

AXIA VERT

Communication Module Manual

CMA-ETH-01 for Ethernet

Frequency inverter 230 V / 400 V

0,25 kW ... 15 kW



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1 General Information about the Documentation

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

The present manual was created in the German language. The German manual is the original version. Other language versions are translated.

Quick Start Guide

The "Quick Start Guide" describes the basic steps required for mechanical and electrical installation of the frequency inverter. The guided commissioning supports you in the selection of necessary objects and the configuration of the software of the frequency inverter.

User manual

The user manual documents 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.

Separate user manuals are supplied for optional components for the frequency inverter. These manuals complement the operating instructions and the "Quick Start Guide" for the frequency inverter.

Application manual

The application manual complements the documentation to ensure goal-directed 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.

Installation instructions

The installation manual describes the installation and use of devices, complementing the "Quick Start Guide" and the user manual.

1.1 This document

The present user manual for the CMA-ETH-01 communication module complements the Operating Instructions and the "Quick Start Guide" for the frequency inverters of the AXIA device series.

The user manual contains important information on the installation and use of the communication module CMA-ETH-01 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 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"

1.2 Warranty and liability

BONFIGLIOLI Deutschland GmbH (hereinafter referred to as "manufacturer") notes 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 these 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.

1.3 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.

1.4 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.

1.5 Storage

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, then the documentation must also be handed over.

2 General safety instructions and information on use

The chapter "General safety instructions and information on use" 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 that 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 that 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 that has special technical know-how and experience relating to the 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 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, 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.

2.5 Safety and warning signs on the 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 used in the user manual

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


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


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 Discharge (can damage components and assemblies)

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
0x1234	bold	Representation of object numbers
<u>/01</u>	bold, underlined	Representation of sub-index numbers
<u>/d01</u>	bold, underlined	Representation of data set numbers
<i>Object</i>	Italic, Font Times New Roman	Representation of object names
P.1234	bold	Representation of object numbers without name, e.g. in formulas
Q.1234	bold	Representation of source numbers

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.
- 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 user manual, the operator should issue separate internal operating instructions for the frequency inverter. The Operating Instructions of the frequency inverter must be included in the user manual 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 qualified technical staff. The staff must not be under the influence of any drugs. Note the minimum age required by law. Define the staff's responsibility in connection with 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 user manual 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 user manual, 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.

2.10 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 office 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 this at your own risk.

2.10.3 Transport and storage

- The frequency inverters must be transported and stored in an appropriate way. During transport and 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.
- The duration of storage without connection to the permissible nominal voltage may not exceed one year.

2.10.4 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 a 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.

2.10.5 Electrical connections

- The five safety rules must be complied with.
- Never touch live terminals. The DC link may have dangerous voltage levels even up to three 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 five safety rules

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

- 1 Isolate
- 2 Secure to prevent restarting
- 3 Check isolation
- 4 Earth and short-circuit,
- 5 Cover or shield neighboring live parts.

2.10.6 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, never open the machine/plant
- Do not connect/disconnect any components/equipment during operation.
- 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 brake 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. Wait for at least 3 minutes after shutdown before starting 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 qualified staff 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 frequency inverters must not have access to the frequency inverter. Do not bypass nor decommission any protective facilities.
- 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 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 the safety directives (e.g. Working Machines Act or Accident Prevention Directives).

2.10.7 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. Repairs on the frequency inverters may only be carried out by the manufacturer or persons authorized by the manufacturer. 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.

2.10.8 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.



Always comply with any applicable national disposal regulations as regards environmentally compatible disposal of the frequency inverter. For more details, contact the competent local authorities.

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

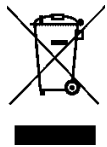


For more information about the decommissioning of the device refer to the applicable operating instructions document.

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 communication module CMA-ETH-01. After connecting via Ethernet/TCP to the PLC, you can use an additional logic connection from CMA-ETH-01 to the AxiaManager software running on a terminal connected via an Ethernet network.



This manual only describes the communication module CMA-ETH-01. This manual is not to be understood as providing general/basic information on Ethernet interfaces or frequency inverters.

General/basic knowledge of the methods and function of Modbus TCP interfaces and Modbus TCP protocol are a prerequisite for understanding and implementing the instructions provided by this document.

NOTICE

With the CMA-ETH-01 communication module, it is possible to access ALL frequency inverter objects via a controller. There are access restrictions via the user management within the software. Changing objects, the functions of which are not known to the user, can result in unintended movements and material and/or personal losses as well as inoperativeness of the frequency inverter.

Be cautious, if the function of a particular object is not fully clear to you.

Ethernet properties:

- 10/100 MB (10Base-T/100Base-T)
- Automatic identification (Auto negotiation)

Ports:

The module supports two logic TCP/IP ports for Ethernet communication.

Software

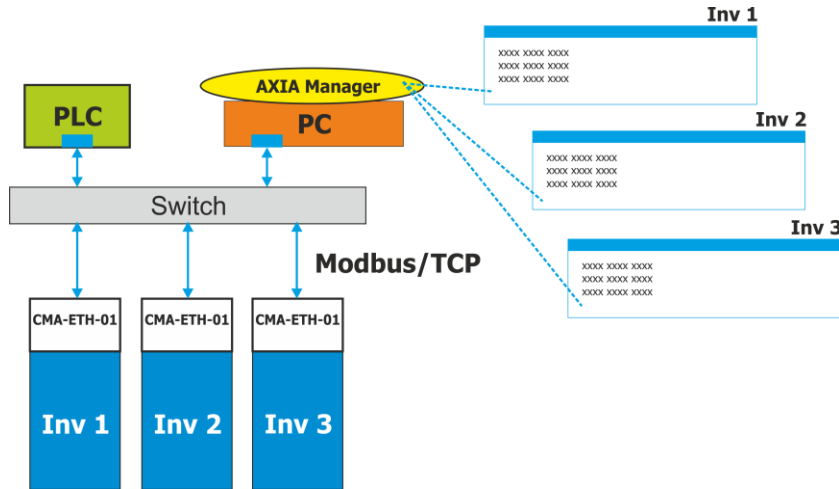
AxiaManager is the software for configuration and maintenance of Bonfiglioli frequency inverters. It can connect with a frequency inverter while it is communicating with a PLC. To run the AxiaManager you require a computer/PC, running on a Windows OS. The manufacturer also provides an iOS and an Android app version of the AxiaManager, with less functionalities than in the Windows software.

Using the AxiaManager you can configure and manage objects relevant for the communication module.

3.1 Modbus TCP interface

The frequency inverter can be controlled by a PLC or another master device via an Ethernet interface and a serial to Ethernet Modbus gateway, using the Modbus TCP protocol.

You can also access the frequency inverter using the AxiaManager software via Ethernet. AxiaManager can be used in parallel with a PLC with Modbus TCP communication.




This document does not provide basic information about Ethernet interfaces. Basic knowledge of the Modbus TCP protocol and Ethernet interfaces is required. In some sections, setting and display options via the PC software AxiaManager are described as an alternative to the control unit. In this case, AxiaManager communicates with the frequency inverter via a serial interface or a direct Ethernet connection.

NOTICE

With the CMA-ETH-01 communication module, it is possible to access **ALL** frequency inverter objects from a controller. Changing objects, the functions of which are not known to the user, can result in unintended movements and material and/or personal losses as well as inoperativeness of the frequency inverter.

