

ACTIVE CUBE

EtherCAT[®]
Communication module
CM-EtherCAT[®] / CM2-EtherCAT[®]
Frequency inverter 230 V / 400 V



愛り Bonfiglioli



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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 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 parameters 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 of the CM-EtherCAT® and CM2-EtherCAT® communication module complements the Operating Instructions and the "Quick Start Guide" for the frequency inverters of the ACU 201, ACU 401, ACU210 und ACU410 device series.

The user manual contains important information on the installation and use of the EtherCAT® communication module CM-EtherCAT® in its specified application range. Compliance with this user manual 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.



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⚠ WARNING

Compliance with the documentation is required to ensure safe operation of the frequency inverter. BONFIGLIOLI VECTRON 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.

1.2 Warranty and liability

BONFIGLIOLI VECTRON GmbH would like to point out that the contents of this user manual do not form part of any previous or existing agreement, assurance or legal relationship. 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 notice. The manufacturer shall not be liable for any damage, injuries or costs which may be caused by the aforementioned reasons.

Furthermore, BONFIGLIOLI VECTRON GmbH excludes any warranty/liability claims for any personal and/or material damage if such damage is due to 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

This user manual 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 user manual and, in particular, the safety instructions in order to prevent personal and material losses.

1.4 Copyright

In accordance with applicable law against unfair competition, this user manual is a certificate. Any copyrights relating to it shall remain with

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These user manual 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 dated 09 September 1965, the law against unfair competition and the 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 form 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 this user manual must also be handed over.

1.6 Final decommissioning

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



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

Disposal requirements under European Union WEEE regulations

The product is marked with the WEEE symbol shown below.

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





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 at all times.

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 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 inside of the frequency inverter if no external disconnection device was installed by the operator.

Electrostatic charging

Touching electronic components bears the risk of electrostatic discharges.

Thermal hazards

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

Charged capacitors in DC link

The DC link may have dangerous voltage levels even up to three minutes after shutdown.

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

Center of gravity is not the middle of the electric cabinet modules.

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.



MARNING

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.

NOTE

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

2.6.2 Hazard symbols

Symbol	Meaning	Symbol	Meaning
<u></u>	General hazard		Suspended load
4	Electrical voltage	<u>\$\$\$\$</u>	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
R	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
i	Tips and information making using the frequency inverter easier.

2.6.9 Font style in documentation

Example	Font style	Use			
1234	bold	Representation of parameter numbers			
Parameter	italic, Font Times New Roman	Representation of parameter names			
P.1234	bold	Representation of parameter 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 VECTRON 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 VECTRON 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:

- 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.



3 Introduction

The present document describes the possibilities and properties of EtherCAT® communication for the frequency inverters of the ACU series of devices.

EtherCAT® communication (as described in this manual) requires software version 5.3.0 or higher.

"Cyclic Synchronous Positioning" mode and "Cyclic Synchronous Positioning" mode is Supported with software version 5.4.0 or higher.

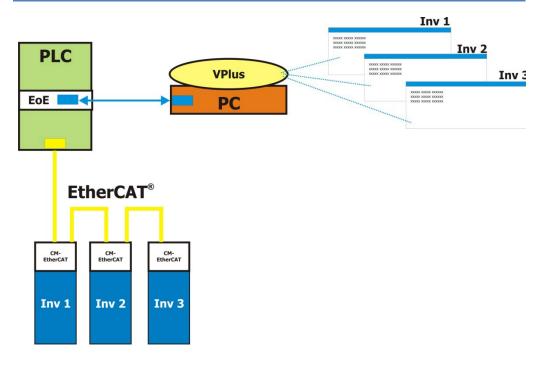


Please refer to chapter 16.6 "Object support in the Software versions and XML" for information on the required objects and XML files.



This manual is not to be understood as providing general/basic information on Ether-CAT®. It requires basic knowledge of the methods and effects of EtherCAT® on the user's side.

In some chapters, setting and display options via the PC software VPlus are described as an alternative to the KP500 control unit. Use of a PCs running the VPlus software requires an optional interface adapter KP232 or EoE modules in the PLC for a direct Ethernet connection from the PC/VPlus to the frequency inverter.





In this document, the hardware circuitry, relevant parameters and the available objects are described.

The available objects are divided by:

Communication objects (0x1nnn)

Manufacturer objects (0x2nnn) Standardized objects (0x6nnn)

The functions and objects are described in this manual to the extent necessary. For more information, refer to the standards of EtherCAT® Technology Group (ETG). The standards referred to are available at:

EtherCAT® Technology Group Headquarters

Ostendstr. 196 90482 Nürnberg, Germany

E-Mail: <u>info@ethercat.org</u> Phone: +49 (911) 5 40 56 - 20 Web: www.ethercat.org Fax: +49 (911) 5 40 56 - 29

NOTE

With the CM-EtherCAT® communication module, it is possible to access **ALL** frequency inverters parameters from a controller. There is no access control via the control level as in the case of the KP500 manual control unit or the VPlus PC software. Changing parameters, 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.

NOTE

If values are to be written cyclically, follow the notes in Chapter 12.3.1 "Handling of data sets/cyclic writing of the parameters".



For operation with a controller, a XML is required. The latest device description can be downloaded from the Bonfiglioli.com website.



Hexadecimal values are marked in the following by a preceding "0x".



3.1 Supported Configurations

ACTIVE CUBE inverters support different types of control and reference values:

- Standard (without Positioning functions)
- Positioning via contacts (or remote contacts)
- Positioning via Motion Control Interface (MCI) via field bus

Motion control configurations are set when parameter configuration **30** = x40 (in example 240). To use the full functionality of the Motion Control Interface Parameter Local/Remote **412** = "1-Control via State machine" must be set.

The inverter's behavior with respect to *control word | status word* and *modes of operation | modes of operation display* is different in the two different types of configuration.

Standard:

Necessary settings: Configuration $30 \neq x40$.

Local/Remote **412** = (Remote) contacts

- → The control (Start, Stop, Frequency change over, etc.) is carried out typically via:
 - Digital contacts
 - Remote contacts via Field bus
- → Reference values result from the select configuration. Typical are:
 - o Reference speed / Reference frequency:
 - Analogue input
 - Fixed values from parameters
 - 0x6042 v/ target velocity
 - o Percentage reference value for technology controller or Torque control
 - Analogue input
 - Fixed values from parameters

Please refer to chapter 14.3 "Configurations without motion control" for the control without Positioning functionality.

Positioning via contacts (or remote contacts):

Necessary settings: Configuration 30 = x40.

Local/Remote **412** = (Remote) contacts

- → The control (Start, Stop, Target position change over, etc.) is carried out typically via:
 - Digital contacts
 - Remote contacts via Field bus
- → Reference values result from the selected configuration. Typical are:
 - o Reference speed / Reference frequency
 - o Reference vI target position

Please refer also to the application manual "Positioning".

MCI (Motion Control Interface - Positioning via Field bus):

Necessary settings: Configuration 30 = x40.

Local/Remote **412** = 1 - Statemachine

- \rightarrow The control (Start, Stop, mode change over, etc.) is carried out via <u>0x6040</u> Control word.
- \rightarrow Reference values result from the selected <u>0x6060</u> *Modes of Operation*.

Typical are:

- Reference speed via 0x6042 v/target velocity
- Target position <u>0x607A</u> Target position.

The usage of the Motion Control Interface is described in this manual in chapter 14.4 "Motion control configurations".



3.2 Initialization time

When the frequency inverter is turned on, the communication module must be initialized in addition to the frequency inverter. The initialization can take up to 20 seconds.



Wait until the initialization phase is complete before starting the communication (RUN LED).

4 First Commissioning

For the first commissioning you should acquaint yourself with the following steps and the described functions:

•	Selection of		Chapter Chapter	
	0	PDO Mapping	Chapter	12.2.9, 12.2.10
	0	Fault reaction	Chapter	10, 12.5.1
		Fault reset	Chapter	16.4, 11.9
•	Setting Refe	rence value:		
	0	Speed setting in speed controlled configuration x10, x11, x15, x16, x30, x60	Chapter	14.3
	0	Reference value in Positioning configuration x40	Chapter	13 and 14.4
		 Velocity Mode 	Chapter	14.4.1
			Chapter	14.4.2
			Chapter	14.4.3
		Homing Mode	Chapter	14.4.5
		 Interpolated Position Mode 	Chapter	14.4.4
		 Cyclic Synchronous Position Mode 	Chapter	14.4.6
		 Cyclic Synchronous Velocity Mode 	Chapter	14.4.7
		 Table Travel record Mode 	Chapter	14.4.8
		 Move Away from Limit Switch 	Chapter	14.4.9
		 Mode of Operation change 	Chapter	12.5.12
•	Diagnosis:		Chapter	15, 16



5 Installation/Disassembly of the communication module

5.1 Installation

The CM-EtherCAT® communication module is delivered in a case for assembly. In addition, a PE-spring is supplied for PE-connection (shield).

⚠ Caution!

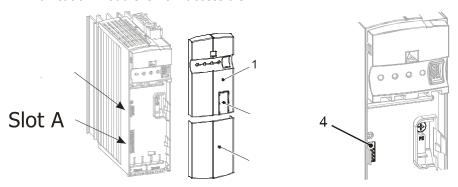
Danger of destroying the frequency inverter and/or the communication module



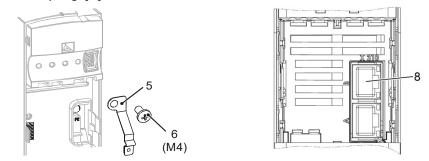
- The frequency inverter must be disconnected from the power supply before installation of the communication module. Assembly under voltage is not permissible.
- Do not touch the PCB visible on the back of the module, otherwise components may be damaged.

Work steps:

- Disconnect the frequency inverter from the mains voltage and protect it against being energized unintentionally.
- Remove covers **(1)** and **(2)** of the frequency inverter. Slot B **(4)** for the communication module is now accessible.



- Mount the supplied PE spring **(5)** using the M4 screw **(6)** in the unit. The spring must be aligned centrally.
- Insert the communication module in slot B (4) until it engages audibly.
- Fix the communication module by screwing the M2 screw (7) of the module to the PE spring (5).

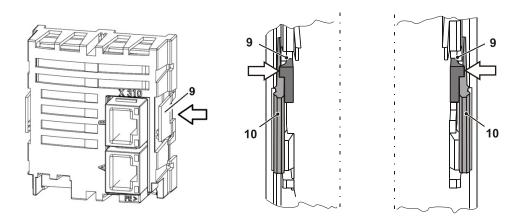


- In the upper cover (1), break out the pre-punched cutout (3) for the plug X310 (8).
- Mount the two covers (1) and (2).



5.2 Disassembly

- Disconnect the frequency inverter from mains voltage and protect it against being energized unintentionally.
- Remove covers (1) and (2) of the frequency inverter.



