety Instructions on Function "Safe Torque Off" (STO)

The function "Safe Torque Off" (STO) is a functional safety feature, i.e. it protects staff from damage, provided that projecting, installation and operation are performed properly. This function does not disconnect the device from power supply.

To disconnect the device from power supply (e.g. for maintenance work), an "Emergency switch-off" provision as per EN 60204 must be installed. The STO function requires a safety module (SMA) to be installed in the main device.

WARNING

Uncontrolled Starting

Improper installation of the safety circuitry may result in uncontrolled starting of the drive. This may cause death, serious injuries and significant material damage.

- Safety functions may only be installed and commissioned by skilled personnel.

The STO function is not suitable for emergency switch-off as per EN 60204. An emergency switch-off can be implemented by installing a mains contactor.
An emergency switch-off according to EN 60204 must be functioning in all operation modes of the frequency inverter. Resetting an emergency switch-off must not result in uncontrolled starting of the drive.
The drive is started again when the function STO is no longer requested. To comply with EN 60204, ensure that the drive does not start without prior confirmation by taking external measures.
Without a mechanical brake, the drive will not stop immediately but coast to a standstill. If this may result in personal or material damage:

- Take additional safety measures.
- If persons may be endangered after disconnection of the motor power supply by STO, access to hazard areas must be prevented until the drive has stopped.
- Check the safety function at regular intervals according to the results of your risk analysis. The manufacturer recommends that the check be performed after one year, at the latest.

The STO function is fail-safe for one fault. However, on rare occasions, the occurrence of component defects may cause jerking of the motor shaft (max. 180°/pole pair, e. g. jerk by 90°, with 4-pole motor, 180°/2).

- Check if this causes a dangerous movement of the machine.
- If the STO function is used, the special safety instructions, installation instructions and instructions on use shall be complied with.

WARNING

Dangerous voltage!

The safety function "Safe Torque Off" may only be used if mechanical work must be performed on the driven machines, not for work on live components.

After disconnection of an external DC 24 V power supply, the DC link of the frequency inverter is still connected to mains supply.

Even if power supply to the motor is disconnected, and the motor is coasting to a standstill or has already stopped, high voltages may still be present on the motor terminals.

Before working (e. g. maintenance) on live parts, the plant must always be disconnected from mains supply (main switch). This must be documented on the plant.

When the function "Safe Torque Off" is triggered, the motor is not isolated from the DC link of the frequency inverter. High voltage levels may be present at the motor.

- Do not touch live terminals.

The application manual "Functional Safety Manual" must be complied with, particularly if the safety function described there is used.

3 Storage and transport

3.1 Storage

NOTICE

Damage caused by incorrect storage

Wrong or inappropriate storage may result in damage, e.g. due to moisture and dirt.

- Avoid major temperature variations and high air humidity.
- During storage, protect the device against moisture and dirt.

NOTICE

Damage due to incorrect storage duration

Wrong or inappropriate storage may result in damage.

- The duration of storage without connection to the permissible nominal voltage may not exceed one year. After one year of storage, connect the device to mains voltage for 60 minutes.

If the device is stored for more than one year, contact Bonfiglioli before commissioning.

- The frequency inverters must be stored in an appropriate way. During storage, the devices must remain in their original packaging.
- The units may only be stored in dry rooms which are protected against dust and moisture and are exposed to small temperature deviations only. The requirements of DIN EN 60721-3-1 for storage, DIN EN 60721-3-2 for transport and labeling on the packaging must be met.

3.2 Special safety instructions for heavy devices

WARNING



High weight and unusual center of gravity!

Tilting the frequency inverter may result in death or serious injuries. Due to the size and weight of the frequency inverter, there is the risk of accidents during transport. Center of gravity is not the middle of the frequency inverter. The underside of the frequency inverter, due to its design, cannot support the frequency inverter.

- Take utmost care during transport in order to prevent damage and deformation. Transport, attachment and lifting of loads may only be carried out by specially instructed staff who are familiar with the work.
- Only use suitable transport and lifting equipment with sufficient carrying capacity. The lifting cables/chains used must be able to carry the weight of the frequency inverter. Check the ropes or chains for damage.
- Wear appropriate safety clothing.
- When lifting the frequency inverter up ensure that it does not fall over, is displaced, swings out or falls down.
- Before the frequency inverter is lifted up, everybody must have left the work area.
- Before transport, make sure the transport path has sufficient carrying capacity.
- Do not step under suspended loads.
- Do not put the frequency inverter down in upright position without providing a suitable supporting structure.

3.3 Dimensions/weight

For information on the weight and dimensions of the device,  "Technical data" VEC509.

3.4 Transfer to place of installation

Transfer to the place of installation is done with the product in its original packaging. A forklift truck or crane with crane fork can be used for transferring to the place of installation.

- Apply the fork in the middle of the transport unit.
- Secure the transport unit to prevent it from falling and overturning.
- Lift the transport unit up carefully.
- At the place of installation, put the transport unit down on a level and bearing surface.

3.5 Unpacking the device

- Carefully remove packaging.
- Check if the delivered devices correspond to the order.
- Check the device for transport damage and completeness.
- Any defects/damage must be reported to the supplier immediately.

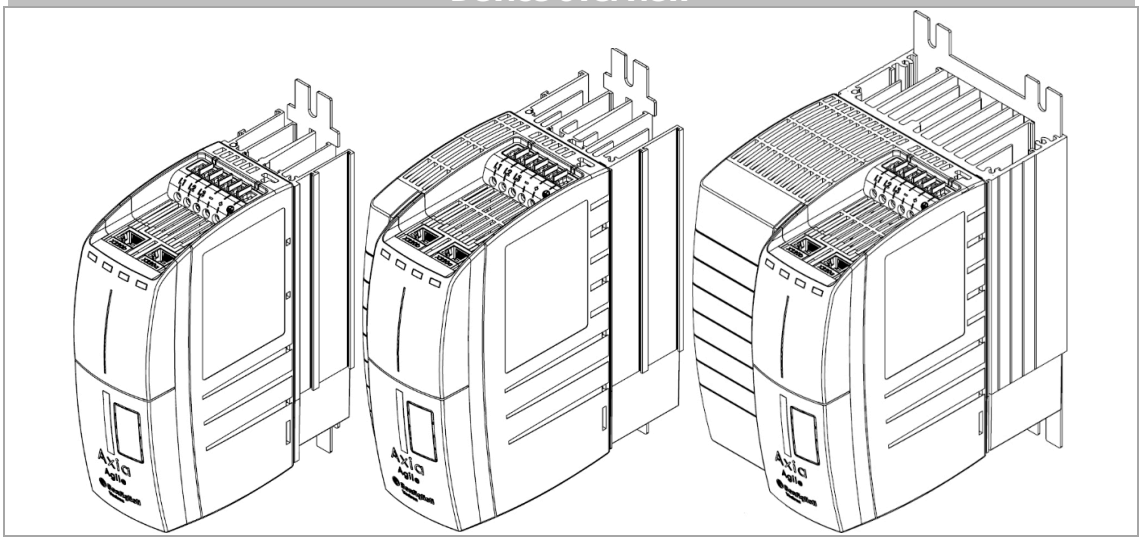
Ensure that all packaging materials are disposed of in an environmentally compatible manner.

4 Device overview

The scope of delivery described can be supplemented by optional components and adapted to the customer-specific requirements.

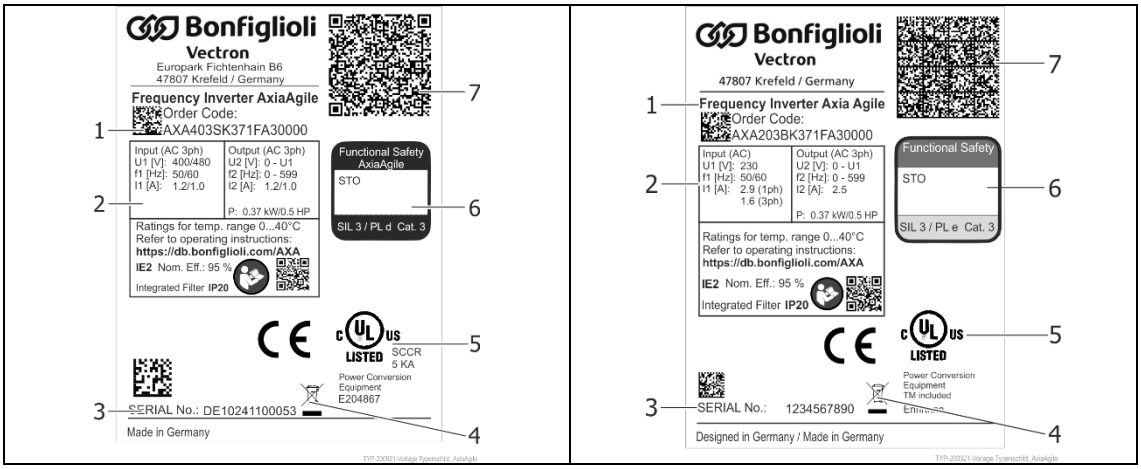
Check incoming goods for quality, quantity and type without delay. Obvious defects such as exterior damage of the packing and/or the unit must be notified to the sender within seven days for insurance reasons.

Device overview



4.1 Type plate

- Identify the type of frequency inverter.
- Check if frequency inverter rated voltage matches the local mains voltage.



Designation

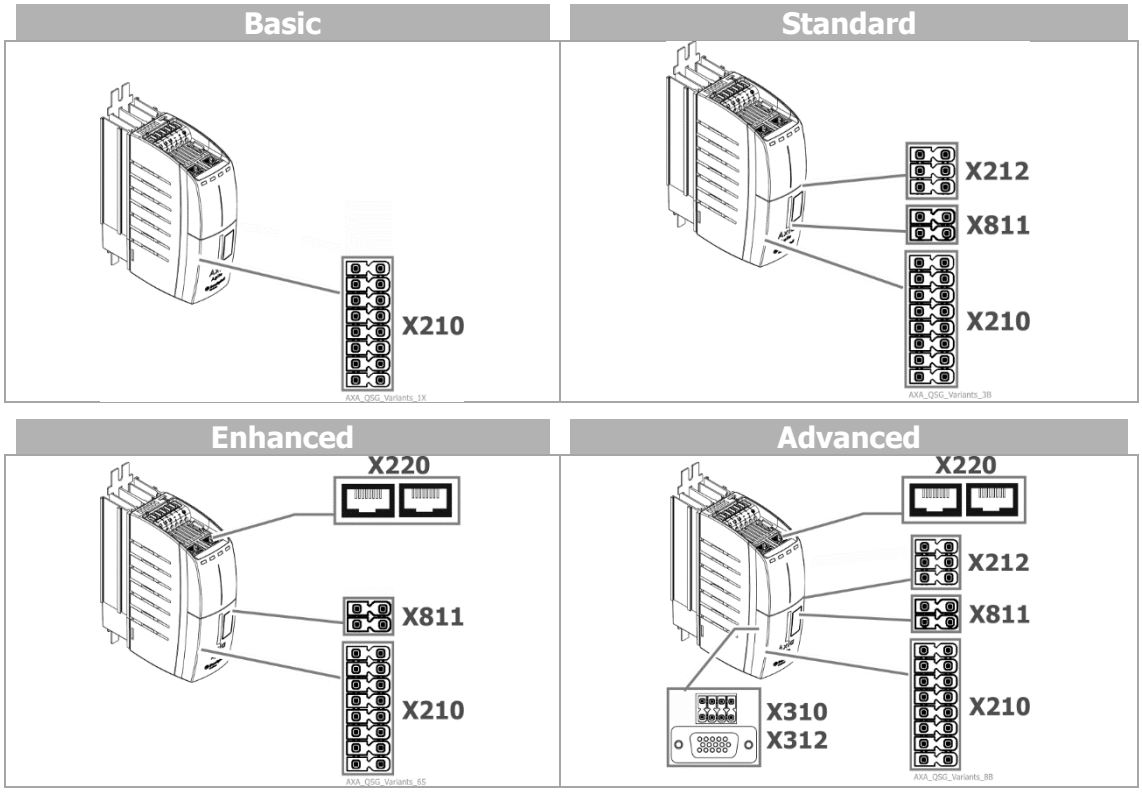
1	Type identifier e.g. **Frequency Inverter AxiaAgile** with the corresponding order code and the data matrix code
2	Rated values (note different voltage ratings)
3	Serial Number with the corresponding data matrix code
4	WEEE symbol
5	Marking for UL61800 (where applicable)
6	Functional Safety marking (where applicable)
7	Data matrix code with relevant information coded

For more information, "Technical data leaflet" VEC509.

4.2 Variants overview

	Basic CBO-AXA-1X	Standard CBO-AXA-3B	Enhanced CBO-AXA-6S	Advanced CBO-AXA-8B
Standard I/Os incl. HTL	X210	X210	X210	X210
Functional safety	-	X811 (STO)	X811 (STO + SS1)	X811 (STO)
CANopen	-	X212	-	X212
TTL Encoder	-	-	-	X310+X312
Ethernet*	-	-	X220	X220

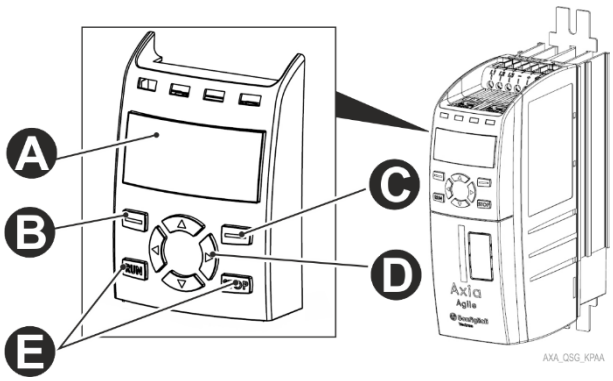
*Industrial Ethernet fieldbuses are available for EtherCAT®, PROFINET®, Ethernet/IP™, Modbus TCP and POWERLINK. The fieldbus system can be selected when ordering and is delivered factory-assembled.



The user may not remove or exchange the pre-configured Safety Module.

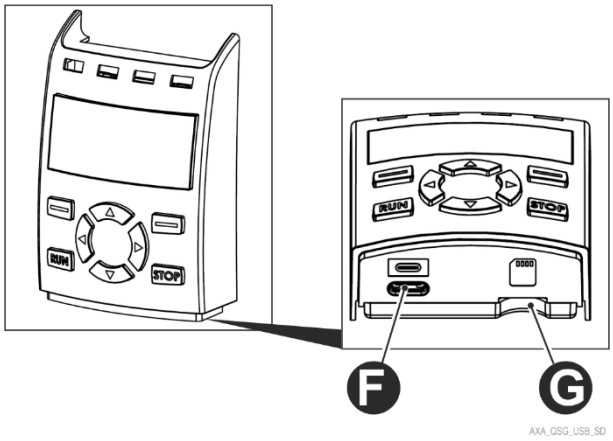
4.3 Keypad module

KPAA-DSP-01/KPAA-DSP-11



A	Display	**B**	Context-dependent function key
C	Context-dependent function key	**D**	Arrow keys
E	RUN and STOP keys		

KPAA-DSP-01 only



F	USB-C port	**G**	Memory card slot

By default, the display shows a standard view with monitored parameters.

- To access a submenu, press the function key on the right.

  The display shows the available submenus:

  - Drive Status
  - System Information
  - Parameters
  - Status
  - Setup and Control
  - Troubleshooting
  - Backup & Recovery
  - Keypad Setup

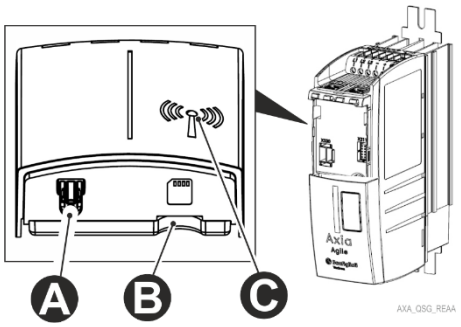
- Using the UP and DOWN keys, position the cursor on the submenu entry as required and press OK to access the submenu.

The display shows the available submenu entries and the submenu title in the upper left corner of the screen. The function keys' designation changes according to the options available in the present submenu.

- To return to the previous menu level, press the ESC key.

4.4 Bluetooth® Module

REAA-WL-01



A	Pairing Mode Button	**B**	Memory card slot	**C**	Bluetooth® LED

Via the optional Bluetooth® module, the user can establish a connection between the inverter and a PC or a mobile device without having to use cable. When connected, the user can then use the AxiaManager software on PC or the AxiaManager Mobile App on mobile device.

In order to connect, the PC or mobile device need to be paired with the Bluetooth® module.

- Note the pairing code and the module name located on the backside of Bluetooth® module:
  - 6-digit pairing code (last 6 digits in the serial number)
  - Module Name: "REAA-WL-01-xx:yy:zz", where xx:yy:zz are the last three octets of the MAC address.
- Assemble the wireless module on the inverter.

With the module installed, activate the pairing mode by pressing the Pairing Mode Button (A) at the bottom of the module for more than 3 seconds. The LED (C) shows the respective status by flashing white.

The module has 2 operating modes, Bluetooth® Low Energy (pale blue LED) and Bluetooth® High Energy (deep blue LED). By pressing the Pairing Mode Button for 1 second you can change the Bluetooth® mode.

Connection to the PC

- On your PC, go to the Device Settings menu.
- Go to the Bluetooth® settings.
- Add the AXA Bluetooth® Module (Module Name: "REAA-WL-01-xx:yy:zz"). For the PIN, enter the 6-digit pairing code (last 6 digits in the serial number) and press "Connect".
- Go to "Further Bluetooth® options".
- In the Dialogue window, go to the COM Ports tab.
- Select the Entry with "KP_BT_SERVER" at the end. Note the port number. Klick "OK".
- Start the AxiaManager on your PC.
- Go to the "Target" menu. Select "Communication settings".
- In the Dialogue window, select the port of the Bluetooth® module.

- In the next Dialogue, select the required action (read/write/do nothing).

This concludes the Bluetooth® connection to the PC.

Connection to the Mobile device

- Activate the AxiaManager App on your mobile device.

You may have to activate the "Low energy" mode on the Bluetooth® module before performing the connection.

- Go to the "Connection" menu.
- In the upcoming device list, select the inverter of your choice.

  A "Bluetooth® pairing request" message is displayed.

- Follow the instructions of the message.

  Upon connection, the Dashboard will appear.

This concludes the Bluetooth® connection to the mobile device.

5 Mechanical installation

By default, the frequency inverters of degree of protection IP20 are designed for installation in electrical cabinets.

- During installation, comply with the installation and the safety instructions and note the device specifications.

WARNING

Risk of physical injury!

Inappropriate handling of the device may result in serious physical injuries or major material damage.

- To avoid serious physical injuries or major material damage, only qualified persons are allowed to work at the device.

WARNING

Risk of short circuit and fire!

During assembly, make sure that no foreign particles (e.g. chips, dust, wires, screws, tools) can get inside the frequency inverter. Otherwise, there is the risk of short circuits and fire.

- The frequency inverter complies with IP20 ingress protection rating only if the covers, components and terminals are mounted properly.
- Conductive contamination not permissible.
- Mount the device in electrical cabinets with protection class IP54 according to IEC529.
- Overhead installation or installation in horizontal position is not permissible.

5.1 Air circulation

CAUTION

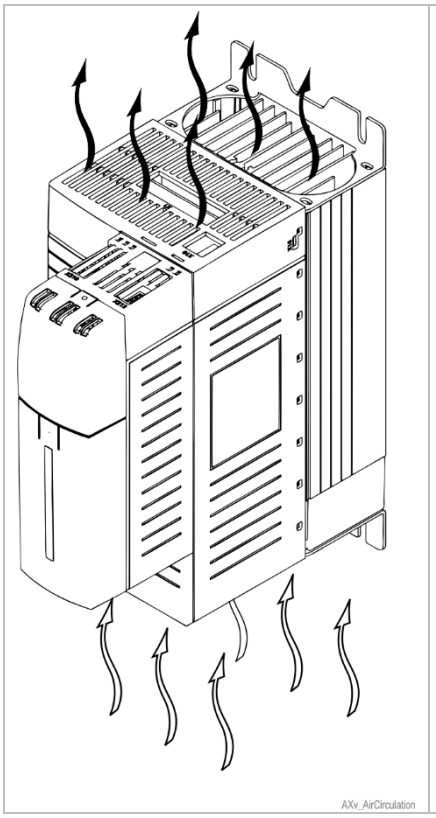
Risk of short circuit and fire!

Insufficient air circulation may result in major material damage, which may in turn result in physical injuries.

- Mount the devices with sufficient top and bottom clearance to other components so that the cooling air can circulate freely.
- Avoid soiling by grease and air pollution by dust, aggressive gases, etc.
- Fan inlet and outlet openings must not be covered.

For information on permissible clearances 5.2.

For air cooling:



For cooling the air-cooled frequency inverters, air is taken in through openings in the bottom plate. The air coming from below heats up and escapes through openings in the top of the case.

Another available cooling option is cold plate mounted cooling. Contact your local representative of BONFIGLIOLI for more information.

5.2 Installation process

WARNING

Improper handling

Improper handling may result in serious physical injuries or major material damage.

- To avoid serious physical injuries or major material damage, only qualified persons may work at the device.

CAUTION

Risk of short-circuits and fire

Insufficient air circulation could result in major material damage, which may in turn result in physical injuries.

- Mount the devices with sufficient clearance to other components so that the cooling air can circulate freely.
- Avoid soiling by grease and air pollution by dust, aggressive gases, etc.
- Fan inlet and outlet openings must not be covered.

NOTICE

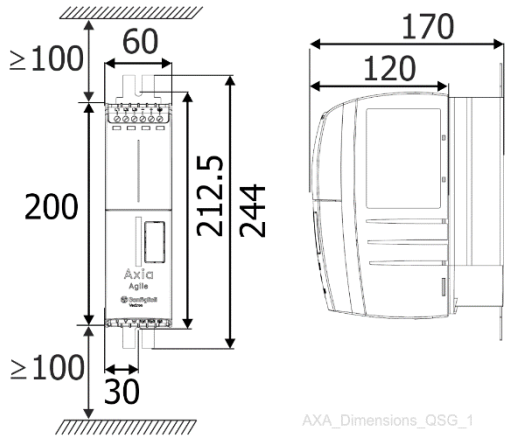
Minor injury/damage

Please notice: it is possible to accidentally insert foreign objects or fingers into the ventilator grill at the underside of the device. This may lead to damage to the device and/or to minor injury.

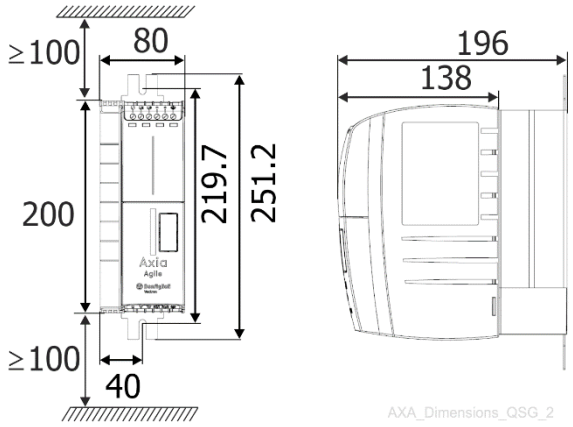
- Avoid inserting foreign objects into the ventilator grill.