NOTICE

If the number of admissible writing cycles is exceeded, the EEPROM is destroyed. When values are to be written cyclically at a high repetition rate, no entries shall be made in the EEPROM, as this only allows a limited number of write cycles (approx. 1 million cycles).  7.3

4 Installation/Disassembly of the communication module

The CMA-ETH-01 communication module is delivered in a separate case ready for assembly.

4.1 Installation



CAUTION

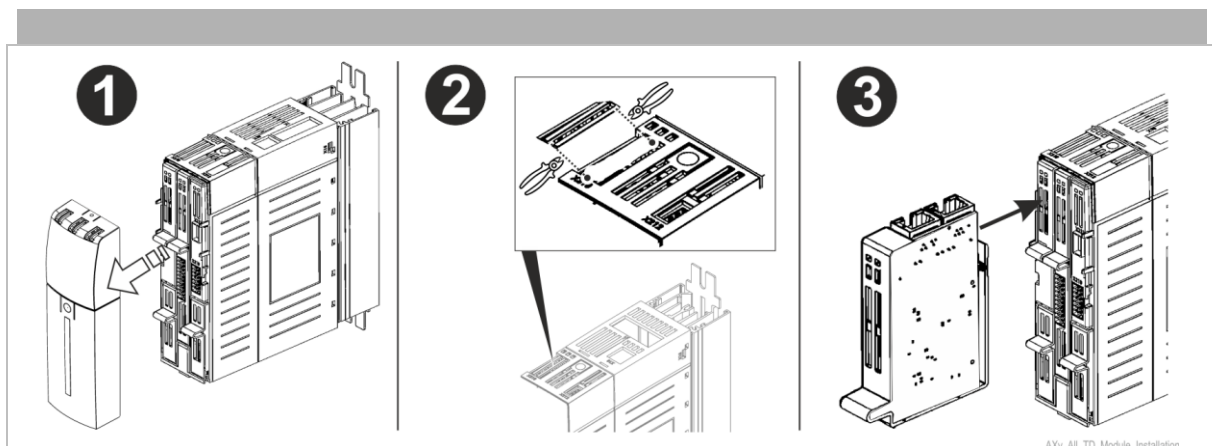
Destroying inverter and/or communication module

Connecting/disconnecting the module while the inverter is connected to live voltage can destroy the module and/or the inverter.

- Disconnect the frequency inverter from the power supply before installation of the communication module. Assembly under live voltage is not permissible.
- Do not touch the PCB visible on the back of the module, otherwise components may be damaged.

Work steps:

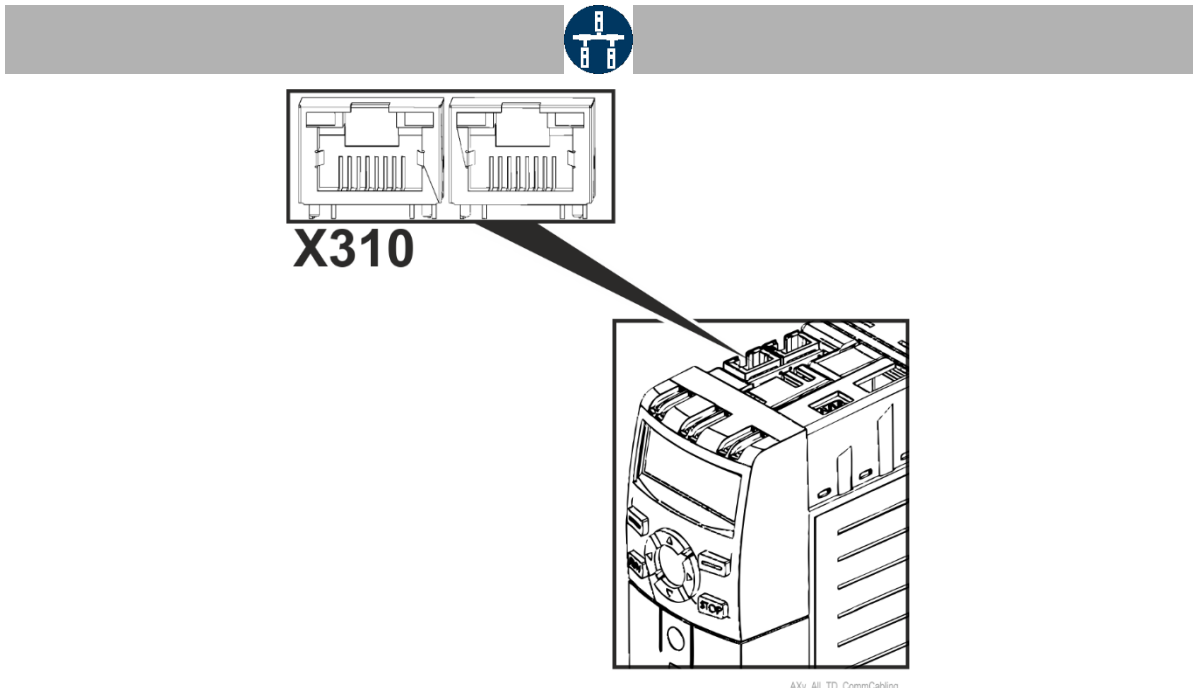
- Disconnect the frequency inverter from the mains voltage and protect it against being energized unintentionally.
- Disconnect the frequency inverter from the external 24 V if used and protect it against being energized unintentionally.



1. Remove covers of the frequency inverter. The upper left slot for the communication module is now accessible.
2. In the upper cover, break out the pre-punched cut-out for the interface X310, if necessary.
3. Insert the communication module into the slot until it engages audibly.

4.1.1 Connector assignment

The CMA-ETH-01 module is connected to the PLC or switch using RJ45 connectors (LAN).



X310	Ethernet, RJ45
-------------	----------------



The interface is electrically isolated from the inverter.

The CMA-ETH-01 interface is connected via the Ethernet connector socket **X310** using standard CAT cables and RJ45 connectors:

Technical characteristics: Ethernet TCP interface X310

- 2 RJ45 connectors
- Ethernet standard: IEEE 802.3, 100Base-TX (fast Ethernet)
- Cable type: S/FTP
 - cable with braided shield
 - ISO/IEC 11801 or EN 50173, Straight Through or Cross Over
- The cable length is restricted by the BAUD rate, cables must not exceed a length of 100 m.

