

AXIA VERT

Encoder Module Manual

EMA-ENC-01

Frequency inverter 400 V
0,25 kW ... 15 kW



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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 mechanical and electrical installation of the frequency inverter. The auto-setup supports you in the selection of necessary objects and the configuration of the frequency inverter by the software.

Operating Instructions

The Operating Instructions document the complete functionality of the frequency inverter. The objects required for special purposes, for adjustment to the application and the numerous additional functions are described in detail.

Application manual

The application manual supplements the documentation for purposeful installation and commissioning of the frequency inverter. Information on various topics in connection with the use of the frequency inverter is described in context with the specific application.



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	Installation and commissioning of communication interface modules.
Manuals Extension modules	Installation and commissioning of encoder interface modules.
Safety manual	Safety modules and their functions, commissioning and operation.
Application manuals	Application-specific settings, best practices and preconditions. (pending)
Graphical User Interface Manual	Description of intended use of the GUI. (pending)
Software PLC Manual	(pending)

1.2 This document

This document describes the encoder module EMA-ENC-01 for the frequency inverters of the AXIA series.

The user manual contains important information on the installation and the use of the product in its specified application range. Compliance with user documentation contributes to avoiding risks, minimizing repair cost and downtimes and increasing 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 any problems occur, which are not covered by the documentation sufficiently, please contact the manufacturer.



For safe commissioning and operation of the AXIA series, the following documentation must be complied with:

- The Operating Instructions Document
- Safety manual "Functional Safety Manual"

This documentation applies to the following frequency inverter series:

- AXIA 20
- AXIA 40

1.3 Warranty and liability

BONFIGLIOLI Deutschland GmbH (hereinafter referred to as "manufacturer") notes that the contents of this document do not form part of any previous or existing agreement, assurance or legal relationship between the manufacturer and the user of the document (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 the document without prior notice. The manufacturer assumes no responsibility to update the document. 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

Read the document before commissioning and comply with it. 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 this document, 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 copyrights 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 the copyright law, the 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 reserved.

1.6 Storage

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

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 has 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 was 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 has 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 in order 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 are 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, opened 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.

During operation, all covers must be installed correctly, and all electrical cabinet doors must be closed to minimize electrical hazards.

When LEDs and other indicating elements on the frequency inverter go out, this does not necessarily mean that the device is deenergized. Before carrying out any Work at the device where contact with energized parts might be possible, it must be checked in any case, i.e., irrespective of the status of any indicating elements that may be installed, if the device is deenergized.

Charged capacitors in DC link

The DC-link may have dangerous voltage levels even up to 10 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 the middle of the electrical cabinet modules.

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

2.6.1 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.

2.6.2 Hazard symbols

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

2.6.3 Prohibition signs

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

2.6.4 Personal safety equipment

Symbol	Meaning
	Wear body protection
	Wear ear protectors

2.6.5 Recycling

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

2.6.6 Grounding symbol

Symbol	Meaning
	Ground connection

2.6.7 ESD symbol

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

2.6.8 Information signs

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

2.6.9 Font style in documentation

Example	Font style	Use
1234	bold	Representation of object index numbers / object numbers
<u>1234</u>	Bold+underlined	Representation of object sub-index numbers
<i>Object</i>	inclined, font: Times New Roman	Representation of object names / object designations
P.1234	bold	Representation of object numbers without name, e.g., in formulas
Q.1234	bold	Representation of source numbers
01234	Courier new	Representation of object values / object settings

2.7 Directives and guidelines to be adhered to by the operator

The operator must follow the following directives and regulations:

- Ensure that the applicable workplace-related accident prevention regulations as well as other applicable national regulation 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 additional 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 of 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 7.

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 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 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 7, the DC-link may have dangerous voltage levels 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, see chapter "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:

- 1 Disconnect
- 2 Secure to prevent restarting
- 3 check for absence of voltage,
- 4 carry out earthing and short-circuiting
- 5 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 10 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.
- In order 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.
- Persons 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 stop, a non-recurrent, direct restart is permissible.
- After a failure and restoration of the power supply, the motor may start unexpectedly if the AutoStart 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 the 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 persons 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.

2.11 Final decommissioning

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



For more information about the decommissioning of the device refer to the applicable operating instructions document.

