Bonfiglioli Vectron

AXIA AGILE

Communication Interface Manual

CMAA-EC-01 for EtherCAT®

Frequency inverter 230 V / 400 V

0,25 kW ... 11 kW

Bonfiglioli

CONTENTS

1 General Information about the Documentation

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

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 parameters 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 and advanced functionalities 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 of the EtherCAT® fieldbus interface complements the Operating Instructions and the "Quick Start Guide" for the frequency inverters of the AxiaAgile series.

The user manual contains important information on the configuration and use of the EtherCAT® interface in its specified application range. Compliance with user documentation contributes to avoiding risks, minimizing repair cost and downtimes and increasing the reliability and service live of the frequency inverter.

For this reason, make sure you read the user manual carefully.

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

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 AXA (AxiaAgile) series, the following documentation must be complied with:

- The document "Operating Instructions"
- 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
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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 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.

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 protection class 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

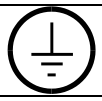
2.6.4 Personal safety equipment

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

Text type	Use
0x1234	Representation of object numbers in text (hexadecimal)
1234	Representation of object numbers in tables (hexadecimal)
:01	Colon, 2 digits: Representation of subindex numbers (hexadecimal)
:1	Colon, 1 digit: Representation of data set numbers (1–4)
Object	Representation of object names
`01234`	Representation of object value/setting

Example: **0x2099:01** *Auto Setup Type:* `0x0000002 (Encoder Offset)`

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 Deutschland GmbH will not accept any responsibility for compatibility with third-party products (e.g. motors, cables or filters).
- In order to enable optimum system compatibility, Bonfiglioli 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 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 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

The present document describes the possibilities and properties of EtherCAT® communication for the frequency inverters of the AxiaAgile device series. It shows how to connect the hardware and describes the relevant available objects.

This manual is not to be understood as providing general/basic information on EtherCAT® interfaces or frequency inverters. The functions and objects in this manual are described to the extent required for the fieldbus communication interface in AxiaAgile.

Basic knowledge of the methods and function of the EtherCAT® protocol are required in order to understand and implement the instructions contained in this document. For more information, refer to the standards of EtherCAT® Technology Group (ETG).

The standards referred to are available at:

EtherCAT® Technology Group

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Web: www.ethercat.org

Phone: +49 (911) 5 40 56 - 20

Fax: +49 (911) 5 40 56 - 29

WARNING

Physical injuries or major material damage

With the communication interface, 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.

- Only qualified persons are allowed to work at the device.

To operate with a controller, you will require an EtherCAT Slave Information (ESI) File. The latest such file can be downloaded from the Bonfiglioli.com website.

Hexadecimal values are marked by a preceding "0x".

Ethernet properties:

- 10/100 MB (10Base-T/100Base-T)
- Automatic identification (Autonegotiation)

Ports:

The interface supports two 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 interface.

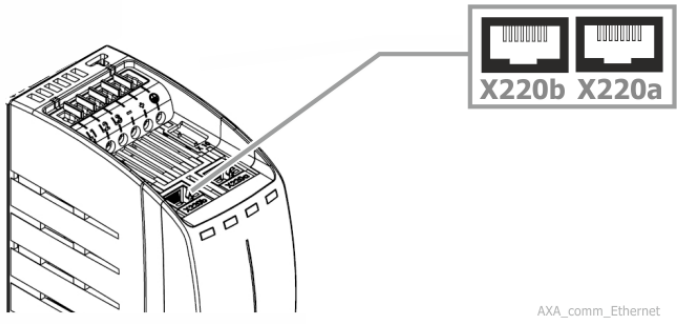
4 Connecting the Fieldbus Communication Interface

The fieldbus communication interface is implemented in the AxiaAgile inverter variants "Enhanced" (CBO-AXA-6S) and "Advanced" (CBO-AXA-8B). The interface has the designation "X220". It is located at the top face of the device. The RJ45 connectors feature LEDs to show the present status of the connection.

4.1.1 Connector assignment

The frequency inverter is connected to the PLC or switch using RJ45 connectors (LAN).

X220 Communication Interface



Fieldbus system	X220a	X220b
EtherCAT®	OUT	IN

Technical characteristics: EtherCAT® interface X220

- 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
  - min. Cat.5

  The cable length is restricted by the Ethernet specifications. Cables must not exceed a length of 100 m.

4.1.2 Status LEDs

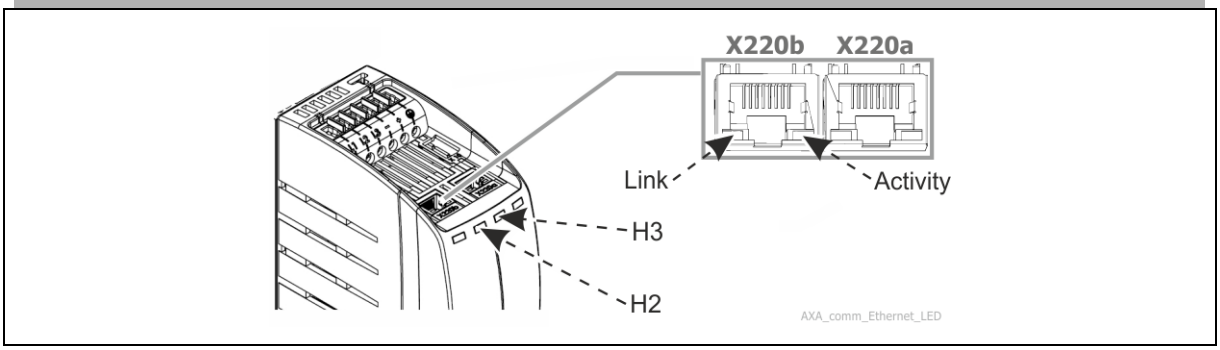
NOTICE

Residual risk

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

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

LED indicators



Link/Activity	RJ45 connector LED indicators
H2	Network LED
H3	Interface LED

Link/Activity: RJ45 connector LED indicators

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

H2, H3: Communication LED indicators:

The multicolor front LEDs (H2, H3) indicate the current statuses of the communication interface:

LED status indicators

Fieldbus communication				
	Link	**Activity**	**H2**	**H3**
green	--	Data activity	Network RUN	Module Operation
red	--	--	Network Error	Module Error
yellow	Link status	--	--	--

5 Initial settings

All objects required for initial settings can be configured in the AxiaManager GUI (Menu> Configure Communication, ☞ AxiaManager GUI manual VEC1en51).

5.1 Setting the fieldbus system to EtherCAT®

The communication interface supports various fieldbus systems featuring RJ45 connectors. The fieldbus system must be selected at the first start. Use the following object for this purpose:

Index	Subindex	Description	Object code	Data type
3904	11	Change Fieldbus	Record	UInt32

- Set the fieldbus system to **0x0000001** `EtherCAT`.

5.2 Setting the node address

Adjustment of the node address is not required. The EtherCAT® master will set an unambiguous, singular 16-bit address for each device upon startup.

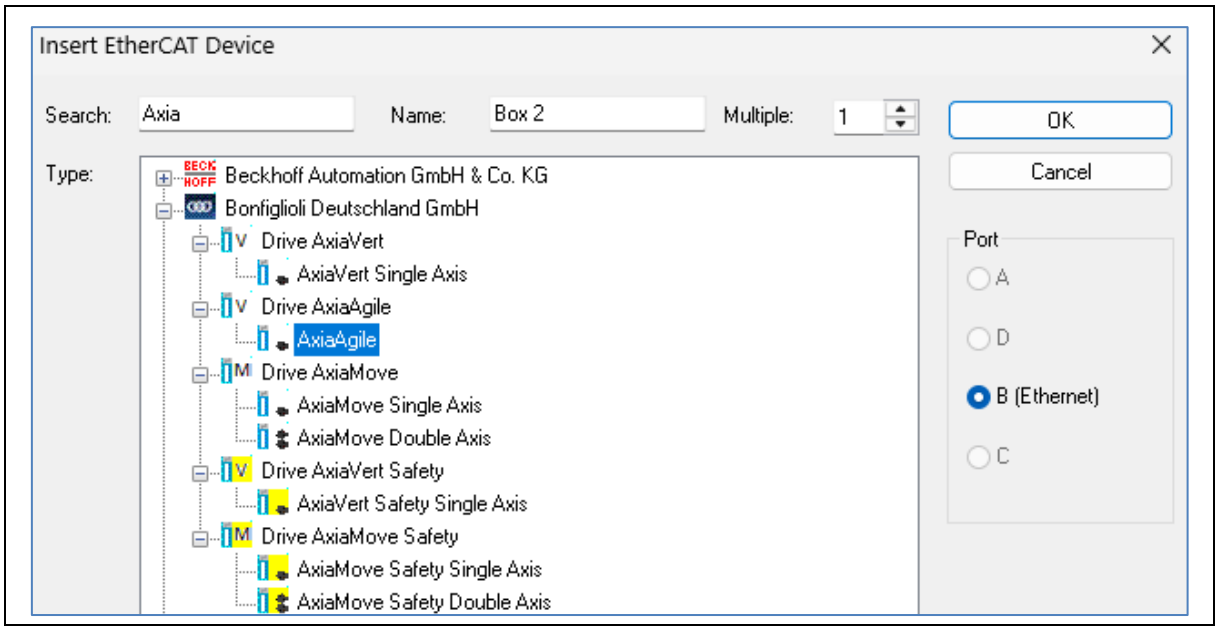
5.3 Configuration

The configuration is based on the Modular Device Profile and explained with Beckhoff® TwinCAT® as an example.