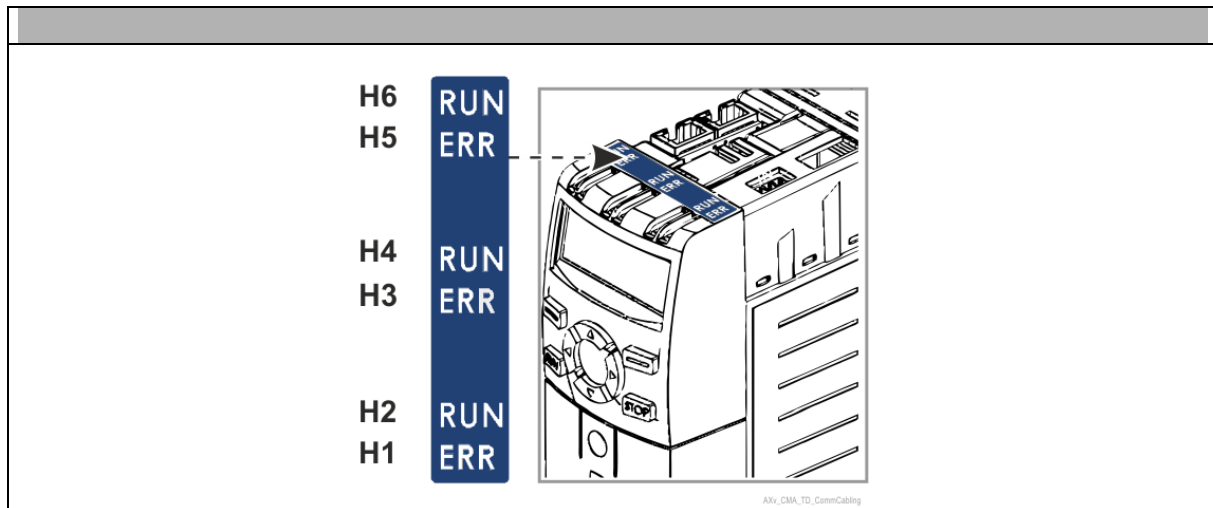
4.1.2 Status LEDs

NOTICE

Residual risk

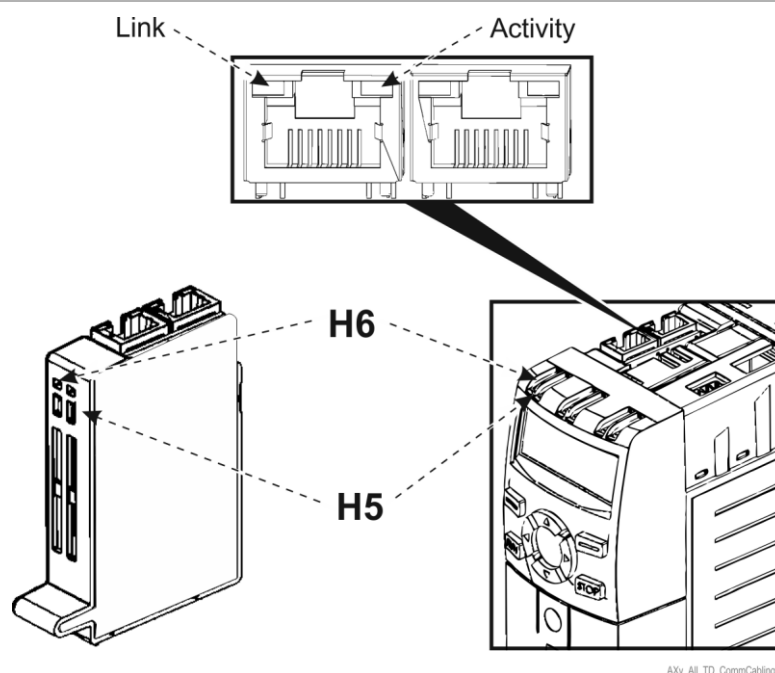
LEDs and other indicating elements on the frequency inverter not displaying anything does not mean that the device is deenergized.

- 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 indicating elements.
- Make sure the adhesive label has been placed correctly according to CEMA leaflet included in the scope of supply.



Status output via communication module LEDs:

The front LEDs (H5, H6) indicate the current status of the corresponding port of the communication module.



Link/Activity	RJ45 connector LED indicators
H5	Network status LED
H6	Module LED

Link/Activity: RJ45 connector LED indicators

The LEDs in the RJ45 connector indicate data activity (green) and the link (yellow) status of the module.

H5: Network status indicator

This LED indicates the current status of the network connection.

Network Status LED		
LED State	Description	Comments
Off	Offline	No power. No connection with IO controller.
Green	Online (Run)	Connection with IO controller established. IO Controller in RUN state.
Green, 1 flash	Online (Stop)	Connection with IO controller established. IO controller in STOP state or IO data bad. IRT synchronization not finished.
Green, blinking	Blink	Used by engineering tools to identify the node on the network.
Red	Fatal event	Major internal error (this indication is combined with a red module status LED).
Red flash	Testing	No connection with IO controller (e.g. cable not connected). The device is performing its power-up testing (Setup and Network initializing).

H6 Module LED

The module LED indicates the current status of the module.

Module Status LED		
LED State	Description	Comments
Off	Not initialized	No power OR module in SETUP
Green	Normal operation	Normal operation
Green, 1 flash	Diagnostic event(s)	Frequency inverter error
Red	Fatal event	Major internal error (this indication is combined with a red network status LED)
Alternating Red/green	Firmware update	Do NOT power off the module. Turning the module off during this phase could cause permanent damage.

4.2 Disassembly

- Disconnect the frequency inverter from mains voltage and external 24 V and protect it against being energized unintentionally.
- Remove covers of the frequency inverter, if necessary.
- Disconnect/unplug any connected lines.
- Unplug the communication module from its slot by unlocking the locking hooks on the right- and left-hand side of the module from the case of the frequency inverter using a small screwdriver.
- Proceed carefully to not damage the module.

5 Initial settings

5.1 Setting the Modbus Operating Mode

Modbus TCP is not activated by default and must be activated at the first start. Use the following object for this purpose:

Index	Sub index	Description	Object code	Data type
0x3950	3	Modbus operating mode	Record	UInt32

These values are available:

<i>Modbus operating mode 0x3950/3</i>	
0	Deactivated (factory setting)
1	RTU
2	ASCII
5	TCP

5.2 TCP/IP Configuration

In order to establish connection with a frequency inverter featuring the CMA-ETH-01, you will have to configure IP settings for the Modbus TCP module.

For all Modbus TCP settings use the following object:

Index: 0x3903

Name: Ethernet Settings

By default, the objects of the communication module CMA-ETH-01 is set up as follows:

Index	Sub index	Description	Object code	Data type
0x3903	1	IP Address (Ref)	Read/write	UInt 32
0x3903	2	Subnetmask (Ref)	Read/write	UInt 32
0x3903	3	Gateway (Ref)	Read/write	UInt 32
0x3903	6	SNTP Server (Ref)	Read/write	UInt 32
0x3903	7	DHCP Option (Ref)	Read/write	Boolean
0x3903	9	Hostname	Read/write	String (max. 20)
0x3903	10	Activate IP Settings	Read/write	UInt8
0x3903	11	IP Address (Actual)	Read	UInt 32
0x3903	12	Subnetmask (Actual)	Read	UInt 32
0x3903	13	Gateway (Actual)	Read	UInt 32
0x3903	14	DNS Server 1 (Actual)	Read	UInt 32
0x3903	15	DNS Server 2 (Actual)	Read	UInt 32
0x3903	16	SNTP (Actual)	Read	UInt 32
0x3903	18	TCP Config activated	Read/write	Boolean
0x3903	19	Certificate Busy	Read	Boolean
0x3903	20	MAC address	Read	Byte String (6 Bytes)
0x3903	21	MAC address Port 1	Read	Byte String (6 Bytes)
0x3903	22	MAC address Port 2	Read	Byte String (6 Bytes)

The object settings must be adapted to the actual application.

5.2.1 Setting the TCP/IP address and subnet

For proper identification, each frequency inverter is assigned an IP address which must be unique in the system.