Dimensions

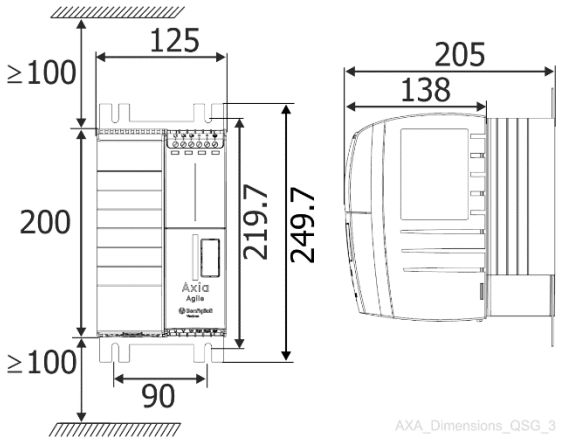
AXA1



AXA2



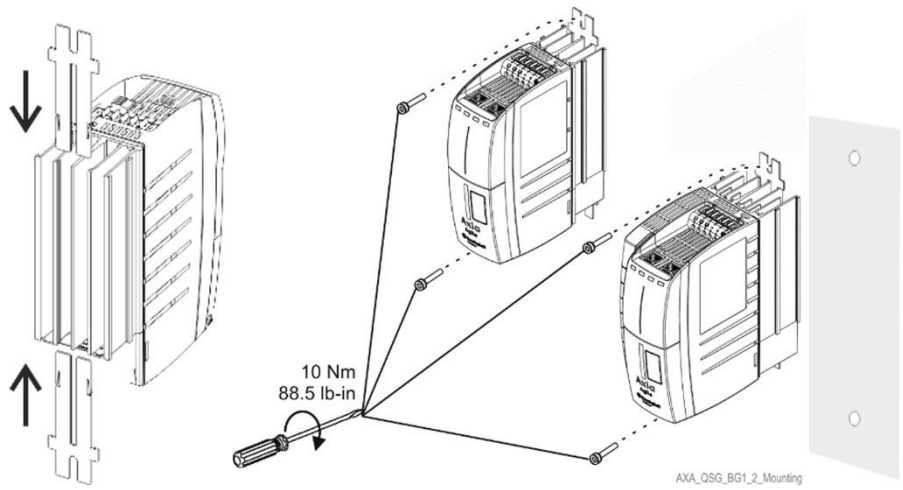
AXA3



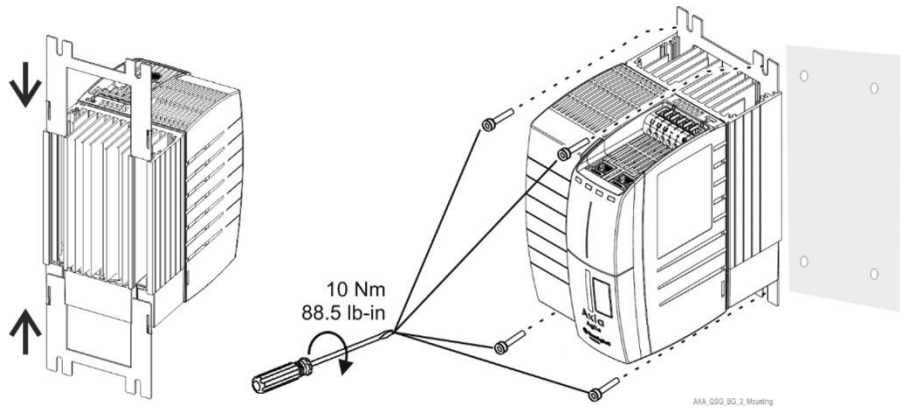
Sizes 1 to 3: AXA 20 (up to 5.5 kW) and 40 (up to 9.2 KW)

The frequency inverter is mounted in a vertical position on the assembly panel by means of the standard fittings. The following illustration shows the different mounting options.

AXA1 – AXA2



AXA3



For assembly, insert the long side of the fixing plate in the heat sink and screw to the assembly panel.

6 Electrical installation

DANGER

Dangerous voltage!

With live mains/DC supply, mains/DC terminals and motor terminals carry dangerous voltage, that will result in high risk of electric shock at contact.

- Adhere to applicable safety rules.
- Before performing any work with the frequency inverter, disconnect the frequency inverter from mains/DC voltage and protect it against being energized unintentionally.
- Verify safe isolation from power supply.
- Before switching mains or DC supply on, re-install any missing covers/terminals.

WARNING

Dangerous voltage!

When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Work at the device may only be started once the DC link capacitors have discharged. The time to wait is at least 3 minutes.

- The electrical installation must be carried out by qualified electricians according to the general and regional safety and installation directives.
- The documentation and device specification must be complied with during installation.
- Before any assembly or connection work, discharge the frequency inverter. Verify safe isolation from power supply.
- Do not connect inappropriate voltage sources. The nominal voltage of the frequency inverter must correspond to the supply voltage.
- The frequency inverter must be connected to ground potential.
- Do not remove any covers of the frequency inverter while power supply is on.

The connecting cables must be protected externally, considering the maximum voltage and current values of the fuses. The mains fuses and cable cross-sections must be selected according to EN 602041 and DIN VDE 0298 Part 4 for the nominal operating point of the frequency inverter. Only use copper cables with a temperature range of 60 / 75 °C.

The fuses must be chosen depending on the individual application. The values recommended in the technical data apply for the continuous rated operation without overload.

The frequency inverters must be grounded properly, i.e. with large connection area and with good conductivity. The leakage current of the frequency inverters may exceed AC 3.5 mA or DC 10 mA. According to EN 61800-5-1, a permanent ground connection must be provided both at the mains side and at the motor side. The protective conductor cross-section required for grounding the fixing plate must be selected according to the size of the unit. In these applications, the cross-section must correspond to the recommended cross-section of the wire.

CAUTION

Possible dirt ingress

IP20 ingress protection rating is only achieved with terminals plugged and with properly mounted covers. Covers mounted improperly lead to ingress of dirt or foreign objects into the housing of the device and might lead to malfunctions.

- Take care to mount all covers correctly and properly.
- Insert all terminal connectors and mount all covers before starting operation.

Connection conditions

- The frequency inverter is suited for connection to the public or industrial supply mains according to the technical data.
- It must be checked, based on the specifications of EN 61000-3-2, if the devices can be connected to the public supply means without taking additional measures. In-creased requirements in connection with the specific application of the fre-quency inverter are to be met by means of optional components. Commutating chokes and EMC filters are optionally available.
- Operation on unearthed mains (IT mains) is admissible after pulling out the IT mains plug-in jumper.

Interference-free operation with residual current device is guaranteed at a tripping current ≥ 30 mA if the following points are observed:

- All-current sensitive residual current devices (Type B to EN 50178)
- Use EMC filters with reduced leakage current or, if possible, do not use EMC filters at all.
- The length of the shielded motor cable is ≤ 10 m and there are no additional capacitive components between the mains or motor cables and PE.

NOTICE

Unexpected currents

Please note (according to EN 61800-5-1): This product may cause direct current in the protective earth conductor.

- Where residual current devices (RCD) or residual current monitors (RCM) are used as protection against direct or indirect contact, only RCDs / RCMs of Type B are permissible on the power supply side of this product.

- Select the fuses depending on the specific application. The safety recommendations in the Technical Data are valid for continuous operation without overload.

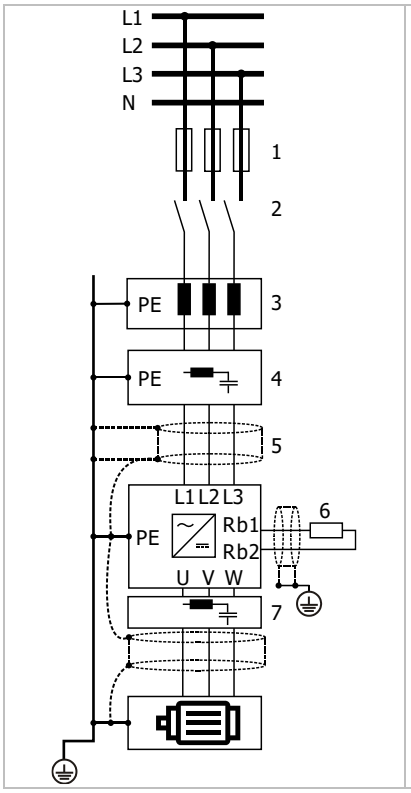
6.1 EMC information

The frequency inverters are designed according to the requirements and limit values of product standard EN 61800-3 with an interference immunity factor (EMI) for operation in industrial applications. Electromagnetic interference must be avoided by expert installation and observation of the specific product information.

Measures

- Install the frequency inverters and commutating chokes on a metal mounting panel. Ideally, the mounting panel should be galvanized, not painted.

- Provide proper equipotential bonding within the system or plant. Plant components such as electrical cabinets, control panels, machine frames must be connected by means of PE cables, i.e. sufficient area and with good conductivity.
- The shield of the control cables must be connected to ground potential properly, i.e. with good conductivity, on both sides (shield clamp). Mount shield clamps for cable shields close to the unit.
- Connect the frequency inverter, the commutating choke, external filters and other components to an earthing point via short cables.
- Avoid excessive cable length and loosely suspended cabling.
- Contactors, relays and solenoids in the electrical cabinet must be provided with suitable interference suppression components.



1 fuse
2 circuit breaker
3 line choke (optional)
4 input filter (optional)
5 cable shield
6 braking resistor (optional)
7 output filter (optional)

Line choke

Line chokes reduce mains harmonics and reactive power. In addition, a longer service life of the frequency inverter is possible. When using a line choke, note that line chokes may reduce the maximum output voltage of the frequency inverter.

The line choke must be installed between the mains connection and the input filter.

Input filter

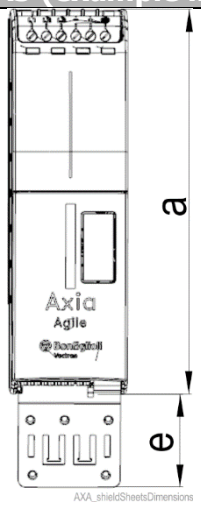
Input filters reduce grid-bound, high-frequency radio interference voltage.

- Install the input filter on the mains side upstream of the frequency inverter.

The frequency inverters meet the requirements of the low voltage directive 2014/35/EU and the requirements of the EMC Directive 2014/30/EU. The EMC product standard EN 61800-3 relates to the drive system. The documentation provides information on how the applicable standards can be complied with if the frequency inverter is a component of the drive system. The declaration of conformity must be issued by the supplier of the drive system.

Control terminals screen sheets (optional):

AXA1 – AXA3 (example illustration)

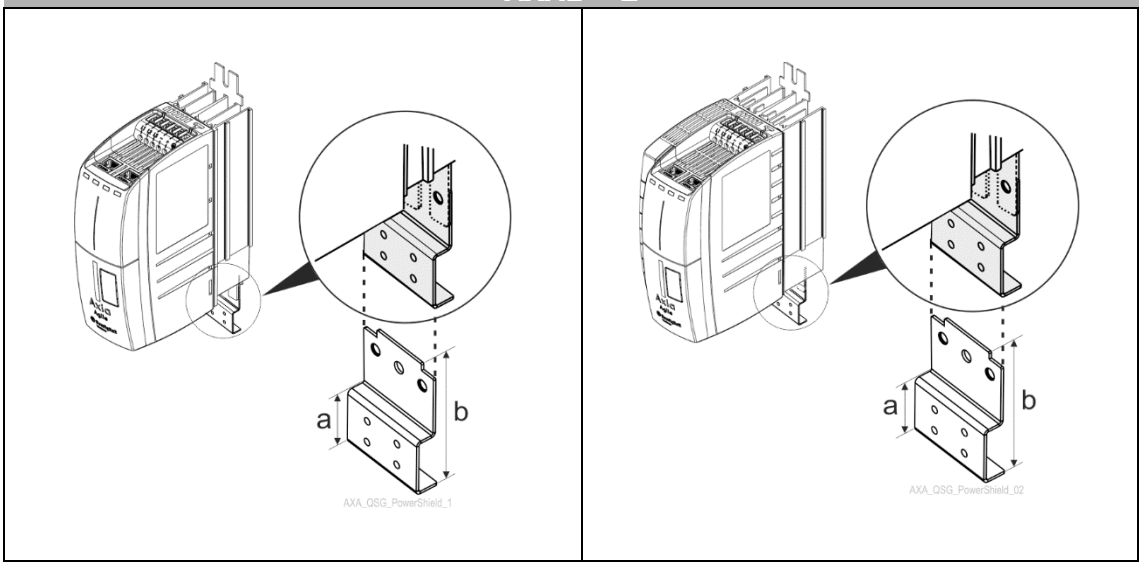


[mm]:

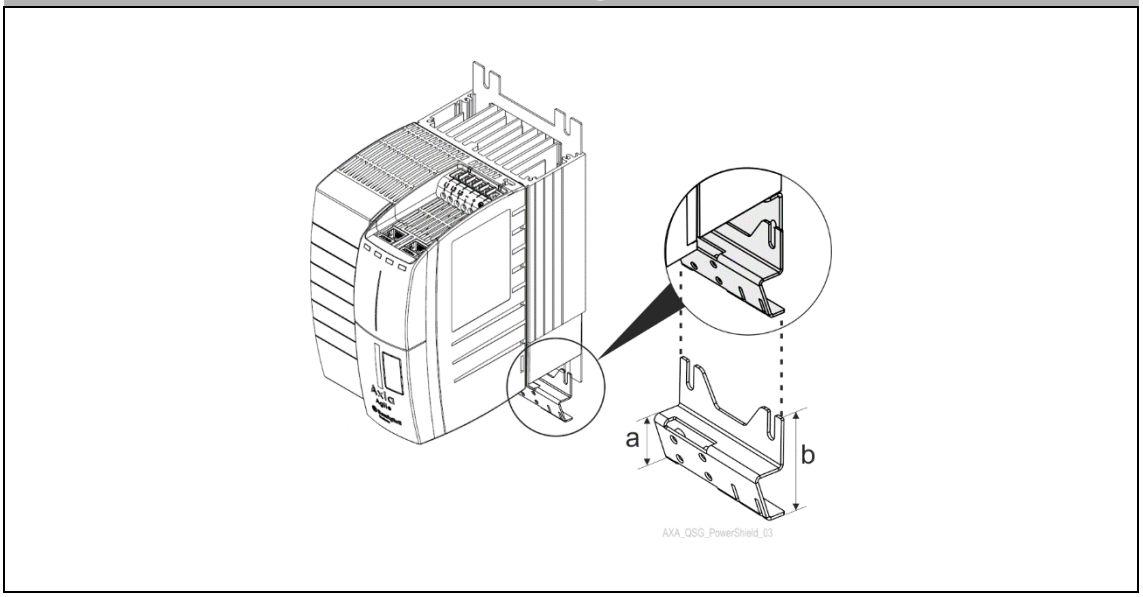
	a	e
AXA1	200	50
AXA2	200	50
AXA3	200	50

Motor terminals screen sheets (optional):

AXA1 – 2



AXA3



[mm]:

	a	b
AXA1	31.5	71.5
AXA2	31.5	71.5
AXA3	34	67

The AXA shield sheets for the motor wiring are mounted as shown above. The image is a depiction of the mounting in principle.

6.2 Dimensioning of conductor cross-section

The connecting cables must be protected externally, considering the maximum voltage and maximum current values of the fuses. The line fuses and cable cross-sections must

be dimensioned according to EN 602041 and DIN VDE 0298 Part 4 for the nominal operating point of the frequency inverter.

The fuses must be chosen depending on the individual application. The values recommended in the technical data apply for the continuous rated operation without overload.

6.2.1 Mains Cable and Motor Cable

The cable dimensions should be selected according to the current load and the expected voltage drop. Select the cable cross-section of the cables such that the voltage drop is as small as possible. If the voltage drop is too great, the motor will not reach its full torque. Also comply with any additional national and application-specific regulations and the separate UL instructions. For typical mains fuses,  "Technical data" (document code VEC509).

According to EN61800-5-1, the cross-sections of the PE conductor shall be dimensioned as follows:

Cable cross-section	Protective conductor
up to 10 mm²	Install two PE conductors of the same cross-section as the cable, or one PE conductor of 10 mm² in cross-section.
10…16 mm²	Install one PE conductor of the same size as the cable.
16…35 mm²	Install one PE conductor of a size of 16 mm².
> 35 mm²	Install one PE conductor of half the size of the cable.

NOTICE

Recommendation

Due to small terminal size, the user may not be able to connect two PE connectors at the same terminal. In size 1 and size 2 devices, the manufacturer recommends connecting the PE cables to available PE rails, when needed.

Typical cross-sections (0.25 kW ... 15 kW)

NOTICE

Recommendation

The manufacturer recommends using wire end ferrules with stranded wires and with flexible wires. Using ferrules with solid copper wires is optional.

The following tables provide an overview of typical wire cross-sections (copper wire with PVC insulation, 30 °C ambient temperature, continuous mains current max. 100% rated input current). Actual mains wire cross-section requirements may deviate from these values depending on actual operating conditions.

230 V: Three-phase connection

AXA20	Mains cable [mm²]	PE-conductor [mm²]	Motor cable [mm²]	Strip length [mm]	Ferrule length [mm]
0.25 kW 0.37 kW 0.55 kW 0.75 kW 1.1 kW	1.5	2x1.5 or 1x10	1.5	10 / 12	10 /12

AXA20	Mains cable [mm²]	PE-conductor [mm²]	Motor cable [mm²]	Strip length [mm]	Ferrule length [mm]
1.5 kW 2.2 kW 3 kW					
4 kW 5.5 kW	4	2x4 or 1x10	4	12 /14	12 / 14
7.5 kW	6	2x6 or 1x10	6	12 /14	12 / 14

400V: Three-phase connection

AXA40	Mains cable [mm²]	PE-conductor [mm²]	Motor cable [mm²]	Strip length [mm]	Ferrule length [mm]
0.25 kW 0.37 kW 0.55 kW 0.75 kW 1.1 kW 1.5 kW	1.5	2x1.5 or 1x10	1.5	10 / 12	10 /12
1.85 2.2 kW 3 kW 4 kW					
5.5 kW 7.5 kW	2.5	2x2.5 or 1x10	2.5	12 /14	12 / 14
9.2 kW 11 kW	4	2x4 or 1x10	4	12 /14	12 / 14

6.2.2 Control wire

Type	Ferrule type	Cross section [mm²]
Solid	-	min. 0.2 max. 1.5
Stranded	-	min. 0.2 max. 1.5
Flexible	ferrule without plastic sleeve	min. 0.25 max. 1.5
Flexible	ferrule with plastic sleeve	min. 0.25 max. 0.75

6.3 Connecting Mains / DC

DANGER

Dangerous voltage!

When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Work with the device may only be started once the DC link capacitors have discharged. The time to wait is at least 3 minutes.

- Disconnect the frequency inverter from mains/DC voltage and protect it against being energized unintentionally.
- Verify safe isolation from power supply.

CAUTION

Device damage possible!

Routing the lines inappropriately may lead to device damage.

- The control, mains and motor lines must be kept physically separate from one another.
- The cables connected to the frequency inverters may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.

CAUTION

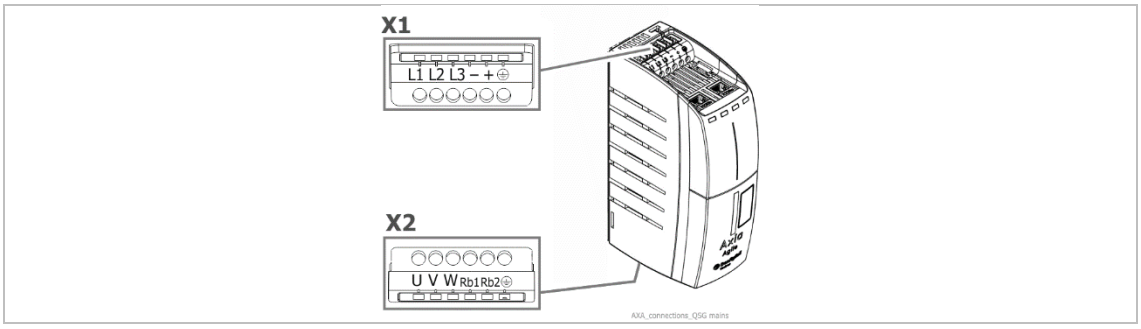
Device damage possible!

Selecting inappropriate cable quality may lead to device damage.

- The connected cables must withstand at least temperatures of 65 °C in operation.

- The mains fuses and cable cross-sections must be selected according to EN 602041 and DIN VDE 0298 Part 4 for the nominal operating point of the frequency inverter.
- Carry out the electrical installation according to the device specifications and the applicable standards and directives.

AXA2 0 (≤ 3.0 kW/7.5 kW) AXA40 (≤ 11 kW)



Designation	Meaning
X1	Mains connections
X2	Motor connections

Conductor cross-section suitable for the connectors:

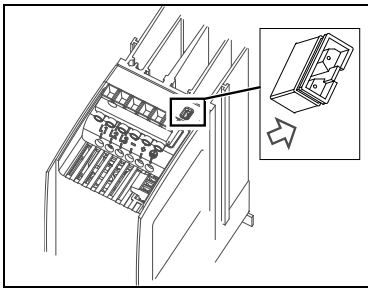
1~230 V	Type	k18…k55	k75…1k1	1k5	2k2	3k0
	kW	0.09…0.25	0.37…0.55	0.75	1.1	1.5
F1	A	6	10	16	25	35
Ø L1, N	mm² [AWG]	1.5 [16]	2.5 [14]			4 [12]
Ø PE	mm² [AWG]	2 x 1.5 [16]	2 x 2.5 [14]			2 x 4 [12]
or		1 x 10 [8]	1 x 10 [8]			1 x 10 [8]

3~230 V	Type	k18…1k1	1k5…2k2	3k0	4k0	5k5	7k5
	kW	0.18…1.1	1.5…2.2	3.0	4.0	5.5	7.5
F1	A	6	10	16	25	35	35
Ø L1, L2, L3	mm² [AWG]	1.5 [16]			2.5 [14]	4 [12]	6 [9]
Ø PE	mm² [AWG]	2 x 1.5 [16]			2 x 2.5 [14]	2 x 4 [12]	2 x 6 [9]
or		1 x 10 [8]			1 x 10 [8]	1 x 10 [8]	1x10 [8]

3~400 V	Type	k25…1k5	2k2	3k0	4k0	5k5	7k5	9k2	11k
	kW	0.25…1.5	2.2	3.0	4.0	5.5	7.5	9.2	11
F1	A	6	10	10	10	16	25	25	35
Ø L1, L2, L3	mm² [AWG]	1.5 [16]				2.5 [14]			4 [12]
Ø PE	mm² [AWG]	2 x 1.5 [16]				2 x 2.5 [14]			2 x 4 [12]
or		1 x 10 [8]				1 x 10 [8]			1 x 10 [8]

AWG = American Wire Gauge

IT mains configuration



To connect the device to IT mains, remove the IT-jumper.

NOTICE

Reduced noise immunity

The removal of the IT jumper reduces the noise immunity.

Use external filters to improve the noise immunity.

6.4 Connecting Motor

DANGER

Dangerous voltage!

When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Work with the device may only be started once the DC link capacitors have discharged. The time to wait is at least 3 minutes.

- Disconnect the frequency inverter from mains/DC voltage and protect it against being energized unintentionally.
- Verify safe isolation from power supply.

CAUTION

Device damage possible!

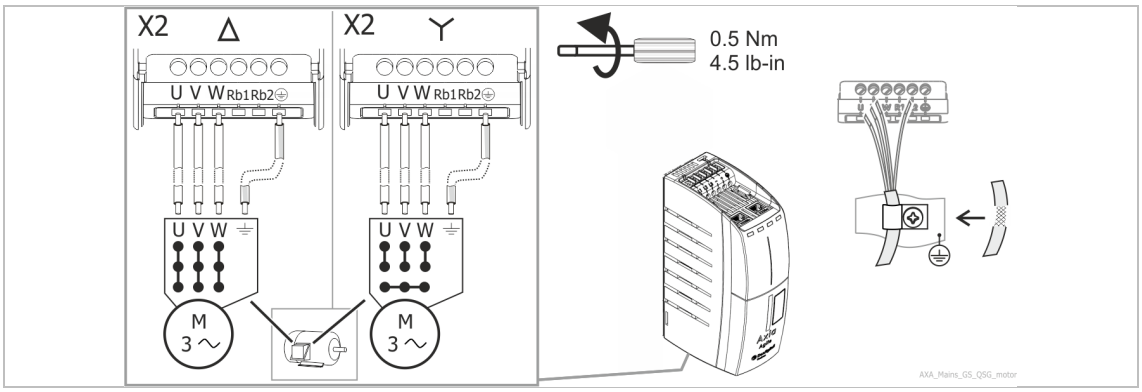
Routing the lines inappropriately may lead to device damage.