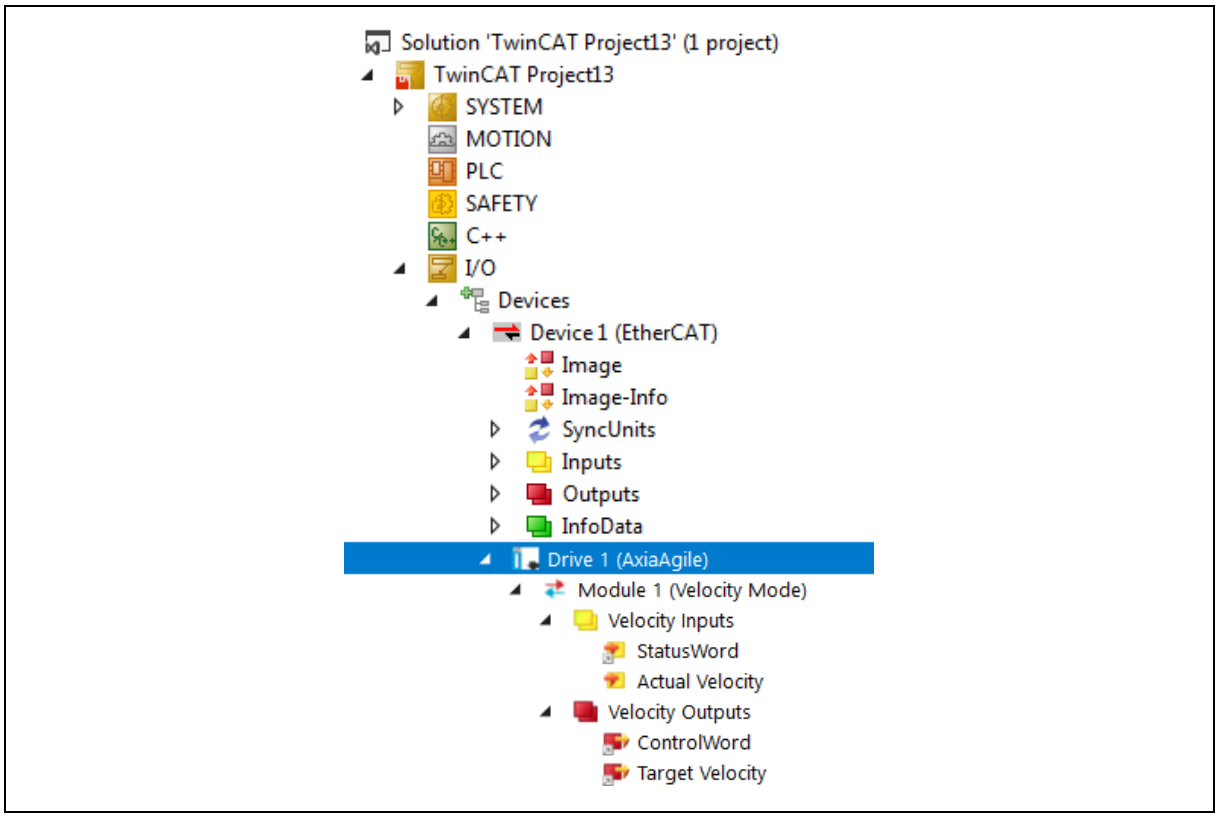
For the implementation in TwinCAT®, a dedicated device description file (ESI xml file) for AxiaAgile inverters is required. This file is provided by Bonfiglioli and can be downloaded at the Bonfiglioli website. must be installed in TwinCAT®. For installation the file must be copied to C:\TwinCAT\3.1\Config\Io\EtherCAT.

With "Add new item" the inverter can be selected from TwinCAT® catalogue (device description).

The described method applies only when Beckhoff® TwinCAT® is used. With other PLCs, there may be other methods for selecting the device in a catalogue.

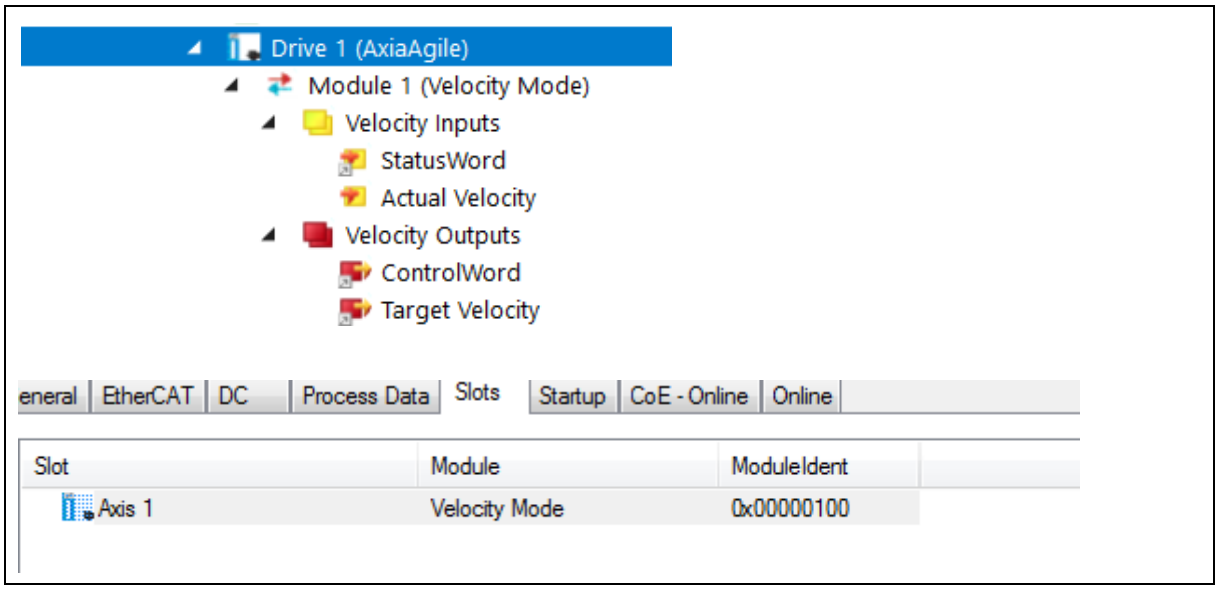


The selected drive is displayed in TwinCAT® tree structure.