5.2.1.1 Network without DHCP server

(DHCP: Dynamic Host Configuration Protocol.) The address is set via object *IP-Address* **0x3903/1**. In addition, the object *Subnetmask* **0x3903/2** and the number of the *Gateway* **0x3903/3** must be entered properly for the local network.

Object		Settings		
No.	Description	Min.	Max.	Default setting
0x3903/1	IP Address (Ref)	0	0xFFFFFFFF	0
0x3903/2	Subnetmask (Ref)	0	0xFFFFFFFF	0
0x3903/3	Gateway	0	0xFFFFFFFF	0
0x3903/10	Activate IP Settings	0	1	0

The settings made with these objects will only become active when setting the object *Activate IP Settings* (**0x3903/10**) to 1.

5.2.1.2 Network with DHCP server

When a DHCP server is used, manual network configuration is not required. Set *DHCP Option* **0x3903/7** to 1 - Enabled if you wish to use the DHCP function.

Object		Settings		
No.	Description	Min.	Max.	Default setting
0x3903/7	DHCP Option (Ref)	0	1	0

<i>DHCP (Ref)</i> 0x3903/7		Function
0 - Disabled		Module must be configured manually, no DHCP server is used (factory setting).
1 - Enabled		The settings are made by a DHCP server.

When *Activate IP Settings* (**0x3903/10**) is enabled, the IP settings in the RAM are set to 0.

5.2.2 Setting the SNTP server

The SNTP server is set via subindex 6.

Object		Settings		
No.	Description	Min.	Max.	Default setting
0x3903/6	SNTP Server (Ref)	0	0xFFFFFFFF	0

The SNTP server only becomes active when setting the object *Activate IP Settings* (**0x3903/10**) to 1.

5.2.3 Setting the Hostname

The hostname is written via subindex 9. Changes become active after a restart.

Object		Settings		
No.	Description	Min.	Max.	Default setting
0x3903/9	Hostname	1	23	Axia-device

5.2.4 Reading IP settings

These objects are used to read the active IP settings directly from the TCP stack interface:

Index	Sub index	Description	Object code	Data type
0x3903	<u>11</u>	IP Address (Actual)	Read	UInt 32
0x3903	<u>12</u>	Subnetmask (Actual)	Read	UInt 32
0x3903	<u>13</u>	Gateway (Actual)	Read	UInt 32
0x3903	<u>14</u>	DNS Server 1 (Actual)	Read	UInt 32
0x3903	<u>15</u>	DNS Server 2 (Actual)	Read	UInt 32
0x3903	<u>16</u>	SNTP (Actual)	Read	UInt 32

5.2.5 Activate changing the IP settings via UDP Broadcast

(UDP: User Datagram Protocol) The object **0x3903/18** can be used to enable or disable the change of the IP settings via UDP Broadcast (Security).

Object		Settings		
No.	Description	Min.	Max.	Default setting
0x3903/18	TCP Config activated	0	1	0

5.2.6 Certificate Busy

Object **0x3903/19** indicates that a certificate is currently being generated.

Index	Sub index	Description	Object code	Data type
0x3903	<u>19</u>	Certificate Busy	Read	Boolean

5.2.7 Reading MAC addresses

Via the objects **0x3903/20**, **21**, and **22** the MAC addresses can be read out (from serial flash).

Index	Sub index	Description	Object code	Data type
0x3903	<u>20</u>	MAC address	Read	Byte String (6 Bytes)
0x3903	<u>21</u>	MAC address Port 1	Read	Byte String (6 Bytes)
0x3903	<u>22</u>	MAC address Port 2	Read	Byte String (6 Bytes)

6 Protocol

The Modbus TCP communication protocol is a Client/Server based protocol. Modbus TCP communication will always be initialized by the client (e.g. PLC). The server nodes (frequency inverters) do not communicate with one another.

Modbus TCP communication is established by the client via the TCP/IP-Port #502 on the side of the Modbus TCP server.



CMA-ETH-01 only supports:

- Port #502 for establishing Modbus TCP connection
- one request per transaction only (NumberMaxOfServerTransaction = 1)

6.1 Message structure

A Modbus TCP telegram comprises the following fields:

MBAP	Function code	Data (Modbus RTU data contents)
------	---------------	---------------------------------

MBAP Modbus Application Header

The Modbus Application Header comprises the following fields:

Field	Length	Description	Client	Server (inverter)
Transaction ID (transaction identifier)	2 bytes	Identification of Modbus request/response transaction	Initialized by client	Written back by the server from the request received
Protocol ID (protocol identifier)	2 bytes	0 = Modbus protocol	Initialized by client	Written back by the server from the request received
Length	2 bytes	Number of subsequent bytes (including ID of data unit)	Initialized by client (request)	Initialized by server (response)
ID of data unit (unit identifier)	1 byte	Identification of serially connected Remote Slave	Initialized by client (request)	Initialized by server (response)

The **Transaction ID** is a counter, so that the client can assign the responses to the server.

The **Protocol Identifier** is set to 0 for Modbus.

The **Length** depends on the frame designation of the Modbus function. For function 0x03, 0x06 and 0x65 it is always 0x0006.

The **Unit Identifier** is equal to the slave address of Modbus RTU.



- The data unit identifier will not be processed by the server.
- The function code and data field structure are the same in Modbus TCP and Modbus RTU.
- Modbus TCP uses byte sequence Big-Endian (Motorola format).

The **function code** indicates to the server/frequency inverter what kind of action to perform. The function code is followed by a data field that contains request objects (or, in the case of the inverters response, the response objects). For supported function codes, see 7.2.

If there are no errors while a request is received via Modbus TCP, the data field will contain the required data. If an error occurs, the field contains an Exception condition code to indicate to the client that the request was unsuccessful. see 7.2.4 and 7.2.5.

7 Object access

Modbus definitions for reading/writing data in a device do not exactly fit object access of inverters. Therefore it is necessary to map the register to the object number.

7.1 Address field

In the communication module, Modbus only defines registers. These registers consist of 16-bit values that can be recalled or written individually or in a block. All objects from the object directory of the Axia inverter, which are to be read or written by Modbus, are mapped into this address field. For this purpose, there is a static mapping (fixed assignment between object and register) as well as a dynamic mapping, where objects can be freely mapped into a certain area.

7.1.1 Static mapping

For static mapping, each object (index and sub index) is mapped to exactly one Modbus register. Reading or writing is possible only to one of these registers at a time. In this process, the data width is written over the number of registers, e.g. 4 bytes are written over 2 registers (for a Float data type).

The data types are processed as follows:

UInt8, Int8, Boolean:	1 register (only the low byte is relevant, high byte must be written "0" and is read as "0").
UInt16, Int16:	1 register
UInt32, Int32, Float:	2 registers
UInt64, Int64, Double:	4 registers

Example:

0x3951/1 Inside temperature

0x3951/2 PCB temperature

These two objects are each "float" data types and would therefore occupy a total of four registers. Thus, these objects would have to be mapped to four registers.

Register no. (example) ¹⁾	Content
100	Lower 16 bits of inside temperature
101	Upper 16 bits of inside temperature
102	Lower 16 bits of PCB temperature
103	Upper 16 bits of PCB temperature

1) Register numbers are randomly chosen to illustrate the principle.

This allows to recall both objects in a block. But it would also allow to recall e.g. only the lower 16 bits of a "float" individually. As it is not practical to recall half objects, all relevant objects must lie additionally in a coherent range.