- The control, mains and motor lines must be kept physically separate from one another.
- The cables connected to the frequency inverters may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.

The manufacturer recommends using shielded cables for the connection of the motor and the braking resistor to the frequency inverter. The shield must be connected to PE potential properly, i.e. with good conductivity, on both sides. The control, mains and motor lines must be kept physically separate from one another.

- Comply with the applicable limits stipulated in the relevant national and international directives as regards the application, the length of the motor cable and the switching frequency.

6.4.1 Motor connection



Designation	Meaning
U, V, W	Mains connectors
Rb1, Rb2	Brake resistor connectors

Note: Motor cable shielding **Rb1**, **Rb2** are only required for braking resistor connection.

Conductor cross-section suitable for the connectors:

1~230 V	Type	**k12…k37**	**k55**	**k75…1k1**	**1k5**	**2k2**	**3k0**
	kW	0.12…0.37	0.55	0.75…1.1	1.5	2.2	3.0
F1	A	6	10	16	25	35	35
Ø U,V,W	mm² [AWG]	1.5 [16]					
Ø PE	mm² [AWG]	2 x 1.5 [16]					
or		1 x 10 [8]					

3~230 V	Type	**k25…k75**	**1k1**	**1k5…2k2**	**3k0**	**4k0**	**5k5**	**7k5**
	kW	0.25…0.75	1.1	1.5…2.2	3.0	4.0	5.5	7.5
F1	A	6	10	16	25	35	35	50
Ø U,V,W	mm² [AWG]	1.5 [16]					4 [12]	
Ø PE	mm² [AWG]	2 x 1.5 [16]					2 x 4 [12]	
or		1 x 10 [8]					1 x 10 [8]	

3~400 V	Type	**k25…1k5**	**2k2**	**3k0**	**4k0**	**5k5**	**7k5**	**9k2**	**11k**
	kW	0.25…1.5	2.2	3.0	4.0	5.5	7.5	9.2	11
F1	A	6	10	10	10	16	25	35	35
⌀ U,V,W	mm² [AWG]	1.5 [16]				2.5 [14]			4 [12]
Ø PE	mm² [AWG]	2 x 1.5 [16]				2 x 2.5 [14]			2 x 4 [12]
or		1 x 10 [8]				1 x 10 [8]			1 x 10 [8]

AWG = American Wire Gauge

6.4.2 Length of motor cables, without filter

Permissible length of motor cable without output filter					
Type	***AxiaAgile*20**		***AxiaAgile*40**	**unshielded**	**shielded**
Mains →	**1ph.**	**3ph.**	**3ph.**		
Power ↓	**kW**	**kW**	**kW**		
K12	0.12	--	--	50 m	25 m
K18	0.18	--	--		
K25	0.25	0.25	0.25		
K37	0.37	0.37	0.37		
K55	0.55	0.55	0.55		
K75	0.75	0.75	0.75		
1K1	1.1	1.1	1.1		
1K5	1.5	1.5	1.5		
2K2	2.2	2.2	2.2		
3K0	3.0	3.0	3.0	100 m	50 m
4K0	--	4.0	4.0		
5K5	--	5.5	5.5		
7K5	--	7.5	7.5		
9K2	--	--	9.2		
1K1	--		11		

The specified lengths of the motor cables must not be exceeded if no output filter is installed.

6.4.3 Motor cable length, with output filter du/dt

Longer motor cables can be used after taking appropriate measures, e.g. use of low-capacitance cables and output filters. The following table contains recommended values for the use of output filters.

Motor cable length with output filter					
Type	***AxiaAgile*20**		***AxiaAgile*40**	**unshielded**	**shielded**
Mains →	**1ph.**	**3ph.**	**3ph.**		
Power ↓	**kW**	**kW**	**kW**		
K12	0.12	--	--	150 m	100 m
K18	0.18	--	--		
K25	0.25	0.25	0.25		
K37	0.37	0.37	0.37		
K55	0.55	0.55	0.55		
K75	0.75	0.75	0.75		
1K1	1.1	1.1	1.1		
1K5	1.5	1.5	1.5		
2K2	2.2	2.2	2.2		
3K0	3.0	3.0	3.0	300 m	200 m
4K0	--	4.0	4.0		
5K5	--	5.5	5.5		
7K5	--	7.5	7.5		
9K2	--	--	9.2		
1K1	--		11		

6.4.4 Motor cable length, with sinus filter

Motor cables can be longer if sinus filters are used. By conversion in sinus-shaped currents, high-frequency portions which might limit the cable length are filtered out. Consider the voltage drop across the cable length and the resulting voltage drop at the sinus filter. The voltage drop results in an increase of the output current. The frequency inverter must be suitable for the higher output current. This must be considered in the projecting phase.

In the case of motor cable lengths exceeding 300 m, contact BONFIGLIOLI service.

6.4.5 Group drive

- In the case of a group drive (several motors at one frequency inverter), the total length shall be divided across the individual motors according to the value given in the table. Please note that group drive with synchronous servomotors is not possible.
- Use a thermal monitoring element on each motor (e.g. PTC resistor) in order to avoid damage.

6.4.6 Braking resistor

Install a braking resistor if feedback of regenerative energy is expected. Overvoltage shutdowns can be avoided by this.

DANGER

Dangerous voltage!

When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Work at the device may only be started once the DC link capacitors have discharged. The time to wait is at least 3 minutes.

- Disconnect the frequency inverter from mains voltage and protect it against being energized unintentionally.
- Verify safe isolation from power supply.

WARNING

Hot surface

The surface of the braking resistor may reach a high temperature during operation and may remain hot for some time after operation.

- Do not touch the braking resistor while the frequency inverter is in operation or ready for operation. Non-compliance may result in burns.
- Install a safeguard to prevent touching or provide a warning sign.
- Do not install the braking resistor near inflammable or heat-sensitive materials.
- Do not cover the braking resistor.

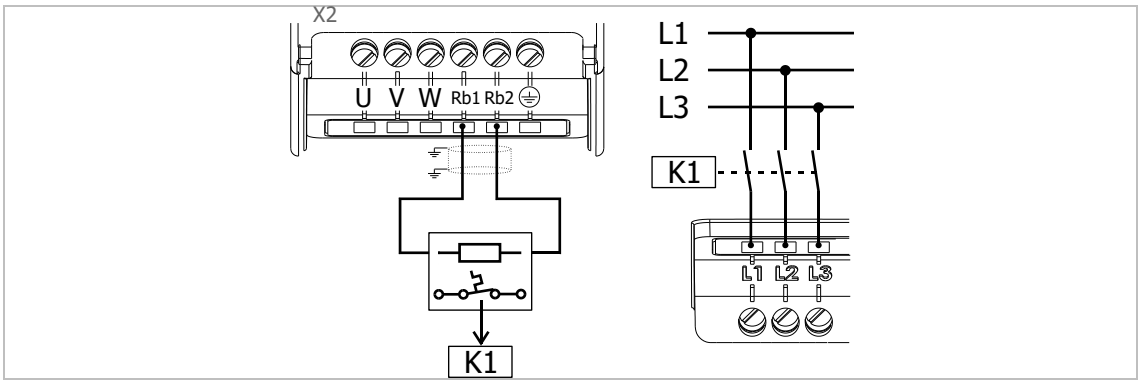
The manufacturer recommends using a temperature switch. Depending on the resistor selected, the temperature switch is integrated as a standard or available as an option. The temperature switch disconnects the frequency inverter from mains supply if the braking resistor is overloaded/overheated.

Using braking resistors without temperature switches may result in critical situations.

- Minimize cable lengths.

NOTICE

DC-connection requires a power estimation of the complete system. The brake resistor is operational dependent on the enable of the frequency inverter. The contactor K1 must disconnect all plant components from the mains.



Minimum Torque to tighten the screws: **0.5 Nm** (4.6 lb-in)
Maximum Torque to tighten the screws: **0.6 Nm** (5.3 lb-in)

6.5 Control terminals

CAUTION

Live voltage
The control terminals may be energized.

- Connect the unit may only with the power supply switched off.
- Verify safe isolation from power supply.
- Switch off power supply before connecting or disconnecting the control inputs and outputs. Otherwise, components may be damaged.

NOTICE

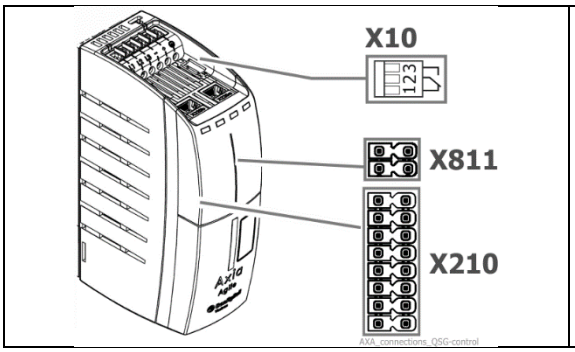
Incorrect measurement

- When connecting an analog PTC signal to X210.15, use X210.4 for ground connection.
- For all other analog signals use X210.16.

NOTICE

Safe isolation
For PTC measurement at X210.15, the terminal must be isolated from the motor potential.

- Ensure the safe isolation inside the motor.



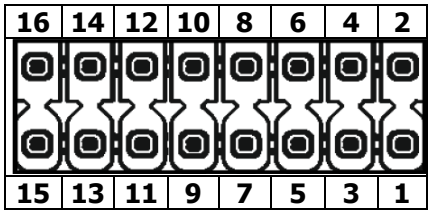
X10 Relay terminal

X811 Functional safety terminal (variants with functional safety)

X210 Standard I/O terminal

6.5.1 Standard I/O terminal

The standard I/O terminal has the designation X210.



Standard IO terminal X210		
1	DC 24 V In	24 V Daisy Chain
2	DC 24 V In	24 V Daisy Chain
3	GND	
4	GND	
5	IN1D: Digital Input 1	(Start)
6	DC 24 V Out, current protected 250 mA	
7	IN2D: Digital Input 2	HTL Track A
8	GND	
9	IN3D: Digital in 3	HTL Track B
10	IN5D/OUT1D: Digital Input 5 / Digital Output 1	Touchprobe A
11	IN4D: Digital Input 4	HTL Track Z
12	IN6D/OUT2D: Digital Input 6 / Digital Output 2	Touchprobe B
13	MFI1: Multifunction Input 1	IN8D, Temp, 0…20 mA, 0…10 V, –10…+10 V
14	IN7D/MFO1/10V: Digital Input 7 / Multifunction Output 1 / DC 10V	10 V default
15	MFI2: Multifunction Input 2	IN8D, Temp, 0…20 mA, 0…10 V, –10…+10 V
16	GND	

Conductor cross-section:

The signal terminals are suitable for the following cable sizes:

- with ferrule: 0.25…1.0 mm²
- without ferrule: 0.14…1.5 mm²

NOTICE

EMC compliance

To ensure EMC compliance, the 24 V input wires must not exceed the length of 30 m and be routed inside a building.

- Ensure that the 24 V input wires are 30 m maximum.
- Ensure that the 24 V input wires are routed inside a building.

6.5.2 Functional Safety terminal

This terminal is not implemented in the Basic variant CBO-AXA-1X.

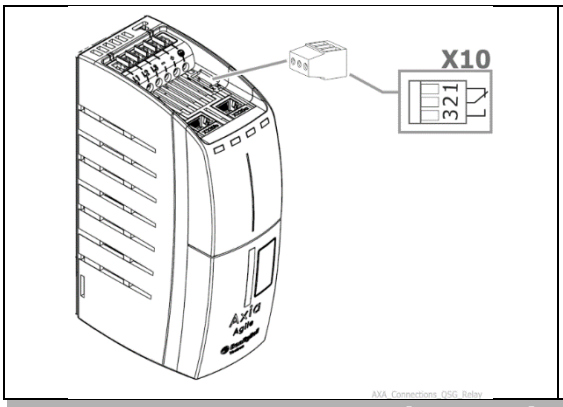
Functional Safety terminal X811						
Safe Torque Off	SIN1D-A	**2**		**1**	SIN1D-A	Safe Torque Off
Safe Torque Off	SIN2D-B	**4**		**3**	SIN2D-B	Safe Torque Off

OSSD – test pulse output for passive switches

The OSSD outputs provide test pulses to detect external short-circuits between two inputs.

6.5.3 Relay terminal

The relay terminal provides an output for generic fault signaling/feedback.
The signal relay function is parametrized in the inverter software.



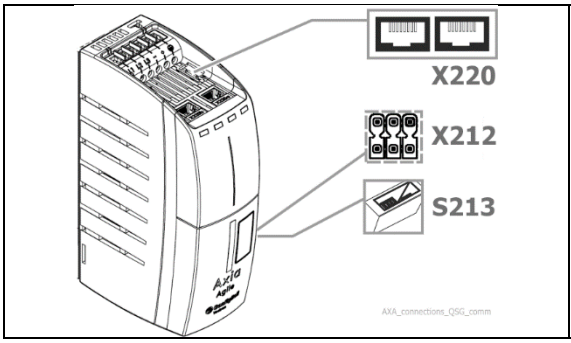
Parameterizable relay output
1 NC
2 COM
3 NO

Relay terminal specification

Terminal	Description
1 ... 3	Relay output, floating change-over contact, response time approx. 40 ms, maximum contact load: – Make contact: AC 5 A / 240 V, DC 5 A (ohmic) / 24 V – Break contact: AC 3 A / 240 V, DC 1 A (ohmic) / 24 V

Conductor cross-section suitable for the connectors:
0.1 … 1.5 mm² [27 … 15 AWG]

6.6 Communication interfaces



X220 Ethernet fieldbus (variants Enhanced and Advanced)
X212 Communication terminal (variants with CANopen)
S213 Bus termination switch (variants with CANopen)

6.6.1 CANopen/System bus interface

The 3-pin interface has the designation "X212". It is implemented for the connection of the CANopen/Systembus. This terminal is implemented in the variants "Standard CBO-AXA-3B" and "Advanced CBO-AXA-8B".

Pin assignment: System bus interface X212

CANopen+	**COM+**	**2**		**1**	**COM+**	CANopen+
CANopen–	**COM–**	**4**		**3**	**COM–**	CANopen–
GND	**COM-GND**	**6**		**5**	**COM-GND**	GND
Raster width 3.81 mm						

Use twisted and shielded cable for the bus line. Use a braided shield (**not a foil shield**).

Connect the cable shield to PE at both ends over the entire surface.

Bus termination switch S213 located below the X212 terminal:

Up = OFF / Down → ON

6.6.2 Ethernet interface

The communication interface has the designation "X220". It is located at the top of the device. This terminal is implemented in the variants "Enhanced" and "Advanced".

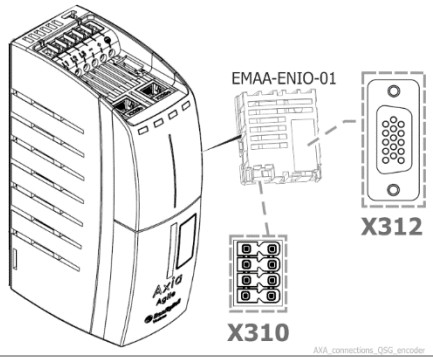
The Ethernet connectors feature LEDs to show the present status of the connection. The actual interface design of the X220 depends on the type of the Expansion module used. ☞🕮 EMAA module.

6.7 Encoder expansion module

The encoder expansion module has the designation "EMAA-ENIO-01". It is implemented in the variant "Advanced".

If the encoder interface module is not installed, the encoder connectors provided in the standard I/O can be used to connect HTL encoders. ☞🗎 chapter 6.5.1.

This module offers two terminals for the connection of encoders.



X310 TTL Encoder terminal

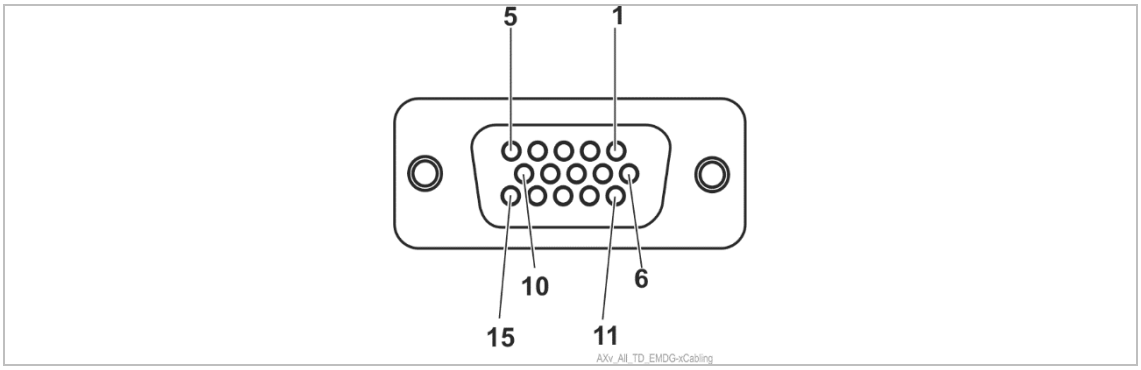
X312 TTL Encoder terminal

- Install encoder cables physically separate from motor cables. Comply with the encoder manufacturer's specifications.
- Connect the shield close to the frequency inverter and limit the cable length to the necessary minimum.
- Install the cables according to the indication on the terminals.

6.7.1 Encoder terminal X310

Pin assignment: Encoder terminal X310				
IN15D / OUT15D	**2**		**1**	IN11D / OUT11D
IN16D / OUT16D	**4**		**3**	IN12D / OUT12D
GND	**6**		**5**	IN13D / OUT13D
GND	**8**		**7**	IN14D / OUT14D

6.7.2 Encoder terminal X312



Pin assignment: Encoder terminal X312		
1	--	--
2	--	--
3	B–	TTL B– track
4	B+	TTL B+ track
5	TM_{PTC}–	Motor temperature evaluation
6	V_{ENC}	Encoder supply
7	R–	Reference track
8	--	--
9	A–	TTL A– track
10	TM_{PTC}+	Motor temperature evaluation
11	V_{ENC}	Sense
12	R+	Reference track
13	--	--
14	A+	TTL A+ track
15	GND	0 V

The reference tracks (R–/R+) are also often designated Z–/Z+.

7 Parameterization method

The AXIA frequency inverters are parameterized via the firmware of the inverter and its firmware objects. The object structure follows the CiA 402 standard. The AXIA series inverters provide several ways to access objects for parameterization. You can access objects via

- communication bus (depends on the communication module or onboard CAN bus)
- keypad module (optional)
- COM-Port provided by the keypad module
- Bluetooth® module (optional)

To read/write the firmware objects, you need the free-of-charge software AxiaManager GUI. The software (AxiaManager GUI) can be downloaded via the Bonfiglioli homepage (www.bonfiglioli.com).

To be able to use the AxiaManager software, the user requires a Windows PC, which requires a USB interface. To connect the PC to the inverter, the user must either have the Keypad module installed and use the USB-C interface of the Keypad (4.3) or use the onboard CAN interface (6.6.1). This interface is available in the variants "Standard CBO-AXA-3B" and "Advanced CBO-AXA-8B".

For details on how to use the AxiaManager software separate user manual VEC1en51.

NOTICE

Object accessibility

Not all firmware objects are accessible at all times via the AxiaManager GUI. The selection of firmware objects available to the user depends on the type of inverter and its expansion modules, the type of motor and on the actual device connected.

- Check the particular configuration to determine your parameterization options.

NOTICE

Menu Access Level

Not all firmware objects are accessible at all times via the AxiaManager GUI. The selection of firmware objects available to the user depends on the menu access level of the user.

- Check the menu access level to determine your parameterization options.

The firmware objects listed in this document are available on the "professional" menu access level within the AxiaManager GUI.

NOTICE

Choice list accessibility

Not all choice list entries are useful at all times via the AxiaManager GUI. The selection of useful choice list entries depends on the type of inverter and its expansion modules, the type of motor and on the actual device connected. If you select entries unavailable in your configuration, an error message may show up informing you that the choice is unavailable with installed hardware.

- Check your particular configuration to determine your parameterization options.

Access to the object values is done on the basis of the object index. The AxiaManager gives access to the object dictionary of the chosen configuration in offline operation and to the object dictionary of the target device when connected.

When using the AxiaManager GUI to write object values, the values are entered automatically in the EEPROM of the controller.

Handling of cyclic writing of the object values

NOTICE

EEPROM protection

Writing to the EEPROM too frequently may shorten the service life of the inverter. To prevent this, the user receives the error message "Cyclic Write" if more than 50 write attempts to the EEPROM are made per minute.

- The number of permitted consecutive write cycles to the same object per minute is limited to 50.
- After the error message, wait for 1 minute before attempting writing or
- Restart the inverter to be able to initiate new write commands.

The data which is written cyclically goes in the RAM. The data storage is volatile, i.e. it is lost when the supply voltage of the inverter is switched off.

You can also access the firmware objects via the keypad 4.3.

Object Structure

The objects are structured following the definitions of the CiA 402 standard by the CiA group.

The objects will be designated as follows:

Object			Value Setting		
Index/Sub-Idx	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x3456/0C	Object Name	[s]	0	12345	0

The object indexes are displayed in the hexadecimal formatting, as well as the subindexes. The AxiaManager GUI allows switching the display to decimal formatting.

Example:

Object			Value Setting		
Index/Sub-Idx	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2010	Rated Magnetizing Current	[A]	0	41.8	0

Some objects have sub-indexes, such that a combination of an object index with its distinct subindex denotes a distinct object

Other objects contain several datasets which can be used in dataset change-over operations. To access specific datasets of such objects via bus communication, they are treated as sub-indexes in read/write access. When using the AxiaManager GUI, you can enter/modify values in the respective datasets by clicking on them.

For example:

Object No.	Designation	Value1	Value2	Value3	Value4	Default
0x2524	Fixed Speed 4	0	40	100	50	0

The object **0x2524** has datasets populated with different values. By default, the first dataset is relevant for read/write processes. However, you can choose to use the *Data Set Change-Over Mode* **0x2103/10** object to configure reading from/writing to another dataset.

The objects have different data types. The data types of the various objects are given in a separate document.

Some objects are reserved for configuration of Functional Safety functions. Some of these are accessible via AxiaManager Safety software, depending on the safety module used in the particular hardware configuration.

7.1 Parameterization via AxiaManager GUI

NOTICE

EEPROM protection

Writing to the EEPROM too frequently may shorten the service life of the inverter. To prevent this, the user receives the error message "Cyclic Write" if more than 50 write attempts to the EEPROM are made per minute.

- The number of permitted consecutive write cycles to the same object per minute is limited to 50.
- After the error message, wait for 1 minute before attempting writing or
- Restart the inverter to be able to initiate new write commands.

Prerequisite for access to specific objects

To gain access to specific firmware objects, you have to ensure **one** of the following:

- establish a data connection between a Windows PC running the AxiaManager GUI and the inverter

To be able to use the bus connection, further settings must be made beforehand. 8

- install the keypad module on the inverter and establish a data connection via the COM-interface featured on the Keypad module via the USB-C terminal (only with KPAA-DSP-**01**) (recommended)
- install the Bluetooth® module on the inverter and establish a Bluetooth® connection between a Windows PC running the AxiaManager GUI (or a mobile device running the AxiaManager Mobile App) and the inverter (7.3)

7.1.1 Access via Keypad

For more details on how to use the AxiaManager software 📖 user manual VEC1en51.