The entry "Module 1 (Velocity Mode)" in the above Figure corresponds to the axis. That means the axis is displayed as one module.

With the definition as "Modular Device" the tab "Slots" is visible in TwinCAT® configuration. For an AxiaAgile one slot is available (single axis).

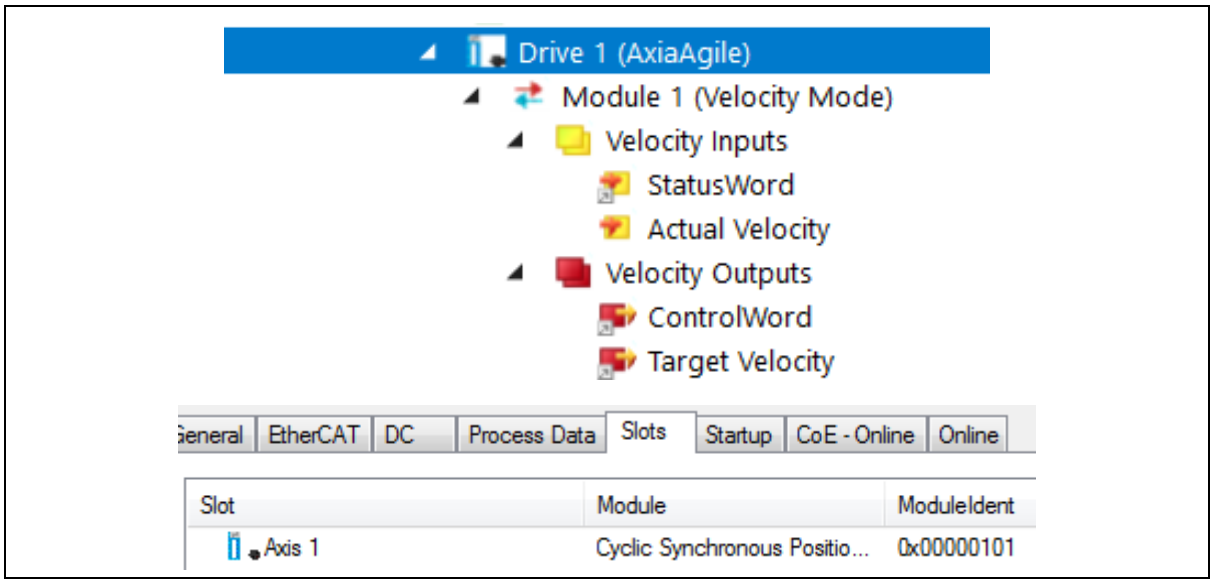


The slot is "Axis 1" with default module "Velocity Mode" selected. The modules represent pre-defined mappings. For "Velocity Mode" the mapping is as follows:

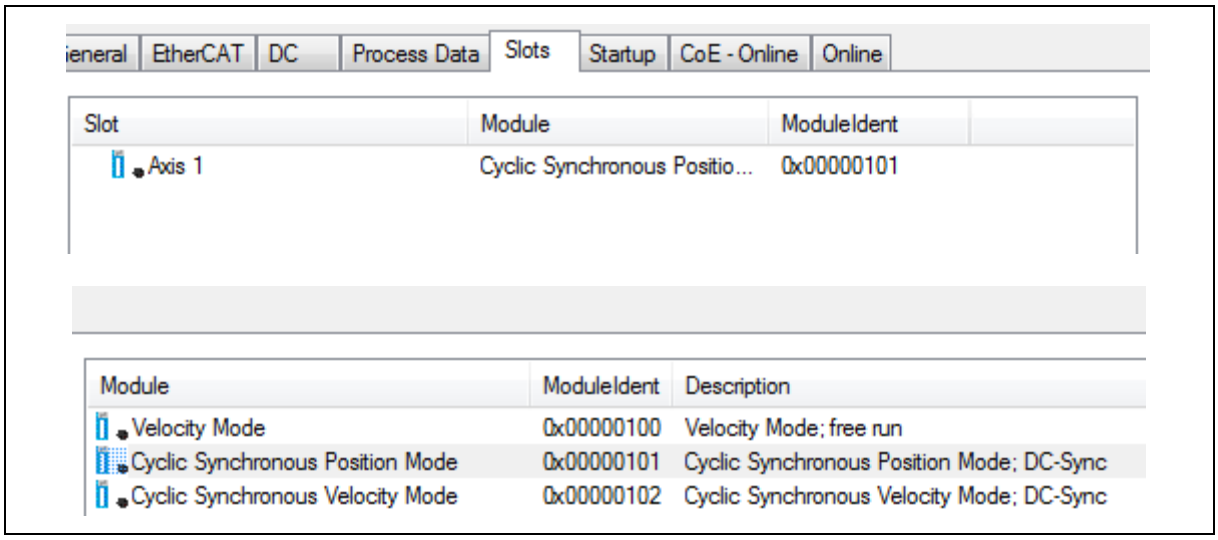
Tx-PDO - Velocity Inputs - Status Word, Actual Velocity [rpm]

Rx-PDO - Velocity Outputs - Control Word, Target Velocity [rpm]