- Loosen the M2 screw (7) on the communication module
- Unplug the communication module from Slot B (4) by unlocking the locking hooks (9) on the right and left hand side of the module from the case of the frequency inverter using a small screwdriver.

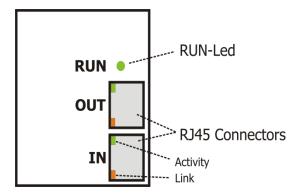
The looking hooks **(9)** are located at the place where the looking hooks **(10)** for the upper cover **(1)** project from the case of the frequency inverter.

- To do this, carefully insert the screwdriver in the gap between the case of the module and the frequency inverter and push the locking hook inwards in the direction of the arrow (⇐). As soon as the right hand side is unlocked, pull the module out a bit on the right hand side and hold it.
- Hold the module on the right hand side while unlocking the locking hook on the left hand side in the same way (⇒).
- Pull the module out of the slot by gently pulling on the right and left hand side alternately.
- Disassemble the PE spring (5).
- Mount the two covers (1) and (2).



6 Connector assignment

The EtherCAT® module is connected to the PLC and/or other devices using standard Ethernet cables with RJ45 connectors.



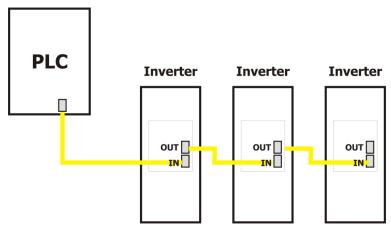
Ethernet standard: IEEE 802.3, 100Base-TX (fast Ethernet)

Cable type: S/FTP (cable with braided shield, (ISO/IEC 11801 or EN

50173, Straight Through or Cross Over)

Connections from the PLC are connected to "IN".

Connections to the next device are connected to "OUT".



7 RUN-LED

The green RUN LED indicates the current status of the CM-EtherCAT®.

LED Status	Module status
Off	INITIALISATION
Blinking	PRE-OPERATIONAL
Single Flash	SAFE-OPERATIONAL
On	OPERATIONAL

8 Cable lengths

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

9 Setting the node address

Adjustment of the node address is not required. The EtherCAT $^{\otimes}$ master will set an unambiguous, singular 16-bit address for each device upon startup.



10 Operating behavior in the case of bus connection failure

The operating behavior in the case of failure of the EtherCAT $^{\otimes}$ systems can be parameterized. The required behavior can be set via in parameter $Bus\ Error\ Behaviour$ 388 .

Bus Error behavior 388	Function
0 - No Reaction	Operating point is maintained
1 - Error	"Fault" status will be activated immediately. Factory setting .
2 - Stop	Control command "Disable voltage" and switch to "switch on disabled" status.
3 - Quick-Stop	Control command "Quick stop" and switch to "switch on disabled d" status.
4 - Ramp-Stop + Error	Control command "Disable operation" and switch to "Error" status once the drive has been shut down.
5 - Quick-Stop + Error	Control command "Quick stop" and switch to "Error" status once the drive has been shut down.

NOTE

The parameter settings $Bus\ Error\ Behaviour\ {\bf 388}=2...\ 5$ are evaluated depending of parameter $Local/Remote\ {\bf 412}.$

There are numerous options of parameterizing the fault and warning behavior of the frequency inverter. For details about possible faults, refer to Chapter 16.4 "Fault messages".

11 EtherCAT® overview

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). This standard 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 sub-index 0xnn (8 bit).

11.1 Communication Objects

The communication objects are located in the index range 0x1nnn. They describe the communication behaviour 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.

11.2 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. The specific device profile objects 0x6nnn are defined by CANopen® DS402 "drive and motion control". They are used for controlling device functions (Start/Stop, speed, positioning functions).



11.3 Function SDO

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

11.3.1 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 tele- gram too big	Parameter has a different data type or telegram length not correct.				
0x0607	0x0013	Data type does not match or length of Service tele- gram 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 transmit- ted or saved	Invalid value for operation				
0x0800	0x0021	Data cannot be trans- ferred because of local control	Parameter cannot be written in operation				



11.4 PDO Function

PDO (Process Data Objects) messages contain up to 8 bytes of process data. Using communication objects (communication/mapping parameters) the process data objects are mapped to Rx/Tx-PDOs. The frequency inverters support three RxPDOs (PLC → frequency inverter) and three TxPDOs (frequency inverter → PLC).

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

PDO-message:

Byte	0	1	2	3	4	5	6	7
	data							

The number of bytes is $1 \dots 8$ and depends on the mapped objects. The bytes are arranged in the Intel format.

Byte	0	1	2	3	4	5
	16 bit object		32 bit object			
	LSB	MSB	LSB			MSB

11.5 Emergency Function

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

Byte	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 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 that are described in the Operating Instructions and in this documentation in chapter 16.4 "Fault messages".

11.6 Synchronization (Distributed Clocks)

CM-EtherCAT® modules 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 on the frequency purchase side.



In the "Interpolated position mode" operation mode, 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.



11.7 NMT Functions

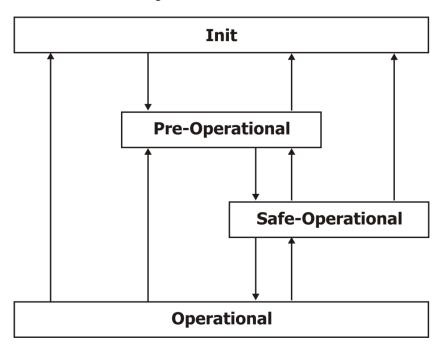
The NMT (= Network Management) functions describe the NMT Statemachine and NMT error saving functions.

The NMT status is displayed via the actual value parameter *NMTNode-State* **1443**.

11.7.1 NMT Statemachine

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

Possible NMT state changes:



NMT-State	Description					
Init	Initialising					
	No SDO Communication					
	No PDO Communication					
Pre-Operational	Fieldbus active					
	SDO Communication					
	No PDO Communication					
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)					



11.8 OS Synchronization

The operating system (OS) of the frequency inverter can be synchronized with a PLC or other device. 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. Note, that only small deviations of the CPU clock frequencies between devices (i.e. different CPU Quartz cock frequencies) of \pm 1 % can be compensated. The synchronization time must be a natural number (multiple of 1 ms).

	OS SyncSource 1452					
Operation mode	Function					
0 - Auto	The synchronization source is selected automatically by the frequency inverter. Factory setting.					
1 - CANopen®	The OS is synchronized via CANopen®.					
2 - Systembus	The OS is synchronized via Systembus.					
3 - Ind. Ethernet Module	The OS is synchronized via Ethernet Module					
4 - Synchronised Ind. Ethernet Module	The OS is synchronized via synchronized Ethernet Module e.g. EtherCAT®					
99 - Off	The OS is not synchronized with other devices.					

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

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

1453 OS SyncSource Act shows the active Synchronization source

The parameter **1451** *OS Synctime* can be used to shift the point of the synchronization inside of 1 ms. When you experience noises from a motor, shifting the *CANopen OS Synctime* can result in a better behavior.

	Parameter		Setting	
No.	Description	Min.	Max.	Factory set- ting
1451	OS Synctime	700 us	900 us	800 us



For the VPlus Scope Function the following sources are available for diagnosis:

Operation mode	Function
731 - B: Sync. OS <-> Sysbus Ok	1 = Synchronization OS to Systembus OK, 0 = Synchronization OS to Systembus not OK
SysBus SYNC time [us] 852 -	Shows the Synchronization cycle. Should show the set SYNC time or TxPDO time of the sending master.
853 - SysBus SYNC position 1ms Task [us]	Shows the Synchronization time inside 1 ms. Should remain constant with small fluctuations.
B: Sync. 854 - OS <-> CANopen/EtherCAT Ok	1 = Synchronization OS to CANopen OK, 0 = Synchronization OS to CANopen not OK
856 - EtherCAT SYNC time [us]	Shows the Synchronization cycle.
857 - EtherCAT SYNC position 1ms Task [us]	Shows the Synchronization time inside 1 ms. Should remain constant with small fluctuations
848 - CANopen SYNC time [us]	Shows the Synchronization cycle.
849 - CANopen SYNC position 1ms Task [us]	Shows the Synchronization time inside 1 ms. Should remain constant with small fluctuations

11.9 Resetting errors

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

- When using control via parameter *Local/Remote* **412** = Statemachine: Set bit 7 in 0x6040 Control word = 0x0080.
- By pressing the stop button of the control panel.
 Resetting by pressing the STOP button is only possible if Parameter *Local/Remote* 412 permits control via the control panel.
- via parameter *Error Acknowledgement* **103** which is assigned a logic signal or a digital input

A reset via a digital signal can only be carried out when parameter Lo-cal/Remote **412** permits this or when an input with the addition (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).



12 Objects

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

EtherCAT® offers the possibility to use CANopen®-Objects via CoE (CANopen® over EtherCAT®). The list of the CANopen manual contains at certain points additional objects that are required for using CANopen® as Field bus system. These objects are not described here.

12.1 Objects tabular overview

The objects are listed in the following tables. The following definitions apply:

	Access ty	ре			
Read only	The PLC can only rea	d data from the freq	uency inverter.		
Read/Write	The PLC is granted u	nlimited access (read	ding and writing)		
	to the frequency inve	erter data.			
	Data typ	e			
Unsigned32	32 Bit value:	02 ³² -1			
		00xFFFF FFFF			
Unsigned16	16 Bit value:	02 ¹⁶ -1	(065535)		
		00x FFFF			
Unsigned8	8 Bit value:	028-1	(0255)		
		00xFF			
Integer32 Signed 32 Bit value: -2 ³¹ 2 ³¹ -1					
		0x8000 00000x7F	FF FFFF		
Integer16	Signed 16 Bit value:	2 ¹⁵ 2 ¹⁵ -1	(-3276832767)		
		0x80000x7FFF			
Integer8	Signed 8 Bit value: -	2 ⁷ 2 ⁷ -1	(-128127)		
		0x800x7F			
Visible string	String up to 99 chara	acters long. Transmis	ssion via Segment-		
	ed Transfer.				
	PDO Mapp				
No	This object cannot be	e used for exchange	of PDO. Only SDO		
	can be used.				
Tx	This object can be tra	ansmitted from the f	requency inverter		
	in a TxPDO.				
Rx	This object can be tra	ansmitted to the frec	juency inverter in		
	a RxPDO.				



[&]quot;Highest sub index supported" shows the highest subindex supported by the object.