Keypad connection

- Install the Keypad module on the inverter and connect the PC workstation to the Keypad module via the USB-C terminal (only with KPAA-DSP-**01**).
- Apply 24 V DC voltage from an external source at the terminal X12 of the main inverter. 📄 **Fehler! Verweisquelle konnte nicht gefunden werden.** Alternative: Apply mains voltage to the terminal X1. 📄 6.3
- Start the AxiaManager GUI on your PC workstation.
- Klick on the `Scan` button in the main window. The `Connection interface` dialogue shows up.
- In the `Connection interface` dialogue, select `USB/COM` on the left.
- In the `Port settings` frame, activate the COM port.
- Now, klick on the `Scan` button on the left to scan for connected inverters.

  The `Devices list` dialogue shows up.
  In the `Devices list` dialogue, klick on `Add` to add the selected inverters.
- Upon successful connection, the `Sync action` dialogue shows up.
- In the `Sync action` dialogue, select the required option.

Connect only:	AxiaManager connects to the inverter without reading or writing objects to the project/inverter.
WRITE ALL parameters to the device:	Load project settings to the inverter.
READ ALL parameters from the device:	Load inverter settings to the project.

- If the communication has been established correctly, the status bar displays `CONNECTED`.

  This concludes the USB connection to the PC.

When connected, you can use the AxiaManager GUI to access and parameterize objects.

📖 user manual VEC1en51 for more details on how to connect to the inverter and to use the AxiaManager software.

7.1.2 Access via Bluetooth® Module

When connected, the user can use the AxiaManager software on PC or the AxiaManager Mobile App on a mobile device to access and parameterize objects. 📄 7.3

Bluetooth® Connection

The connection via Bluetooth® using the PC and AxiaManager GUI offers the same functionality as the USB connection. Also, the REA-WL-01 Bluetooth® module allows to connect with the AxiaManager Mobile App on a mobile device. When connected, the user can use the AxiaManager GUI on a PC workstation or the AxiaManager Mobile App on a mobile device to access and parameterize objects.

Bluetooth® pairing

In order to connect, the PC or mobile device need to be paired with the Bluetooth® module first.

- Write down the pairing code and the module name located on the back of the wireless module:
  - -6-digit pairing code (last 6 digits in the serial number)
  - -Module NameREA-WL-01-xx:yy:zz", where xx:yy:zz are the last three octets of the MAC address.
- Mount the wireless module on the inverter.
- Apply 24 V DC voltage from an external source at the terminal X12 of the main inverter.
  Alternative: Apply mains voltage to the terminal X1. **Fehler! Verweisquelle konnte nicht gefunden werden.** 6.3
- **With the module installed**, activate the pairing mode by pressing the Pairing Mode Button (see arrow in the figure for the location of the pairing button) at the bottom of the module for more than 3 seconds. The LED shows the respective status by flashing white.

The module has 2 operating modes, Bluetooth® Low Energy (pale blue led) for use with mobile device and Bluetooth® Classic (deep blue led) for use with PC. By pressing the Pairing Mode Button for 1 second you can change the Bluetooth® mode.

Connection to PC

- On your PC, go to the Windows "Device Settings" menu.
- Go to the Bluetooth® settings.
- Go to "Further Bluetooth® options".
- In the Dialogue window, go to the COM Ports tab.
- Select `COM15` for the Bluetooth®-to-PC connection. Then confirm with "OK".
- Add the AXIA Bluetooth® Module (Module NameREA-WL-01-xx:yy:zz"). For the PIN, enter the 6-digit pairing code (last 6 digits in the serial number) and press "Connect".

  This concludes the pairing with the REA-WL-01 Bluetooth® module.
- Start the AxiaManager GUI on your PC workstation.
- Klick on the `Scan` button in the main window.

  The `Connection interface` dialogue shows up.
- In the "Connection Interface" area on the right, select "USB/COM".
- Then click on "Scan" to initiate scanning for connected inverters.
- Select the port `COM15` of the Bluetooth® module where the inverter is connected to and select the port setting as well as global settings.

  The next window will list all frequency inverters connected to your system.
- In the `Sync action` dialogue, select the required option.

Connect only:	AxiaManager connects to the inverter without reading or writing objects to the project/in-verter.
WRITE ALL parameters to the device:	Load project settings to the inverter.
READ ALL parameters from the device:	Load inverter settings to the project.

- If the communication has been established correctly, the Status bar displays `CONNECTED`. This concludes the USB connection to the PC.

- When connected, you can use the AxiaManager GUI to access and parameterize objects.

☞ separate user manual VEC1en51 for more details on how to connect to the inverter and to use the AxiaManager software.

This concludes the Bluetooth® connection to the PC.

7.1.3 Downloading/Uploading Configuration File

The AXIA Manager software for PC workstations allows editing the object values offline (i.e. without permanent connection to the inverter). In order to transfer the modified configuration to the inverter (to upload), proceed as follows:

Assuming you have made all necessary modifications to the firmware objects as required, save the new configuration to a configuration file (*.bfe).

- Electronically connect the inverter.
- Open the configuration file using the AxiaManager.
- Check the user credentials. Adjust if necessary.
- Scan for connected inverters.
- Select the inverters you want to upload the configuration to.
- Connect to your AXIA inverters.

  At connection, the prompt "Sync action" appears.
- Select "WRITE ALL parameters to all devices".

  The modifications from your present configuration file are written to the selected AXIA inverter (s).
  This concludes the upload procedure.

To download the configuration from a given AXIA inverter to your PC workstation proceed as follows:

- Electronically connect the inverter.
- Open the configuration file using the AxiaManager.
- Check the user credentials. Adjust if necessary.
- Scan for connected inverters.
- Select the inverters you want to upload the configuration to.
- Connect to your AXIA inverters.

  At connection, the prompt "Sync action" appears.
- Select "READ ALL parameters from all devices".

  The data from your selected AXIA inverter is written to the present configuration file. You will get one object tree per connected device.
- Save the configuration file under a new file name as required.

  This concludes the download procedure.

☞ separate user manual VEC1en51 for details on how to use the AxiaManager software.

7.2 Parameterization via Keypad

By default, the keypad display shows a standard view with monitored objects. To change the standby display parameters, use the object **0x3921/1** *Keypad Actual Value* to set the standby value display.

The function keys have context-dependent function assignments.

- To access a submenu, press the function key on the right.
- Using the UP and DOWN keys, position the cursor on the submenu entry as required and press OK to access the submenu.
- If you are changing a numerical object value, you can use the LEFT and RIGHT keys to position the cursor and then use the UP and DOWN keys to increase or decrease the setting value. The right function key is then pressed to confirm the setting and the left function key is used to abort the action.

  The keypad display shows the available submenu entries and, in the upper left corner of the screen, the submenu title. The function keys' designation changes according to the options available in the present submenu.
- To return to the previous menu level, press the ESC key.

For more details on the Keypad **Fehler! Verweisquelle konnte nicht gefunden werden.**.

7.3 Parameterization via AxiaManager Mobile App

Connection to mobile device

- On your mobile device, go to Bluetooth® settings and make sure the Bluetooth® mode is active.
- On your mobile device, open the AxiaManager Mobile App.
- In the AxiaManager Mobile App, go to "Connect" > "Bluetooth®" and, in the device list, select your AXIA Bluetooth® Module.

  The "Bluetooth® Pairing Request" dialogue appears.
- In the "Bluetooth® Pairing Request" dialogue, enter the previously noted 6-digit pairing code.

  The "Authentication" dialogue appears.
- In the "Authentication" dialogue, tap on "Default credentials" to proceed.

  The Dashboard appears. From there, you can use the AxiaManager Mobile App to view actual data, check any detected faults or warnings and access objects.

separate user manual VEC1en51 for details on how to use the AxiaManager software.

8 Commissioning the inverter

NOTICE

Incorrect parameterization

The rated data of the motor must be entered according to the specifications on the rating plate of the motor. The data must correspond to the actual motor connection type (star or delta connection).

If the data entered deviate from the rating plate, the parameters will not be identified correctly.

- Parameterize the rated data according to the rating plate of the motor for the wiring of the motor winding. Consider the increased rated current of the connected three-phase motor.

NOTICE

Commissioning Prerequisite

To be able to establish a data connection between a PC and any given Axia inverter it is necessary to configure the inverter for the chosen type of data connection. For instance, it is necessary to change the IP-Address of the inverter to be able to integrate the inverter in your TCP network.

Initial connection via the keypad module KPAA-DSP-01:

The keypad module KPAA-DSP-**01** features the USB-C service interface, which allows access from a PC to the firmware configuration stored in the inverter.

- Use a KPAA-DSP-**01** Keypad module mounted on the inverter with its USB-C service interface to access the TCP configuration.

To set up any Ethernet-Type connection, configure TCP connection parameters in the inverter firmware via the AxiaManager software installed on your PC. Use the Axia TCP Configurator tool to set the TCP address appropriate for your network.

separate user manual VEC1en51 for details on how to use the Axia-Manager software.

OR

- Use a KPAA-DSP-**01** Keypad module mounted on the inverter to access the TCP configuration via the function keys.

For more details on the Keypad **Fehler! Verweisquelle konnte nicht gefunden werden.** and 7.2.

Initial connection via the wireless module REAA-WL-01:

As an alternative to using the Keypad module for connection, you can connect via Bluetooth®. **Fehler! Verweisquelle konnte nicht gefunden werden.**, 7.3.

- Use the AxiaManager App on your mobile device to configure TCP connection parameters in the inverter firmware.

Commissioning via AxiaManager

- Start up the AxiaManager software on the PC workstation.
- Connect the PC workstation running the AxiaManager Software Suite to the inverter.

When the option `READ ALL parameters from the device` is chosen, the configuration of the inverter presently connected to the PC workstation is loaded into the active AxiaManager project file.

- Configure other firmware settings as required. 8.1 - 8.5

separate user manual VEC1en51 for details on how to use the AxiaManager software.

Commissioning via Keypad

- Connect the keypad module to the interface X211 of the main device.
- Via the function keys and the arrow keys on the keypad module, access the required submenu.
- Select the object for modification.
- Enter the required values for the objects. 8.1

NOTICE

If filters (e.g. dU/dt filters or sine filters) are used between the frequency inverter and motor, the following must be noted.

For configurations with encoder feedback:

- Carry out the installation with the filter connected. Note the filter manufacturer's specifications concerning permissible switching frequencies. During setup, note that the filter may be overloaded thermally.

For configurations without encoder feedback:

- Carry out the installation without connected filters. After setup, connect the filters between the frequency inverter and the motor.

8.1 Firmware Objects Relevant to Commissioning

NOTICE

EEPROM protection

Writing to the EEPROM too frequently may shorten the service life of the inverter. To prevent this, the user receives the error message "Cyclic Write" if more than 50 write attempts to the EEPROM are made per minute.

- The number of permitted consecutive write cycles per minute is limited to 50.
- After the error message, wait for 1 minute before attempting writing or
- Restart the inverter to be able to initiate new write commands.

The manufacturer recommends using the PC software "AxiaManager Suite" for commissioning. Using the AxiaManager Suite removes the need to browse individual objects via the Keypad to commission the inverter. The `Drive Train` subtree within the AxiaManager Suite gives access to guided configuration options. The guided configuration populates the correct firmware objects with the selected data.

user manual VEC1en51 for details on how to use the AxiaManager software.

If the user does not use the AxiaManager software, they can access the firmware objects via:

- the installed KPAA-DSP module (manually, via the display and the function keys)

Further below in this document it is assumed that the AxiaManager software is used to parameterize firmware objects.

The firmware objects listed in the table below refer to **Basic Setup** of AxiaAgile series inverters.

Index/Sub-Idx	Designation	Explanation	Chapter
0x2001	Motor Type	**Setting Motor Type** ASM [Asynchronous Motor] SynRM [Synchronous reluctance motor] PMSM [Permanent Magnet synchronous motor]	8.3.1
0x2002	Rated Voltage	Rated Voltage in Volt [V]	
0x2003	Rated Current	Rated Current in Ampere [A]	
0x2004	Rated Speed	Rated speed in revolutions per minute [rpm]	
0x2005	No. of Pole Pairs	Number of pole pairs	
0x2006	Rated Cosinus Phi	Rated active power factor	
0x2007	Rated Frequency	Rated frequency in Hertz [Hz]	
0x2008	Rated Mech. Power	Rated mechanical power in kilo watt [kW]	
0x2009	Rated Torque	Rated Torque in newton meter [Nm]	
0x2080	Motor Control	**Setting Motor Control** Choose V/f- scalar control for simple ASM-applications. For higher demands on speed or torque accuracy select field-oriented control (FOC) applicable to all types of motors. In addition, the encoder signal can be integrated into the speed or position control.	8.3.2
0x2081	Actual Speed Source		
0x20A0	Invert Sense of Rotation		
0x2101/1	Software Release	**Function Assignment for Digital Inputs** Assign the digital inputs to configure the source for release and start command.	10.1.1
0x2101/2	IO Start		
0x2200	Control Mode	**Control Methods** Choose IOs for controlling the inverter via I/O contacts. The mode of operation can be assigned as the Manufacture Velocity or Torque Mode.	9.5.1
0x2201	Mode of Operation (IO's)		
0x3840/1	Encoder Type	**Setting of HTL encoder data** Irrelevant for sensorless control. If closed-loop control for FOC or motor feedback information are required, an HTL encoder signal (A/B/Z-Track) can be evaluated by standard I/O (X210.7, .9, .11).	8.3.4
0x3840/10	Speed Filter Constant		
0x3840/11	Change Sense of Rotation		
0x3840/20	Division Marks		
0x3840/21	Z-Track Window		
0x2099/1	Auto-Setup Type	**Auto-Setup Procedure** Several motor parameters are measured during Auto-Setup. Different modes such as complete setup or encoder offset tuning can be used either for all or for individual data sets. The Auto-Setup is activated when the	8.3.6
0x2099/2	Allow Brake Release		
0x2099/6 0x2099/8	Auto-Setup Data Set Auto-Setup Offset Mode		
0x209A	Auto-Setup State		

Index/Sub-Idx	Designation	Explanation	Chapter
0x209B/1 0x209B/5	Auto-Setup Error Auto-Setup Warning	correct Control Mode is selected, the mains voltage is switched on and the inverter is released. Furthermore, the *Mode of Operation IOs* **0x2201** must be set to `Axia Auto-Setup`. The progress is shown in the *Auto-Setup State* **0x209A**.	

Most of the objects above do not require setting specific values other than defaults, in a basic case. However, in some cases, additional adjustments may become necessary.

8.2 Switching on Mains Voltage

WARNING

Device damage / personal injuries

Faulty or incorrect parameterization may lead to unwanted device behavior. This may lead to device damage or to personal injuries.

- Parameter settings may only be changed by skilled personnel. Before starting the commissioning process, read the documentation carefully and comply with the safety instructions.

After completing the installation work 6, make sure to re-check all control and power connections before switching on the mains voltage. When all electrical connections are correct, make sure that the frequency inverter cannot auto-start at power-up.

- First, apply DC 24 V voltage from an external source.
- Then apply the mains voltage.

  After power-up, the frequency inverter will perform a self-test.

8.3 Setting up Firmware for Commissioning

Axia Manager user manual VEC1en51 for information on how to use the GUI to execute the planning and configuring of the drive train.

Follow the steps described in 7.2 to establish a data connection with the inverter and to parameterize basic inverter settings.

- Assuming the connection to the inverter is established, now parameterize the motor.

8.3.1 Rated Parameters

In the subtree `Parameters\Installation\Motor\Rated Parameters`, set the values for the following objects according to the specifications of the motor:

Object			Explanation
Index	**Designation**	**Unit**	
0x2001	Motor Type	[-]	**Setting Motor Type** ASM [Asynchronous Motor] SynRM [Synchronous reluctance motor] PMSM [Permanent Magnet synchronous motor]
0x2002	Rated Voltage	[V]	Rated Voltage in Volt [V]
0x2003	Rated Current	[A]	Rated Current in Ampere [A]
0x2004	Rated Speed	[rpm]	Rated speed in revolutions per minute [rpm]

Object			Explanation
Index	**Designation**	**Unit**	
0x2005	No. of Pole Pairs	[-]	Number of pole pairs
0x2006	Rated Cosinus Phi	[-]	Rated active power factor
0x2007	Rated Frequency	[Hz]	Rated frequency in Hertz [Hz]
0x2008	Rated Mechanical Power	[W]	Rated mechanical power in kilo Watts [kW]
0x2009	Rated Torque	[Nm]	Rated torque in newton meter [Nm]
0x200B	Maximum Current	[A]	User-configurable limit
0x200C	Maximum Speed	[rpm]	User-configurable limit
0x200D	Maximum Mechanical Power	[W]	User-configurable limit

The values for the objects listed above depend on the type and on the particular configuration of the individual motor. The captured and calculated machine data is checked for plausibility during the Auto-Setup procedure (9.6). The user should verify the preset rated data of the motor. The manufacturer recommends using the guided AxiaManager GUI "Planning" feature to set the relevant motor parameters. Also, 9.2.1 for more details.

8.3.2 Motor Control

In the subtree `Parameters\Installation\Motor\Control`, set the values for the following objects:

Index	Designation	Explanation
0x2080	Motor Control	**Setting of Motor Control** Choose V/f- scalar control for simple ASM- applications. For higher demands on speed or torque accuracy select Field orientated control (FOC) applicable to all types of motors. In addition, the encoder signal can be integrated into the speed or position control.
0x2081	Actual Speed Source	
0x2082	Actual Position Source	
0x20A0	Invert Sense of Rotation	

NOTICE

Possible Error

Depending on the settings of the different datasets of the object **0x2080**, switching the dataset may result in an overcurrent error. To prevent this, the software release must be interrupted before switch-over.

- Interrupt the software release signal before performing the dataset switch-over.

8.3.3 Digital IO Function Assignment

Link the function to an assignable digital input to configure the activation command for the chosen function. An active signal at a digital input then triggers the corresponding function execution.

Index	Designation	Index	Designation
0x2083	Activate Sensorless	0x2103/1	Data Set Change-Over 1
0x2101/1	Software Release	0x2103/2	Data Set Change-Over 2
0x2101/2	IO Start	0x2104/1	Fixed Speed Change-Over 1
0x2101/3	IO Counter Clockwise Operation	0x2104/2	Fixed Speed Change-Over 2
0x2101/4	IO Halt	0x2104/3	Fixed Speed Change-Over 3
0x2101/5	IO Quick Stop	0x2105/1	Fixed Percentage Change-Over 1
0x2101/6	JOG Mode	0x2105/2	Fixed Percentage Change-Over 2
0x2101/7	JOG Start	0x2105/3	Fixed Percentage Change-Over 3
0x2101/8	JOG Counter Clockwise Operation	0x2106/1	Motor Potentiometer Up (Speed)

Index	Designation	Index	Designation
0x2101/10	External Halt (State-Machine)	0x2106/2	Motor Potentiometer Down (Speed)
0x2101/11	External Quick Stop (State-Machine)	0x2107/1	Motor Potentiometer Up (Perc)
0x2101/12	IO Controlword Bit4	0x2107/2	Motor Potentiometer Down (Perc)
0x2101/13	IO Controlword Bit 5	0x2108	HW Home Switch
0x2101/14	IO Controlword Bit 6	0x2109	HW Pos Limit Switch Src
0x2101/15	IO Controlword Bit 9	0x210A	HW Neg Limit Switch Src
0x2101/16	Start Axis Positioning	0x2413	Motor Thermal Contact
0x2102	Fault Reset		

Also 10.1.1 for more information.

8.3.4 Encoder

If the setting for the object **0x2081** *Actual Speed Source* is any other than `Sensorless`, you also have to configure the objects in the subtree `Parameters\Installation\Encoder` according to the type of encoder present in the application.

Index/Sub-Idx	Designation	Explanation
0x3840/1	Encoder Type	Settings for the configuration of the HTL Encoder connected at the X210 interface (StandardIO). 6.5.1 9.3
0x3840/10	Speed Filter Constant	
0x3840/11	Change Sense of Rotation	
0x3840/20	Division Marks	
0x3840/21	Z-Track Window	

The selection of objects parameterizable in this object subset varies depending on the selected encoder type.

Index/Sub-Idx	Designation	Explanation
0x2078/1	Encoder Type	encoder module manuals
...	...	
0x2078/n	...	

Index/Sub-Idx	Designation	Explanation
0x3850/1	Encoder Type	encoder module manuals
...	...	
0x3850/n	...	

8.3.5 Brake

If the setting for the object **0x2099/1** *Auto-Setup Type* includes brake activation, you also must configure the objects in the subtree `Parameters\Installation\Brake` according to the parameters of the brake present in the application.

Index	Designation	Explanation
0x2050	Brake Operation Mode	Settings for the configuration of the brake 9.4

8.3.6 Auto-Setup

Within the AxiaManager GUI, you can access the objects mentioned below via the `Parameters\Installation\Brake` subtree.

Via **0x2099/1** *Auto-Setup Type* you set the type of auto-setup.

Auto-Setup Type 0x2099/1	Function
0x00000000 Complete Setup	Complete Measurement of Motor Data / **Default**
0x00000001 Motor Parameter Measurement Only	
0x00000002 Encoder Offset Only	Measurement of encoder/ resolver offset
0x00000003 Tuning Current Controller Only	

0x2099/2 – *Allow brake release* (brake will be disengaged during auto-tuning): `0(default)/1`.

Allow brake release 0x2099/2
0x00000000 – No Brake Available – Free Shaft
0x00000001 – Brake Release Allowed - Free Shaft
0x00000002 – No Brake Release – Shaft Blocked

0x2099/8 – *Auto-Setup Encoder Evaluation*: `0-3 (1 - default)`.

Auto-Setup Offset Mode 0x2099/8
0x00000000 – No Offset Measurement
0x00000001 – Free Shaft Mode
0x00000002 – Pseudo Static Mode
0x00000003 – Anisotropic Mode (with Brake)

Status messages during Auto-Setup

The actual status of the Auto-setup process is shown in object **0x209A** *Auto-Setup State*.

The following status messages are possible during commissioning (setup):

Status message		Meaning
0x00000000	Not Done	Auto-Setup has not yet been run
0x00000001	Store Inverter State	During the Auto-Setup, the individual process steps are displayed as status depending on the operating mode selected in object **0x2099/1**. As long as one of these status messages is displayed, the Auto- Setup is still running.
0x00000002	Plausibility Check	
0x00000003	Nominal Tuning	
0x00000004	Alignment	
0x00000005	Tuning Current Controller	
0x00000006	Measuring Stator Resistor	
0x00000007	Demagnetization	
0x00000008	Measuring Stator Inductance part 1	
0x00000009	Measuring Stator Inductance part 2	
0x0000000A	Encoder Evaluation	
0x0000000B	Final	
0xFFFFFFFF	Done	Auto-Setup was carried out successfully

Whenever there is an error during the setup process, the setup shall halt at the corresponding step. This may facilitate troubleshooting.

Error and warning messages during Auto-Setup

After completion or during the Auto-Setup, error messages may be displayed via the object **0x4010/1** *Fault Message*. The value of **0x209B/1** *Auto-Setup Error* contains the particular reason for the auto-setup fault. The error code indicates the likely source of the issue.

Code	
Error messages	
0x00000000	No Error
0x06090030	Object value invalid
0x06090031	Object value too small
0x06090033	Object value too big
0x50000001	Volt. and Volt. Constant missing
0x50000003	Mismatch In, Un, Pn
0x50000004	Rotor Losses too high
0x50000005	Mismatch Power, Torque, Speed
0x50000006	Bad Motor Efficiency
0x50000007	Mismatch Speed, Freq, PPN

Code	
Error messages	
0x50000008	Invalid Time Const (Elec. or Rotor)
0x50000009	Nominal Tuning
0x5000000A	Wrong Encoder Sense of Rotation
0x5000000B	ITAE Process failed
0x5000000F	General Autosetup Error
0x50000010	Invalid Cosinus Phi
0x50000011	Invalid Slip
0x50000015	No Motor Connection
0x50000016	Auto-Setup aborted
0x50000017	Magnetizing Current not found
0x5000001C	Mismatch Un, ke
0x5000001F	Wrong Value for Kp or Ki
0x50000020	Rotor Blocked at Offset Measurement
0x50000021	Wrong Encoder Pole Pair Number
0x50000022	Watchdog
0x50000023	Mode Of Operation changed
0x50000024	Current Noise Too High
0x50000025	No Offset Measurement possible
0x50000026	Tune current controller first

The object **0x209B/5** *Auto-Setup Warning* provides information on warnings during the Auto-Setup.