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 legislation in force in the country.



3 Introduction

This document describes the possibilities and the properties of the EMA-ENC-01 encoder module for the frequency inverters of the AXIA device series.



This document exclusively describes the EMA-ENC-01 encoder module. It does not provide basic information on the operation of the AXIA series frequency inverters.

The EMA-ENC-01 module is an optional hardware component to extend the functionality of the frequency inverter. It allows using TTL type sensors.



The EMA-ENC-01 encoder module is a separate component and may have to be fitted by the user.  "Mechanical Installation".

The EMA-ENC-01 encoder module extends the functionality of the frequency inverters with the following additional functions:

Encoder interface including PTC evaluation via D-Sub female connector.

Supported encoder types:

- TTL with A/B
- TTL with A/B/Z

Adjustable voltage output for encoder supply.



Depending on the motor and encoder type used there may be restrictions to its usability in some applications.



The EMA-ENC-01 module supports a baud rate of 100 kBit/s. Other baud rates will not be supported.

4 Technical data

When using the EMA-ENC-01 encoder module, the technical data of the main device must be considered.

Encoder and PTC input X412 (D-Sub)	
Encoder input	PTC input
Internal resistance < 100 Ω	PTC or temperature sensor: 0...5 k Ω
A/B track	
R-track	
Power supply encoder: V+DG track: Supply DC 5...12 V Sense track: Encoder sensor cable	

Function and signal	
Function	Signal
Housing	Shield connected with PE
A+/A- B+/B-	Constant part: V = DC 2.5 V $\pm$ 0.5 V, RS485 Standard TTL (push-pull) according to specification RS-422A/RS-485: U _{max} = 5 V
R+/R-	Reference track (RS485 Standard)
TM _{PTC} + TM _{PTC} -	Motor Temperature evaluation
V+DG	Encoder supply (DC 5 ...12 V), max. load capacity 1 W
Sense	Measuring line for monitoring of V _{Enc}



BONFIGLIOLI servo motors of types BCR and BTB are provided with safe isolation to the motor winding.



BONFIGLIOLI recommends connecting an external power supply to the voltage input of the control terminal. This auxiliary voltage enables powering an encoder via the voltage output of the control terminal. Note the encoder manufacturer's input power specifications.

5 Installation

5.1 General



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.
- Comply with the documentation and device specifications 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 mechanical and electrical installation of the EMA-ENC-01 encoder module is to be carried out by qualified personnel according to the general and regional safety and installation directives.

Safe operation of the frequency inverter requires that the documentation and the device specification be complied with during installation and start of operation. For specific areas of application further provisions and guidelines must be complied with where applicable.

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. The electromagnetic interference is to be avoided by expert installation and observation of the specific product information.

For further information, refer to the chapter "Electrical Installation" of the frequency inverter operating instructions.

5.2 Mechanical installation



CAUTION

Possible dirt ingress

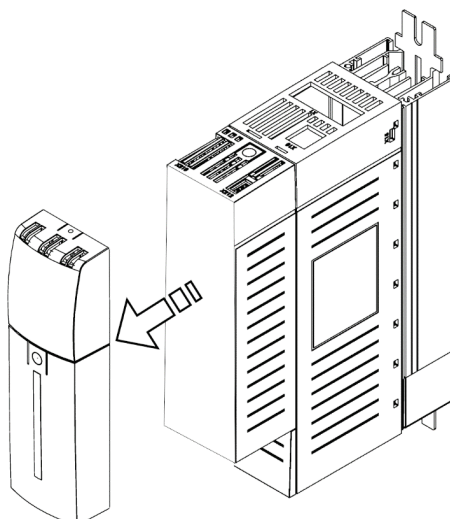
IP20 ingress protection rating is only achieved with terminals plugged and with properly mounted covers. Improperly mounted covers lead to ingress of dirt or foreign objects into the housing of the device and might lead to malfunctions.