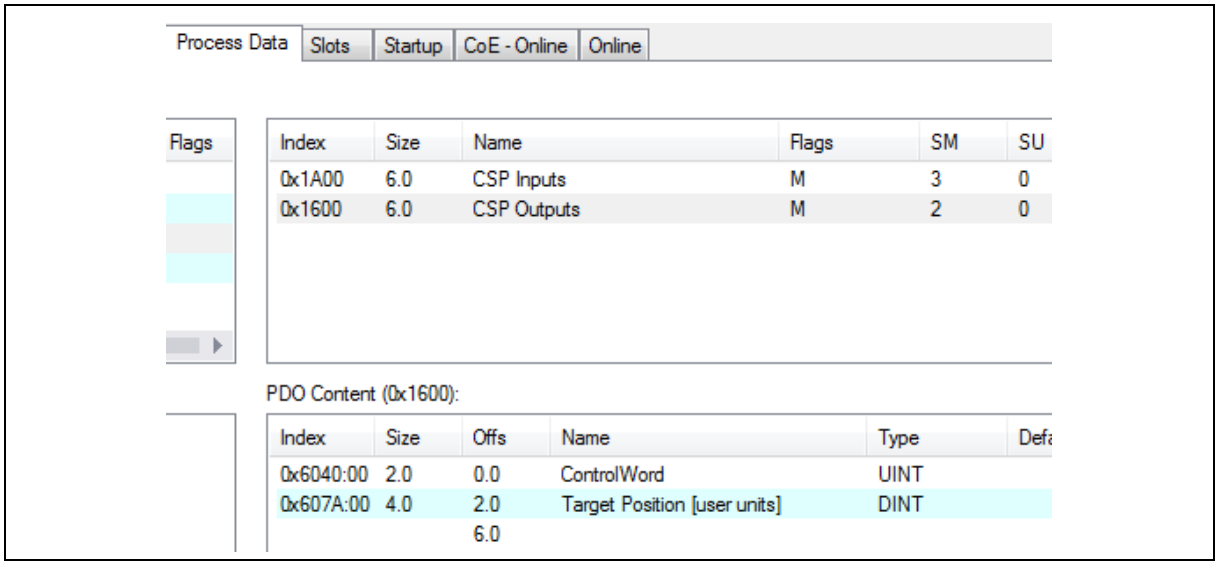
The modules can be removed and another module can be selected. The screenshot displays the change from "Velocity Mode" to "Cyclic Synchronous Position Mode" module.



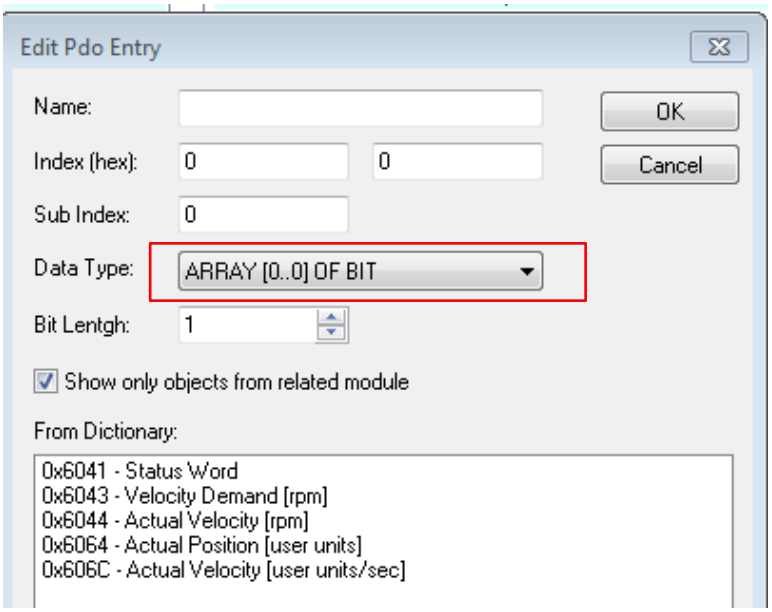
The pre-defined and usable modules are listed in the tab "Slots". The selectable options depend on the data contained in the ESA file.



The module "Cyclic Synchronous Position Mode" is displayed in "Process Data" with the mapped objects.



For CSP Outputs the two objects **0x6040** *Control Word* and **0x607A** *Target Position* are mapped. The mapping can be changed and/or extended with "Insert".



With activated "Show only objects from related module" only objects are displayed for selection that are assigned to the module (e.g. "Cyclic Synchronous Position Mode"). De-activating this setting displays all available objects for mapping.

AxiaAgile features

The minimum cycle time for synchronous operation is 1 ms.

AxiaAgile supports one axis with one RxPDO and one TxPDO with each up to 24 bytes.

6 Operating behavior in the case of bus connection failure

The operating behavior in the case of failure of the bus system can be parameterized. The required behavior can be set via the object **0x6007** *Abort conn. option code* .

Index	Subindex	Meaning	Data type	Access	Map	Def.-Val
6007	00	Abort Conn. option code	Integer16	rw	No	1

Object *Abort conn. option code* defines the operating characteristics of the frequency inverter in the case of an error in the bus connection due to BusOff, RxPDO length error or NMT state change (leaving of NMT state "Operational").

Depending on the setting of **0x2200** *Control Mode*, the response of the setting of object **0x6007** will change as shown in the following table.