12.1.1 Communication objects

Index	SubIndex	Name	SDO Access	Data type	PDO-mapping
<u>0x1000</u>	0	Device type	Read Only	Unsigned32	No
<u>0x1001</u>	0	Error register	Read Only	Unsigned8	No
<u>0x1008</u>	0	Manufacturer device name	Read Only	Visible string	No
<u>0x1009</u>	0	Manufacturer hardware version	Read Only	Visible string	No
<u>0x100A</u>	0	Manufacturer software version	Read Only	Visible string	No
<u>0x1010</u>		Store parameters			
	0	Highest Sub-index supported	Read Only	Unsigned8	No
	1	Save all parameters	Read/Write	Unsigned32	No
	2	Save communication parame-	Read/Write	Unsigned32	No
		ters			
	3	Save application parameters	Read/Write	Unsigned32	No



Index	SubIndex	Name	SDO Access	Data type	PDO-mapping
<u>0x1011</u>	•	Restore default parameters			
	0	Highest Sub-index supported	Read Only	Unsigned8	No
	1	Restore all default parameters	Read/Write	Unsigned32	No
	2	Restore communication default parameters	Read/Write	Unsigned32	No
	3	Restore application default parameters	Read/Write	Unsigned32	No
<u>0x1018</u>	<u> </u>	Identity object		l	
	0	Highest Sub-index supported	Read Only	Unsigned8	No
	1	Vendor ID	Read Only	Unsigned32	No
	2	Product code	Read Only	Unsigned32	No
	3	Revision number	Read Only	Unsigned32	No
0x1600	4	Serial number	Read Only	Unsigned32	No
<u>0X1000</u>	0	RxPDO1 mapping parameter No. of mapped objects	Read/Write	Unsigned8	No
	1	1. mapped objects	Read/write	Unsigned32	No
	2	2. mapped obj.	Read/write	Unsigned32	No
	3	3. mapped obj.	Read/write	Unsigned32	No
	4	4. mapped obj.	Read/write	Unsigned32	No
	5	5. mapped obj.	Read/write	Unsigned32	No
	6	6. mapped obj.	Read/write	Unsigned32	No
	7	7. mapped obj.	Read/write	Unsigned32	No
0x1601	8	8. mapped obj.	Read/write	Unsigned32	No
<u>0X1001</u>		RxPDO2 mapping parameter	Read/Write	Unsigned8	No
	0	No. of mapped objects			No
		1. mapped obj.	Read/write	Unsigned32	
	3	mapped obj. mapped obj.	Read/write Read/write	Unsigned32 Unsigned32	No No
	4	4. mapped obj.	Read/write	Unsigned32	No
	5	5. mapped obj.	Read/write	Unsigned32	No
	6	6. mapped obj.	Read/write	Unsigned32	No
	7	7. mapped obj.	Read/write	Unsigned32	No
	8	8. mapped obj.	Read/write	Unsigned32	No
<u>0x1602</u>		RxPDO3 mapping parameter			
	0	No. of mapped objects	Read/Write	Unsigned8	No
	1	1. mapped obj.	Read/write	Unsigned32	No
	2	2. mapped obj.	Read/write	Unsigned32	No
	3	3. mapped obj.	Read/write	Unsigned32	No
	4	4. mapped obj.	Read/write	Unsigned32	No
	<u>5</u>	5. mapped obj. 6. mapped obj.	Read/write Read/write	Unsigned32 Unsigned32	No No
	7	7. mapped obj.	Read/write	Unsigned32	No
	8	8. mapped obj.	Read/write	Unsigned32	No
0x1A00		TxPDO1 mapping parameter	,		
	0	No. of mapped objects	Read/Write	Unsigned8	No
	1	1. mapped obj.	Read/write	Unsigned32	No
	2	2. mapped obj.	Read/write	Unsigned32	No
	3	3. mapped obj.	Read/write	Unsigned32	No
	4	4. mapped obj.	Read/write	Unsigned32	No
	5 6	5. mapped obj.6. mapped obj.	Read/write Read/write	Unsigned32 Unsigned32	No No
	7	7. mapped obj.	Read/write	Unsigned32	No
	8	8. mapped obj.	Read/write	Unsigned32	No
0x1A01	•	TxPDO2 mapping parameter			
	0	No. of mapped objects	Read/Write	Unsigned8	No
	1	1. mapped obj.	Read/write	Unsigned32	No
			Read/write	Unsigned32	No
	2	2. mapped obj.			
	3	3. mapped obj.	Read/write	Unsigned32	No
	3 4	3. mapped obj. 4. mapped obj.	Read/write Read/write	Unsigned32 Unsigned32	No
	3 4 5	3. mapped obj.4. mapped obj.5. mapped obj.	Read/write Read/write Read/write	Unsigned32 Unsigned32 Unsigned32	No No
	3 4	3. mapped obj. 4. mapped obj.	Read/write Read/write	Unsigned32 Unsigned32	No



Index	SubIndex	Name	SDO Access	Data type	PDO-mapping
<u>0x1A02</u>		TxPDO3 mapping parameter			
	0	No. of mapped objects	Read/Write	Unsigned8	No
	1	1. mapped obj.	Read/write	Unsigned32	No
2		2. mapped obj.	Read/write	Unsigned32	No
	3	3. mapped obj.	Read/write	Unsigned32	No
	4	4. mapped obj.	Read/write	Unsigned32	No
	5	5. mapped obj.	Read/write	Unsigned32	No
	6	6. mapped obj.	Read/write	Unsigned32	No
	7	7. mapped obj.	Read/write	Unsigned32	No
	8	8. mapped obj.	Read/write	Unsigned32	No

12.1.2 Manufacturer objects

Index	Sub- index	Name	SDO Access	Data type	PDO- map- ping	Default setting	MinMax	Belonging Param.		
			1	Manufact	urer specif	fic		l		
<u>0x2nnn</u>	0, 1, 9			Direct access to ad/write access	inverter pa	arameters				
		Please refer to chapter	se refer to chapter 12.3.1 "Handling of data sets/cyclic writing of the parameters"							
0x3001	0	Digital In actual values	Read only	Unsigned16	Tx	-	-	-		
<u>0x3002</u>	0	Digital Out actual values	Read only	Unsigned16	Tx	-	1	-		
<u>0x3003</u>	0	Digital Out set values	Read/write	Unsigned16	Rx	0	00x1F			
0x3004	0	Boolean Mux	Read only	Unsigned16	Tx	-	-	-		
0x3005	0	Boolean Demux	Read/write	Unsigned16	Rx	0	00xFFFF	-		
<u>0x3006</u>	0	Percentage set value	Read/write	Unsigned16	Rx	0	0x8AD0 0x7530	-		
<u>0x3007</u>	0	Percentage actual value 1	Read only	Unsigned16	Tx	-	-	-		
0x3008	0	Percentage actual value 2	Read only	Unsigned16	Tx	-	-	-		
0x3011	0	Act. value Word 1	Read only	Unsigned16	Tx	-	-	-		
0x3012	0	Act. value Word 2	Read only	Unsigned16	Tx	-	-	-		
0x3021	0	Act. value Long 1	Read only	Unsigned32	Tx	-	-	-		
0x3022	0	Act. value Long 2	Read only	Unsigned32	Tx	-	-	-		
0x3111	0	Ref. value Word 1	Read/write	Unsigned16	Rx	0	00xFFFF	-		
0x3112	0	Ref. value Word 2	Read/write	Unsigned16	Rx	0	00xFFFF	-		
0x3121	0	Ref. value Long 1	Read/write	Unsigned32	Rx	0	0 0xFFFF.FFFF	-		
<u>0x3122</u>	0	Ref. value Long 2	Read/write	Unsigned32	Rx	0	0 0xFFFF.FFFF	-		
0x5F10		Gear factor g)								
	0	Highest sub-index supported	Read only	Unsigned8	No	-	1	-		
	1	Numerator	Read/write	Integer16	Rx	1	10x7FFF	p.1123		
	2	Denominator	Read/write	Unsigned16	Rx	1	10xFFFF	p.1124		
	3	Resync on Change	Read/write	Integer16	No	1	01	p.1142		
0x5F11		Phasing 1 g)								
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-		
	1	Offset	Read/write	Integer32	No	0x0001.0000	0x8000.0001 	p.1125 DS1		
	2	Speed	Read/write	Unsigned32	No	0x0005.0000	0x7FFF.FFFF 1	p.1126 DS1		
	3	Acceleration	Read/write	Unsigned32	No	0x0005.0000	0x7FFF.FFFF 1	p.1127 DS1		
0x5F12		Phasing 2 ^{g)}	<u> </u>		<u> </u>		0x7FFF.FFFF			
UX5F1Z	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-		
	1	Offset	Read/write	Integer32	No	0x0001.0000	0x8000.0001	p.1125 DS2		
	2	Speed	Read/write	Unsigned32	No	0x0005.0000	0x7FFF.FFFF 1	p.1126 DS2		
		•		J			0x7FFF.FFFF			



Index	Sub- index	Name	SDO Access	Data type	PDO- map- ping	Default setting	MinMax	Belonging. Param.
	3	Acceleration	Read/write	Unsigned32	No	0x0005.0000	1 0x7FFF.FFFF	p.1127 DS2
0x5F13		Phasing 3 g)						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Offset	Read/write	Integer32	No	0x0001.0000	0x8000.0001 0x7FFF.FFFF	p.1125 DS3
ŀ	2	Speed	Read/write	Unsigned32	No	0x0005.0000	1 0x7FFF.FFFF	p.1126 DS3
-	3	Acceleration	Read/write	Unsigned32	No	0x0005.0000	1 0x7FFF.FFFF	p.1127 DS3
0x5F14		Phasing 4 g)						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Offset	Read/write	Integer32	No	0x0001.0000	0x8000.0001 0x7FFF.FFFF	p.1125 DS4
-	2	Speed	Read/write	Unsigned32	No	0x0005.0000	1 0x7FFF.FFFF	p.1126 DS4
	3	Acceleration	Read/write	Unsigned32	No	0x0005.0000	1 0x7FFF.FFFF	p.1127 DS4
0x5F15	0	In Gear Threshold	Read/write	Unsigned32	No	0	0 0x7FFF.FFFF	p.1168
0x5F16	0	In Gear Time	Read/write	Unsigned16	No	10	10xFFFF	p.1169
0x5F17		Position Controller v) u)	n) i) p) t) g)					
	0	Highest sub-index supported	Read only	Unsigned8	No	-	1	-
	1	Time Constant [ms]	Read/write	Integer32	No	10,00	1,00300,00	p.1104
	2	Limitation	Read/write	Unsigned32	No	327680	0 0x7FFF.FFFF	p.1118
0x5F18	0	Master Synchronization Offset ^{g)}	Read/write	Integer32	No	0	0x8000.0001 0x7FFF.FFFF	p.1284
0x5FF0	0	Active motion block t)	Read only	Unsigned8	Tx	-	-	-
0x5FF1	0	Motion block to resume t)	Read only	Unsigned8	Tx	-	-	-

- v) Velocity Mode only: This Object is only used in Velocity mode [rpm].
- u) Profile Velocity Mode only: This Object is only used in Profile Velocity mode [u/s].
- h) Homing Mode only: This Object is only used in Homing mode.
- i) Interpolated Position Mode only: This Object is only used in Interpolated Position mode.
- p) Profile Position Mode only: This Object is only used in Profile Position mode.
- g) Electronic gear: slave Mode only: This Object is only used in Electronic Gear mode.
- t) Table travel record mode only: This Object is only used in Table travel record mode.