8.4 Status LEDs

NOTICE

Residual risk

When LEDs and/or other indicating elements on the frequency inverter are not active, the inverter still may be energized.

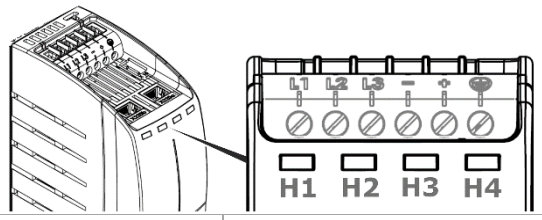
- Before carrying out any work with the device, where contact with energized parts might be possible, always check if the device is deenergized, irrespective of the status of any installed indicating elements.

The total number of available LED signals depends on the installed extension modules.

Status LEDs provide visual feedback on the general status of the corresponding module.

The scope of delivery contains a sticker with "RUN"/"ERR" inscriptions to be applied on the housing next to the LEDs.

LEDs



H1-H2 Main device diagnosis LEDs	**H3-H4** Safety module diagnosis LEDs

Status output via main unit LEDs (H1):

8.5 Checking direction of rotation

To check if the reference value and the actual direction of rotation of the drive correspond to one another, proceed as follows:

- Operate the drive at low speed, i.e. specify a reference value of approx. 10%.
- Briefly switch on release of frequency inverter:
  Check if the motor shaft turns in the required direction.
  In case the sense of rotation is wrong: go to the subtree
  `Parameters\Installation\Motor\Control`, in the AxiaManager;
  Use the firmware object **0x20A0** *Invert Sense Of Rotation* to correct,
  or swap two motor phases, e.g. U and V at the terminals of the frequency inverter.
  You may also check the firmware objects **0x3840/11** and/or **0x2078/11**, if the sense of rotation in the encoder needs adjusting.

The mains-side connection of the frequency inverter does not affect the sense of rotation of the drive. In addition to checking the drive, you can read the corresponding actual values and operating messages by means of the operating unit.

If the release of the frequency inverter is interrupted/deactivated, the power output stage will be disabled. The motor will coast down or, if installed, a break will be activated.

9 Inverter functionality

NOTICE

Drive damage

The control method of the motor depends on the motor type **0x2001** *Motor Type* and the motor control **0x2080** *Motor Control*. The motor type setting must correspond to the motor type used, otherwise the motor may be damaged.

- Make sure to enter the motor/machine data according to the rating plate of the motor.
- When the motor/ machine data is specified by the user without using guided start-up/commissioning via Keypad or AxiaManager Drive Train, the nominal data on the motor nameplate or the associated motor data sheet must be used.

The firmware objects listed in this document are available on the "professional" menu access level within the AxiaManager GUI.

9.1 System Information

The `System Information` subtree contains objects, which display actual values for the inverters presently connected to the PC workstation. The values are read automatically from the hardware. The objects cannot be edited by the user, they do not require further editing. The object range displayed in this subsection may depend on the particular hardware configuration of the inverter.

9.1.1 Inverter basics

Object		Setting		
Index/Sub-Idx	**Designation**	**Min.**	**Max.**	**Default**
0x20E0	Customer Axis Name	Custom string		
0x3800	Customer Device Name	Custom string		
0x3801	Device Serial Number	Custom string		
0x3E21	Safety Module Serial Number	Internal ID		
0x3803/1	Software Version CBO	Internal ID		
0x3803/2	Software Version SMA	Internal ID		
0x3803/3	Software Version BDM	Internal ID		
0x3806	Device Part Number	Device Part Number		
0x3908/10	Control Board AXA	Internal ID		

9.1.2 Inverter specifics

Object			Setting		
Index/Sub-Idx	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x3802	Device ID	[-]	Internal ID		
0x3804/17	Capability Flags	[-]	Commissioning Info Code		
0x5840/1	Rated Voltage	[V]	Type Plate Value		
0x5840/2	Rated Current	[A]	Type Plate Value		
0x5840/3	Rated Power	[W]	Type Plate Value		
0x5840/4	Maximum Output Frequency	[Hz]	Type Plate Value		
0x5840/5	Maximum DC-Link Voltage	[V]	Type Plate Value		
0x5840/6	Maximum Heatsink Temperature	[°C]	Type Plate Value		
0x5840/7	Maximum Interior Temperature	[°C]	Type Plate Value		

9.1.3 Optional modules

Object			Setting		
Index/Sub-Idx	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x3908/12	Extension Module AXA	[-]	Internal ID		

9.2 Motor configuration

9.2.1 Rated motor parameters

Motor Type 0x2001	Function
0 - ASM	Asynchronous machine/motor
1 - SynRM	Synchronous reluctance motor
2 - PMSM	Permanent Magnet Synchronous Motor

The motor data to be entered are indicated on the rating plate or the data sheet of the motor/machine. The defaults for the machine parameters are based on the nominal data of the frequency inverter and the corresponding motor. The captured and calculated machine data is checked for plausibility during the Auto-Setup procedure (9.6). The user should check the preset rated data of the motor.

Object		
Index	**Designation**	**Unit**
0x2002	Rated Voltage	[V]
0x2003	Rated Current	[A]
0x2004	Rated Speed	[rpm]
0x2005	No. of Pole Pairs	[-]
0x2006	Rated Cosinus Phi	[-]
0x2007	Rated Frequency	[Hz]
0x2008	Rated Mechanical Power	[W]
0x2009	Rated Torque	[Nm]
0x200B	Maximum Current	[A]
0x200C	Maximum Speed	[rpm]
0x200D	Maximum Mechanical Power	[W]

For some motor types it is advisable to use the objects **0x200B** *Maximum Current*, **0x200C**, *Maximum Speed* and **0x200D** *Maximum Mechanical Power* to limit the current, speed and power applied to the motor. This is to improve the motor performance in certain applications. If left at the default value `0`:

- the object **0x200B** is set to 200% of object **0x2003**,
- the object **0x200C** is set to 100% of object **0x2004** and
- the object **0x200D** is set to 150% of object **0x2008**.

Specific motor type values

In case of **asynchronous motors (ASM)**, the *Rated Torque* **0x2009** is often missing on the nameplate. The rated torque will be calculated during the Auto-Setup procedure, if the rated mechanical power (**0x2008**) is available (9.6). In case of a mismatch of motor parameters, the plausibility check will lead to the Auto-Setup process being aborted.

Star or delta connection

NOTICE

Wrong parameterization

The rated data of the motor must be entered according to the specifications on the rating plate for the motor connection type used (star or delta connection).

If the data entered deviate from the rating plate, the parameters will not be identified correctly.

- Parameterize the rated data according to the rating plate of the motor for the wiring of the motor winding. Consider the increased rated current of the connected three-phase motor.

In the star motor connection, the nominal voltage and the nominal current behave as follows compared to the delta motor connection:

$$RatedVoltage0x2002[V] = \frac{400_{(Star)}}{\sqrt{3}} = 230_{(Delta)}$$

$$RatedCurrent0x2003[A] = I_{Star} \times \sqrt{3} = I_{(Delta)}$$

Example: BONFIGLIOLI BN 90LA Motor

Object		Star	Delta
0x2002	Rated Voltage	400 V	230 V
0x2003	Rated Current	3.7 A	6.4 A
0x2004	Rated Speed	1410 rpm	1410 rpm
0x2006	Rated Cosinus Phi	0.77	0.77
0x2007	Rated Frequency	50 Hz	50 Hz
0x2008	Rated Mech. Power	1500 W	1500 W

9.2.2 Additional motor parameters

Additional motor parameters include the following:

Object		
Index	**Designation**	**Unit**
0x2010	Rated Magnetisation Current	[A]
0x2022	Voltage Constant	[mVmin]
0x2023	Stator Resistance	[Ohm]

The rated and the additional motor data characterize the motor around the nominal operation point. These motor data may depend on the operation point of the drive and can be influenced by the motor temperature and the saturation of inductances.

To track the actual values of the motor, 15.3.

9.2.3 Control (Motor Control)

In the Subtree `Parameters\Installation\Motor\Control`, set the values for the following objects:

Object		Function
0x2080	Motor Control	**Setting Motor Control** Choose V/f- scalar control for simple ASM- applications. For higher demands on speed or torque accuracy, select Field Oriented Control (FOC) applicable to all types of motors. In addition, the encoder signal can be integrated into the speed or position control.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2081	Actual Speed Source	[-]	Selection		
0x2082	Actual Position Source	[-]	Selection		
0x20A0	Invert Sense of Rotation	[-]	Selection		

Actual Speed Source 0x2081	Function
0x00000000	HTL Encoder via X210
0x00000002	Enc. Module Slot X312
0xFFFFFFFF	Sensorless

Actual Position Source 0x2082	Function
0x00000000	HTL Encoder via X210
0x00000002	Enc. Module Slot X312
0xFFFFFFFF	Sensorless

Invert Sense of Rotation 0x20A0	Function
0x00000000	Off
0x00000001	Motor Only
0x00000002	On

Via the object **0x20A0** *Invert Sense of Rotation* you can select to invert the sense of rotation signal for the motor only or for the entire drive train. The default setting is `off`.

9.3 Encoder

HTL encoders can connect to the standard I/O interface of AxiaAgile inverters.

If the encoder interface module is not installed, the encoder connectors provided in the standard I/O can be used to connect HTL encoders. 6.5.1.

Operation Mode Standard IO Encoder

The following objects are available for HTL encoder configuration via interface X210:

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x3840/1	Encoder Type	[-]	Selection		
0x3840/11	Change Sense of Rotation	-	Off	On	Off
0x3840/20	Division Marks	[incr]	1	8192	Type-Dependent

Encoder Type 0x3840/1	
0x00000000:	No Encoder
0x00002100:	HTL incremental: A/B
0x00002500:	HTL incremental: A/B/Z

In addition to tracks A and B, encoders often feature a reference track (also referred to as Z track, zero track, R track). The reference track delivers one pulse per revolution. This track is used for plausibility checking or for additional functions.

Some applications require using several encoders. To be able to use two or three encoders with one inverter, encoder interface modules must be installed on the main device. Standard I/O encoders and extension module encoders are configured independently from one another. For more information, encoder module manuals.

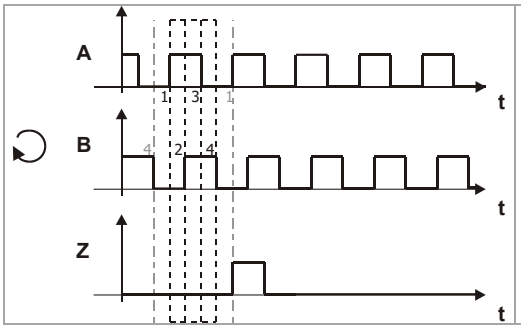
- Set the values in the object **0x3840/1** according to your HTL encoder type.

The following options for HTL encoder evaluation are supported by AXIA:

(HTL incremental: A/B)	Two-channel speed sensor with recognition of direction of rotation via track signals A and B; four signal edges are evaluated per division mark.
(HTL incremental: A/B/Z)	Two-channel speed sensor with recognition of direction of rotation via track signals A and B, four signal edges are evaluated per division mark. Reference track via digital input.

- Check for proper functioning:
- Scope: set up basic IO encoder position → Let the motor run → Check for the encoder signal
- If there is no signal → check wiring /Hardware

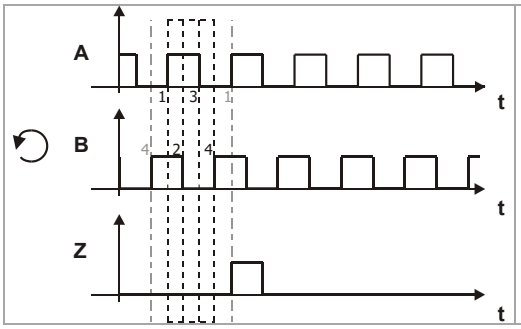
Also, for connection details 6.7.



Example:

Each edge 1, 2, 3 and 4 is an evaluated signal within the pulse-pause cycle of Track A. After that, the cycle is restarted. The type of edges indicates the direction of rotation:

Clockwise direction of rotation: A rising edge of A (1) is followed by a rising edge of B (2).



Anticlockwise direction of rotation A rising edge of A (1) is followed by a falling edge of B (2).

Track Z: One pulse per revolution

HTL encoders can be connected to the basic device. For connection of TTL encoders, you will need an "EMAA-ENIO-01" type encoder expansion module installed on the main device. It is implemented in the variant "Advanced".

This variant offers two terminals for the connection of encoders and additional digital I/Os.

Division Marks, Standard IO Encoder

The number of increments of the connected speed sensor can be adjusted via parameter *Division Marks* **0x3840/20**. Select the division marks of the speed sensor according to the datasheet of the encoder.

The maximum number of division marks S_{max} is defined by the frequency limit

$$f_{max} = 300 \text{ kHz}$$

of the digital inputs IN3D (track A) and IN4D (track B).

$s_{max} = f_{max} * \frac{60}{n_{max}}$	f_{max}	= 300000 Hz
	n_{max}	= max. speed of the motor in rpm

To guarantee true running of the drive, an encoder signal must be evaluated at least every 2 ms (signal frequency f = 500 Hz). The minimum number of division marks S_{min} of the incremental encoder for a required minimum speed n_{min} can be calculated from this requirement.

$s_{min} = f_{min} * \frac{60}{A * n_{min}}$	n_{min}	= min. speed of the motor in rpm
	A	= evaluation (1, 2, 4)

9.4 Brake

The operational behavior of the mechanical brake is defined via object *Brake Operation Mode* **0x2050**.

Via object **0x2050**, two brake operation modes are available.

0x2050		Selection
0 -	Off	Brake control deactivated
1 -	Simple	Brake follows the settings in the Obj. **0x2051** and **0x2052**
2 -	Advanced	Planned function

The brake behavior is controlled via the following objects:

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2050	Brake Operation Mode	[-]	-	-	Off
0x2051	Brake ReleaseTime	[s]	0	30	0
0x2052	Brake CloseTime	[s]	0	30	0

To protect the motor holding brake against damage, the motor may only start after the brake has been disenganged. Ramping up to reference speed is carried out only after the *Brake Release Time* **0x2051** has elapsed. The time should be set such that it is at least as long as the time required for disenganging the holding brake.

Advanced Brake Configuration

The advanced options for brake behavior are controlled via the following objects:

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2053	Current Injection Time Start	[s]	0	200	1
0x2054	Current Control Time Start	[s]	0	200	1
0x2055	Release Brake Time Start	[s]	0	200	1
0x2056	Process Ref Value Time Start	[s]	0	200	1
0x2057	Current Control Time Stop	[s]	0	200	1
0x2058	Current Injection Time Stop	[s]	0	200	1
0x2059	Circuit Breaker Time	[s]	0	200	1
0x205A	Drive Current Control	[A]	0	12.6	0.84

9.5 Controls

9.5.1 Control mode

Object	
Index/Sub-Idx	**Designation**
0x2200	Control Mode
0x2201	Mode of Operation IOs
0x2103/10	Data Set Change-Over Mode

- In the `Parameters\Installation\Controls\Mode` subtree, via object **0x2200** *Control Mode*, you can select the control mode:

0x2200 Control mode	
Entry	**Designation**
0x00000001	IOs (default)
0x00000002	Keypad
0x00000003	State machine
0x0000000B	IOs w/o switch-over in op.
0x0000000C	Keypad w/o switch-over in op.
0x0000000D	State machine w/o switch-over in op.

If the **0x2200** *Control Mode* is set to an option "…w/o switch-over in operation", it will not be possible to carry out the dataset change-over while the inverter is in operation. You will have to halt the operation first.

- Via object **0x2201** *Mode of Operation IOs*, you can select the mode of operation:

0x2201 Mode of operation IOs	
Entry	**Designation**
0x00000000	No mode (Drive Stopped)
0xFFFFFFF6	Axia Auto-Setup
0xFFFFFFFB	Axia Speed Control (default)
0xFFFFFFFC	Axia Torque Control
0xFFFFFFFD	Electronic Gear

For this parameterization, the **0x2200** *Control Mode* must be set to `0x00000001 IOs` or `0x0000000B IOs w/o switch-over in operation`.

Data Set Change-Over Mode

The data set change-over function allows switching the data set upon receiving a signal from one of the assignable sources.

- Use the objects **0x2103/10** – *Data Set Change-Over Mode* to assign the target dataset. If any option other than 0x..00 is selected, the corresponding dataset is selected as target data set. The switch-over is then disabled.

0x2103/10 Data Set Change-Over Mode	
Entry	**Designation**
0x00000000	Controlled by Contacts (default)
0x00000001	Data Set 1
0x00000002	Data Set 2
0x00000003	Data Set 3
0x00000004	Data Set 4

By default, the frequency inverter uses data set `1` as the active data set. This corresponds to:

0x2103/10 set to `0x00000000`

0x2103/1 AND **0x2103/2** set to `0x00000000`

In order to write specific object values to specific datasets, the external system (GUI, software tools or keypad) must state the target data set in the respective communication telegram.

If the setting `Controlled by Contacts` is selected in **0x2103/10**, the target data set is defined by the setting made in the objects **0x2103/1** AND **0x2103/2**. 10.1.1

9.5.2 State-Machine

In the subtree `Parameters\Installation\Controls\State Machine`, you can use the objects to parameterize sources for Controlword, mode of operation and other values. The default setting is the Controlword as defined in the CiA standard. For this, the object **0x6040** is used as source.

So, to use the state machine, you have to set the object **0x2200** *Control Mode* in the `Parameters\Controls and Controllers\Controls\Mode` subtree to `3 - State Machine`.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x25E0	Controlword Source	[-]	Selection		0x00604000
0x25E1	Mode of Operation Source	[-]	Selection		0x00606000

9.6 Auto-Setup

During Auto-Setup, the inverter performs several measurements to determine the optimized motor settings.

- Before activating the Auto-Setup, ensure that the prerequisites are met.

The Auto-Setup function can be initiated either via IO contacts, via AxiaManager or via an external control (state machine).

To initiate the Auto-Setup via the **IO contacts**:

Prerequisite

- Start up the AxiaManager software on the PC workstation.
- In the AxiaManager, connect to the inverter.
- Via object **0x2200** Control Mode, select the control mode "IOs": `0x00000001 - IOs` → use this setting for Auto-Setup 9.5.1

To initiate the Auto-Setup via the **IOs**:

- Connect the Standard I/O interface X210 to appropriate signal source. 6.5.1
- The Auto-Setup is initiated, if the digital inputs assigned for **0x2101/1** *Software Release* and **0x2101/2** *IO Start* are activated.

To initiate the Auto-Setup via the **AxiaManager**:

- Connect the PC workstation running the AxiaManager software to the inverter.
- Start up the AxiaManager software on the PC workstation.
- In the AxiaManager, connect to the inverter.

- The Auto-Setup is initiated, if **0x2101/1** *Software Release* and **0x2101/2** *IO Start* is activated.

Auto-Tuning is the sub-routine of the Auto-Setup that performs measurements determining the most optimal values to be set for the motor.

Prerequisite: 0x2001-0x2009 Motor Data

The rated motor data such as stator inductance, magnetization current and others is stored in the objects **0x2001**-**0x2009**. This data is required as a starting point for Auto-Setup so that it can be carried out. 9.2.1

The auto-tuning values are determined by way of measurement and pre-set accordingly. Auto-tuning should be carried out while the machine is cold, because a part of the machine data depends on the operating temperature.

- In the `Parameters\Controls and Controllers\Controls\Mode` subtree set **0x2201** to "`-10`" (dec)/"`FFFFFFF6`" (hex) which means "`Auto-setup`" 9.5.1

Auto-Setup configuration

The Auto-Setup can be carried out via different operating modes, which can be selected via object **0x2099/1** *Auto-Setup Type*.

- Via **0x2099/1** set the type of Auto-Setup.

Auto-Setup Type 0x2099/1	Function
0x00000000 Complete Setup	Complete Measurement of Motor Data / **Default**
0x00000001 Motor Parameter Measurement Only	
0x00000002 Encoder Offset Only	Measurement of encoder/ resolver offset
0x00000003 Tuning Current Controller Only	

With the Tuning Mode `0`, a complete pre-setting is made for the additional motor data and different motor controller types. In mode `1`, only the motor parameters are determined by measurement. Mode `2` only determines the encoder/resolver offset.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2099/1	Auto-Setup Type	[-]	Selection		
0x2099/2	Allow Brake Release	[-]	Selection		
0x2099/6	Auto-Setup Data Set	[-]	0 - All Data Sets/1 - Actual Data set		
0x2099/8	Auto-Setup Offset Mode	[-]	Selection		
0x209A	Auto-Setup State	[-]	Selection		
0x209B/1	Auto-Setup Error	[-]	Actual Value/Status		
0x209B/5	Auto-Setup Warning	[-]	Actual Value/Status		

0x2099/2 – *Allow Brake Release* (brake will be disengaged during auto-tuning) 0/1(def)

0x2099/6 – *Auto-Setup Data Set* 0-1 (0 – default; All Data Sets)

0x2099/8 – *Auto-Setup Offset Mode* 0-3 (1 – default)

0x209A – *Auto-Setup State* 0/-1

When the auto-tuning is finished, the object **0x209A** is set to the value `-1` (`Auto-Setup Done`). This object is used to display the auto-tuning progress.

At completion of the auto-setup, the user can select the next configuration step: the selection of the mode of operation.

The **motor control method** selected in object **0x2080** has no impact on the Auto-Setup. However, if the offset of an encoder/resolver must be determined by measurement, the respective encoder settings must be set separately.

The behavior of the brake control during auto-tuning can be set via object **0x2099/2** *Allow Brake Release*. If there is no motor brake installed, set the value to `Brake Release Allowed – Free Shaft`. When using a motor brake, the Auto-Tuning can be carried out either with or without a brake, depending on the application. The setting `No Brake Release – Shaft Blocked` in object **0x2099/2** enables the Auto-Tuning without moving the motor shaft.

General settings for brake control must be carried out beforehand (9.2.3).

Allow Brake Release 0x2099/2	
Entry	**Function**
0x00000000	No Brake Release – Shaft Blocked
0x00000001	Brake Release Allowed – Free Shaft (default)

The values determined by the Auto-Setup can be stored in four different data sets (8.1). *Auto-Setup Data Set* can be specified in object **0x2099/6**.

Auto- Setup Data Set 0x2099/6	
Entry	**Function**
0x00000000	All data sets
0x00000001	Actual Data set

If data set `0` is selected, the object values are copied to data sets `1` through `4`. In the default settings, the frequency inverter uses data set `1` as the active data set.

Process Description for Auto-Setup:

The Auto-Setup procedure can only be carried out if the inverter is supplied with mains voltage. When using a switching relay in the drive train, make sure that the connection to the motor is closed during the entire measurement process.

- Enter *Motor Data* **0x2001-0x2009** according to motor nameplate or datasheet.
- In the `Parameters\Controls and Controllers\Controls\Mode` subtree, via object **0x2200** *Control Mode*, select the control mode:

0x2200 Control mode	
Entry	**Designation**
0x00000001	IOs **(default)**
0x00000002	Keypad
0x00000003	State machine
0x0000000B	IOs w/o switch-over in op.
0x0000000C	Keypad w/o switch-over in op.
0x0000000D	State machine w/o switch-over in op.