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

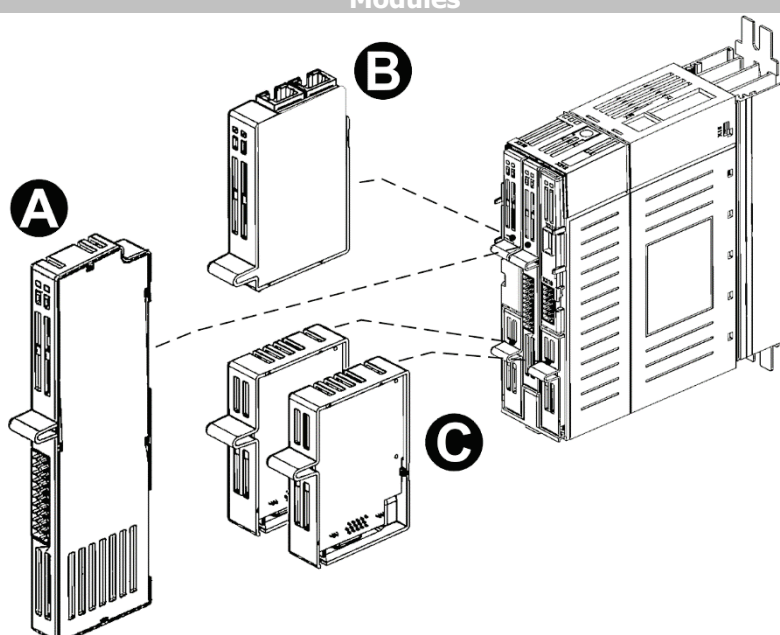
Before assembly or disassembly of the EMA-ENC-01 encoder module, the frequency inverter must be de-energized.

Work steps:

- Disconnect the frequency inverter from the mains voltage and protect it against being energized unintentionally.
- Remove covers of the frequency inverter. The slot for the encoder module is now accessible.



Modules



AXv_All_TD_ModulesOverview

A	Safety module	B	Communication module
C	Encoder modules		



CAUTION!

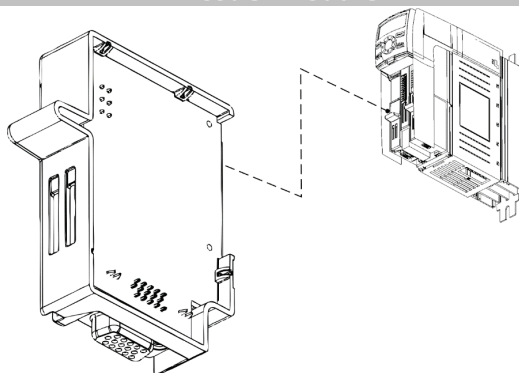
ESD damage

If touched, an ESD can occur in the PCB on the back of the module. This may damage the device.

- Do not touch the PCB visible on the back of the module.
- If possible, take measures to prevent ESD from happening.

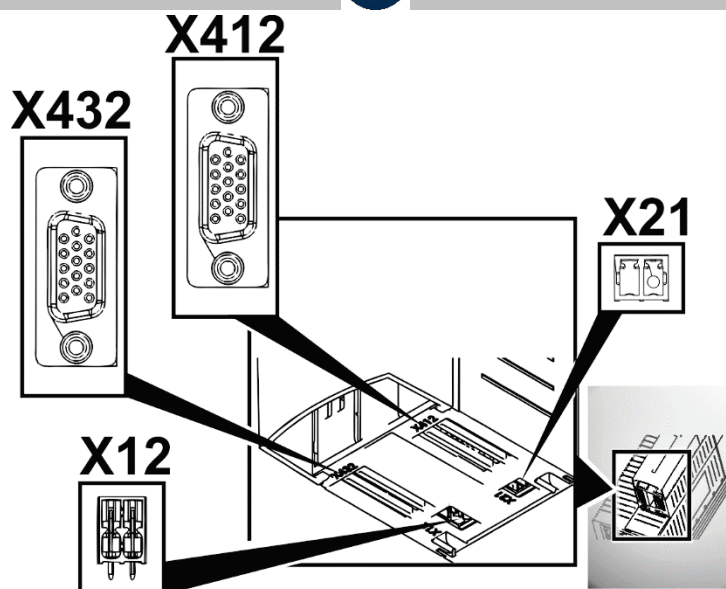
- Insert the module into the slot until it engages audibly.
- In the lower cover of the main device, break out the pre-punched cutout for the interface X412 (X432), if necessary.