12.1.3 Device profile objects

Index	Sub- index	Designation	SDO Ac- cess	Data type	PDO- map- ping	Default setting	MinMax	Belong- ing. Param.
<u>0x6007</u>	0	Abort connection option code	Read/write	Integer16	No	1	-23	p.388
0x603F	0	Error code	Read only	Unsigned16	No	-	-	-
0x6040	0	Control word	Read/write	Unsigned16	Rx	-	-	p.410
<u>0x6041</u>	0	Status word	Read/only	Unsigned16	Tx	-	-	p.411
<u>0x6042</u>	0	v/target velocity v)	Read/write	Interger16	Rx	0	-32768 32767	-
<u>0x6043</u>	0	vl velocity demand	Read only	Integer16	Tx	-	-	-
<u>0x6044</u>	0	v∕velocity actual value	Read only	Integer16	Tx	-	-	-
<u>0x6046</u>		v∕ velocity min max amount						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	v/velocity min amount	Read/write	Unsigned32	No	0	032767	p.418
	2	v/velocity max amount	Read/write	Unsigned32	No	32767	032767	p.419
<u>0x6048</u>		v/velocity accelera- tion v)				-	-	-
	0	Highest sub-index supported	Read only	Unsigned8	No			
	1	Delta speed	Read/write	Unsigned32	No	150	132767	p.420 &
	2	Delta time	Read/write	Unsigned16	No	1	165535	p.422
<u>0x6049</u>		v/velocity deceleration v)						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Delta speed	Read/write	Unsigned32	No	150	132767	p.421 &
	2	Delta time	Read/write	Unsigned16	No	1	165535	p.423
<u>0x604A</u>		√/velocity quick stop						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Delta speed	Read/write	Unsigned32	No	150	132767	p.424 &
	2	Delta time	Read/write	Unsigned16	No	1	165535	p.425
<u>0x6060</u>	0	Modes of operation	Write only	Integer8	Rx	2	-39	-
<u>0x6061</u>	0	Modes of operation display	Read only	Integer8	Tx	2	-	-
<u>0x6064</u>	0	Position actual value	Read only	Integer32	Tx	-	0x8000.0001 0x7FFF.FFFF	p.1108
<u>0x6065</u>	0	Following error win- dow	Read/write	Unsigned32	No	0xFFFF.FFFF	0 0xFFFF.FFFF	p.1105
<u>0x6066</u>	0	Following error time out	Read/write	Unsigned16	No	10	065535	p.1119
<u>0x6067</u>	0	Position window	Read/write	Unsigned32	No	0xFFFF.FFFF	0 0xFFFF.FFFF	p.1165
0x6068	0	Position window time	Read/write	Unsigned16	No	10	065535	p.1166
<u>0x606C</u>	0	Velocity Actual value	Read	Integer32	Tx			-
<u>0x606D</u>	0	Velocity Window ^{u)}	Read/write	Unsigned16	No	1000	065535	p.1276
<u>0x606E</u>	0	Velocity Window Time ^{u)}	Read/write	Unsigned16	No	0	065535	p.1277
<u>0x606F</u>	0	Velocity Threshold u)	Read/write	Unsigned16	No	100	065535	p.1278
<u>0x6070</u>	0	Velocity Threshold Time ^{u)}	Read/write	Unsigned16	No	0	065535	p.1279
<u>0x6071</u>	0	Target torque	Read/write	Integer16	Rx			-
<u>0x6077</u>	0	Torque actual value	Read only	Integer16	Tx			p.224
<u>0x6078</u>	0	Current actual value	Read only	Integer16	Tx			p.214
<u>0x6079</u>	0	DC link circuit voltage	Read only	Integer32	Tx			p.222



Index	Sub- index	Designation	SDO Ac- cess	Data type	PDO- map- ping	Default setting	MinMax	Belong- ing. Param.
<u>0x607A</u>	0	Target position p)sv)	Read/write	Integer32	Rx	0	0x8000.0001 0x7FFF.FFFF	p.1202
0x607C	0	Home offset h)	Read/write	Integer32	No	0	0x8000.0001 0x7FFF.FFFF	p.1131
<u>0x6081</u>	0	Profile velocity p) i) u)	Read/write	Unsigned32	Rx	0x0005.0000	1 0x7FFF.FFFF	
<u>0x6083</u>	0	Profile acceleration p) i) u)	Read/write	Unsigned32	Rx	0x0005.0000	1 0x7FFF.FFFF	
0x6084	0	Profile deceleration p) i) u)	Read/write	Unsigned32	Rx	0x0005.0000	1 0x7FFF.FFFF	
0x6085	0	Quick stop deceleration (h) i) p) t) u)	Read/write	Unsigned32	No	0x000A.0000	1 0x7FFF.FFFF	p.1179
<u>0x6086</u>	0	Motion profile type ^{u)}	Read/write	Integer16	No	3	03	-
0x6091		Gear ratio						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Motor revolutions	Read/write	Unsigned32	No	1	165535	p.1116
	2	(Driving) Shaft revo- lutions	Read/write	Unsigned32	No	1	165535	p.1117
0x6092		Feed constant						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Feed	Read/write	Unsigned32	No	0x0001.0000	1 0x7FFF.FFFF	p.1115
	2	(Driving) Shaft revolutions	Read/write	Unsigned32	No	1	1	
<u>0x6098</u>	0	Homing method h)	Read/write	Integer8	No	0	035	p.1130
0x6099		Homing speeds h) l)						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Speed during search for switch	Read/write	Unsigned32	No	0x0005.0000	1 0x7FFF.FFFF	p.1132
	2	Speed during search for zero	Read/write	Unsigned32	No	0x0002.0000	1 0x7FFF.FFFF	p.1133
<u>0x609A</u>	0	Homing acceleration h)	Read/write	Unsigned32	No	0x0005.0000	1 0x7FFF.FFFF	p.1134
<u>0x60C1</u>		Interpolation data record ⁱ⁾						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Interpolation data record 1	Read/write	Integer32	Rx	0	0x8000.0001 0x7FFF.FFFF	
<u>0x60F4</u>	0	Following error actual value	Read only	Integer32	Тх			p.1109
0x60F8	0	Max Slippage ^{u)}	Read/write	Integer32	No	0		p. 1275
<u>0x60FF</u>	0	Target velocity u)sv)	Read/write	Integer32	Rx			
0x6502	0	Supported drive modes	Read only	Unsigned32	No	0x0202	0x0202	-

- v) Velocity Mode: This Object is used in Velocity mode [rpm].
- u) Profile Velocity Mode: This Object is used in Profile Velocity mode [u/s].
- h) Homing Mode: This Object is used in Homing mode.
- i) Interpolated Position Mode: This Object is used in Interpolated Position mode.
- p) Profile Position Mode: This Object is used in Profile Position mode.
- t) Table travel record mode: This Object is used in Table travel record mode.
- I) Move away from limit switch Mode: This Object is used in Move away from limit switch mode.
- sp) Cyclic Sync Position mode: This Object is used in Cyclic Synchronous Position mode.
- sv) Cyclic Sync Velocity mode: This Object is used in Cyclic Synchronous Velocity mode.



The Modes "Homing", "Interpolated Position", "Profile Position", "Profile Velocity" and "Table travel record", "Move away from Limit Switch", Cyclic Sync Position" and "Cyclic Sync Velocity" require a configuration capable of Positioning. Check chapter 14.4 Motion control configurations" for details.



The representations of CANopen® objects and parameters may be different (refer to relevant object description.

NOTE

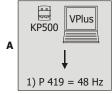
Some of the above listed CANopen® objects have corresponding inverter parameters.

These objects are handled in a special way. If one of these CANopen® objects has been written by SDO followed by a "save" command (see object 0×1010), the written value is stored to non-volatile memory of the inverter. After the next power on of the inverter these CANopen® object values are restored again and overwrite the inverter parameter values.

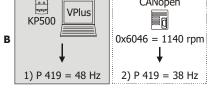
Be careful when using this method. If a CANopen[®] object was written and saved and then the corresponding inverter parameter was set by e. g. VPlus, the next power on cycle overwrites the value set by VPlus with the value stored by the "save" command.

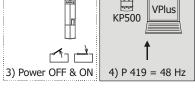
Effect of the "save" command (Object 0x1010)

(Example of sequence of parameter entries and object entries)



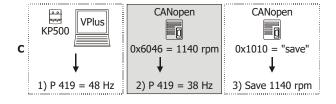


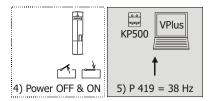


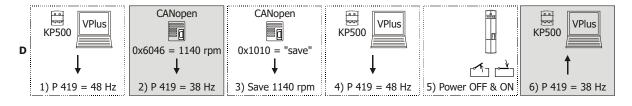


VPlus

KP500







Sequence



- **A** Value of a parameter is set via KP500 or VPlus. No "save" command.
 - 1) Setting of *Maximum Frequency* **419** = 48 Hz at KP500 or in VPlus.
 - 2) Power OFF and ON.
 - 3) The value of KP500/VPlus is active (48 Hz).
- **B** No "save" command. The value of the CANopen® object is overwritten.
 - 1) Setting of *Maximum Frequency* **419** = 48 Hz at KP500 or in VPlus.
 - 2) Setting of CANopen® object 0x6046 = 1140 rpm* (equivalent to 38 Hz).
 - 3) Power OFF and ON.
 - 4) Parameter value of KP500/VPlus overwrites the value of the CANopen® object. The value of KP500/VPlus is active (48 Hz).
- **C** "Save" command. The value of the CANopen® object is stored.
 - 1) Setting of *Maximum Frequency* **419** = 48 Hz at KP500 or in VPlus.
 - 2) Setting of CANopen® object 0x6046 = 1140 rpm* (equivalent to 38 Hz).
 - 3) "Save" command via CANopen® object 0x1010.
 - 4) Power OFF and ON.
 - 5) The value of CANopen[®] object 0x6046 is active (38 Hz).
- **D** "Save" command. The value of the CANopen® object is stored even if the corresponding parameter value has been changed after the "save" command.
 - 1) Setting of *Maximum Frequency* **419** = 48 Hz at KP500 or in VPlus.
 - 2) Setting of CANopen® object $0x6046 = 1140 \text{ rpm}^*$ (equivalent to 38 Hz).
 - 3) "Save" command via CANopen® object 0x1010.
 - 4) Setting of *Maximum Frequency* **419** = 48 Hz at KP500 or in VPlus.
 - 5) Power OFF and ON.
 - 6) Value of CANopen® object 0x6046 overwrites the parameter value. The value of CANopen® object 0x6046 is active (38 Hz).
- * Internal conversion to a frequency value taking into account the *No. of Pole Pairs* **373**. In this example the number of pole pairs is two (four-pole machine).