- Set object **0x2201** *Mode of Op. (IOs)* to `Axia Auto-Setup` when **0x2200** is set to `IOs`. The Auto-Tuning is initiated, if **0x2101/1** *Software Release* and **0x2101/2** *IO Start* is activated.

Once the **Auto-Setup** procedure is activated, the motor starts noising, and status can be monitored by object **0x209A** *Auto-Setup State*.

9.6.1 Data Set Selection

The data set selection function enables the selection of one of four (or all four) data sets for storing parameter settings.

- Use object **0x2099/6** – *Auto-Setup Data Set* to define the target data set for population with data during Auto-Setup.

By default, the frequency inverter uses "all data sets" (**0x2099/6** = `0`) when writing auto-setup data.

Example:

If `1 - Actual Data Set` is selected in **0x2099/6** *Auto-Setup Data Set*, all values determined or entered are saved in the data set selected in the object **0x2103/10**. The other data sets will still contain the default values. For proper operation of the frequency inverter, the pre-selected data set then must be selected as the active data set.

9.6.2 Status messages during Auto-Setup

The actual status of the Auto-Setup procedure is shown in object **0x209A** *Auto-Setup State*.

The following status messages are possible during commissioning (Auto-Setup):

Status message		Meaning
Entry	**Designation**	
0x00000000	Not Done	Auto-Setup has not yet been run
0x00000001	Store Inverter State	During the Auto-Setup, the individual process steps are displayed as status depending on the operating mode selected in object **0x2099/1**. As long as one of these status messages is displayed, the Auto- Setup is still running.
0x00000002	Plausibility Check	
0x00000003	Nominal Tuning	
0x00000004	Alignment	
0x00000005	Tuning Current Controller	
0x00000006	Measuring Stator Resistor	
0x00000007	Demagnetization	
0x00000008	Measuring Stator Inductance part 1	
0x00000009	Measuring Stator Inductance part 2	
0x0000000A	Measuring Encoder Offset	
0x0000000B	Final	
0xFFFFFFFF	Done	Auto-Setup was carried out successfully

9.6.3 Error messages during Auto-Setup

After completion or during the Auto-Setup, error messages may be displayed. Depending on the error code, the following instructions should be observed, and the measures indicated should be taken. Errors according to the Auto-Setup procedure are shown in object **0x209B/1** *Auto-Setup Error*:

Error messages	
0x00000000	No Error
0x06090030	Object value invalid
0x06090031	Object value too small
0x06090033	Object value too big
0x50000001	Volt. and Volt. Constant missing
0x50000003	Mismatch In, Un, Pn
0x50000004	Rotor Losses too high
0x50000005	Mismatch Power, Torque, Speed
0x50000006	Bad Motor Efficiency
0x50000007	Mismatch Speed, Freq, PPN
0x50000008	Invalid Time Const (Elec. or Rotor)

Error messages	
0x50000009	Nominal Tuning
0x5000000A	Wrong Encoder Sense of Rotation
0x5000000B	ITAE Process failed
0x5000000F	General Autosetup Error
0x50000010	Invalid Cosinus Phi
0x50000011	Invalid Slip
0x50000015	No Motor Connection
0x50000016	Auto-Setup aborted
0x50000017	Magnetizing Current not found
0x5000001C	Mismatch Un, ke
0x5000001F	Wrong Value for Kp or Ki
0x50000020	Rotor Blocked at Offset Measurement
0x50000021	Wrong Encoder Pole Pair Number
0x50000022	Watchdog
0x50000023	Mode Of Operation changed
0x50000024	Current Noise Too High
0x50000025	No Offset Measurement possible
0x50000026	Tune current controller first

9.6.4 Warning messages during Auto-Setup

After completion or during the Auto-Setup, warning messages may be displayed. Warnings according to the Auto-Setup procedure are shown in object **0x209B/5** *Auto-Setup Warning*:

Warning messages	
0x00000000	No Warning
0x00000001	Nominal Voltage out of Tolerance
0x00000002	Mismatch Speed, Freq, Pole Pair Number
0x00000003	Bad Motor Efficiency
0x00000004	Mismatch In, Un, Pn
0x00000005	Invalid Cosinus Phi
0x00000006	Invalid Slip
0x00000007	Invalid Time Const (Elec. or Rotor)
0x00000008	Mag Current Not Found, Set to 30per
0x00000009	Offset Mode Changed to Anisotropic

10 Control interface configuration (IOs)

This chapter describes the configuration of control inputs and outputs in the AXIA firmware. The described inputs and outputs are featured on the main inverter and do not include any optional hardware modules. 6.7

Control interface configuration via AxiaManager

- Connect the PC workstation running the AxiaManager software to the inverter.
- Start the AxiaManager software on the PC workstation.
- Configure the inverter settings as required.

separate user manual VEC1en51 for details on how to use the AxiaManager software.

Control interface configuration via keypad

- Connect the keypad module to the interface X211 of the main device.
- Via the function keys and the arrow keys on the keypad module, access the required submenu.
- Select the object for modification.
- Enter the required values in the objects listed below.

10.1 Digital inputs

10.1.1 Functional assignment

The functional assignment allows assigning digital inputs to functions.

Objects	
Index/Sub-Idx	**Designation**
0x2101/1	Software Release
0x2101/2	IO Start
0x2101/3	IO Counter Clockwise Operation
0x2101/4	IO Halt
0x2101/5	IO Quick Stop
0x2101/6	JOG Mode
0x2101/7	JOG Start
0x2101/8	JOG Counter Clockwise Operation
0x2101/10	External Halt (State-Machine)
0x2101/11	External Quick Stop (State-Machine)
0x2101/12	IO Control Word Bit4
0x2101/13	IO Control Word Bit5
0x2101/14	IO Control Word Bit6
0x2101/15	IO Control Word Bit9
0x2101/16	Start Axis Positioning
0x2102	Fault Reset
0x2103/1	Data Set Change-Over 1
0x2103/2	Data Set Change-Over 2
0x2104/1	Fixed Speed Change-Over 1
0x2104/2	Fixed Speed Change-Over 2
0x2104/3	Fixed Speed Change-Over 3
0x2105/1	Fixed Percentage Change-Over 1
0x2105/2	Fixed Percentage Change-Over 2
0x2105/3	Fixed Percentage Change-Over 3
0x2106/1	Motorpoti Up (Speed)
0x2106/2	Motorpoti Down (Speed)
0x2107/1	Motorpoti Up (Perc)
0x2107/2	Motorpoti Down (Perc)

Objects	
Index/Sub-Idx	**Designation**
0x2108	HW Home Switch
0x2109	HW Pos Limit Switch Src
0x210A	HW Neg Limit Switch Src
0x2413	Motor Thermal Contact

NOTICE

Malfunction possible

If the input assigned to object **0x2102** *Fault Reset* is active ("high") prior to starting the inverter, the inverter does not start.

- Ensure that the input assigned to **0x2102** is set to "low" before you try to start the inverter.

Data Set Change-Over

The data set change-over function allows switching the data set upon receiving a signal from one of the assignable sources listed in the table below.

- Use the objects **0x2103/1** – *Data Set Change-Over 1* AND **0x2103/2**– *Data Set Change-Over 2* to assign the source for the change-over signal.

By default, the frequency inverter uses data set `1` as the active data set.

By setting **0x2103/1** AND **0x2103/2** to "low" you select the data set 1 as target. By setting **0x2103/1** to "high" AND **0x2103/2** to "low", you select the data set 2 and so on. The following truth table then applies:

0x2103/1	0x2103/2	Result
Low	Low	Dataset 1
High	Low	Dataset 2
Low	High	Dataset 3
High	High	Dataset 4

You achieve the state "high" by activating the digital input assigned to the object.

Depending on the active reference value channel, the function is assigned to a digital signal via parameters *Motorpoti Up (Speed)* **0x2106/1**, *Motorpoti Down (Speed)* **0x2106/2** or *Motorpoti Up (Perc)* **0x2107/1**, *Motorpoti Down (Perc)* **0x2107/2**.

Motor Potentiometer (MP)

Reference Speed

The digital control inputs assigned to *Motorpoti Up (Speed)* **0x2106/1** and *Motorpoti Down (Speed)* **0x2106/2** control the increasing and decreasing of the speed.

Limitation of the reference values is done via parameters *Minimum Speed* **0x2301** and *Maximum Speed* **0x2300**.

Reference Percentage

The digital control inputs assigned to *Motorpoti Up (Perc)* **0x2107/1** and *Motorpoti Down (Perc)* **0x2107/2** control the increasing and decreasing of the torque percentage.

Limitation of the reference values is done via parameters *Minimum Percentage* **0x2311** and *Maximum Percentage* **0x2310**.

Motor Potentiometer on the Keypad

It is not possible to control while the keypad is displaying a value. First, access the correct menu.

In the motor potentiometer function, the motor speed is controlled via

- digital control signals (function Motor Potentiometer MP) or via
- the keys of the control unit KPA (function Motor Potentiometer KP - **0x2200** *Control Mode* set to `0x00000002: Keypad`).

Refer to the chapters "Axia Speed Control" and "Axia Torque Control" below to learn about further configuration steps. 12.1.2 12.1.3

The control up/down commands are assigned the following functions:

Control				
Motorpoti (MP)		**Motorpoti (KP)**		**Function**
Up	**Down**	**Up**	**Down**	
0	0	–	–	Output signal does not change
1	0	▲	–	Output value rises at set ramp
0	1	–	▼	Output value drops at set ramp
1	1	▲ + ▼		Output value is reset to zero

0 = Contact open 1 = Contact closed

▲ ▼ = Arrow keys on control unit "KeyPad"

10.1.2 Configuration

Object			Setting		
Index	**Sub-Idx**	**Designation**	**Min.**	**Max.**	**Default**
0x3940	1	PNP/NPN	Selection		

0x3940/1 PNP/NPN	
Choice list	**Designation**
0x00000001	PNP (active: 24 V)
0x00000002	NPN (active: 0 V)

10.2 Digital outputs

Object			Setting
Index	**Sub-Idx**	**Designation**	**Default**
0x3821	1	Relay Output X10	0x00000000 - 0 / null / false / none
0x2198		Brake Output	0x00205000 – Brake Output

NOTICE

Malfunction possible

The relay output X10 will be **operable only**, if the inverter is connected **to mains**. The 24 VDC power supply will not be sufficient.

- Ensure that the inverter is sufficiently supplied via the mains.

10.3 Analog inputs

10.3.1 Standard IO

The following objects configure the type of input and processing parameters for analog inputs X210.9 (Multi Function Analog Input 2) and X210.13 (Multi Function Analog Input 1) on the Standard IO interface.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x3961	MFAI 1 Filter Time Constant	[s]	0	1	0,004
0x3962	MFAI 1 Operation Mode	-	Selection		
0x3963	MFAI 1 Point X1	[%]	0	100	2
0x3964	MFAI 1 Point Y1	[%]	-100	100	0
0x3965	MFAI 1 Point X2	[%]	0	100	98
0x3966	MFAI 1 Point Y2	[%]	-100	100	100
0x3967	MFAI 1 Tolerance Range	[%]	0	25	2

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x3981	MFAI 2 Filter Time Constant	[s]	0	1	0,004
0x3982	MFAI 2 Operation Mode	-	Selection		
0x3983	MFAI 2 Point X1	[%]	0	100	2
0x3984	MFAI 2 Point Y1	[%]	-100	100	0
0x3985	MFAI 2 Point X2	[%]	0	100	98
0x3986	MFAI 2 Point Y2	[%]	-100	100	100
0x3987	MFAI 2 Tolerance Range	[%]	0	25	2

Operation Modes MFAI 1		Operation Modes MFAI 2	
Entry	**Designation**	**Entry**	**Designation**
0x00000000	Off	0x00000000	Off
0x00000001	Voltage Input 0 ... 10V	0x00000001	Voltage Input 0 ... 10V
-	-	0x00000002	Voltage Input -10 ... 10V
0x0000000B	Current Input 0-20mA	0x0000000B	Current Input 0-20mA
-	-	0x0000001F	PTC
-	-	0x00000020	KTY (General)
-	-	0x00000021	PT1000
-	-	0x00000022	PT100
-	-	0x00000023	KTY 84 130
-	-	0x00000024	KTY 84 110

10.4 Multi-function in-/outputs

The following objects configure the multi-function input X210.8 on the Standard IO interface.

Object			Setting		
Index	**Sub-Idx**	**Designation**	**Min.**	**Max.**	**Default**
0x398A	11	MFIO X210.10 OpMode	0x00000001 Digital Output 0x00000011 Digital Input PNP (def) 0x00000012 Digital Input NPN		
0x398A	12	MFIO X210.10 Dig. Out	Selection		
0x398B	11	MFIO X210.12 OpMode	0x00000001 Digital Output (def) 0x00000011 Digital Input PNP 0x00000012 Digital Input NPN		
0x398B	12	MFIO X210.12 Dig. Out	Selection		

11 Controls and controllers

The control functions can be parameterized as required and optimized for the application by further functions.

11.1 Voltage Controller

The voltage controller contains the functions necessary for monitoring the DC link voltage.

- The DC link voltage, which rises in generator operation or in the process of braking of the 3-phase machine, is limited to the value that is set by the voltage controller.
- The mains support function uses the inertia rotation energy of the drive train to bridge short-term power failures.

The voltage controller operation mode is set in the object *Operation Mode* **0x2291** in accordance with the application.

Operation Mode 0x2291		Function
0x00000000	off	The function is switched off.
0x00000001	U_{dc} limitation	Overvoltage controller switched on.
0x00000002	Mains Support	Mains failure regulation turned on.
0x00000003	Udc-Limit. + Mains Support	Overvoltage controller + power failure regulation active w motor chopper.
0x00000004	Mains Support, NO chopper	Same as "2", but without chopper.
0x00000005	Udc-Limit. & Mains Support, NO chopper	Same as "3", but without chopper.

Object		
Index	**Designation**	**Unit**
0x2291	Operation Mode	[-]
0x2292	Max. Speed Rise	[rpm]

The value ranges for the objects of the voltage controller depend on other values of the inverter. Refer to the AxiaManager software to see the values for your particular configuration.

Operation mode Udc limitation

Prerequisite:

- Pulse width modulation must be active.
- The minimum electrical frequency must be 1 Hz

Voltage controller: *Operation Mode* **0x2291 =** `1`

In the operation mode `Udc limitation` the inverter limits the DC link voltage by reducing the ramp gradient.

The overvoltage controller prevents a switch-off of the frequency inverter in generator operation. The reduction of the drive speed by a ramp gradient can lead to an overvoltage in the DC link. If the voltage exceeds the figure set by the parameter *Ref. Value Vdc Limitation* **0x3A12**, the deceleration is reduced in such a way that the DC link voltage is regulated to the set value. If the DC link voltage cannot be regulated to the set reference value by the reduction of the deceleration, the deceleration stops and the output rotation speed (rpm) increases. The output rpm is calculated by addition of the parameter value *Max. Speed Rise* **0x2292** to the rpm at the operating point of the controller intervention.

Operation Mode Mains Support

Prerequisite:

- Pulse width modulation must be active.
- The minimum electrical frequency must be 1 Hz

Voltage controller: *Operation Mode* **0x2291 =** 2

In the operation mode `Mains support` the inverter reduces the speed to bring the motor to generative operation. Then the inverter either resumes the normal operation or performs a controlled stop.

11.2 Functions of field-oriented control

The field-oriented control systems are based on a cascade control and the calculation of a complex machine model. During the Auto-Setup, several relevant parameters of the connected machine are determined by the Auto-Setup and transferred to various objects. These objects are accessible to the user and can be optimized for various operating points.

11.2.1 Sensorless

The objects in the subtree `Parameters\Controls and Controllers\Field Oriented Control\Sensorless` parameterize the field-oriented sensorless control.

Current Impression

In the context of motor control in electrical motors, the term "current impression" refers to the electrical current flowing through the motor windings at a given moment. Managing the current impression can influence the performance and the overall health of the motor.

The current impression is maintained while the rotation speed (in rpm) is within the thresholds defined in the objects **0x2030** and **0x2031**. If acceleration ramp or deceleration ramp is lower than the setting in object **0x2237**, the current impression is used. Otherwise, at faster ramps, the field-oriented control is used, even if speed is lower than **0x2030**. Via the object **0x225B** the slip compensation can be activated or deactivated.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2030	Deactivation Threshold	[rpm]	0	35940	
0x2031	Activation Threshold	[rpm]	0	35940	
0x2237	Ramp Threshold	[rpm/s]	0	599000	
0x225B	Slip Compensation at CI	[-]	OFF	ON	ON
0x2242	Start Anti Sway	[-]	0	1	0.2

Model

In field-oriented control methods, the torque-forming current component and the slip frequency of the 3-phase machine depend on the required torque. The field-oriented control method also includes the parameter *Slip Limit* **0x2029** to limit the torque in the calculation of the machine model. The rated slip calculated from the rated motor parameters is limited in accordance with the *Slip Limit* **0x2029**.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2029	Slip Limit Sensorless	[-]	0.1	10	10
0x22B2	Max. Current Angle Sensorless	[deg]	45	89	75

11.2.2 Speed and Torque Controller

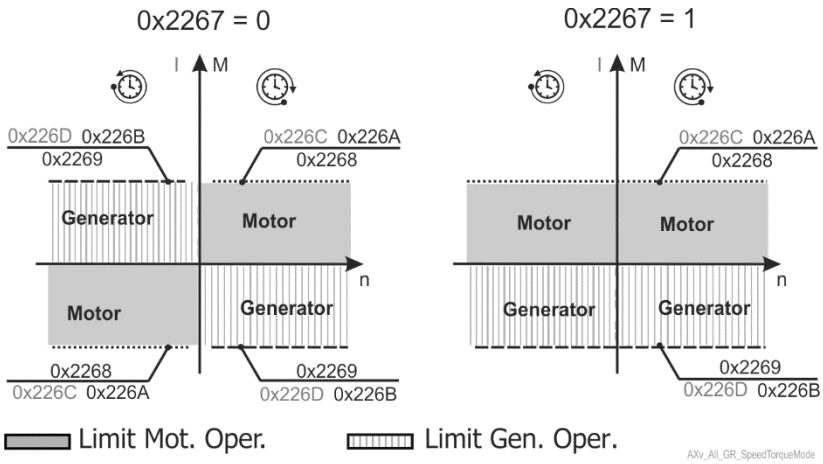
The speed controller can derive the actual values from the machine model. The prerequisite for the speed and torque controller to function correctly is that the Auto-Setup procedure (9.6) is carried out properly.

The following objects are relevant for the speed and torque controller:

Index	Designation	Index	Designation
0x2261	Switch-over Limit	0x2271	Integral Time High Speed
0x2262	Switch-over Hysteresis	0x2272	Amplification Torque
0x2263	Overspeed	0x2273	Integral Time Torque
0x2264	Underspeed	0x2274	Fact. Acc. Feed Forward
0x2265	Speed Hysteresis	0x2275	Speed Difference Limit
0x2266	Torque Hysteresis	0x2276/1	Speed Integrator
0x2267	Limitation Type	0x2276/2	Speed Integrator (Init)
0x2268	Power Limit Motor	0x2277	Factor Speed Limit
0x2269	Power Limit Generator	0x2278	Online Tuning
0x226A	Torque Limit Motor	0x2279	Online Tuning Min. Ramp
0x226B	Torque Limit Generator	0x4209/1	Factor Torque Limit Motor
0x226C	Current Limit Motor	0x4209/2	Factor Torque Limit Generator
0x226D	Current Limit Generator	0x4209/3	Factor Current Limit Motor
0x226E	Amplification Low Speed	0x4209/4	Factor Current Limit Generator
0x226F	Integral Time Low Speed	0x4209/9	Factor Overspeed
0x2270	Amplification High Speed	0x4209/10	Factor Underspeed

The objects parameterizing the speed and torque controller functions are located in the `Parameters\Controls and Controllers\Field Oriented Control\Speed / Torque Controller` subtree inside the AxiaManager GUI. The control of the torque forming current is done in the outer control loop by the speed controller. Via parameter *Limitation type* **0x2267**, you can select the operation mode for the speed controller. The operation mode defines the use of the parameterizable limits. These are referred to the direction of rotation and the direction of the torque and depend on the selected configuration.

Limitation type 0x2267	Function
0 - Limits for Motor/Generator Op.	The limitation of the speed controller assigns the upper limit to the motor operation of the drive. Independent of the direction of rotation, the same limit is used. The same applies in the case of regenerative operation with the lower limit.
1 - Limits for pos./neg. values	The absolute limit is assigned irrespective of the motor or generator operating modes of the drive. The positive limitation is done by the upper limit. The lower limit is regarded as a negative limitation.



If limitation type **0x2267** = `1` is chosen, the objects for **motor operation** are used for the upper limit and objects for **generator operation** are used for the lower limit. Out of all limit values, the smallest absolute value applies.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2274	Fact. Acc. Feed Forward	[-]	0	100	1

To intensify or to decrease the effect of the acceleration feed forward, use the object **0x2274**. The additional acceleration moment of the acceleration feed forward will be multiplied with the value set in **0x2274**.

Limitation of speed controller

The output signal of the speed controller is the torque-forming current component Isq. The output and the I portion of the speed controller can be limited via parameters *Torque Limit Generator* **0x226B**, *Current Limit Generator* **0x226D**, *Power Limit Generator* **0x2269**, and *Torque Limit Motor* **0x226A**, *Current Limit Motor* **0x226C**, *Power Limit Motor* **0x2268**.

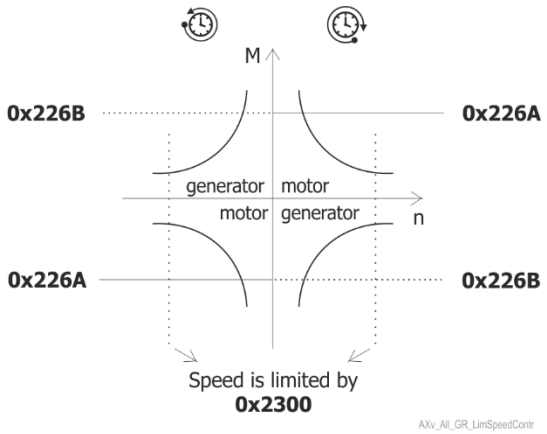
Upper and lower speed limit in torque control

NOTICE

Unexpected dynamic behavior

If torque control is activated while the torsional speed is outside of the range between *Torque Limit Motor* **0x226A** and *Torque Limit Generator* **0x226B**, (e.g. when a machine is started from standstill or a quickly rotating machine is stopped quickly), the permissible torque range will be approached without ramps by means of the speed/torque controller. Then, the torque is only limited by the limitations of the speed controller (current and torque). For this reason, there may be unexpected dynamic behavior.

- Consider this when planning.



In many situations, the speed must be limited at operating points with reduced or without load torque, as the speed is adjusted according to the preset torque and the load behavior. To avoid unwanted speeds (in most cases excessive speed, but sometimes low speeds, too, and to avoid current impression), the speed is limited by the speed controller via *Maximum Speed* **0x2300** and *Minimum Speed* **0x2301**.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2300	Maximum Speed	[rpm]	0	Motor-Specific	Motor-Specific
0x2301	Minimum Speed	[rpm]	0	Motor-Specific	0

NOTICE

Optimize the settings in actual operating conditions, as control parameters for speed controller and acceleration feed forward control depend on actual load. Optimize with different load types to obtain a good control behavior in all situations.

Online Tuning

The controller online tuning allows re-estimating the drive train inertia at every restart. This is useful in applications with variable inertia. In some cases, a one-time-execution of this function may allow to estimate the inertia of the application more precisely.