Encoder Module



Depending on the application, it is possible to use both encoder slots at once to process additional encoder signals.

- When using this module in combination with the EMA-RES-01 encoder module select the left module slot (X432). For technical reasons the EMA-RES-01 installs only on the right module slot (X412).



AXiv_Alt_TD_EncoderCabling

X412	(Optional) D-Sub F Encoder	X12	4pol. External 24 V
X432	(Optional) D-Sub F Encoder	X21	2pol. Brake output (SBC)

This completes the assembly procedure.

When connected the main device shall identify the EMA-ENC-01 encoder module by its hardware ID. Further action by the user is not necessary.

5.3 Electrical Installation



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.
- Comply with the documentation and device specifications 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.

5.3.1 Sockets



CAUTION

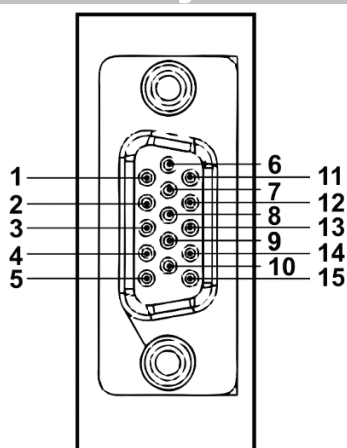
Component damage

The control terminals may be energized.

- The unit may only be connected while 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.

When the supply voltage of the frequency inverter is switched on, the EMA-ENC-01 encoder module is ready for operation.

Pin assignment



Contact	Name	Contact	Name	Contact	Name
1	-	6	V+DG	11	Sense
2	-	7	R-	12	R+
3	B-	8	-	13	-
4	B+	9	A-	14	A+
5	TM _{PTC} -	10	TM _{PTC} +	15	0 V



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



CAUTION

Possible device damage

The PTC input is not insulated. Connecting PTCs without appropriate insulation may result in device damage.

- Only connect PTCs featuring a safe insulation from the motor winding as per EN61800-5-1.

Check the power demand of the encoder to be connected. The internal power supply unit can only supply a maximum total of 2 W for all consumers connected. In the case of a higher power demand, connect an external DC 24 V supply to X12 (DC 24 V voltage input). Bonfiglioli recommends connecting an external power supply.

- Install encoder cables separately from motor cables to minimize interference.
- Upon first commissioning and during operation, make sure that the encoder and other electrical components can acclimatize in order to prevent condensation and resulting malfunction.

5.4 Encoder power supply

Encoder power supply can be implemented in different ways. Depending on the consumers connected, there are different encoder power supply possibilities or requirements.

NOTICE

Encoders with high power demand (> 2 W) or voltage higher than DC 12 V must be connected directly to an external power supply.

Generally, there are three different application types:

- Low power demand (< 0.5 W) and voltage supply ≤ 12 V:
→ Internal power supply.
- Medium power demand (0.5... 2 W) and voltage supply ≤ 12 V:
→ Power supply to be provided via X12.
- High power demand (> 2 W) or voltage supply > 12 V:
→ Connect encoder directly to external power supply.

6 Object Structure



For more information on objects  operating instructions document VEC2en1-.

The available objects are marked with Index and Sub index and must be addressed via this ID. The following definitions apply:

Access type			
Read only	The PLC can only read data from the frequency inverter.		
Read/Write	The PLC is granted unlimited access (reading and writing) to the frequency inverter data.		
Data type			
Unsigned32	32 Bit value:	0...2 ³² -1 0...0xFFFF FFFF	
Unsigned16	16 Bit value:	0...2 ¹⁶ -1 0...0x FFFF	(0...65535)
Unsigned8	8 Bit value:	0...2 ⁸ -1 0...0xFF	(0...255)
Integer32	Signed 32 Bit value:	-2 ³¹ ...2 ³¹ -1 0x8000 0000...0x7FFF FFFF	
Integer16	Signed 16 Bit value:	2 ¹⁵ ...2 ¹⁵ -1 0x8000...0x7FFF	(-32768...32767)
Integer8	Signed 8 Bit value:	2 ⁷ ...2 ⁷ -1 0x80...0x7F	(-128...127)
Float32	32 Bit value:	2 ⁻¹⁴⁹ ...2 ¹²⁷	(0...16777216)

Object Grouping

Every object is addressed via a 16 Bit index, which is displayed as a 4-digit hexadecimal number.