NOTE

For some frequency parameters which are calculated from CANopen® DS402 objects it is necessary to enter the number of pole pairs, e.g. for calculation of the deceleration or acceleration parameters. These calculations use the number of pole pairs from Dataset 1. If the number of pole pairs in the datasets is different, the result of the calculation may be implausible to the user. For this reason, we recommend writing the frequency inverter parameters via the SDO channel with objects Ox2nnn (manufacturer) and not using the CANopen® DS402 objects. In this way, inconsistencies are avoided.

CANopen® DS402 objects with corresponding frequency inverter parameters are indicated in this manual.



12.2 Communication Objects (0x1nnn)

Communication objects 0x1nnn contain all parameters for communication.



For easier usage, the objects are summarized by a table in each paragraph. This table is marked additional by colour.

Orange colour = Read Only object

Green colour = Read and Write object

Blue colour = Write only object

Abbreviations used

Access: Access type 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*.

12.2.1 0x1000/0 Device Type

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x1000	0	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.

		Ot	oject Ux10	טעע / טעע		
Additional Information					Davisa Profile Number	
	Mode Bits	Туре	9		Device Profile Number	
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 = 42 servo drive Mode bits = 0 unused



Up to Firmware 5.2.0 (including) "Type" depends on the setting of parameter *Configuration* **30**.

A motion control configuration (Configuration **30**=x**40**) sets type = 42 "servo drive".

Other configurations set type = 41 "frequency converter".

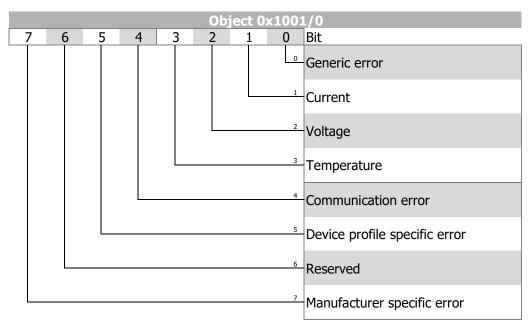
Firmware 5.3.0 and higher always sets type = 42 "servo drive".

12.2.2 0x1001/0 Error Register

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x1001	0	Error Register	Unsigned 8	ro	No	0

Object 0x1001/0 is the error register for internal frequency inverter errors. Status "no error" (0x1001/0 = 0) or "Error" $(0x1001/0 \neq 0)$ is displayed.

Detailed information on the device error can be read via VPlus, Parameter *Current error* **259** and EtherCAT[®] via Parameter **260** (see Chapter 16.4 "Fault messages"). In case of an error, the PLC can evaluate detailed information via the Emergency Message (see Chapter 11.5 "Emergency Function" and 12.5.2 "0x603F/0 Error code").



12.2.3 0x1008/0 Manufacturer Device Name

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x1008	0	Manufacturer Device name	Visible string	ro	No	See Text

The device name is displayed as a sequence of ASCII characters.

Example: "ACTIVE CUBE"

12.2.4 0x1009/0 Manufacturer Hardware Version

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x1009	0	Manufacturer Hardware version	Visible string	ro	No	See Text

The device version is displayed as a sequence of ASCII characters.

Example: "ACU 400 512 344"

12.2.5 0x100A/0 Manufacturer Software Version

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x100A	0	Manufacturer Software version	Visible string	ro	No	See Text

The software version is displayed as a sequence of ASCII characters.

Example: 5.4.0



12.2.6 0x1010/n Store Parameters

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x1010	0	Highest sub-index supported	Unsigned8	ro	No	3
	1	Store all parameters	Unsigned32	r/w	No	See text
	2	Store communication parameters	Unsigned32	r/w	No	See text
	3	Store application parameters	Unsigned32	r/w	No	See text

With object 0x1010/n parameter/object settings can be stored to non-volatile memory. This object supports three subindexes with various functions.

Writing of "save" in 0x1010/3 saves all application parameters ($\underline{0x6nnn}$) in the non-volatile memory.

Specification for writing the "save" instruction

LSB			MSB
" s "	"a"	" v "	"e"
0x73	0x61	0x76	0x65



Writing of values other than "save" will result in cancellation of SDO. The store command is **not** processed.

12.2.7 0x1011/n Restore default Parameters

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x1011	0	Highest sub-index supported	Unsigned8	ro	No	3
	1	Restore all parameters	Unsigned32	r/w	No	See text
	2	Restore communication parame-	Unsigned32	r/w	No	See text
		ters				
	3	Restore application parameters	Unsigned32	r/w	No	See text

With object 0x1011/n, you can reset parameters/objects to the default values. This object supports three subindexes with different functions.

Writing of "load" in 0x1011/3 restores all application parameters (0x6nnn).

Specification for writing the "load" instruction

LSB			MSB
"I "	"o "	"a"	" d "
0x6C	0x6F	0x61	0x64



Writing of values other than "load" will result in cancellation of SDO. The restore defaults command is **not** processed.



12.2.8 0x1018/n Identity Object

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

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x1018	0	Highest Sub-index supported	Unsigned8	ro	No	4
	1	Vendor ID	Unsigned32	ro	No	See text
	2	Product code	Unsigned32	ro	No	See text
	3	Revision number	Unsigned32	ro	No	See text
	4	Serial number	Unsigned32	ro	No	See text

"Vendor ID" "**0xD5**" refers to manufacturer **BONFIGLIOLI VECTRON GmbH**. This "Vendor ID" is assigned by the EtherCAT® (EtherCAT Technology Group) in Nuremberg.

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.



12.2.9 0x1600/n, 0x1601/n, 0x1602/n, RxPDO Mapping Parameter

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x1600	0	Number of mapped objects	Unsigned8	rw	No	2
0x1601						
0x1602						
	1	1 st mapped obj.	Unsigned32	rw	No	See text
	2	2 nd mapped obj.	Unsigned8	rw	No	See text
	3	3 rd mapped obj.	Unsigned8	rw	No	See text
	4	4 th mapped obj.	Unsigned8	rw	No	See text
	5	5 th mapped obj.	Unsigned8	rw	No	See text
	6	6 th mapped obj.	Unsigned8	rw	No	See text
	7	7 th mapped obj.	Unsigned8	rw	No	See text
	8	8 th mapped obj.	Unsigned8	rw	No	See text

RxPDO Mapping parameters:

0x1600/n RxPDO1 0x1601/n RxPDO2 0x1602/n RxPDO3

0x1600/0 = 0 = no object mapped

 $0x1600/0 = 1 \dots 8 = 1 \dots 8$ mapped objects

Mapping entry:

MSB			LSB
Objec	t index	Subindex	Length (no. of bits)
High byte	Low byte	si	

Examples:

Mapping of 0x6040/0 <u>Control word</u> (unsigned16 = 10_{hex}) to 1^{st} mapped object in RxPDO1:

0x1600/1 = 0x60400010

Mapping of 0x60C1/1 <u>interpolation data record 1</u> (integer 32 = 20_{hex}) to 2^{nd} mapped object in RxPDO1:

0x1600/2 = 0x60C10120

Refer to chapter 12.1 for a tabular overview of all objects and their corresponding data types.

Default mapping

RxPDO1	0x1600/0	0x1600/1	0x1600/2	0x1600/38
	2	<u>0x6040</u>	<u>0x6042</u>	0x00000000
		Control word v/target velocity		
RxPDO2	0x1601/0	0x1601/18		
	1	No mapping		
RxPDO3	0x1602/0	0x1602/18		
	1	No mapping		

12.2.10 0x1A00/n, 0x1A01/n, 0x1A02/n, TxPDO Mapping Parameter



Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x1A00	0	Number of mapped objects	Unsigned8	rw	No	2
0x1A01						
0x1A02						
	1	1 st mapped obj.	Unsigned32	rw	No	See text
	2	2 nd mapped obj.	Unsigned32	rw	No	See text
	3	3 rd mapped obj.	Unsigned32	rw	No	See text
	4	4 th mapped obj.	Unsigned32	rw	No	See text
	5	5 th mapped obj.	Unsigned32	rw	No	See text
	6	6 th mapped obj.	Unsigned32	rw	No	See text
	7	7 th mapped obj.	Unsigned32	rw	No	See text
	8	8 th mapped obj.	Unsigned32	rw	No	See text

TxPDO Mapping parameters:

0x1A00/n TxPDO1 0x1A01/n TxPDO2 0x1A02/n TxPDO3

0x1A00/0 = 0 = no object mapped

0x1A00/0 = 1 ... 8 = 1 ... 8 mapped objects

Mapping entry:

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

Examples:

Mapping of 0x6041/0 <u>Statusword</u> (unsigned16) to "1st mapped obj." in TxPDO1: 0x1A00/1 = 0x60410010

Mapping of 0x6064/0 <u>Position actual value</u> (integer 32) to "2nd mapped obj." in TxPDO1:

0x1A00/2 = 0x60640020

Default mapping

TxPDO1	0x1A00/0	0x1A00/1	0x1A00/2	0x1A00/38
	2	<u>0x6041</u>	<u>0x6044</u>	0x00000000
		Status word	√ velocity actual	
			value	
TxPDO2	0x1A01/0		0x1A01/18	
	1	No mapping		
TxPDO3	0x1A02/0	0x1A02/18		
	1	No mapping		



The number of objects that can be mapped depends on the length of the object. The maximum number of bytes that can be mapped is 8.

12.3 Manufacturer objects (0x2nnn) – Parameter access

For direct write/read access to inverter parameters via the SDO channel, a parameter is addressed via index and sub-index. Index and sub-index are used as follows for accessing the inverter parameters:



Index = Parameter number + 0x2000 Sub-index = required data set (0, 1 ... 4, 5, 6 ... 9)



Mapping of numerical data is always an integer or long data type. Values with decimal places will be written without decimal point (e.g. value 17.35 will be transmitted as 1735).

12.3.1 Handling of data sets/cyclic writing of the parameters

The parameter values are accessed based on the parameter number and the required dataset. There are parameters which only have one value (data set 0), as well as parameters which have four values (data sets 1...4). The latter are used for the data set change-over of a parameter.

If parameters with four data values are set via data set = 0, all four data sets are set to the same transmitted value. A read access with data set = 0 to such parameters is only successful if all four data sets are set to the same value. If this is not the case, an error will be signaled.

NOTE

The values are entered automatically in the EEPROM of the controller. However, 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.

In the RAM, the data is not protected against loss of power. Once power supply is disrupted, the data must be written again.

This mechanism is activated by the target data set being increased by five in the specification of the data set.

Writing on virtual dataset in RAM

Parameter	EEPROM	RAM
Data set 0	0	5
Data set 1	1	6
Data set 2	2	7
Data set 3	3	8
Data set 4	4	9



12.3.2 Handling of index parameters/cyclic writing

Index parameters are used for various frequency inverter functions. Here, 16 or 32 indexes are used instead of the 4 data sets. For each function, the individual indexes are addressed separately via an index access parameter. Via the indexing parameter, you can select if the data is to be written to EEPROM or RAM.