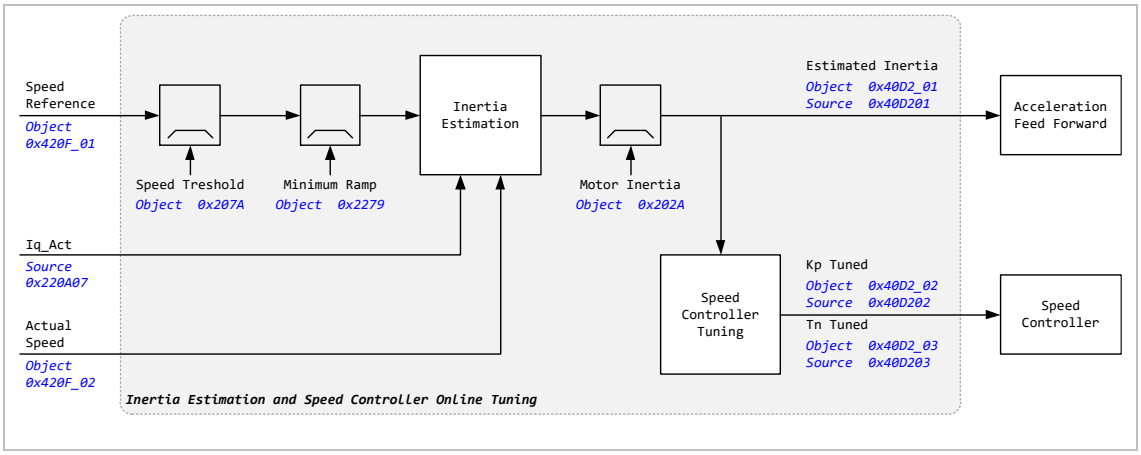
Object				Setting		
Index	**Sub-Idx**	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2278	-	Online Tuning and Inertia Est.	[-]	Selection		
0x2279	-	Minimum Ramp	[rpm/s]	0	35940	
0x227A	-	Speed Threshold	[rpm]	0	35940	
0x227B	-	Damping Factor	[-]	2	10	
0x227C	1	Inertia Filter	[s]	0.001	0.1	
0x227C	2	Measurement Duration	[s]	0.001	1	
0x227C	3	Speed Filter Compensation	[-]	0	1	
0x227D	-	Maximum Gain Kp	[-]	0	200	
0x227E	-	Minimum Integral Time Tn	[-]	0.001	200	
0x227F	-	Maximum Inertia	[-]	0	1	
0x40D2	1	Estimated Inertia	[kg*m^2]	Actual Value/Status		
0x40D2	2	Kp tuned	[-]	Actual Value/Status		
0x40D2	3	Tn tuned	[s]	Actual Value/Status		
0x420F	3	S. Restart	[-]	Selection		

Via the object **0x2278** the user can control the estimation parameters:

Online Tuning and Inertia Est. 0x2278	Function
0x00000000 Off	The function is deactivated.
0x00000001 Speed Ctrl. & Inertia at Start	The function performs the selected measurements at every start of the inverter or after a digital signal. The "Restart on Pos./Neg. Edge" option refers to the signal set at the source selected in the object 0x420F.
0x00000002 Speed Ctrl. & Inertia, Restart on Pos. Edge	
0x00000003 Speed Ctrl. & Inertia, Restart on Neg. Edge	
0x00000011 Speed Ctrl. Tuning at Start	
0x00000012 Speed Ctrl. Tuning, Restart on Pos. Edge	
0x00000013 Speed Ctrl. Tuning, Restart on Neg. Edge	
0x00000021 Inertia Estimation at Start	
0x00000022 Inertia Estimation, Restart on Pos. Edge	
0x00000023 Inertia Estimation, Restart on Neg. Edge	

The objects **0x40D2/1**, **0x40D2/2**, **0x40D2/3** contain the values measured/estimated in the process. These values can be used to also optimize the behavior of applications without variable inertia. For this purpose, the *Estimated Inertia* can be entered in the object **0x202A** (`..\Motor\Additional Parameters`) after a one-time execution of the Online Tuning function. Accordingly, the values of *Kp tuned* and *Tn tuned* can be entered in **0x226E** and **0x226F** or in **0x2270** and **0x2271**, respectively.

The other objects in this subsection parameterize the boundary conditions for the execution of the Online Tuning.



11.2.3 Current Controller

The following objects are relevant for the current controller:

Controller Settings

The objects listed in this paragraph parameterize the behavior of the current controller during operation depending on the output switching frequency.

Index	Designation	Index	Designation
0x22C0	Amplification d-Axis 2kHz	0x22CA	Amplification q-Axis 8kHz
0x22C1	Integral Time d-Axis 2kHz	0x22CB	Integral Time q-Axis 8kHz
0x22C2	Amplification q-Axis 2kHz	0x22CC	Amplification d-Axis 16kHz
0x22C3	Integral Time q-Axis 2kHz	0x22CD	Integral Time d-Axis 16kHz
0x22C4	Amplification d-Axis 4kHz	0x22CE	Amplification q-Axis 16kHz
0x22C5	Integral Time d-Axis 4kHz	0x22CF	Integral Time q-Axis 16kHz
0x22C6	Amplification q-Axis 4kHz	0x22DB	Crosscoupling Factor
0x22C7	Integral Time q-Axis 4kHz	0x22DC	Back EMF Factor
0x22C8	Amplification d-Axis 8kHz	0x22DD	Max. Output Voltage
0x22C9	Integral Time d-Axis 8kHz	0x22DE	Activate Smith Predictor

Adaptive Gain Settings

The objects listed in this paragraph parameterize the thresholds and control points for the Current Controller function.

Index	Designation	Index	Designation
0x22D0	Adaptive Gain Mode	0x22D6	Gain Fact. Medium Current (d-Axis)
0x22D1	Low Current Threshold	0x22D7	Gain Fact. High Current (d-Axis)
0x22D2	Medium Current Threshold (Min.)	0x22D8	Gain Fact. Low Current (q-Axis)
0x22D3	Medium Current Threshold (Max.)	0x22D9	Gain Fact. Medium Current (q-Axis)
0x22D4	High Current Threshold	0x22DA	Gain Fact. High Current (q-Axis)
0x22D5	Gain Fact. Low Current (d-Axis)		

Filter Settings

The objects listed in this paragraph parameterize the current filter settings in relation to the switching frequency.

Index	Designation	Index	Designation
0x22E0	Reference Current Filter Type	0x22E2	Center Frequency
0x22E1	Bandwidth Frequency	0x22E5	Low Pass Frequency

Using the object **0x22D0** *Adapive. Gain Mode*, the gain mode can be selected. The following options are available:

`1 - Constant gain` (default)

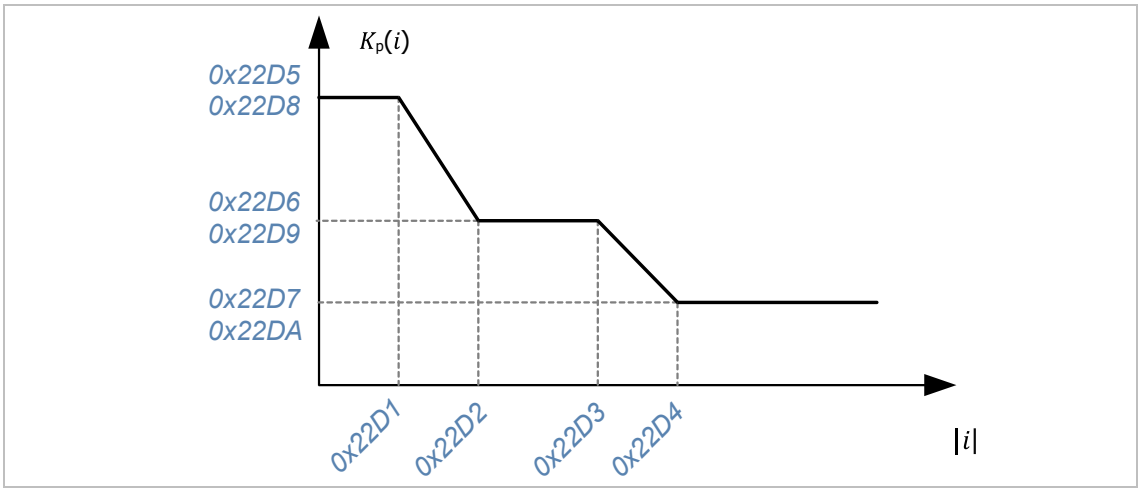
`2 - Absolute Current Dependent Gain`

`3 - dq-Axis individual gain`

When using `1 - Constant gain`, the inverter uses the settings for d-Axis depending on the actual switching frequency.

The following parameters are controlled in the current controller:

- the flux-forming current value I_{sd}
- the torque-forming current value I_{sq}



By separate regulation of these two parameters, a decoupling of the system equivalent to an externally excited direct current machine is achieved.

The Auto-Setup has selected the parameters of the current controller in such a way that they can be used without having to be changed in most applications.

The settings of the current controllers should not be too dynamic in order to ensure a sufficient reserve range. The control tends to increase oscillations if the reverse range is reduced.

In some machines, it may be necessary to set different amplification factors for different current ranges.

11.3 Pulse width modulation

The motor noise can be reduced by switching parameter *Switching Frequency* **0x2209/1**. The switching frequency should be reduced to a maximum ratio of 1:10 to the frequency of the output signal for a sine-shaped output signal. The maximum possible switching frequency depends on the drive output and the ambient conditions. For the required technical data refer to the corresponding table and the device type diagrams.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2209/1	Switching frequency	[kHz]	2	16	4
0x2209/2	Minimum Switching Freq.	[kHz]	2	16	2
0x2209/9	Activate NSPWM	[BOOL]	0	1	0

The heat losses increase proportionally to the load point of the frequency inverter and the switching frequency. The automatic reduction adjusts the switching frequency to the current operating state of the frequency inverter.

The switching frequency is adjusted between the limits set with parameters *Switching Frequency* **0x2209/1** and *Minimum Switching Freq.* **0x2209/2**. If **0x2209/2** is higher or equal to the **0x2209/1**, automatic reduction will be disabled.

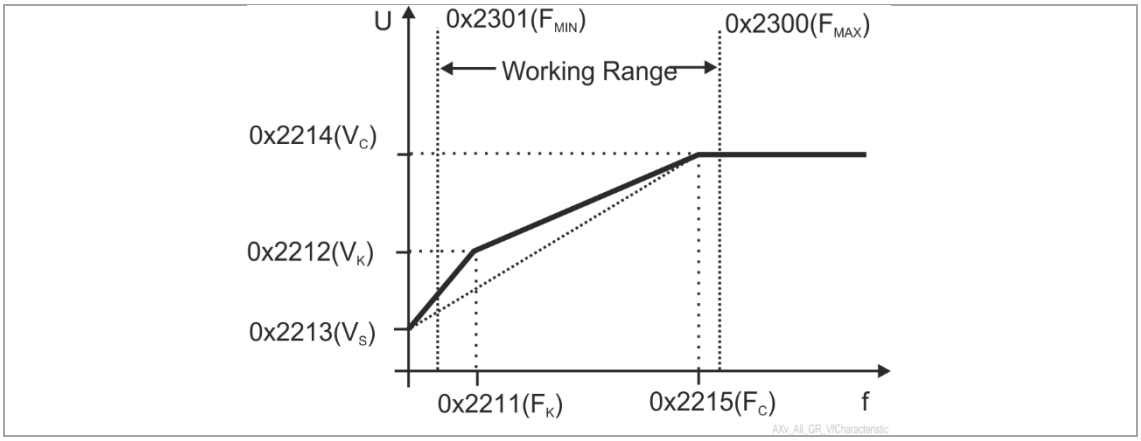
11.4 V/f control

11.4.1 V/f Characteristic (V/f Curve)

To use the V/f-characteristic optimally, first set the machine parameters, such as the number of pole pairs, Stator impedance, Rotor impedance. To set the values for the Current impression best use the Auto-setup.

By setting the V/f-characteristic, the voltage of the connected 3-phase motor is controlled according to the frequency. At a constant output voltage / output frequency ratio of the frequency inverter, the magnetization is constant in the nominal operating range of the 3-phase motor. The rating point of the motor or end point of the V/f-characteristic is set via the Auto-Setup or with parameter *Cut-Off Voltage* **0x2214** and parameter *Cut-Off Frequency* **0x2215**.

The lower frequency range, where an increased voltage is necessary for the start of the drive, is critical. The voltage at output frequency = `zero` is set with the parameter *Starting Voltage* **0x2213**. A voltage increase deviating from the linear course of the V/f characteristic can be defined by parameters *Ku* **0x2212** and *Kf* **0x2211**. The parameter value percentage is calculated from the linear V/f characteristic. Via parameters *Minimum Speed* **0x2301** and *Maximum Speed* **0x2300**, the working range and/or V/f characteristic are defined.



(F_{MIN}): *Minimum Speed* **0x2301**, (F_{MAX}): *Maximum Speed* **0x2300**,
(V_S): *Starting Voltage* **0x2213**,
(V_K): *Rise Voltage* **0x2212**, (F_K): *Rise Frequency* **0x2211**
(V_C): *Cut-Off Voltage* **0x2214**, (F_C): *Cut-Off Frequency* **0x2215**

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2211	Rise Frequency	[%]	0	100	30
0x2212	Rise Voltage	[%]	-100	100	0
0x2213	Starting voltage	[V]	Device-Specific		
0x2214	Cut-off voltage	[V]	Device-Specific		
0x2215	Cut-off frequency	[Hz]	Device-Specific		
0x221E	Curve Type	[-]	0x00000001: Linear (dflt) 0x00000002: Quadratic		
0x221F	Quadratic Factor	[-]	0	100	50

The Auto-Setup takes the parameterized rated motor values and reference data of the frequency inverter into account when it comes to pre-setting the V/f-characteristic. In the case of asynchronous machines, the speed can be increased at a constant torque if the motor winding can be switched over from star to delta connection. If the data for delta connection indicated on the rating plate of the three-phase motor were entered, the cut-off frequency is increased automatically by the square root of three.

The default *Cut-Off Voltage* **0x2214** (V_C) and *Cut-Off Frequency* **0x2215** (F_C) are derived from the motor data *Rated Voltage* **0x2002** and *Rated Frequency* **0x2007**. With the parameterized *Starting Voltage* **0x2213** (V_S), the linear equation of the V/f-characteristic results in:

$$V = \left[\left(\frac{Vc - Vs}{Fc - 0}\right) \cdot f + V_s = \left(\frac{400.0\ V - 5.0\ V}{50.00\ Hz - 0.00\ Hz}\right) * f + 5.0\ V\right] * (1 + Vk)$$

Where:

$$f = \mathrm{Fc} * \mathrm{Fk} = 0\mathrm{x}2215 * 0\mathrm{x}2211$$

11.4.2 V/f Current Limitation

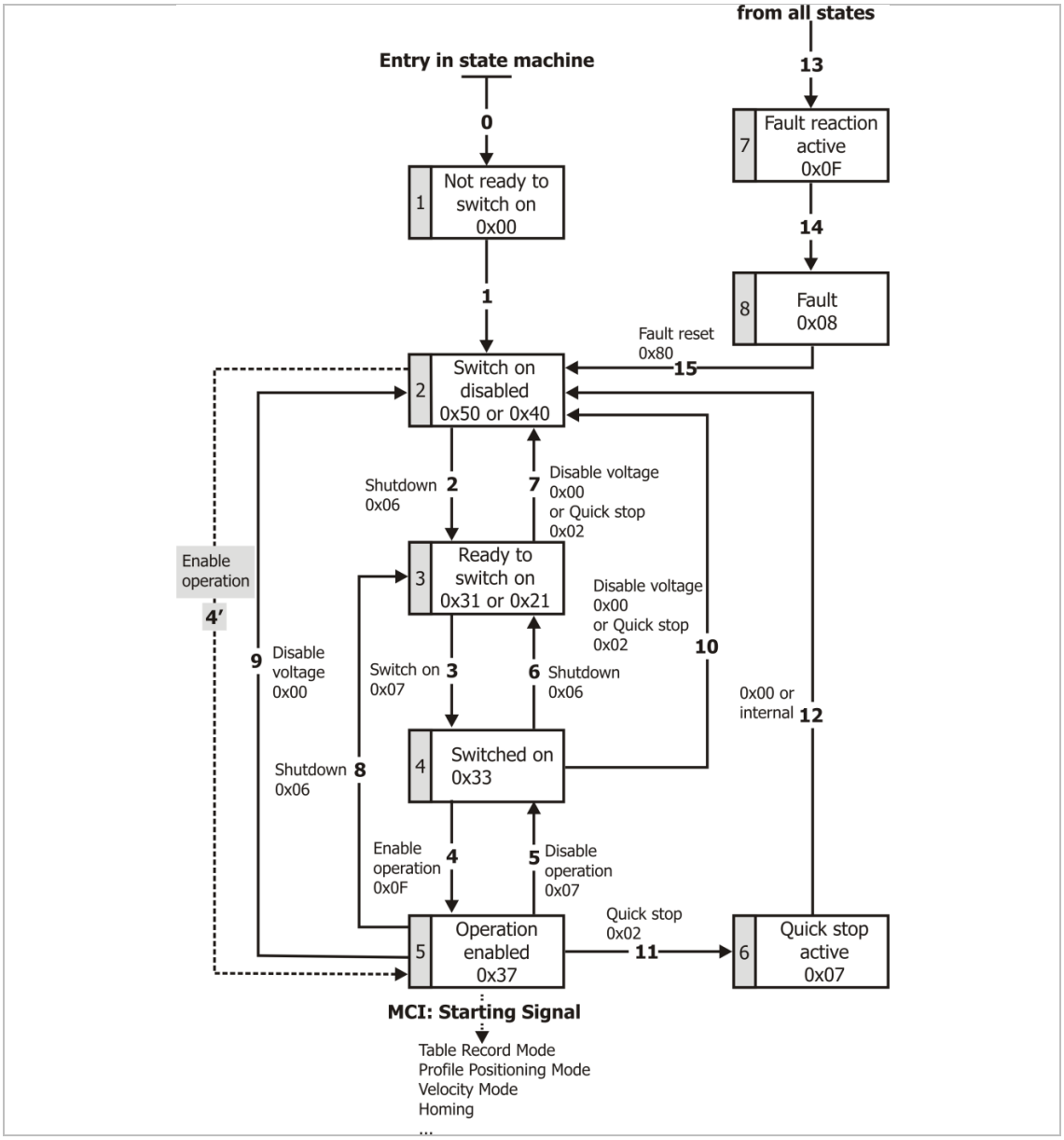
The current limitation described below pertains only to V/f-control. In specific control modes other limiting parameters apply.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x221A	Minimum Speed	[rpm]	59.9	35940	59.9

12 Motion Control

The motion control functions are based on the provisions of the CiA402 standard. The control can be either carried out via IOs (9.5), via the KPA module (limited to Axia Speed Control and Jog Mode), or via state machine.

State machine diagram:



12.1 Axia Modes of Operation

12.1.1 Axia Jog Mode

The Jog mode is intended for finetuning, testing and commissioning purposes. You can activate the JOG mode by selecting in the In the `Parameters\Controls and Controllers\Controls\Mode` subtree, in the object **0x2200** *Control Mode* the entry `0x00000002 Keypad`. Then, in the object **0x2202** *Mode of Operation Keypad*, select `0xFFFFFFFA Axia Jog mode`. With these settings, the JOG Mode is operated via the Keypad. You can then use the Keypad to make the drive move clockwise or counter-clockwise. When active, the JOG mode will operate according to the parameterization of the following objects:

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2500	JOG Speed	[rpm]	0	35940	1500
0x2501	JOG Acceleration	[rpm/s]	0	60000	300
0x2502	JOG Deceleration	[rpm/s]	0	60000	300

An alternative activation option is via the digital inputs (10.1.1). There, you can use the objects **0x2101/6** *JOG Mode*, **0x2101/7** *JOG Start*, **0x2101/8** *JOG Counter Clockwise Operation* to assign digital inputs to the functions of the JOG mode. Using the digital inputs, you can also make the drive move clockwise or counterclockwise.

12.1.2 Axia Speed Control

You can use IOs to control the inverter in the Axia Speed Control mode.

The Axia Speed Control Mode requires the following settings:

0x2200 = `0x00000001 - IOs` AND

0x2201 = `-5 (0xFFFFFFFB) - Axia Speed Control`

Relevant objects:

Index	Designation	Index	Designation
0x2301	Minimum Speed	0x2532	Deceleration Clockwise
0x2300	Maximum Speed	0x2533	Ramp Fall Time Clockwise
0x2510	Operation Mode	0x2534	Acceleration Anticlockwise
0x2511-0x2514	Speed Reference 1-4	0x2535	Ramp Rise Time Anticlockwise
0x2521-0x2528	Fixed Speed 1-8	0x2536	Deceleration Anticlockwise
0x2530	Acceleration Clockwise	0x2537	Ramp Fall Time Anticlockwise
0x2531	Ramp Rise Time Clockwise		

Reference Configuration:

- **0x2510** Operation Mode for Axia Speed Control
- **0x2511 - 0x2514** Speed reference configuration

Index	Designation	Values
0x2510	Operation Mode	Selection
0x2511	Speed Reference 1	Up to four speed reference sources can be selected. (Fixed speed values, analog, MFI analog) See below for full list
0x2512	Speed Reference 2	
0x2513	Speed Reference 3	
0x2514	Speed Reference 4	

0x2510 Operation Mode		Function
0x00000000	Stop	No Speed Control
0x00000001	Normal	Standard operation according to settings made
0x00000002	Only Positive	Speed control only for clockwise direction
0x00000003	Only Negative	Speed control only for counter-clockwise direction

For each speed reference there are four data sets.

Per data set, the following choice list of signal sources is available:

0x2511 - 0x2514 Speed reference source (value 1 to value 4)			
Entry Idx	**Designation**	**Entry Idx**	**Designation**
		0x00251002	Speed Motorpoti
0x0021A300	Simple Math. 1 Output	0x00251003	Speed MFAI 1 (X210.13)
0x0021A301	Simple Math. 1 Output Inverted	0x00251004	Speed MFAI 2 (X210.9)
0x0021A310	Simple Math. 2 Output	0x00251005	Speed PWM-Input (IN1D)
0x0021A311	Simple Math. 2 Output Inverted	0x00253012	Target Speed
0x0021A320	Simple Math. 3 Output	0x0025F101	Interpolated Speed

0x2511 - 0x2514 Speed reference source (value 1 to value 4)			
0x0021A321	Simple Math. 3 Output Inverted	0x00260020	Safe Speed
0x0021A330	Simple Math. 4 Output	0x00260021	SLS-SL Speed Setpoint
0x0021A331	Simple Math. 4 Output Inverted	0x00384003	Encoder X210: Speed
0x0021F010	PROFIx_TargetVelocity	0x00385003	Encoder X432: Speed
0x0021F508	CIP Speed Ref	0x00391040	SB RxPDO1 Single 0
0x00224003	MM Speed	0x00391041	SB RxPDO1 Single 1
0x00228000	Speed Ref.	0x00391090	SB RxPDO2 Single 0
0x00228006	Speed Limit Positioning	0x00391091	SB RxPDO2 Single 1
0x00228100	Speed Limit Obj2281	0x003910E0	SB RxPDO3 Single 0
0x00231200	PID Controller Output	0x003910E1	SB RxPDO3 Single 1
0x00251000	Speed Setpoint Channel	0x003CA070..7	PLC Out Float32 0..7
0x00251001	Fixed Speed		

Thus, for each of the objects **0x2511 - 0x2514**, there are up to four signal sources available. Switching between preset sources is done via the dataset change-over function.

10.1.1 for details on how to configure the data set change-over, how to use the motor potentiometer and for other related information.