The object indexes are sorted in groups as follows:

- DS301 Communication Objects: **0x1000 – 0x1FFF**
- Bonfiglioli-specific objects: **0x2001 – 0x5FFF** with

Axis-dependent object ranges:

- **0x2001 – 0x27FF**
- **0x4000 – 0x47FF**

The Bonfiglioli-specific objects can be subdivided in axis-dependent objects versus axis-independent objects. There is an offset of 800 per axis in the axis-dependent range.

For example:

0x2001 Motor Type on Axis 1 and **0x2801** Motor Type on Axis 2. The Bonfiglioli-specific objects in the range

- **0x3000 – 0x37FF**
- **0x5800 – 0x5FFF**

are not axis-dependent.

DS402 Drive Profile objects: **0x6000 – 0x7FFF**

7 Commissioning the encoder

This chapter describes how the encoder is commissioned.



WARNING

Significant failures of the system

Some absolute value encoder types can “zero” or change the position transmitted by the encoder. Changing the value while the system is in operation can result in significant failures of the system.

- Do not use this function, as this will change the commutation angle in synchronous motors and correct speed control is not guaranteed.

7.1 Commissioning to slot X412



CAUTION

Possible device damage

Via object **0x2078/2** *Supply Voltage*, you can select the value of the supply voltage for the encoder. The selected parameterization takes effect immediately. Setting values inappropriate for the encoder type can result in encoder damage or encoder destruction.

- Double-check the setting of **0x2078/2** *Supply Voltage*, before connecting the encoder cable.



CAUTION

Possible device damage

Via object *Change Sense of Rotation* **0x2078/11**, you can change the rotation direction of the motor system. In the case of absolute value encoders, changing **0x2078/11** will result in a jump of actual values. This can lead to device damage or slave drives in an electronic gear configuration.

- Switch off slave drives in an electronic gear upon the time of changeover.

The internal resolution of encoder information is 32 bits, 16 bits for the position in one turn and 16 bits for the number of turns. Encoders with other properties will be converted to this format internally.

In positioning applications, the absolute position of the encoder can be used for the reference system directly in user units [u]. Using gear factors, a gear transmission between the encoder and the travel distance can be considered (this does only apply to application encoders in the case of synchronous motors).

NOTICE

Identification of position not guaranteed

The input data of the encoder is evaluated via the reference systems. The evaluated objects (e.g., motor frequency, drive speed in rev/s, position in rev.) are available for diagnosis via actual value objects,  8.2 “Actual value display”.

List of Relevant Objects

Object			Setting		
No.	Designation	Unit	Min.	Max.	Default setting
0x2078/1	Encoder Type	[-]	Selection		
0x2078/2	Supply Voltage	[-]	Selection (0 V – 12 V)		
0x2078/3	Enable Encoder (Supply Mode)	[-]	Selection		
0x2078/5	Enc. Data Source	[-]	1-Automatic / 2-Objects		
0x2078/10	Speed Filter Constant	[s]	0	1	0
0x2078/11	Change Sense of Rotation	[-]	Off	On	Off
0x2078/20	Division Marks	[-]	0	8192	1024
0x2078/21	Z-Track Window	[incr]	0	200	4
0x2078/60	Theta Mot. Sensor	[-]	Selection		
0x2078/61	Theta AddOn1 Sensor	[-]	Selection		
0x2078/62	Theta AddOn2 Sensor	[-]	Selection		

During operation, the encoders and communication with the encoder are monitored. Critical conditions are reported via device errors. Most error evaluations will only be performed when the power output stage is activated.

The voltage level is set in *Supply voltage* **0x2078/2** according to the technical specification of the encoder.

NOTICE

Faults / system shutdown

Setting *Enable Encoder (Supply Mode)* **0x2078/3** to modes with “sense” function, while the power supply terminals are not connected, might result in faults and system shutdown.

- Always set the *Supply Voltage* **0x2078/2** first, then set *Enable Encoder (Supply Mode)* **0x2078/3**.