Function	Parameter	Index rang	je	Index access parameter
		Write EEPROM and Read	Write RAM	
Positioning	1202 Target Position / Distance 1203 Speed 1204 Acceleration 1205 Ramp Rise time 1206 Deceleration 1207 Ramp Fall time 1208 Motion mode 1209 Touch-Probe-Window 1210 Touch-Probe-Error:Next Motion Block 1211 No. of Repetitions 1212 Delay 1213 Delay: Next Motion Block 1214 Event I 1215 Event1: Next Motion Block 1216 Event 2 1217 Event2: Next Motion Block 1218 Digital Signal I 1219 Digital Signal I 1219 Digital Signal I 1248 Digital Signal I 1248 Digital Signal 2 1260 Interrupt-Event I 1261 IntEvent 1: EvalMode 1262 IntEvent 1: Next Motion Block 1263 Interrupt- Event 2 1264 IntEvent 2: EvalMode 1265 IntEvent 2: Next Motion Block	0 ¹⁾ ; 132	33 ¹⁾ ; 3465	1200 Write 1201 Read
PLC Function (Function table)	1343 <i>FT-instruction</i> 1344 <i>FT-input 1</i> 1345 <i>FT-input 2</i> 1346 <i>FT-input 3</i>	01)	221)	4244 147
	 1347 FT-input 4 1348 FT-Parameter 1 1349 FT-Parameter 2 1350 FT-target output 1 1351 FT- target output 2 1352 FT-commentary 	0 ¹⁾ ; 132	33 ¹⁾ ; 3465	1341 Write 1342 Read
Multiplexer	1252 Mux Input	0 ¹⁾ ; 116	17 ¹⁾ ; 1833	1250 Write 1251 Read
CANopen Mul- tiplexer	1422 CANopen Mux Input	0 ¹⁾ ; 116	17 ¹⁾ ; 1833	1420 Write 1421 Read

¹⁾ If the index access parameter is set = 0, all indexes are accessed to write into EEPROM. Selection 17 and 33 respectively, write all indexes into RAM.



NOTE

The values are entered automatically in the EEPROM of the controller. However, 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.

In the RAM, the data is not protected against loss of power. Once power supply is disrupted, the data must be written again.

This mechanism is activated by the target data set being increased by five in the specification of the data set.

12.3.2.1 Example Writing an index parameter

Typically an index parameter is written during commissioning or regularly at simple positioning applications.

Writing Parameter *Target Position / Distance* **1202** (Type long), in Index 1 into RAM (→index 34 for write access) with Parameter value 30000.

```
Index = 1200 + 0x2000 = 0x24B0, Value (int) = 34 = 0x0022
Index = 1202 + 0x2000 = 0x24B2, Value (long) = 30000 = 0x0000 7530
```



If various parameters of an index are to be edited, it will be sufficient to set index access via parameter **1200** once at the beginning.

12.3.2.2 Example Reading an index parameter

In order to read an index parameter, you will have to set the index parameter to the relevant index first, then you can read the parameter.

Reading Parameter $Target\ Position\ /\ Distance\$ **1202** (Type long), in Index 1 with Parameter value 123000.

```
Index = 1201 + 0x2000 = 0x24B1, Value (int) = 1 = 0x0001
Index = 1202 + 0x2000 = 0x24B2, Value (long) = 123000 = 0x0001 E078
```



If various parameters in an index are to be edited, it will be sufficient to set index access via parameter **1201** once at the beginning.



12.4 Manufacturer objects (0x3000 ... 0x5FFF)

In addition to the device profile objects the following manufacturer specific objects are implemented.

12.4.1 0x3001/0 Digital In actual value

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3001	0	Digital In actual value	Unsigned16	ro	Tx	

Object 0x3001 *Digital In actual value* shows – like parameter *Digital inputs* **250** – the current state of the digital inputs and multifunction input 1 (when parameter *Operation mode* **452** is set to "3 – Digital input").

12.4.2 0x3002/0 Digital Out actual value

Index	Sub-index	Meaning	Data type	Access	Map	DefVal
0x3002	0	Digital Out actual value	Unsigned16	ro	Tx	

Object 0x3001 *Digital Out actual value* shows – like parameter *Digital outputs* **254** – the current state of the digital outputs and multifunction output 1 (when parameter *Operation mode* **550** is set to "1 – Digital"). The selection of digital outputs depends on the extension modules installed as an option.



12.4.3 0x3003/0 Digital Out set values

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3003	0	Digital Out set values	Unsigned8	rw	Rx	0

Via object 0x3003, five digital parameter sources are available requiring assignment of digital sources.

Object 0x3003						
Bit	Source number	Source name	Operation mode Digital output			
0	810	Obj 0x3003 Digout 1	90/190			
1	811	Obj 0x3003 Digout 2	91/191			
2	812	Obj 0x3003 Digout 3	92/192			
3	813	Obj 0x3003 Digout 4	93/193			
4	814	Obj 0x3003 Digout 5	94/194			

The value of object 0x3003 is limited from 0 to 31.

No.	Object	Min.	Max.
0x3003/0 Digit	al Out set values	0	31 (= 0x1F)

Digital outputs use these sources as operation modes 90 ... 94 *Obj 0x3003 DigOut* $1 ext{ ... } 5$ and, inverted, as 190 ... 194 *inv. Obj 0x3003 DigOut* $1 ext{ ... } 5$ (e.g. parameter Op. $Mode Digital Output 1 ext{ 530}$). These object bits can be mapped to the output as required

Example:

Francisco	Danishan	Chaire list (source)
Function	Parameter no.	Choice list (excerpt)
Op. Mode Digi-	532	0 - OFF
tal Output 3		1 - Ready or Standby Signal
		2 - Run Signal
		43 - External Fan
		90 - Obj 0x3003 Digout 1
		91 - Obj 0x3003 Digout 2
		92 - Obj 0x3003 Digout 3
		93 - Obj 0x3003 Digout 4
		94 - Obj 0x3003 Digout 5
		143 - inv. External Fan
		190 - inv. Obj 0x3003 Digout 1
		191 - inv. Obj 0x3003 Digout 2
		192 - inv. Obj 0x3003 Digout 3
		193 - inv. Obj 0x3003 Digout 4
		194 - inv. Obj 0x3003 Digout 5

Sources 810...814 *Obj 0x3003 DigOut 1 ... 5* can be selected directly via the selection list for parameters. This can be used, for example, for direct setting of Boolean inputs.



12.4.4 0x3004/0 Boolean Mux

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3004	0	Boolean Mux	Unsigned16	ro	Tx	

Via object 0x3004, up to 16 packed Boolean values can be read. Each bit in 16-bit object 0x3004 shows the actual value of the assigned Boolean source.

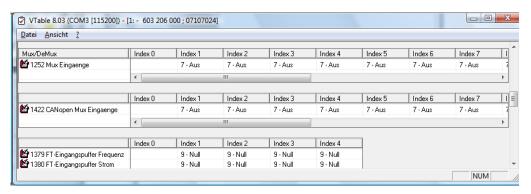


Bit numbers 0 ... 15 correspond to index numbers 1 ... 16!

The sources of the 16 bits can be selected from a choice list of index parameter *CANopen Mux Input* **1422**. Parameters **1420** and **1421** are write and read parameters which must be set before writing/reading of parameter **1422**.

By using VTable this process is easier and more clearly laid out.

For writing and reading index parameters refer to chapter 12.3.2 "Handling of index parameters/cyclic writing".



Default value is 7 - Off.

12.4.5 0x3005/0 Boolean DeMux

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3005	0	Boolean DeMux	Unsigned16	rw	Rx	0

Via object 0x3005, up to 16 packed Boolean values can be written. These values are available as sources and can be selected via a choice list for parameters as objects **832**...**847** *Obj 0x3005 Demux Out 1...16* .

	Obj. 0x3005					
Bit no.	Source No.	Source name				
0	832	Obj. 0x3005 Demux Out 1				
1	833	Obj. 0x3005 Demux Out 2				
2	834	Obj. 0x3005 Demux Out 3				
3	835	Obj. 0x3005 Demux Out 4				
4	836	Obj. 0x3005 Demux Out 5				
5	837	Obj. 0x3005 Demux Out 6				
6	838	Obj. 0x3005 Demux Out 7				
7	839	Obj. 0x3005 Demux Out 8				
8	840	Obj. 0x3005 Demux Out 9				
9	841	Obj. 0x3005 Demux Out 10				
10	842	Obj. 0x3005 Demux Out 11				
11	843	Obj. 0x3005 Demux Out 12				
12	844	Obj. 0x3005 Demux Out 13				
13	845	Obj. 0x3005 Demux Out 14				
14	846	Obj. 0x3005 Demux Out 15				



15	847	Obj. 0x3005 Demux Out 16
	0 17	obj. oxbood bemax out 10

12.4.6 0x3006/0 Percentage set value

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3006	0	Percentage set value	Unsigned16	rw	Rx	0

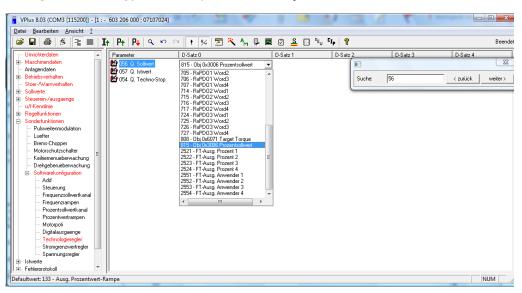
Via object 0x3006, you can write a percentage source – e.g. parameter *S. reference* **056**.

The value of object 0x3006 is available as a source and can be selected as **815** – *Obj* 0x3006 Reference Percentage via a choice list for parameters.

The value range of object 0x3006 is limited from -30000 to 30000 (equivalent to percentage range from - 300.00 % to 300.00 %)

No.	Object	Min.	Max.
0x3006/0	Percentage set value	-30000	30000
	-	(= 0x8AD0)	(= 0x7530)

Example: Technology controller parameter *S. Reference Value* **056**.



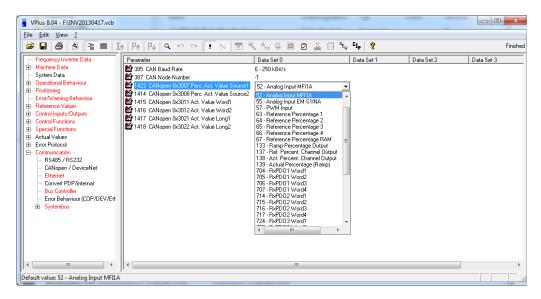
The percentage value is scaled as percent * 100 (e.g. 5678 represents 56.78%).

12.4.7 0x3007/0 Percentage Actual Value Source 1

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3007	0	Percentage Actual Value Source 1	Unsigned16	ro	Tx	

Object 0x3007 shows the actual value of the percentage source which can be selected via parameter *CANopen Percentage Actual Value Source 1* **1423**. Default setting: 52 – Analog input MFI1A.