For this reason, a different mapping is used:

Register no. (example) ¹⁾	Content
100	Inside temperature
101	PCB temperature

1) Register numbers are randomly chosen to illustrate the principle.

Please note that always the exact number of registers is read during a recall. It corresponds to the size of the object – in this case exactly two per access. A different number of accesses is not permitted.

7.1.1.1 Address field mapping

The address field is divided into Modbus "Holding Register" and "Input Register". This results in a total address field of 17 bits (16 bit holding and 16-bit input register).

The address field is sorted in groups as follows:

Axia objects	Holding Register	Input Register
0x1001 – 0x1FFF	n. a.	n. a.
0x2001 – 0x27FF	0x S 001 – 0x S 7FF	n. a.
0x3800 – 0x3FFF	0x S 800 – 0x S EFF	n. a.
0x4000 – 0x47FF	n. a.	0x S 000 – 0x S 7FF
0x5800 – 0x5FFF	n. a.	0x S 800 – 0x S FFF
0x6000 – 0x67FF	n. a.	n. a.
0xF000 – 0xF7FF	n. a.	n. a.

n. a. = not applicable

Here, **S** is used as sub index. This means that 4 bits (up to 16 sub indexes) are available per object. Thus, all data-set-dependent objects are covered but higher sub indexes can not be used in static mapping. There are only a few records that contain many sub indexes which are not applicable. These objects must either be preconfigured in the dynamic mapping or defined once with the GUI via the service interface.

The following object areas are excluded from static mapping:

- Communication objects in the range of 0x1XXX
- DS402 objects in the range of 0x6XXX (not available)
- Objects in the range 0x3F00 – 0x3FFF. (This area is used for dynamic mapping.)

When using multi-axis inverters, objects of the second axis can be accessed by setting the object *Active Axis* **0x3950/5** beforehand.

Index	Sub index	Name	Object code	Data type
0x3950	5	Active Axis	Record	UInt8

The following values are possible:

Object 0x3950/5	
1	Axis 1 (default)
2	Axis 2

7.1.2 Dynamic mapping

In contrast to the static mapping, the dynamic mapping allows standard block access (both reading and writing). A fixed address range of the Modbus address field can be freely allocated with objects via parameterization. In the configuration, a new object is defined in the object directory.

Index	Sub index	Name	Object code	Data type	Info
0x3951	1 – 128	Modbus Object Mapping	Array	UInt32	FFSSIIII

All entries in the array are defined as follows:

FF: Flags (Bit 0: permanent write accesses Yes/No. Other bits are reserved → Set to zero)

IIII: Index of the object to be mapped

SS: Sub index of the object to be mapped

Up to 128 objects can be mapped into the dedicated Modbus block transfer area (Holding Register 0xFF00 – 0xFFFF). Depending on the data type, the objects are mapped as follows:

UInt8, Int8, Boolean: 1 register (only the low byte is relevant, high byte must be written "0" and is read as "0").

UInt16, Int16: 1 register

UInt32, Int32, Float: 2 registers

UInt64, Int64, Double: 4 registers

If only Float data types are used for mapping, the entire address range can be used by the 128 objects.

If only UInt16 objects are used for mapping, only half of the address field is used.

When using Int64, a maximum of 64 objects can be mapped.

Example:

0x3951/1 0x00580501 (inside temperature)

0x3951/2 0x00580502 (PCB temperature)

Register	Content
0xFF00	Lower 16 bits of inside temperature
0xFF00	Upper 16 bits of inside temperature
0xFF00	Lower 16 bits of PCB temperature
0xFF00	Upper 16 bits of PCB temperature
...	
0xFFFF	

From this register area any desired number of subsets can be recalled and start register and length are freely selectable. Object boundaries should be considered when writing: Start and end point must not lie amidst an object.



The maximum number of registers result from the maximum frame length of 256 bytes.

Please note, that there may be read-only objects in the mapped area. If the block write is used the read-only objects **must** be written with 0xFFFF in each corresponding register.

Example: Read 3 mapped objects

Mapped object 1: 0x5801.2 (4 bytes, 2 registers) 0x41BF70A4 float = 23.93
 Mapped object 2: 0x2003.4 (4 bytes, 2 registers) 0x40466666 float = 3.1
 Mapped object 3: 0x3910.1 (2 bytes, 1 register) 0x0015 USINT = 21

Request:

Transaction ID	Protocol ID	Length	Unit ID	Function Code	Start Register	No. of Registers
00 00	00 00	00 06	00	03	FF 00	00 05

Response:

Transaction ID	Protocol ID	Length	Unit ID	Function Code	No. of Bytes	Value 0x5801.2	Value 0x2003.4	Value 0x3910.1
00 00	00 00	00 0D	00	03	0A	41 BF 70 A4	40 46 66 66	00 15

7.2 Supported Function Codes

The access to objects via the Modbus protocol is possible by mapping the Modbus address range to the index/sub index addressing of the Axia object register. For this, only standard function codes are implemented. There is no user-specific extension.

Modbus definitions for reading/writing data in a device do not fit directly to object access of inverters (independent of inverter manufacturer). Modbus is defined for reading/writing bits and registers in a different way. Furthermore, data access is limited to 16-bit wide data.

To fulfill the Modbus requirements the data access to objects in the devices (inverters) uses the following standard function codes:

16 bits values:

- Read Holding Register (Function Code 3, Read one 16-bit wide data)
- Read Input Register (Function Code 4, Read one 16-bit wide data)
- Preset Multiple Register (Function Code 16, Write one 16-bit wide data)

32 bits values:

For data access to 32-bit wide data two new inverter specific function codes are defined:

- Read Holding Register (Function Code 3, Read two 16 bits (=32 bit) wide data)
- Read Input Register (Function Code 4, Read one 16-bit wide data)
- Preset Multiple Register (Function Code 16, Write two 16 bits (=32 bit) wide data)



The Modbus specification does not specify the handling of 32-bit values. The implemented handlings and function codes to access 32-bit values are however widely spread and commonly used. These functions allow data access to 32 bit "long" variables/objects in the inverter.



In all data fields with more than one byte, the highest order byte is transmitted first.

7.2.1 Read Holding Register (8/16 bit or 32-bit objects)

With this command it is possible to read one or more contiguous holding register objects. The function code 0x03 is used to read the value of 16-bit or 32-bit objects in the inverter.

Request:

Field:	MBAP						Unit ID	Func. code	Object no.		Number of registers	
	Transaction ID		Protocol ID		Length							
Hex	nn	nn	nn	nn	nn	nn		03			00	01

Request 32 Bit:

Field:	MBAP						Unit ID	Func. code	Object no.		Number of registers	
	Transaction ID		Protocol ID		Length							
Hex	nn	nn	nn	nn	nn	nn		03			00	02

Response 8/16 Bit:

Field:	MBAP						Unit ID	Func. code	No. bytes	Object value	
	Transaction ID		Protocol ID		Length						
Hex	nn	nn	nn	nn	nn	nn		03			

Response 32 Bit:

Field:	MBAP						Unit ID	Func. code	No. bytes	Object value			
	Transaction ID		Protocol ID		Length								
Hex	nn	nn	nn	nn	nn	nn		03					

Request 8/16 Bit object read:

Function Code	1 Byte	0x03
Start address (object no.)	2 Bytes	0x0000 – 0xFFFF
No. of Registers	1 Byte	0x0001

Response 8/16 Bit object read:

Function Code	1 Byte	0x03
No. of Bytes	1 Byte	0x02
Register Value (object value)	2 Bytes	0 – 0xFFFF

Request 32 Bit object read:

Function Code	1 Byte	0x03
Start address (object no.)	2 Bytes	0x0000 – 0xFFFF
No. of Registers	2 Bytes	0x0002

Response 32 Bit object read:

Function Code	1 Byte	0x03
No. of Bytes	1 Byte	0x04
Register Value (object value)	4 Bytes	0 – 0xFFFFFFFF

Exception Condition Response:

Error Code	1 Byte	0x83
Exception condition code	1 Byte	2, 3 or 4

Start address

This field is used for saving the object number.