Encoder Type 0x2078/1

0x00000000	No encoder
0x00002100	TTL Incremental: A/B
0x00002500	TTL Incremental: A/B/Z

Supply Voltage 0x2078/2

0x00000000	0 V
0x00000005	5 V
0x00000008	8 V
0x0000000A	10 V
0x0000000C	12 V

Enable Encoder (Supply Mode) 0x2078/3

0x00000000	Off (Disable encoder)	Voltage supply is inactive.
0x00000001	On (Internal supply)	Internal supply voltage is active.
0x00000002	On (External supply)	Encoder is supplied externally. Supply voltage is not monitored.
0x00000011	On (Internal with Sense)	Internal supply voltage is active. The voltage level is measured at the sense line. This voltage level is used to automatically readjust the supply voltage to comply with the voltage preselected at sub index 2.

NOTICE

Encoder damage in supply mode 1 and 11

The encoder may be damaged if the voltage is automatically readjusted during an overload followed by a relief of the internal power supply unit.

- As soon as the supply voltage has reached a stable condition the readjustment function must be deactivated.

7.2 Commissioning to slot X432

Some AXIA inverters provide further encoder module interfaces per inverter for application encoders. The second encoder module is then assigned the interface designation "X432". To implement the corresponding encoder control in the firmware, the object **0x3850** is used.



CAUTION

Possible device damage

Via object **0x3850/2** *Supply Voltage*, you can select the value of the supply voltage for the encoder. The selected parameterization takes effect immediately. Setting values inappropriate for the encoder type can result in encoder damage or encoder destruction.

- Double-check the setting of **0x3850/2** *Supply Voltage*, before connecting the encoder cable.



CAUTION

Possible device damage

Via object *Change Sense of Rotation* **0x3850/11**, you can change the rotation direction of the motor system. In the case of absolute value encoders, changing **0x3850/11** will result in a jump of actual values. This can lead to device damage of slave drives in an electronic gear configuration.

- Switch off slave drives in an electronic gear upon the time of changeover.

The internal resolution of encoder information is 32 bits, 16 bits for the position in one turn and 16 bits for the number of turns. Encoders with other properties will be converted to this format internally.

In positioning applications, the absolute position of the encoder can be used for the reference system directly in user units [u]. Using gear factors, a gear transmission between the encoder and the travel distance can be considered (this does only apply to application encoders in the case of synchronous motors).

NOTICE

Identification of position not guaranteed

The input data of the encoder is evaluated via the reference systems. The evaluated objects (e.g., motor frequency, drive speed in rev/s, position in rev.) are available for diagnosis via actual value objects,  8.2 "Actual value display".

List of Relevant Objects

Object			Setting		
No.	Designation	Unit	Min.	Max.	Default setting
0x3850/1	Encoder Type	[-]	Selection		
0x3850/2	Supply Voltage	[-]	Selection (0 V – 12 V)		
0x3850/3	Enable Encoder (Supply Mode)	[-]	Selection		
0x3850/5	Enc. Data Source	[-]	1-Automatic / 2-Objects		
0x3850/10	Speed Filter Constant	[s]	0	1	0
0x3850/11	Change Sense of Rotation	[-]	Off	On	Off
0x3850/20	Division Marks	[-]	0	8192	1024
0x3850/21	Z-Track Window	[incr]	0	200	4
0x3850/60	Theta Mot. Sensor	[-]	Selection		
0x3850/61	Theta AddOn1 Sensor	[-]	Selection		
0x3850/62	Theta AddOn2 Sensor	[-]	Selection		

During operation, the encoders and communication with the encoder are monitored. Critical conditions are reported via device errors. Most error evaluations will only be performed when the power output stage is activated.

The voltage level is set in *Supply voltage* **0x3850/2** according to the technical specification of the encoder.

NOTICE

Faults / system shutdown

Setting *Enable Encoder (Supply Mode)* **0x3850/3** to modes with "sense" function, while the power supply terminals are not connected, might result in faults and system shutdown.

- Always set the *Supply Voltage* **0x3850/2** first, then set *Enable Encoder (Supply Mode)* **0x3850/3**.