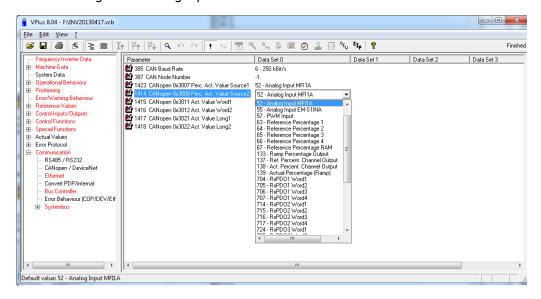


The percentage value is scaled as percent * 100 (e.g. 5678 represents 56.78%).

12.4.8 0x3008/0 Percentage Actual Value Source 2

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3008	0	Percentage Actual Value Source 2	Unsigned16	ro	Tx	

Object 0x3008 shows the actual value of the percentage source which can be selected via parameter *CANopen Percentage Actual Value Source 2* **1414**. Default setting: 52 – Analog input MFI1A.



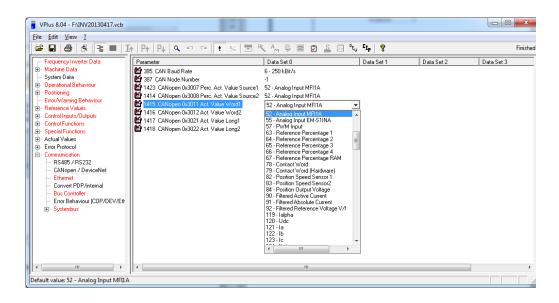
The percentage value is scaled as percent * 100 (e.g. 5678 represents 56.78%).

12.4.9 0x3011/0 Actual Value Word 1

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3011	0	Actual Value Word 1	Unsigned16	ro	Tx	

Object 0x3011 shows the actual value of the word source which can be selected via parameter $CANopen\ 0x3011\ Act.\ Value\ Word\ 1\ 1415.$ Default setting: 52 – Analog input MFI1A.

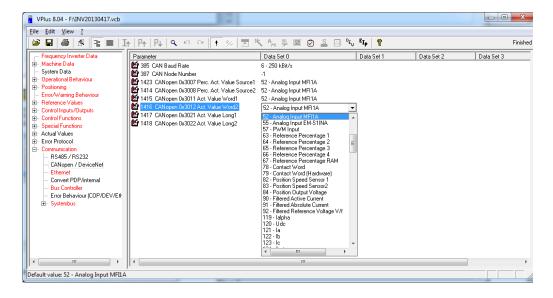




12.4.10 0x3012/0 Actual Value Word 2

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3012	0	Actual Value Word 2	Unsigned16	ro	Tx	

Object 0x3012 shows the actual value of the word source which can be selected via parameter $CANopen\ 0x3012\ Act.\ Value\ Word\ 2\ 1416.$ Default setting: 52 – Analog input MFI1A.

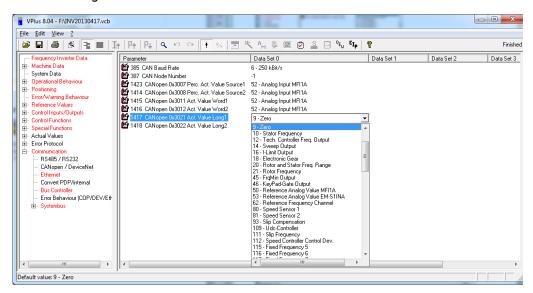




12.4.11 0x3021/0 Actual Value Long 1

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3021	0	Actual Value Long 1	Unsigned32	ro	Tx	

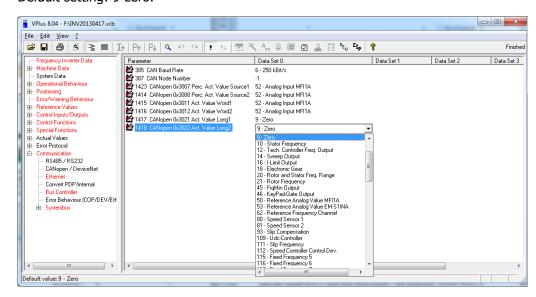
Object 0x3021 shows the actual value of the long source which can be selected via parameter $CANopen\ 0x3021\ Act.\ Value\ Long\ l\ 1417.$ Default setting: 9-zero.



12.4.12 0x3022/0 Actual Value Long 2

	Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
(0x3022	0	Actual Value Long 2	Unsigned32	ro	Tx	

Object 0x3022 shows the actual value of the long source which can be selected via parameter $CANopen\ 0x3022\ Act.\ Value\ Long\ 2\ 1418.$ Default setting: 9-zero.



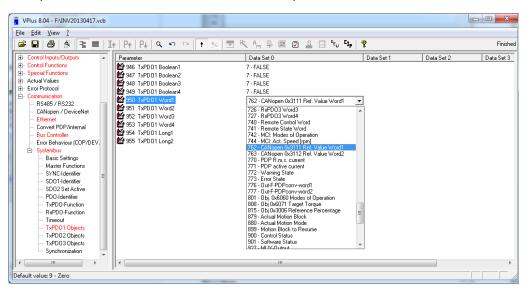


12.4.13 0x3111/0 Ref. Value Word 1

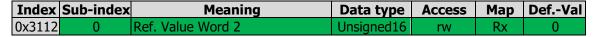
Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3111	0	Ref. Value Word 1	Unsigned16	rw	Rx	0

Via object 0x3111, you can write a word source – e.g. parameter *TxPDO1 Word 1* **950** of System Bus.

The value of object 0x3111 is available as a source and can be selected as 762 – *CANopen 0x3111 Ref. Value* via a choice list for parameters.

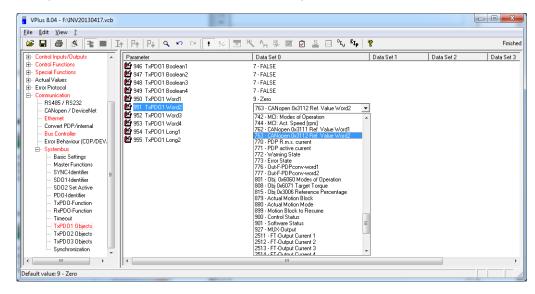


12.4.14 0x3112/0 Ref. Value Word 2



Via object 0x3112, you can write a word source – e.g. parameter $TxPDO1\ Word\ I$ **950** of System Bus.

The value of object 0x3112 is available as a source and can be selected as 763 – *CANopen 0x3112 Ref. Value* via a choice list for parameters.



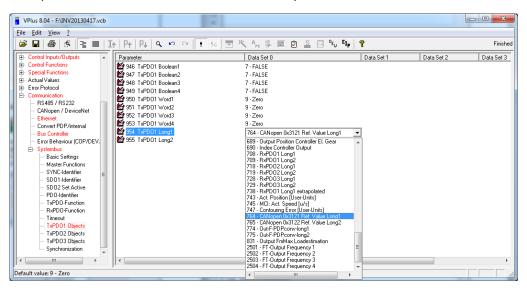


12.4.15 0x3121/0 Ref. Value Long 1

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3121	0	Ref. Value Long 1	Unsigned32	rw	Rx	0

Via object 0x3121, you can write a long source – e.g. parameter *TxPDO1 Long 1* **954** of System Bus.

The value of object 0x3121 is available as a source and can be selected as 764 – *CANopen 0x3121 Ref. Value* via a choice list for parameters.

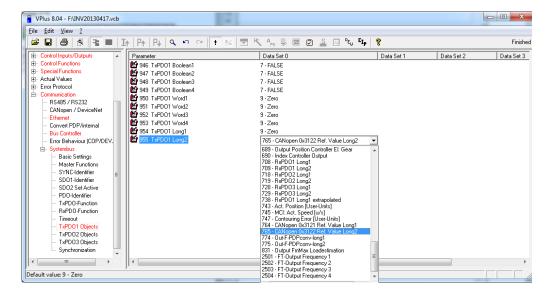


12.4.16 0x3122/0 Ref. Value Long 2

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x3122	0	Ref. Value Long 2	Unsigned32	rw	Rx	0

Via object 0x3122, you can write a long source – e.g. parameter *TxPDO1 Long 2* **955** of System Bus.

The value of object 0x3122 is available as a source and can be selected as 765 – *CANopen 0x3122 Ref. Value* via a choice list for parameters.





12.4.17 0x5F10/n Gear factor

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x5F10	0	Highest sub-index supported	Unsigned8	ro	No	3
	1	Numerator	Integer16	rw	Rx	1
	2	Denominator	Unsigned16	rw	Rx	1
	3	Resync on change	Integer16	rw	No	1

Object works in:	Object doesn't work in:
 Motion Control: 	Motion Control:
 Electronic Gear: Slave 	 Profile Positioning mode
○ Table Travel Record	 Velocity mode
mode	 Profile Velocity mode
(Electronic Gear operation)	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Move away from Limit Switch
	 Non motion Control (conf. ≠ x40)

Object 0x5F10 active motion block is available in *Electronic Gear: Slave* mode in motion control configurations (P.30 = x40). The *Electronic Gear: Slave* mode is activated by object 0x6060 modes of operation set to -3.

With the Gear factors (numerator and denominator) a multiplier for the master speed can be set up. The Slave speed results in:

$$v_{Slave} = v_{Master} \times \frac{Numerator~0x5F10/1}{Denominator~0x5F10/2}$$

Limitation of acceleration when the gear factor is changed is effected via Object 0x5F10/3 *Gear Factor: Resync on change*. The slave is resynchronized with the master when the gear factor has changed. This function avoids sudden speed changes.

0x5F10 /3 <i>Gear Factor:</i> Resync on change.	Function
0 - Off	Resynchronization is switched off.
1 - On	The slave is resynchronized with the master frequency when the gear factor has changed. The drive adjusts to the new frequency. The acceleration ramps set in Object Oxeologies/Oxeologies/Oxeologies/

Alternatively the parameters **1123**, **1124** and **1142** can be used instead of the Objects.

Usage of the Objects will write the parameters in RAM (data set 5).

_	Object		Parameter
0x5F10/1	Gear factor Numerator	1123	Gear Factor Numerator
0x5F10/2	Gear factor Denominator	1124	Gear Factor Denominator
0x5F10/3	Gear factor Resync on change	1142	Resync. on Change of Gear-Factor



12.4.18 0x5F11/n...0x5F14/n Phasing 1...4

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x5F11	0	Highest sub-index supported	Unsigned8	ro	No	3
	1	Offset	Integer32	rw	No	0x1 0000
	2	Speed	Unsigned32	rw	No	0x5 0000
Y	3	Acceleration	Unsigned32	rw	No	0x5 0000

Object works in:	Object doesn't work in:
 Motion Control: 	Motion Control:
 Electronic Gear: Slave 	 Profile Positioning mode
 Table Travel Record 	 Velocity mode
mode	 Profile Velocity mode
(Electronic Gear operation)	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel Record mode
	 Move away from Limit Switch
	 Non motion Control (conf. ≠ x40)

Objects 0x5F11 *Phasing 1*, 0x5F12 *Phasing 2*, 0x5F13 *Phasing 3* and 0x5F14 *Phasing 4 active motion block* is available in *Electronic Gear: Slave* mode in motion control configurations (P.30 = x40). The *table travel record* mode is activated by object 0x6060 *modes of operation* set to **-3**.