Object 0x6007		Setting in object 0x2200	
Operation mode		**Function with "Control via Statemachine"**	**Function in other control modes**
0	No action	Operating point is maintained.	Operating point is maintainied.
1	Fault signal	"Fault" status will be activated immediately. **Default**.	The controller (state machine) switches to "Fault" state immediately.
2	Disable voltage command	Control command "Disable voltage" and switch to "switch on disabled" status.	
3	Quick Stop command	Control command "Quit Stop" and switch to "switch on disabled" status.	
-1	Slow Down Ramp, Fault	Control command "Disable operating" and switch to "Error" status once the drive has been shut down.	
-2	Quick Down Ramp, Fault	Control command "Quick stop" and switch to "Error" status once the drive has been shut down.	

When object **0x6007** is written and a parameter saving instruction (Object **0x1010**) has been generated after that, the value of **0x6007** will be saved in the non-volatile memory.

7 EtherCAT® communication

EtherCAT® is used in a wide range of occasions, preferably as a communication system for positioning applications. EtherCAT® supports the CANopen®-based standard DS402 "drives and motion control" (drives and positioning controls). The standard DS402 describes and defines the required objects and functions for positioning controllers.

Every EtherCAT® device contains an object dictionary with all supported objects. The objects can be divided into the two main groups—communication objects and application objects. The objects are addressed by their index **0xnnnn** (16 bit) and subindex **0xnn** (8 bit). In this document, the object indexes and subindexes are written like this: **0xnnnn:nn** (e.g. **0x3910:2A**, *RxPDO3 Time*).

7.1 Communication Objects

The communication objects are located in the index range **0x1nnn**. They describe the communication behavior of an EtherCAT® device. Some of the communication objects comprise device information (e. g. manufacturer's vendor-id or inverter serial number). With the help of communication objects the application objects for device control are mapped to the PDO messages.

7.2 Application Objects

Application objects are divided in two groups. Index range **0x2000** to **0x5FFF** is reserved for manufacturer-specific objects, and index range **0x6nnn** is reserved for specific device profile objects. These objects are defined by CANopen® DS402 "drive and motion control". They are used for controlling device functions (Start/Stop, speed, positioning functions).

7.3 SDO Function

The SDO (Service Data Objects) messages are used for reading and writing the objects located in the object dictionary.

7.4 PDO Function

PDO(Process Data Objects) messages contain up to 24 bytes of process data per axis. Using communication objects (communication/mapping parameters) the process data objects are mapped to Rx/Tx-PDOs. The frequency inverters support one RxPDO per axis (PLC ➔ frequency inverter, **0x1600** - 1st axis, **0x1610** – 2nd axis) and one TxPDO per axis (frequency inverter ➔ PLC, **0x1A00** - 1st axis, **0x1A10** – 2nd axis).

Process data objects are linked directly to the functions of the frequency inverter.

PDO-message:

Byte	0	1	2	3	4	5	6	7	...	23
	data	data	data	data	data	data	data	data	data	data

7.5 Emergency Function

If there is a fault in the frequency inverter, the frequency inverter will send an error message (emergency message). The fault message contains the relevant fault information. Once the fault is acknowledged (fault reset), another emergency message is sent, with the data bytes reset to zero.

Byte	0	1	2	3	4	5	6	7
Content	EEC	EEC	ER				MEC	MEC

EEC: Emergency Error Code according to DS301 ER: Emergency Register Code according to DS301
MEC: Manufacturer Error Code

The Manufacturer Error Code corresponds to the inverter Fault codes.

Error code table

If an error occurs in reading or writing, the server SDO of the frequency inverter replies with the SDO abort message.

Error codes			
Abort code high	**Abort code low**	**Description as per CANopen®**	**Product-specific allocation**
0x0601	0x0000	Unsupported access to an object	Parameter cannot be written or read
0x0602	0x0000	Object does not exist	Parameter does not exist
0x0604	0x0047	General internal incompatibility in the device	Data sets differ
0x0606	0x0000	Access failed due to a hardware error	EEPROM Error (Read/write/checksum)
0x0607	0x0010	Data type does not match	Parameter has a different data type
0x0607	0x0012	Data type does not match or length of Service telegram too big	Parameter has a different data type or telegram length not correct.
0x0607	0x0013	Data type does not match or length of Service telegram too small	Parameter has a different data type or telegram length not correct.
0x0609	0x0011	Subindex does not exist	Data set does not exist
0x0609	0x0030	Value range of parameter exceeded	Parameter value too large or too small
0x0609	0x0031	Value of parameter written too high.	Parameter value too large
0x0609	0x0032	Value of parameter written too low.	Parameter value too small
0x0800	0x0020	Data cannot be transmitted or saved	Invalid value for operation
0x0800	0x0021	Data cannot be transferred because of local control	Parameter cannot be written in operation

7.6 OS Synchronization (Distributed Clocks)

EtherCAT® interfaces support synchronized communication via Distributed Clocks (DCs) and non-synchronized communication. The configuration of the DCs is done via the PLC configuration utility. No settings have to be made in the frequency inverter.

In the operation modes "Interpolated position mode" "Cyclic Synchronous Position Mode" (CSP) and Cyclic Synchronous Velocity" (CSV), DCs **must** be used for exact and equidistant time control.