Encoder Type 0x3850/1	
0x00000000	No encoder
0x00002100	TTL Incremental: A/B
0x00002500	TTL Incremental: A/B/Z

Supply Voltage 0x3850/2	
0x00000000	0 V
0x00000005	5 V
0x00000008	8 V
0x0000000A	10 V
0x0000000C	12 V

Enable Encoder (Supply Mode) 0x3850/3		
0x00000000	Off (Disable encoder)	Voltage supply is inactive.
0x00000001	On (Internal supply)	Internal supply voltage is active.
0x00000002	On (External supply)	Encoder is supplied externally. Supply voltage is not monitored.
0x00000011	On (Internal with Sense)	Internal supply voltage is active. The voltage level is measured at the sense line. This voltage level is used to automatically readjust the supply voltage to comply with the voltage preselected at sub index 2.

NOTICE

Encoder damage in supply mode 1 and 11

The encoder may be damaged if the voltage is automatically readjusted during an overload followed by a relief of the internal power supply unit.

- As soon as the supply voltage has reached a stable condition the readjustment function must be deactivated.

7.3 Connecting the encoder to Speed Control or Position Control

For integrating the encoder signals into speed control or position control use the following firmware objects:

0x2081 Actual Speed Source

0x2082 Actual Position Source

The complete commissioning process of the frequency inverter is described in the operating instruction of the AXIA frequency inverter.

7.3.1 Connecting to Speed control

- For connecting the encoder signals to speed control set the object *Actual Speed Source* **0x2081/255** to value 2 (Enc. Module Slot X412) or value 1 (Enc. Module Slot X432).

Object			
No.	Designation	Object Code	Data type
0x2081/255	Actual Speed Source	Record	UInt32

Selection 0x2081/255	
0x00000000	HTL Encoder vis X210
0x00000001	Enc. Module Slot X432
0x00000002	Enc. Module Slot X412
0x00000003	Enc. Module Slot X422
0xFFFFFFFF	Sensorless



For more information on commissioning the encoder  operating instructions document VEC2en1-.

7.3.2 Connecting to Position control

- For connecting the encoder signals to Position control set the object *Actual Position Source* **0x2082/255** to value 2 (Enc. Module Slot X412) or value 1 (Enc. Module Slot X432).

Object			
No.	Designation	Object Code	Data type
0x2082/255	Actual Position Source	Record	UInt32

Selection 0x2082/255	
0x00000000	HTL Encoder vis X210
0x00000001	Enc. Module Slot X432
0x00000002	Enc. Module Slot X412
0x00000003	Enc. Module Slot X422
0xFFFFFFFF	Sensorless



For more information on commissioning the encoder  operating instructions document VEC2en1-.

8 Control Input and Output Objects

8.1 Encoder input

The encoder input is used for evaluating the position information from the encoder.

Depending on the encoder system used, certain objects need to be set up by the user. The following table describes the use of the individual objects for the encoder systems.

Object			
No.	Designation	Object Code	Data type
0x2078/2	Supply voltage	Record	Int32
0x2078/3	Enable Encoder (Supply Mode)	Record	Int32
0x2078/20	Division Marks	Record	UInt32
0x3850/2	Supply voltage (X432)	Record	Int32
0x3850/3	Enable Encoder (Supply Mode) (X432)	Record	Int32
0x3850/20	Division Marks (X432)	Record	UInt32

8.2 Actual value display

The actual values of the encoder can be read out via the objects **0x4052/n** and **0x5832/n**.

Object					
No.	Designation	Object Code	Data type	Setting	Unit
0x4052/1	Encoder Speed X412/X422	Record	Float32	0	[rpm]
0x4052/2	Encoder Position X412/X422	Record	Int32	0	[-]
0x4052/3	Encoder Status X412/X422	Record	Int32	0	[-]
0x4052/4	Encoder Fault X412/X422	Record	UInt16	Encoder status: 0-None (default) 1-Fault	[-]
0x4052/5	Encoder Warning X412/X422	Record	UInt32	0	[-]
0x4052/6	Theta Enc.X412/X422	Record	Float32	0	[°C]
0x4052/7	Theta Mot. Winding X412/X422	Record	Float32	0	[°C]
0x4052/8	Theta AddOn 1 Enc.X412/X422	Record	Float32	0	[°C]
0x4052/9	Theta AddOn 2 Enc.X412/X422	Record	Float32	0	[°C]
0x5832/1	Encoder Speed X432	Record	Float32	0	[rpm]
0x5832/2	Encoder Position X432	Record	Int32	0	[-]
0x5832/3	Encoder Status X432	Record	Int32	0	[-]
0x5832/4	Encoder Fault X432	Record	UInt16	Encoder status: 0-None (default) 1-Fault	[-]
0x5832/5	Encoder Warning X432	Record	UInt32	0	[-]
0x5832/6	Theta Enc. X432	Record	Float32	0	[°C]
0x5832/7	Theta Mot. Winding X432	Record	Float32	0	[°C]
0x5832/8	Theta AddOn 1 Enc. X432	Record	Float32	0	[°C]
0x5832/9	Theta AddOn 2 Enc. X432	Record	Float32	0	[°C]