Number of registers

This field is used for saving the number of objects to be written. The value must always be 1, since only one object can be written at a time.

Number of bytes

This field is set to:

- 2 for 8/16-bit objects
- 4 for 32-bit objects

Register value

This field contains the 16-bit or 32-bit object value.

Exception condition code

The following exception condition codes can occur:

Code	Modbus Name	Cases when generated by the inverter
2	ILLEGAL DATA ADDRESS	Object unknown
3	ILLEGAL DATA VALUE	No. of bytes in the data field too small or too large
4	SLAVE DEVICE FAILURE	Error on writing objects

For a description of exception condition codes  7.2.5 "Exception Condition Codes".

7.2.2 Read Input Register (16 bit or 32-bit objects)

With this command, it is possible to read single input register objects. Function code 0x04 can be used to read the value of 16 Bit objects in the inverter.

Request 16 Bit:

Field:	MBAP						Unit ID	Func. code	Object no.		Number of registers	
	Transaction ID		Protocol ID		Length							
Hex	nn	nn	nn	nn	nn	nn		04			00	01

Request 32 Bit:

Request Data												
Field:	MBAP						Unit ID	Func. code	Object no.		Number of registers	
	Transaction ID		Protocol ID		Length							
Hex	nn	nn	nn	nn	nn	nn		04			00	02

Response 16 Bit:

Field:	MBAP						Unit ID	Func. code	No. bytes	Object value	
	Transaction ID		Protocol ID		Length						
Hex	nn	nn	nn	nn	nn	nn		04			

Response 32 Bit:

Response 02 Data												
Field:	MBAP						Unit ID	Func. code	No. bytes	Object value		
	Transaction ID		Protocol ID		Length							
Hex	nn	nn	nn	nn	nn	nn		03				

Request 16 Bit object read:

Function code	1 Byte	0x04
Start address (object no.)	2 Bytes	0x0000 – 0xFFFF
No. of registers	1 Byte	0x0001

Response 16 Bit object read:

Function code	1 Byte	0x04
No. of bytes	1 Byte	0x02
Register value (object value)	2 Bytes	0 – 0xFFFF

Request 32 Bit object read:

Function Code	1 Byte	0x04
Start address (object no.)	2 Bytes	0x0000 – 0xFFFF
No. of Registers	2 Bytes	0x0002

Response 32 Bit object read:

Function Code	1 Byte	0x04
No. of Bytes	1 Byte	0x04
Register Value (object value)	4 Bytes	0 – 0xFFFFFFFF

Exception Condition Response:

Error code	1 Byte	0x83
Exception condition code	1 Byte	1, 2, 3 or 4

Start address

This field is used for saving the object number.

Number of registers

This field is used for saving the number of objects to be written. The value must always be 1, since only one object can be written at a time.

Register value

This field contains the 16-bit object value.

Exception condition code

The following exception condition codes can occur:

Code	Modbus Name	Cases when generated by the inverter
1	ILLEGAL FUNCTION	Function code unknown Subfunction code unknown
2	ILLEGAL DATA ADDRESS	Object unknown
3	ILLEGAL DATA VALUE	No. of bytes in the data field too small or too large
4	SLAVE DEVICE FAILURE	Error on writing objects

For a description of exception condition codes  7.2.5 "Exception Condition Codes".

7.2.3 Write Multiple Registers

With this command, it is possible to write one or more consecutive holding registers.

Request 16 Bit:

Field:	MBAP						Unit ID	Func. code	Object no.		No. of registers		No. Byte	Object value	
	Transaction ID		Protocol ID		Length										
Hex	nn	nn	nn	nn	nn	nn		16							

Response 16 Bit:

Field:	MBAP						Unit ID	Func. code	Object no.		No. of registers	
	Transaction ID		Protocol ID		Length							
Hex	nn	nn	nn	nn	nn	nn		16				

Request 32 Bit:

Field:	MBAP						Unit ID	Func. code	Object no.		No. of registers		No. Byte	Object value			
	Transaction ID		Protocol ID		Length												
Hex	nn	nn	nn	nn	nn	nn		16									

The response contains the numbers of registers written.

Response: 32 Bit:

Field:	MBAP						Unit ID	Func. code	Object no.	No. of registers	
	Transaction ID		Protocol ID		Length						
Hex	nn	nn	nn	nn	nn	nn		16			

Function code 0x16 can be used to write the value of 16-bit objects or 32-bit objects in the inverter.

Request 16 Bit object write:

MBAP header	7 Bytes	
Function code	1 Byte	0x16
Start address (object no.)	2 Bytes	0x0000 – 0xFFFF
No. of registers	2 Bytes	0x0001
No. of bytes	1 Byte	0x02
Register value (object value)	2 Bytes	0 – 0xFFFF

Response 16 Bit object write:

MBAP header		
Function code	1 Byte	0x16
Start address (object no.)	2 Bytes	0x0000 – 0xFFFF
No. of registers	2 Bytes	0x0001

Request 32 Bit object write:

MBAP header	7 Bytes	
Function code	1 Byte	0x16
Start address (object no.)	2 Bytes	0x0000 – 0xFFFF
No. of registers	2 Bytes	0x0002
No. of bytes	1 Byte	0x04
Register value (object value)	2 Bytes	0 – 0xFFFF FFFF

Response 32 Bit object write:

MBAP header		
Address	1 Byte	1 – 0xFF (=255)
Function code	1 Byte	0x16
Start address (object no.)	2 Bytes	0x0000 – 0xFFFF
No. of registers	2 Bytes	0x0002

Exception condition response:

MBAP header		
Address	1 Byte	1 – 0xFF (=255)
Error code	1 Byte	0x90
Exception condition code	1 Byte	2, 3 or 4

Start address

This field is used for saving the object number.

Register value

This field is used for saving the 16-bit or 32-bit object value.

Exception condition code

The following exception condition codes can occur:

Code	Modbus Name	Cases when generated by the inverter
2	ILLEGAL DATA ADDRESS	Object unknown
3	ILLEGAL DATA VALUE	No. of bytes in the data field too small or too large
4	SLAVE DEVICE FAILURE	Error on reading the object

For a description of exception condition codes  7.2.5 "Exception Condition Codes".

7.2.4 Exception Condition Responses

When the master device sends a request to the inverter it expects a normal response. One of four possible events can occur from the master's query:

- If the inverter receives the request without a transmission error and can handle the query normally, it returns a normal response.
- If the inverter does not receive the request due to a transmission error, it will not send a response. The master will check the conditions for time monitoring of the request.
- If the inverter receives the request and identifies a transmission error, it will not send a response. The master will check the conditions for time monitoring of the request.
- If the inverter receives the request without a transmission error, but cannot handle it (for example, if the request is to read an unknown object), the inverter will return an exception condition response informing the client about the type of the error.