The DC Sync Time (synchronization time) must be set in steps of 1 ms. Minimum is 1 ms, maximum 20 ms.

The operating system (OS) of the frequency inverter is synchronized with a PLC or other device using DCs. Synchronization of the operating system will improve the operating characteristics of the machine. Synchronization is used to eliminate CPU **phase** shifting between master and slave devices to make sure that calculations are carried out at the same time. Also, the synchronization via DCs compensates frequency deviations of the quartzes. The synchronization time must be a natural number (multiple of 250 ms for AxiaAgile).

Sync Source 0x3906:0E	
Operation mode	**Function**
0 - Off	The OS is not synchronized with other devices.
1 - Automatic	The synchronization source is selected automatically by the frequency inverter. **Factory setting.**
2 - CM Module	The OS is synchronized via CM interface.
3 - CANopen®	The OS is synchronized via CANopen®.
4 - Systembus	The OS is synchronized via System bus.
5 - IO Module	The OS is synchronized via IO interface.

For proper functioning, Auto or CM must be selected.

Auto mode: Selection is done based on the decision table:

EtherCAT® active	Systembus active	Synchronization
Yes	Yes	Synchronization via EtherCAT®
Yes	No	
No	Yes	Synchronization via Systembus
No	No	No Synchronization activated.

0x3906:0F *Active SyncSource* shows the active Synchronization source.

The parameter **0x3906:01** *Synctime* shows the synctime in seconds as set by PLC.

7.7 NMT Functions

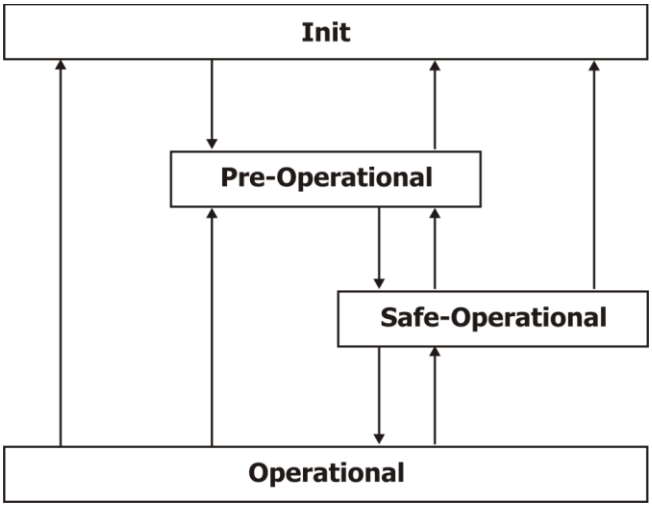
The NMT (= Network Management) functions describe the NMT Statemachine and NMT error saving functions.

The NMT status is displayed via the actual value parameter **0x3911:09** *CANopen NMT State*.

NMT State Machine

On start up, each EtherCAT® slave passes through the NMT state machine.

Possible NMT state changes:



NMT-State	Description
Init	Initializing • No SDO Communication • No PDO Communication
Pre-Operational	Fieldbus active • SDO Communication • No PDO Communication

NMT-State	Description
Safe-Operational	Fieldbus active • SDO Communication • PDO Communication – IN data (TxPDO's) from inverter application send to PLC/master – OUT data (RxPDO's) blocked (not transferred to application in inverter)
Operational	Fieldbus active • SDO Communication • Full PDO Communication "OUT" and "IN" (RxPDO's, TxPDO's)

7.8 Resetting errors

Depending on the settings and operating state of the device, errors can be reset in various ways:

When you are using statemachine, parameter *Control Mode* **0x2200** = `3 - Statemachine`:

– Set bit 7 in **0x6040** *Control word* = `0x0080`.

When using control via Keypad, parameter *Control mode* **0x2200** = `2 - Keypad`:

- Press the STOP button of the keypad.

– Resetting by pressing the STOP button is only possible if parameter *Control Mode* **0x2200** permits control via the keypad.

When using control via IOs, parameter *Control mode* **0x2200** = `1 - IOs`:

- Reset the error by activating the corresponding digital input.

– Resetting via digital signal can only be carried out when parameter *Control Mode* **0x2200** permits this or when an input with the additional (hardware) is selected in the case of physical inputs.

Some errors will occur again after an error reset. In such cases, it may be necessary to take certain measures (e.g. moving from a limit switch in the non-disabled direction).

8 Object Structure

The available objects are marked with Index and Subindex and must be addressed via this ID.

EtherCAT® offers the possibility to use CANopen®-Objects via CoE (CANopen® over EtherCAT®). 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 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)
Integer8	Signed 8 Bit value: -	$-2^{7}…2^{7}-1$ 0x80…0x7F	(-128…127)
Boolean		FALSE…TRUE	0…1
Float32	Floating-point number with 4 digits after the point	$-2^{31}…2^{31}-1$ 0x8000 0000…0x7FFF FFFF	
Visible string	String up to 99 characters long. (Transmission via Segmented Transfer in CANopen®).		
PDO Mapping			
No	This object cannot be used for exchange of PDO. Only SDO can be used.		
Tx	This object can be transmitted from the frequency inverter in a TxPDO.		
Rx	This object can be transmitted to the frequency inverter in a RxPDO.		