Fixed Reference Values

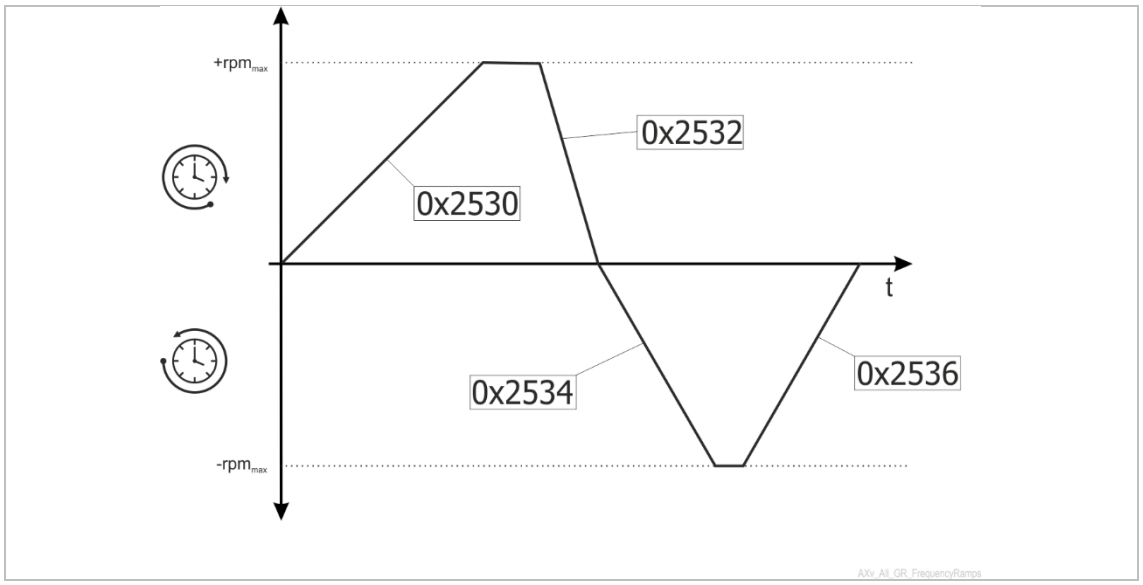
The fixed reference values must be parameterized as fixed speeds according to the configuration and function.

The signs of the fixed reference values determine the sense of rotation. A positive sign means clockwise rotation, a negative sign means anticlockwise rotation.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2521	Fixed Speed 1	[rpm]	-35940	35940	0
...	...	...	...	...	...
0x2528	Fixed Speed 8	[rpm]	-35940	35940	0

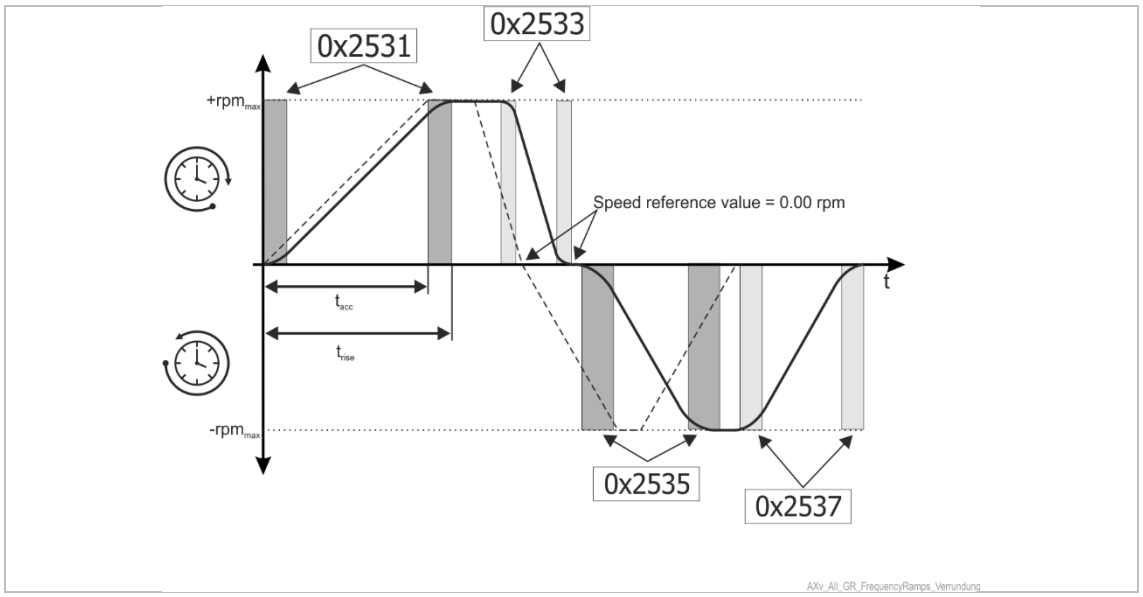
Ramps

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2530	Acceleration Clockwise	[rpm/s]	0.1	600000	300
0x2531	Ramp Rise Time Clockwise	[s]	0.001	5	0.005
0x2532	Deceleration Clockwise	[rpm/s]	0.1	600000	300
0x2533	Ramp Fall Time Clockwise	[s]	0.001	5	0.005
0x2534	Acceleration Anticlockwise	[rpm/s]	0.1	600000	300
0x2535	Ramp Rise Time Anticlockwise	[s]	0.001	5	0.005
0x2536	Deceleration Anticlockwise	[rpm/s]	0.1	600000	300
0x2537	Ramp Fall Time Anticlockwise	[s]	0.001	5	0.005



The jerk occurring in a linear acceleration of the drive is reduced by the adjustable modification speeds (S curve). The non-linear course of the frequency is defined as a ramp and states the time range in which the frequency will be guided to the set ramp. The values set with parameters **0x2530** to **0x2536** are maintained regardless of the selected ramp times.

Setting the ramp rise time to `1` ms deactivates the function S curve and enables the use of the linear ramps. The data set change-over of the parameters within an acceleration phase of the drive mechanism demands the defined take-over of the values.



Limits

Limitation of the reference values is done via parameters *Minimum Speed* **0x2301** and *Maximum Speed* **0x2300**.

The output speed setting range is defined by the parameters *Minimum Speed* **0x2301** and *Maximum Speed* **0x2300**. The relevant control methods use the two limit values for scaling and limiting the speed.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2300	Maximum Speed	[rpm]	0	Motor-Specific	Motor-Specific

0x2301	Minimum Speed	[rpm]	0	Motor-Specific	0

12.1.3 Axia Torque Control

You can use IOs to control the inverter in the Axia Torque Control mode.

The Axia Torque Control mode requires the following settings:

0x2200 = `0x00000001 - IOs` AND

0x2201 = `-4 (0xFFFFFFFC) - Axia Torque Control`

Relevant objects:

Index	Designation	Index	Designation
0x2310	Maximum Percentage	0x2541-4	Percentage Reference 1-4
0x2311	Minimum Percentage	0x2551-8	Fixed Percentage 1-8
0x2540	Operation Mode		

Reference Configuration:

- **0x2541 - 0x2544** Percentage Reference

10.1.1 for details on how to configure the data set change-over, the motor potentiometer and for other related information.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2540	Operation Mode	[-]	Selection		
0x2541-4	Percentage Reference 1-4	[-]	Selection		

0x2541 - 0x2544 Percentage Reference source (value 1 to value 4)			
Entry Idx	**Designation**	**Entry Idx**	**Designation**
0x00000000	0 / null / false / none	0x00391090	SB RxPDO2 Single 0
0x0021A300	Simple Math 1 Output	0x00391091	SB RxPDO2 Single 1
0x0021A301	Simple Math 1 Output Inverted	0x003910E0	SB RxPDO3 Single 0
0x0021A310	Simple Math 2 Output	0x003910E1	SB RxPDO3 Single 1
0x0021A311	Simple Math 2 Output Inverted	0x0039AA00	PWM-Input 1 (X210.3)
0x0021A320	Simple Math 3 Output	0x003CA070/..7	PLC Out Float32 0/..7
0x0021A321	Simple Math 3 Output Inverted	0x00403200	Percentage Setpoint Ch.
0x0021A330	Simple Math 4 Output	0x00403202	Percentage Motorpoti
0x0021A331	Simple Math 4 Output Inverted	0x00403203	Percentage Analog In
0x0021F50E	CIP Process Ref	0x00403204	Percentage MFI Analog
0x00231200	PID Controller Output	0x00403205	Percentage PWM-Input
0x00391040	SB RxPDO1 Single 0	0x00403B00	Pos. Torque Limit
0x00391041	SB RxPDO1 Single 1		

0x2540	Function
0 - Stop	Percentage channel deactivated
1 - Normal (Default)	Percentage reference shall be taken over as entered.
2 - Only Positive	Only absolute value of the percentage reference shall be taken over.
3 - Inverted	The inverted value of the percentage reference shall be taken over.

Limits

Limitation of the reference values is done via parameters *Minimum Percentage* **0x2311** and *Maximum Percentage* **0x2310**.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2310	Maximum Percentage	[%]	0	1000	100
0x2311	Minimum Percentage	[%]	0	1000	0

12.1.4 Profile Objects

The object in this section is implemented in accordance with the CiA 402 standard. It parameterizes aspects of the inverter behavior, when it is controlled via the state machine.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x60F2	Position option code	[-]	Selection		

0x60F2	
0x00000000 Normal/Off	Positioning options deactivated
0x00000040 Only CW	Positioning search clockwise only
0x00000080 Only CCW	Positioning search counter-clockwise only
0x000000C0 Optimized	Positioning search optimized

13 Add-On Functions

13.1 Brake Chopper

The frequency inverters may feature an internal brake chopper with brake resistor.

The settings of the brake chopper and the motor chopper may influence each other. Keep this in mind when setting the respective object values.

The following objects configure the functioning of the brake chopper.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x3948/1	Activate Brake Chopper	[-]	Selection		
0x3948/2	Trigger Threshold	[V]	620	800	750

The operator is required to ensure that the chosen values are appropriate for the particular drive system and suitable for the intended purposes.

The object **0x3948/1** *Activate Brake Chopper* defines the source for the activation signal of the brake chopper function. In most cases, this function should be activated. The object **0x3948/2** *Trigger Threshold* defines the voltage limit for the DC link voltage, above which the brake chopper operation is triggered.

The manufacturer recommends the following formula for the calculation of suitable parametrization:

$$U_{grid} * 1{,}1 * \sqrt{2} < U_{dBC} < U_{dmax}$$

13.2 Motor Chopper

The frequency inverters may feature a motor chopper function. The motor chopper function provides parameters for dissipating the rising voltage in the DC link as heat inside the connected motor(s). This allows dynamic speed changes at minimum system costs.

The settings of the brake chopper and the motor chopper may influence each other. Keep this in mind when setting the respective object values.

The operator is required to ensure that the chosen values are appropriate for the particular drive system and suitable for the intended purposes.

The manufacturer recommends the following formula for the calculation of suitable parametrization:

$$U_{grid} * 1{,}1 * \sqrt{2} < U_{dMC} < U_{dmax}$$

The following objects configure the functioning of the motor chopper.

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x420E/4	Activate Motor Chopper	[-]	Selection		
0x22A0	Trigger Threshold	[V]	624	1000	750

Via object *Activate Motor Chopper* **0x420E/4** you can activate the function. You can select a source for the activation signal from a list of possible sources. Refer to the AxiaManager software for the full list. Additionally, the objects **0x22A0** configures further operation parameters/limitations for this function.

14 Error behavior and warning behavior

Operation of the frequency inverter and the connected load are monitored continuously. The monitoring functions must be parameterized with the corresponding limit values specific to the application. If the limits were set below the switch-off limit of the frequency inverter, an error switch-off can be prevented by suitable measures if a warning message is issued.

Some objects are only accessible in higher access levels ("Advanced" and above).

14.1 Inverter Error and Warning Behavior

14.1.1 Temperature

You can configure several parameters to set the error and warning behavior regarding the inverter internal temperature:

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x3C00/6	Heat Sink Fan Switch On	[°C]	0	100	55
0x3C00/9	Interior Fan Switch On	[°C]	0	100	40

14.2 Motor protection

In order to protect the motor against excessive heat-up, monitoring mechanisms are required which will identify potential thermal overloading in due time to prevent the motor from damage. The thermal condition of a motor can be identified in different ways.

14.2.1 Motor Temperature Monitoring

Direct monitoring via temperature sensors in the winding

- PTC
- KTY
- PT1000
- Thermocontact

Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2409	Motor Temperature Source	[-]	Selection		
0x2410	Over Temperature Mode	[-]	Selection		
0x2411	Over Temperature Warning	[°C]	0	300	120
0x2412	Over Temperature Error	[°C]	0	300	150

For the source to be functional, it is necessary to correctly configure the corresponding inputs. 9.3 10

Motor Temperature Source 0x2409	
0x00207804	Encoder X4X2: Motor Winding Temperature Digital
0x00211003	MFAI 1 Temperature (X4X2)
0x00241100	Motor Thermal Contact Temperature
0x00385004	Encoder X432: Motor Winding Temperature Digital
0x00398003	MFAI 1 Temperature (X210)
0x00398013	MFAI 2 Temperature (X210)
0x0039A003	MFAI 1 Temperature (X432)

Over Temperature Mode 0x2410	
0x00000001	Off
0x00000002	Only Warning No Fault Trigger
0x00000003	Warning + Fault Trigger
0x00000004	Warning + 1 min Delay Fault Trigger
0x00000005	Warning + 5 min Delay Fault Trigger
0x00000006	Warning + 10 min Delay Fault Trigger

14.2.2 Overload I2t

Indirect monitoring of motor temperature

Modeling of motor heat-up by consideration of temperature-relevant factors via a mathematical model I^2t:

The thermal monitoring method is selected based on the type and operating conditions of the motor. Generally, any of the available methods is sufficient for reliable motor protection. A combination of methods from both groups (one from each group) and parallel execution is possible.

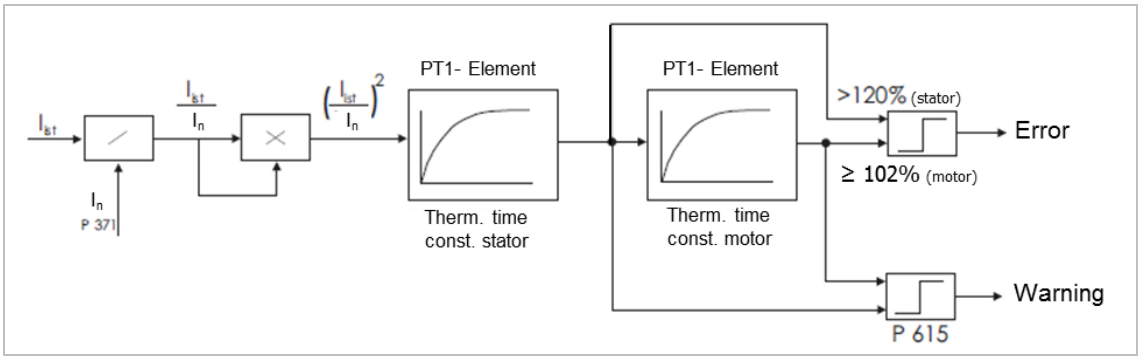
Object			Setting		
Index	**Designation**	**Unit**	**Min.**	**Max.**	**Default**
0x2415	Operation Mode I2t	[-]	Selection		

I2t monitoring is another way to protect the motor against thermal overload. This motor protection method is mainly used in servo systems.

Wherever synchronous servomotors are used, I2t monitoring is a proven alternative to motor circuit breakers. By integrating measurable or known motor parameters, heat-up is modeled based on a mathematical model.

The I2t monitoring feature can be selected via *Operation Mode I2t* **0x2415**. The settings are data set change-over settings. I²t monitoring is done, as shown in the illustration, via (Iact/Irated)².

The monitored variable is valued via a PT1 element with the thermal time constant of the stator. If the PT1 element output exceeds 120%, an error message will be triggered, and the inverter will shut down. The 120% threshold ensures the overshooting will not result in immediate shutdown. Permanent exceeding of the 100% load of the stator winding should be avoided in the application.



The output of the first PT1 element is connected to the input of the second PT1 element which contains the thermal time constant of the motor. This output may be loaded at 100% permanently. This corresponds to full thermal loading of the motor. Once 102% are reached, the inverter will shut down and an error will be reported. Both outputs are linked to an adjustable *Warning Limit*.

Operation Mode I2t 0x2415	Function
0 - I²t Off	The I²t load of the motor is not monitored.
1 - MultiMotFail	In each of the four data sets, the I²t load of the motors is monitored based on the corresponding rated values. Once the fixed error threshold of **0x2416** (**0x2417**) is exceeded, there will be an error shutdown "F0104".
2 - SingleMotFail	The I²t load of the motor is monitored via the rated values from the active data set. Once the defined *Warning Threshold I2t* **0x2418** is reached, a power warning "A1000" will be triggered by the active data set.
3 - MultiMotWarn	In each of the four data sets, the I²t load of the motors is monitored based on the corresponding rated values. Once the defined *Warning Threshold I2t* **0x2418** is reached, a warning "A1000" will be triggered.
4 - SingleMotWarn	The I²t load of the motor is monitored via the rated values from the active data set. Once the defined *Warning Threshold I2t* **0x2418** is reached, a warning "A1000" will be triggered.
5 - MultiMotWarnFail	In each of the four data sets, the I²t load of the motors is monitored based on the corresponding rated values. Once the defined *Warning Threshold I2t* **0x2418** is reached, a warning "A1000" will be triggered. Once the fixed error threshold of **0x2416** (**0x2417**) is exceeded, there will be an error shutdown "F0104". Both events will be triggered by the active data set.
6 - SingleMotWarnFail	The I²t load of the motor is monitored via the rated values from the active data set. Once the defined *Warning Threshold I2t* **0x2418** is reached, a warning "A1000" will be triggered. Once the fixed error threshold of **0x2416** (**0x2417**) is exceeded, there will be an error shutdown "F0104". Both events will be triggered by the active data set.

14.3 Speed

The max. permissible output speed of the frequency inverter can be set to a low value via parameter *Speed Switch-Off Limit* **0x2420**. If this speed limit is exceeded by the *Mechanical Speed* **0x4040/10** , the frequency inverter is switched off. The value of *Mechanical Speed* **0x4040/10** is used to capture the rpm speed of the drive shaft and it is set in relation to the value set in **0x2420** to detect overspeeding.

Object		Setting		
Index	**Designation**	**Min.**	**Max.**	**Default**
0x2420	Speed Switch-Off Limit	0 rpm	35940 rpm	35940 rpm
0x2421	Speed Warning Threshold	0 rpm	35940 rpm	33000 rpm

15 Status Information

The various control functions and methods include electrical control variables and various calculated actual values of the machine or system. The different actual values can be read out for operational and error diagnosis via a communication interface or in the AxiaManager (Mobile) Software UI or displayed on a Keypad.

Below, you can view the list of actual value objects as grouped in the AxiaManager Software UI. These objects are read-only, therefore no Min/Max settings are included.

15.1 Inverter

General		
Index	**Designation**	**Unit**
0x3913/1	Date / Time Str	[-]
0x3913/2	Date / Time unix	[s]
0x4000/3	Working Time	[-]
0x4001	Active Data-Set	[-]
0x4002/1	Ready to switch on	[-]
0x4002/2	Release State Info	[-]
0x4049	Switching Frequency	[Hz]
0x5800	Operating Time	[-]
0x5801/1	DC-Link Voltage	[V]

Temperature		
Index	**Designation**	**Unit**
0x4005	Heat Sink Temperature	[°C]
0x5805/1	Inside Temperature	[°C]

Digital I/O		
Index	**Designation**	**Unit**
0x5820/1	Status Digital Inputs String	[-]
0x5820/2	Status Digital Inputs	[-]
0x5820/3	PWM-Input 1 Duty Cycle	[-]
0x5821/1	Status Digital Outputs String	[-]
0x5821/2	Status Digital Outputs	[-]

Analog I/O		
Index	**Designation**	**Unit**
0x5822/10	MFAI 1 Percentage	[%]
0x5822/20	MFAI 2 Percentage	[%]
0x5823/1	Analog Output X210.11	[V]

Setpoints		
Index	**Designation**	**Unit**
0x4032	Actual Reference Speed	[rpm]
0x4033	Internal Speed Reference FOC	[rpm]

Warnings		
Index	**Designation**	**Unit**
0x4015/17	Groups Warning Message	[-]
0x4015/18	Warning Message Power	[-]
0x4015/19	Warning Message Communication	[-]
0x4015/20	Warning Message Application	[-]
0x4015/21	Warning Message Encoder	[-]

Faults		
Index	**Designation**	**Unit**
0x3930/1	Total Number of Faults	[-]

Faults		
Index	**Designation**	**Unit**
0x3930/2	Faults in Fault History	[-]
0x3930/3	Automatic Acknowledged Faults	[-]
0x4010/1	Fault Message	[-]
0x4010/7	Fault Code	[-]

15.2 Control

Control		
Index	**Designation**	**Unit**
0x2203	Control Mode Display	[-]

15.3 Motor

Motor		
Index	**Designation**	**Unit**
0x4040/1	Stator Frequency	[Hz]
0x4040/10	Mechanical Speed	[rpm]
0x4041/3	Output Voltage	[V]
0x4042/3	RMS Current	[A]
0x4042/4	Active Current	[A]
0x4042/5	Reactive Current	[A]
0x4043/1	Active Power	[W]
0x4043/2	Reactive Power	[var]
0x4043/3	Apparent Power	[VA]
0x4043/4	Power Factor	[-]
0x4044/1	Torque	[Nm]
0x4048/1	Motor Temperature	[°C]
0x40C0	Brake Status	[-]

15.4 Encoders

The values available in this subtree depend in part on your actual configuration. The data below serve as an example. For your actual status information, refer to the Axia-Manager software or check via the keypad module.

HTL X210 Actual Values		
Index	**Designation**	**Unit**
0x5830/1	Encoder Speed X210	[rpm]
0x5830/2	Encoder Angle X210	[deg]

X312 Actual Values		
Index	**Designation**	**Unit**
0x4052/1	Encoder Speed X312	[rpm]
0x4052/2	Encoder Angle X312	[deg]

Sensorless Actual Values		
Index	**Designation**	**Unit**
0x4070/1	Sensorless Speed	[rpm]
0x4070/2	Sensorless Angle	[deg]

15.5 Communication

Systembus Status			
Index	**Designation**	**Index**	**Designation**
0x3910/6	Sysbus Sync Count	0x3910/68	Sysbus TxPDO2 Value
0x3910/7	Sysbus CAN State	0x3910/73	Sysbus TxPDO3 Value
0x3910/8	Sysbus CAN Last Error	0x3911/5	CANopen Sync Time
0x3910/9	Sysbus Nmt State	0x3911/6	CANopen Sync Count
0x3910/33	Sysbus RxPDO1 Value	0x3911/7	CANopen CAN State
0x3910/38	Sysbus RxPDO2 Value	0x3911/8	CANopen CAN Last Error
0x3910/43	Sysbus RxPDO3 Value	0x3911/9	CANopen Nmt State
0x3910/63	Sysbus TxPDO1 Value		

CANopen Bus Status	
Index	**Designation**
0x3911/5	CANopen Sync Time
0x3911/6	CANopen Sync Count
0x3911/7	CANopen CAN State
0x3911/8	CANopen CAN Last Error
0x3911/9	CANopen Nmt State

Mapping	
Index	**Designation**
0x4080/1	RxPDO Mapping
0x4081/1	TxPDO Mapping

OS Sync Status	
Index	**Designation**
0x3906/1	Synctime
0x3906/2	Synctime Measured
0x3906/3	Sync State
0x3906/15	Active Sync Source

16 Maintenance and Repair

16.1 Modifications to the device

Hardware modifications

Any **hardware** modifications to the device may only be done by BONFIGLIOLI or its authorized service providers.

Firmware modifications

Any **firmware** modifications to the device may only be done by BONFIGLIOLI or its authorized service providers.

16.2 Warranty

If the device is manipulated by the user without prior authorization by BONFIGLIOLI the safety certification and any right to claim under warranty shall become void.

16.3 Maintenance

Maintenance frequency and procedures depend on the particular operation environment.

- To determine when and how to execute maintenance on your device, contact your local representative of BONFIGLIOLI.

16.4 Repair

Only BONFIGLIOLI or its authorized service providers may perform repair on the device.

- If repair is required, contact your local representative of BONFIGLIOLI.

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