The exception condition response contains two fields which are different from normal responses:

Function code field:

In a normal response, the inverter echoes the function code of the original request in the function code field of the response. All function codes have a most-significant bit (MSB) of 0 (their values are all below 0x80 hexadecimal). In an exception condition response, the inverter sets the MSB of the function code to 1. This makes the function code value in an exception condition response exactly 0x80 hexadecimal higher than the value would be for a normal response. With the function code's MSB set to the new value, the master can identify the exception condition response and analyze the exception condition code in the data field.

Data field:

In a normal response, the inverter will send data or statistical values in the data field (requested information). In an exception condition response, the inverter will send an exception condition code in the data field. This code indicates the cause of the exception to the server.

The exception condition codes generated by the inverter are listed in chapter 7.2.5 "Exception Condition Codes".


7.2.5 Exception Condition Codes

The inverter generates the following exception condition codes:

Code	Modbus Name	Cases when generated by the Inverter
1	ILLEGAL FUNCTION	Function code unknown Subfunction code unknown (Diagnostics Function)
2	ILLEGAL DATA ADDRESS	No. of registers field incorrect (must always be 0x01) Unknown object or object data type mismatch
3	ILLEGAL DATA VALUE	Block check error No. of bytes too small or too large Certain fields not set to specific values
4	SLAVE DEVICE FAILURE	Error on reading the object Read or Write object failed The reason for the error can be obtained by reading out object <i>Error Register 0x1001</i> .

7.2.6 Modbus TCP mode of transmission

The usable contents of Modbus TCP are basically structured like Modbus RTU.

The transmission mode for the Modbus TCP communication can be selected via object *Modbus operating mode* **0x3950/3**.  5.1 "Setting the Modbus Operating Mode".

Example: Read 3 mapped objects

Mapped object 1: 0x**5801.2** External 24 V Voltage (4 bytes, 2 registers)
 Mapped object 2: 0x**2003.4** Rated Current (DS4) (4 bytes, 2 registers)
 Mapped object 3: 0x**3910.1** Systembus Node ID (2 bytes, 1 register)

Index	Sub index	Name	Object code	Data type	Info
0x3951	1 – 128	Modbus Object Mapping	Array	UInt32	FFSSIIII

0x3951.1 = 153601 (0x**00015801**)

0x3951.2 = 270339 (0x**00012003**)

0x3951.3 = 80144 (0x**00013910**)

7.2.7 Modbus RTU message telegram

Modbus messages are added by a sending device into a telegram which has a defined start and end point. The TCP/IP frame enables receiving devices to identify the beginning and end of the message. Incomplete messages must be detected and result in an error.

Modbus RTU messages		
Address	Function	Data
8 bits	8 bits	N x 8 bits

In the RTU (Remote Terminal Unit) mode, each 8-bit byte in a message contains two 4-bit hexadecimal characters. The whole message telegram must be transmitted as a coherent flow of characters.

7.3 Handling of data sets/Cyclic writing

Access to the object values is carried out on the basis of the object number and the required data set. There are objects which only have one value as well as objects which have four values. The latter are used for the data set change-over of an object.

NOTICE

Component damage possible

Only a limited number of write cycles is permissible for the EEPROM (approx. 1 million cycles). When this number is exceeded, the EEPROM will be destroyed.

If values are to be written cyclically with a high repetition rate, avoid entries into the EEPROM.

Data which must be written cyclically can be entered in the RAM exclusively without a writing cycle on the EEPROM. In this case, the data is volatile, i.e. it is lost when the supply voltage is switched off (Mains Off). Data must be written into the RAM again after the restart (Mains On).

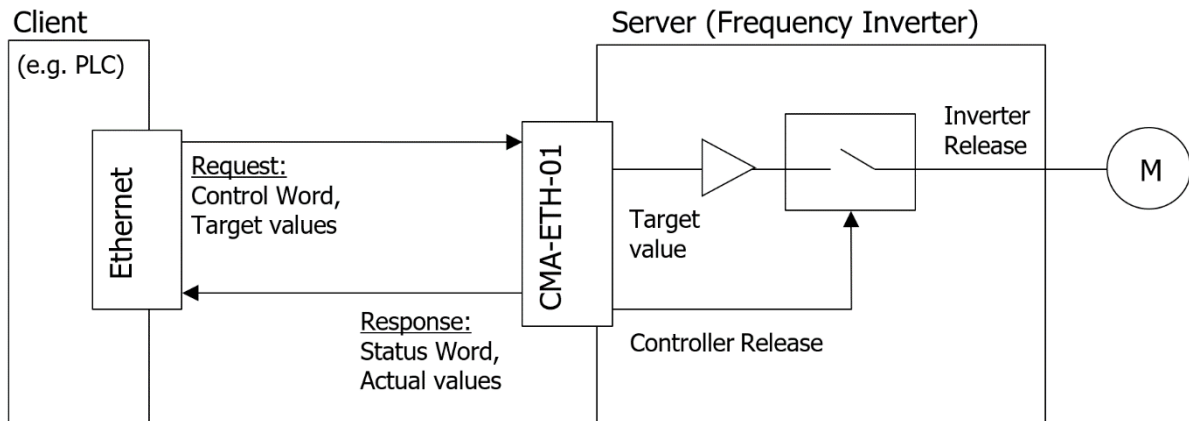
As a safety measure, the number of consecutive write cycles per minute is limited to 10. This safety measure works for up to 32 objects.

8 Control of Frequency Inverter

The PLC can control the frequency inverter completely via the Ethernet interface. Generally, the control over Modbus is possible using all available objects. the Operating Instructions of the frequency inverter for more details.



Please note that the DS402 Drive Profile objects (**0x6000 – 0x7FFF**) are only accessible with dynamic mapping.



The client (PLC) sends its control commands to the frequency inverter via Modbus as an output and gets back the input of the status:

Object			Setting			
Index	Sub index	Designation	Type	Min.	Max.	Default Value
0x6040	0	Control Word	UInt16	0	65535	0
0x6041	0	Status Word	UInt16	0	0	0

With the *Control Word* **0x6040**, control commands are sent to the frequency inverter. Via the *Status Word* **6041**, the status of the frequency inverter is read out.



Control Word **0x6040** is stored in the RAM of the frequency inverter. This is generally addressed via data set 0.

The frequency inverter can be controlled with various control modes. The control mode can be selected with object *Control Mode* **2200/d01**. For more information on setting the control mode the Operating Instructions of the frequency inverter.

If the *Control Mode* **0x2200/d01** is set to mode 3 -State machine the frequency inverter can be controlled with various operation modes. These operation modes can be selected with object **0x6060** *Mode of operation*. For more information on setting the mode of operation the Operating Instructions of the frequency inverter.


0x6040 Control Word

Object *Control Word* **0x6040** is relevant to the frequency inverter if object *Control Mode* **0x2200/d01** is set to "0x00000003 - State machine". In this mode, the frequency inverter is controlled via the control word of the State machine.

For more information on the object *Control Word* the Operating Instructions of the frequency inverter.

0x6041 Status Word

Object *Status Word* **0x6041** shows the current state of the frequency inverter.