"Highest subindex supported" shows the highest subindex 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**
- 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 **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**

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
0x6000	0x67FF	CiA 402 objects Axis 1
0x6800	0x6FFF	CiA 402 objects Axis 2

9 Communication Objects (0x1nnn)

Communication objects **0x1nnn** contain all parameters for communication.

Abbreviations used

r/w: Read/Write
ro: Read only
wo: Write only
Map: Mapping
Def.-Val: Default value

The headings are displayed in the format *Index/Subindex Object name*.

9.1 0x1000 Device Type

Index	Subindex	Meaning	Data type	Access	Map	Def.-Val
1000	00	Device Type	Unsigned 32	ro	No	0

The device identification is carried out upon network startup. The information about the device type and functionality (type) is defined by the CANopen® DS402 standard.

Object 0x1000					
Additional Information				Device Profile Number	
Mode Bits		Type			
31	24	23	16	15	0

The standard device profile "Drives and Motion Control" used by the frequency inverter is shown as device profile number 402. The other information specifies the device functionality of the frequency inverter.

Device Profile Number	= 402	drives and motion control
Type	= 41	Frequency inverter
Mode bits	= 0	unused

9.2 0x1001 Error Register

Index	Subindex	Meaning	Data type	Access	Map	Def.-Val
1001	00	Error Register	Unsigned 8	ro	No	0

Object **0x1001** is the register for internal frequency inverter faults. Status "no fault" (**0x1001** = 0) or "fault" (**0x1001** ≠ 0) is displayed.

In case of a fault, the PLC can evaluate detailed information via the Emergency Message (☞ 7.5).

Object 0x1001			
Bit		**Bit**	
0	Generic error	**4**	Communication error
1	Current	**5**	Device profile specific error
2	Voltage	**6**	Reserved
3	Temperature	**7**	Manufacturer specific error

9.3 0x1008 Manufacturer Device Name

Index	Subindex	Meaning	Data type	Access	Map	Def.-Val
1008	00	Manufacturer Device name	Visible string	ro	No	See Text

9.4 0x1009 Manufacturer Hardware Version

Index	Subindex	Meaning	Data type	Access	Map	Def.-Val
1009	00	Manufacturer Hardware version	Visible string	ro	No	See Text

9.5 0x100A Manufacturer Software Version

Index	Subindex	Meaning	Data type	Access	Map	Def.-Val
100A	00	Manufacturer Software version	Visible string	ro	No	See Text

9.6 0x1018:nn Identity Object

The *identity object* provides information about the device manufacturer and the device.

Index	Subindex	Meaning	Data type	Access	Map	Def.-Val
1018	00	Highest Subindex supported	Unsigned8	ro	No	4
	01	Vendor ID	Unsigned32	ro	No	See text
	02	Product code	Unsigned32	ro	No	See text
	03	Revision number	Unsigned32	ro	No	See text
	04	Serial number	Unsigned32	ro	No	See text

"Vendor ID" "**0xD5**" refers to manufacturer **BONFIGLIOLI GmbH**.

This "Vendor ID" is assigned by the EtherCAT® (EtherCAT Technology Group) in Nuremberg, Germany.

Product code:
Shows the type ID of the frequency inverter.

Revision number:
Shows the revision level of the EtherCAT®/CANopen® system of the frequency inverter.

Serial number:
Shows the serial number of the frequency inverter.

9.7 0x1600:nn, 0x1601:nn, 0x1602:nn, 0x1603:nn, RxPDO Mapping Parameter

Index	Subindex	Meaning	Data type	Access	Map	Def.-Val
1600 1601 1602 1603	00	Number of mapped objects	Unsigned8	rw	No	2
	01	1st mapped obj.	Unsigned32	rw	No	See text
	02	2nd mapped obj.	Unsigned8	rw	No	See text

Mapping entry:

MSB			LSB
Object index		Subindex	Length (no. of bits)
High byte	Low byte	si	ll

Examples:

Mapping of 0x6040 Control word (unsigned16 = 10hex) to 1st mapped object in RxPDO1:

0x1600:01 = 0x60400010

Default mapping

RxPDO1	0x1600:00	0x1601:00	0x1602:00	0x1600:03…08
	2	0x6040 Control word	0x6042 *v* target velocity	0x00000000

9.8 0x1A00:nn, 0x1A01:nn, 0x1A02:nn, 0x1A03:nn, TxPDO Mapping Parameter

Index	Subindex	Meaning	Data type	Access	Map	Def.-Val
1A00 1A01 1A02 1A03	00	Number of mapped objects	Unsigned8	rw	No	2
	01	1st mapped obj.	Unsigned32	rw	No	See text
	02	2nd mapped obj.	Unsigned32	rw	No	See text

Mapping entry:

MSB			LSB
Object index		Subindex	Length (no. of bits)
High byte	Low byte	si	ll

Examples:

Mapping of **0x6041:00** Statusword (unsigned16) to "1st mapped obj." in TxPDO1:

0x1A00:01 = 0x60410010

Mapping of **0x6064:00** Position actual value (integer32) to "2nd mapped obj." in TxPDO1:

0x1A00:02 = 0x60640020

Default mapping

TxPDO1	0x1A00:00	0x1A00:01	0x1A00:02	0x1A00:03…08
	2	0x6041 Status word	0x6044 *v* velocity actual value	0x00000000

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COD. VEC 5en31 R0

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