8.2.1 Actual position

Act. position **0x4052/2(0x4852/2)** or **0x5832/2** shows the current actual value (position) in user units [u].

8.3 Motor temperature

The temperature monitoring is a part of the error and warning behavior. The connected load can be monitored by the connection of a measurement resistor (motor PTC resistor / PTC) with a temperature characteristic according to DIN 44081.

The operation mode of the motor PTC port can be selected via objects *Theta Mot. Sensor* **0x2078/60**, *Theta AddOn1 Sensor* **0x2078/61** and *Theta AddOn2 Sensor* **0x2078/62**.

Object			
No.	Designation	Object Code	Data type
0x2078/60	Theta Mot. Sensor	Record	Int32
0x2078/61	Theta AddOn1 Sensor	Record	Int32
0x2078/62	Theta AddOn2 Sensor	Record	Int32
0x3850/60	Theta Mot. Sensor (X432)	Record	Int32
0x3850/61	Theta AddOn1 Sensor (X432)	Record	Int32
0x3850/62	Theta AddOn2 Sensor (X432)	Record	Int32

Selection 0x2078/60 ../61 ../62	
1	No Resistor
2	Wire Wound Resistor
3	PTC Resistor
4	PT100
5	PT1000
6	KTY 84 130
7	KTY 83 110

In operation modes with error-switch-off, the fault message "FAULT" with fault number "F0400" is displayed.

9 Annex

9.1 Error messages

The various control methods and the hardware of the frequency inverter includes functions which continuously monitor the application. The following error messages are activated by the EMA-ENC-01 encoder module.

Error messages and troubleshooting		
F04	00	Motor temperature too high or temperature evaluation connection defective. Check cables and connections.
F14	30	Incr. Encoder: Division Marks Fault
	31	Incr. Encoder: Z-Track Missing
	83	Sense voltage out of range. Via object <i>Supply voltage</i> 0x2078/2 , an operation mode using an external power supply was selected, but there is no external voltage. Connect external power source or change operation mode.
	84	Encoder supply overvoltage. The voltage level of the external power supply is too high, or the external power supply is overloaded. Check the voltage level of the external power supply.
	85	Encoder supply undervoltage. The internal power supply to the encoder provided by the frequency inverter is overloaded. Check the connections at the control terminals.
	86	Encoder overcurrent. Via object <i>Supply voltage</i> 0x2078/2 , an operation mode using a sense measuring line was selected, but no sense line is connected. Connect sense measuring line or select another operation mode. Sense measuring line defective or broken. Check cables and connections.
F14	87	Sense cable missing. A/B track not found. Connect A/B track. A/B track cable broken. Check cables and connections. Check set <i>Division marks</i> 0x2078/20 . In some cases, you may have to reset the device if the error occurs directly after connection of mains supply.
	91	Z-Track missing. Reference track not found. The settings of object <i>Division marks</i> 0x2078/20 does not match the type-specific division marks of the encoder. Check settings. Z track defective or cable broken. Check cables and connections.
F21	nn	Fault report to system bus master in fault in system bus slave nn = Node ID of slave (hex)
F22	00	Communication fault, system bus, timeout SYNC telegram
	01	Communication fault, system bus, timeout RxPDO1
	02	Communication fault, system bus, timeout RxPDO2
	03	Communication fault, system bus, timeout RxPDO3



The error messages described above may occur depending on the encoder connected. Error messages intended for in-depth diagnosis by specialists are not listed.

Additional fault messages are described in the Operating instructions of the frequency inverter.

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