For more information on the object *Status Word*  the Operating Instructions of the frequency inverter.

8.1 Special behavior in Modbus

8.1.1 Control via State machine

In control Mode 3 "State machine" (object *Control Mode* **2200/255** = 3: *State-Machine*), the following operation modes cannot be selected with object **0x6060** *Mode of operation*:

- 0x00000008 (Cyclic Synchronous position)
- 0x00000009 (Cyclic Synchronous velocity)
- 0x0000000A (Cyclic Synchronous torque)

8.1.2 Control via IOs

In control mode 1 "IOs" (object *Control Mode* **2200/255** = 1: *IOs*), the frequency inverter is controlled via the digital inputs or via the multi-functional inputs that have been set to digital inputs.

8.1.3 Control via PLC

In control mode 4 "PLC" (object *Control Mode* **2200/255** = 4: *PLC*), the frequency inverter is controlled via the individual bits of the virtual digital inputs in the control word.

If the frequency inverter is controlled via the digital inputs, then in this operation mode control via the *Control Word* **6040** does not apply.

If the operation mode "PLC" is used, the Controller Release "STOA+STOB" must be switched on and bit 0 of the control word must be set, in order to start the drive.

With the use of Remote Contacts the signal sources (digital inputs or multifunctional inputs set as digital inputs) are taken virtually from the *Control Word* **6040**. Signals at the hardware terminals are not evaluated in the standard operation modes.

Operation modes which are marked with the extension (Hardware) are available in order to evaluate signals at the hardware terminals.

Exception: The release must always be made via hardware-inputs IN1D (Terminal X210).

A Controller Release by software alone is not possible.



The frequency inverter supports an external 24 V voltage supply for the control electronics of the frequency inverter. Communication between the controlling device (PLC) and the frequency inverter is still possible even when the mains supply has been switched off.

Bit 4 "Voltage enabled" in the status word indicates the current status of the mains supply.

Bit 4 "Voltage enabled" = 0 signals "no mains supply" and that starting the drive is not possible.

Bit 4 "Voltage enabled" = 1 signals "mains supply switched on" and drive ready for starting.

9 Objects

The available objects are marked with index and sub index and must be addressed via this ID. The objects are listed in the following tables. The following definitions apply:

Access type			
Read only	The PLC can only read data from the frequency inverter.		
Read/Write	The PLC is granted access (reading and writing) to the frequency inverter data.		
Data type			
Unsigned32	32 Bit value: (UDINT)	$0 \dots 2^{32}-1$ 0...0xFFFF FFFF	(0...4294967295)
Unsigned16	16 Bit value: (UINT)	$0 \dots 2^{16}-1$ 0...0x FFFF	(0...65535)
Unsigned8	8 Bit value (USINT)	$0 \dots 2^8-1$ 0...0xFF	(0...255)
Integer32	Signed 32 Bit value (DINT)	$-2^{31} \dots 2^{31}-1$ 0x8000 0000...0x7FFF FFFF	(-2147483648 ... 2147483647)
Integer16	Signed 16 Bit value (INT)	$2^{15} \dots 2^{15}-1$ 0x8000...0x7FFF	(-32768...32767)
Integer8	Signed 8 Bit value (SINT)	$2^7 \dots 2^7-1$ 0x80...0x7F	(-128...127)
Float32	32 Bit value	$2^{-149} \dots 2^{127}$	(0...16777216)



"Highest sub index supported" shows the highest sub index supported by the object.

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** (not available here)
- 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 0x0800 per axis in the axis-dependent range.

For example:

0x2001 *Motor Type* on Axis 1 and **0x2321** *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** (accessible only with dynamic mapping)

Object-no		Group
from	to	
0x2001	0x27FF	Configuration: Axis 1, Settings for Axis 1 Example: 0x2001 for motor type Axis 1
0x2801	0x28FF	Configuration: Axis 2, Settings for Axis 2 Example: 0x2801 for motor type Axis 2
0x3800	0x3FFF	Configuration: Axis independent settings Example: 0x3801 for serial-no. of Axia device
0x4000	0x47FF	Actual Values: Readings for Axis 1 Example: 0x4001 for active data set Axis1
0x4800	0x4FFF	Actual Values: Readings for Axis 2 Example: 0x4801 for active data set Axis2
0x5800	0x5FFF	Actual Values: axis independent readings Example: 0x5801 for DC-link Voltage

9.1 Available objects

Object			Value setting		Chapter
Index	Sub index	Name	Min.	Max.	
0x3950	3	Modbus operating mode	0	5	6.1
0x3950	5	Active Axis	1	2	7.1.1
0x3903	1	IP Address (Ref)	0	0xFFFFFFFF	5.2.1.1
0x3903	2	Subnetmask (Ref)	0	0xFFFFFFFF	5.2.1.1
0x3903	3	Gateway (Ref)	0	0xFFFFFFFF	5.2.1.1
0x3903	6	SNTP Server (Ref)	0	0xFFFFFFFF	5.2.2
0x3903	7	DHCP Option (Ref)	0	1	5.2.1.2
0x3903	9	Hostname	1	23	5.2.3
0x3903	10	Activate IP Settings	0	1	5.2.1.1
0x3903	11	IP Address (Actual)	-	-	5.2.4
0x3903	12	Subnetmask (Actual)	-	-	5.2.4
0x3903	13	Gateway (Actual)	-	-	5.2.4
0x3903	14	DNS Server 1 (Actual)	-	-	5.2.4
0x3903	15	DNS Server 2 (Actual)	-	-	5.2.4
0x3903	16	SNTP (Actual)	-	-	5.2.4
0x3903	18	TCP Config activated	0	1	5.2.5
0x3903	19	Certificate Busy	-	-	5.2.6
0x3903	20	MAC address	-	-	5.2.7
0x3903	21	MAC address Port 1	-	-	5.2.7
0x3903	22	MAC address Port 2	-	-	5.2.7
0x3951	1-128	Modbus Object Mapping	0	0	7.1.2

9.2 Error Messages

The various control methods and the hardware of the frequency inverter include functions which continuously monitor the application. The following error messages are activated by the CMA-ETH-01 communication module.

Error messages and troubleshooting		
F00	00	No error has occurred
	02	Frequency inverter was overloaded (60 sec), check load behavior.
	03	Short-term overload (1 sec), check motor and application objects.
F02	00	Case temperature outside the temperature limits, check cooling and fan.
F03	00	Inside temperature outside the temperature limits, check cooling and fan.
F04	00	Motor temperature too high or sensor defective.
F05	00	Motor phase current above current limits, check load situation and ramps.
	03	Short circuit or earth fault, check motor and wiring.
	05	Asymmetric motor current, check current and wiring.
	07	Message from phase monitoring, check motor and wiring.
F07	00	DC link voltage outside the voltage range, check deceleration ramps and connected brake resistor.
	01	DC link voltage too low, check mains voltage.
	02	Power failure, check mains voltage and circuit.
	06	Motor chopper trigger voltage too low, check mains voltage.
F08	01	Electronics voltage 24 V too low, check control terminal.
	04	Electronics voltage too high, check wiring of control terminals.
F11	00	Output frequency too high, check control signals and settings.
	01	Max. frequency reached by control, check deceleration ramps and connected brake resistor.
	30	Speed sensor signal defective, check connections S4IND and S5IND.
	31	One track of the speed sensor signal is missing, check connections.

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

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