For better readability in the following section Object 0x5F11 is used. For Objects 0x5F12, 0x5F13 und 0x5F14 the descriptions apply analogously.

With the phasing function, the slave position is offset from the received position of the master by the value entered in 0x5F11/1 *Phasing 1: Offset*.

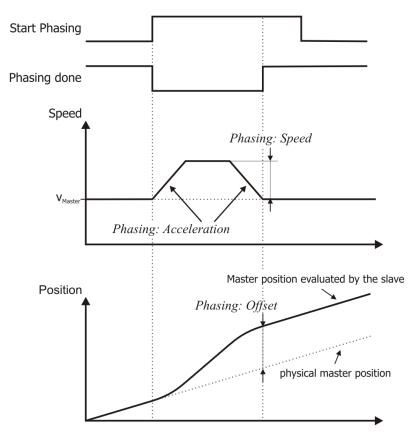
The function can is started via Bit 9 of the Control Word. After start, 0x5F11/2 *Phasing 1: Speed* and 0x5F11/3 *Phasing 1: Acceleration* are used until the slave position is offset from the master position by *Phasing 1: Offset*.

During Phasing the Status word bit 8 "Phasing Done" is set to "Low". As soon as the Phasing is finished or cancelled, the Bit is set to "High". After first switch-on (or after a device reset) the "Phasing Done" bit is also "Low".

The values of Objects 0x5F11/n...0x5F14/n are limited as follows:

	Object	Setting		
No.	Object	Min.	Max.	
0x5F11/1 0x5F12/1 0x5F13/1 0x5F14/1	Phasing: Offset	-2147483647 (= 0x8000 0001)	2147483647 (= 0x7FFF FFFF)	
0x5F11/2 0x5F12/2 0x5F13/2 0x5F14/2	Phasing: Speed	1	2147483647 (= 0x7FFF FFFF)	
0x5F11/3 0x5F12/3 0x5F13/3 0x5F14/3	Phasing: Acceleration	1	2147483647 (= 0x7FFF FFFF)	





Via Objects 0x5F11, 0x5F12, 0x5F13 and 0x5F14 four different Phasing profile can be created. The Phasing Profile is selected via Control word bits 12 and 13.

Phasing select		Phasing Profile
Bit 13	Bit 12	
0	0	1 (0x5F11)
0	1	2 (0x5F12)
1	0	3 (0x5F13)
1	1	4 (0x5F14)

Alternatively the parameters **1125**, **1126** and **1127** can be used instead of the Objects. The 4 data sets of the parameters correspond to the 4 Objects. Usage of the Objects will write the parameters in RAM (data set 6...9).

	Object		Parameter
0x5F11/1	Phasing 1: Offset	1125.1	Phasing: Offset
0x5F12/1	Phasing 2: Offset	1125.2	
0x5F13/1	Phasing 3: Offset	1125.3	
0x5F14/1	Phasing 4: Offset	1125.4	
0x5F11/2	Phasing 1: Speed	1126.1	Phasing: Speed
0x5F12/2	Phasing 2: Speed	1126.2	
0x5F13/2	Phasing 3: Speed	1126.3	
0x5F14/2	Phasing 4: Speed	1126.4	
0x5F11/3	Phasing 1: Acceleration	1127.1	Phasing: Acceleration
0x5F12/3	Phasing 2: Acceleration	1127.2	_
0x5F13/3	Phasing 3: Acceleration	1127.3	
0x5F14/3	Phasing 4: Acceleration	1127.4	



12.4.19 0x5F15/0 In Gear Threshold

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x5F15	0	In Gear Threshold	Unsigned32	rw	No	0

Object works in:	Object doesn't work in:
 Motion Control: 	 Motion Control:
 Table Travel record mode 	 Profile Positioning mode
 Electronic Gear: Slave 	 Velocity mode
	 Profile Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Move away from Limit Switch
	 Non motion Control (conf. ≠ x40)

The Status Word Bit 10 "In Gear" is set if the relative deviation between master- and slave-position is lower than the value of 0x5F15/0 *In Gear Threshold* for at least 0x5F16/0 *In Gear Time*.



When 0x5F15/0 In Gear Threshold is set to zero, the signal "in gear" is set as soon as the drive reaches the master speed.

The signals "In Gear" are reset in the following occurrences:

- The relative deviation between master- and slave-position exceeds the value of 0x5F15/0 *In Gear Threshold*.
- The speed of the master drive exceeds the value of Maximum Speed *.
- *) Maximum speed refers to either ox6046/2_vl_velocity_max_amount or Maximum frequency **419**. It is set either via ox6046/2_vl_velocity_max_amount [rpm] or Maximum frequency **419** is usually set up during motor commissioning.

The value range of des Object 0x5F15/0 is limited as follows:

Object		Setting		
No. Object		Min.	Max.	
0x5F15/0	In Gear Threshold	0	2147483647 (= 0x7FFF FFFF)	

Alternatively parameter "In-Gear"-Threshold **1168** can be used instead of the Object 0x5F15/0 *In Gear Threshold*.

Object	Parameter
0x5F15/0 In Gear Threshold	1168 "In-Gear"-Threshold



12.4.20 0x5F16/0 In Gear Time

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x5F16	0	In Gear Time	Unsigned16	rw	No	10

Object works in:

- Motion Control:
 - Table Travel record mode
 - Electronic Gear: Slave

Object doesn't work in:

- Motion Control:
 - Profile Positioning mode
 - Velocity mode
 - Profile Velocity mode
 - Homing mode
 - Interpolated mode
 - Cyclic Sync Position mode
 - Cyclic Sync Velocity mode
 - Move away from Limit Switch
- Non motion Control (conf. ≠ x40)

The Status Word Bit 10 "In Gear" is set if the relative deviation between master- and slave-position is lower than the value of 0x5F15/0 <u>In Gear Threshold</u> for at least 0x5F16/0 <u>In Gear Time</u>.



If parameter 0x5F15/0 *In Gear Threshold* is set to the value zero the signal "In Gear" is set when the drive attains the master speed.

The signals "In Gear" are reset in the following occurrences:

- The relative deviation between master- and slave-position exceeds the value of 0x5F15/0 *In Gear Threshold*.
- The speed of the master drive exceeds the value of Maximum Speed *.
- *) Maximum speed refers to either Ox6046/2 vi velocity max amount or Maximum frequency **419**. It is set either via Ox6046/2 vi velocity max amount [rpm] or Maximum frequency **419** [Hz]. Maximum frequency **419** is usually set up during motor commissioning.



The Position Controller (0x5F17 <u>Position Controller</u>) can cause a higher overall speed than $Maximum\ speed$. However the Position Controller doesn't affect the Signal "In Gear".

The value range of des Object 0x5F16/0 is limited as follows:

Object		Setting		
No.	No. Object		Max.	
0x5F16/0	In Gear Time [ms]	1	65535 (= 0xFFFF)	

Alternatively parameter "*In-Gear"-Time* **1169** can be used instead of the Object 0x5F16/0 *In Gear Time*.

Object	Parameter	
0x5F16/0 In Gear Time	1169 <i>In Gear-Time</i>	



12.4.21 0x5F17/n Position Controller

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x5F17	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Time Constant	Integer32	rw	No	10,00 ms
	2	Limitation	Unsigned32	rw	No	327680

Object works in:	Object doesn't work in:
Motion Control: All modes	• Non motion Control (conf. ≠ x40)

The position controller evaluates the positioning operation (target/actual position) and tries to control the drive such that it comes as close as possible to the specifications. For this purpose, an additional frequency is calculated for compensation of position deviations. By setting the corresponding parameter, this frequency can be limited. The parameter settings of the position controller determine how quick and to what extent position deviations are to be compensated.

Via the *Position Controller:Time Constant*, you can define the maximum time in which the position deviation is to be compensated.

Via parameter *Position Controller:Limitation*, you can define to which value the speed is limited for compensation of the position deviation.

NOTE

The Output of the Position Controller is not limited by oxeo.org/0x6046/2 vi velocity max <a href="https://oxeo.org/

Maximum speed* and Limitation **1118** must be set for fitting values during the commissioning.

Chapter 16.5 contains conversion formulas between Hz, rpm and u/s. Bonfiglioli Vectron recommends:

- Set *Maximum speed** to 90 % of the mechanical rated speed and the *Limitation* **1118** of the Position Controller to the value corresponding to 10 % of the Maximum frequency.
- *) Maximum speed refers to either Ox6046/2 vI velocity max amount or Maximum frequency **419**. It is set either via Ox6046/2 vI velocity max amount [rpm] or Maximum frequency **419** [Hz]. Maximum frequency **419** is usually set up during motor commissioning.

The values of Objects 0x5F17/n are limited as follows:

	Object	Setting		
No.	Object	Min.	Max.	
0x5F17/1	Position Controller: Time Constant	1,00 ms	300,00 ms	
0x5F17/2	Position Controller: Limitation	0	2147483647 (= 0x7FFF FFFF)	

Alternatively the parameters **1104** and **1118** can be used instead of the Objects.

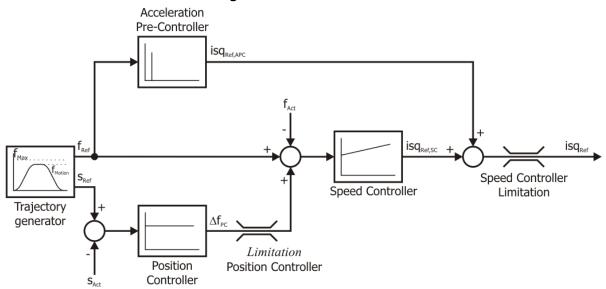
Object	Parameter
0x5F17/1 Position Controller: Time Constant	1104 Time Constant
0x5F17/2 Position Controller: Limitation	1118 Limitation



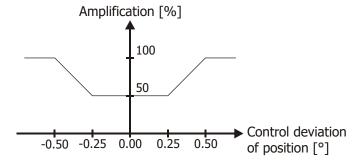
Example:

Position deviates by 1 motor shaft revolution, time constant is set to 1 ms. The position controller will increase the motor frequency by 1000 Hz in order to compensate the position deviation. Parameter *Limitation* **1118** must be set accordingly.

Controller block diagram



In order to avoid oscillations of the drive while it is at standstill, amplification is reduced to 50 % of the parameterized value for small position deviations



The following behaviour may indicate that the controller parameters are not configured properly:

- drive is very loud
- drive vibrates
- frequent contouring errors
- inexact control

For the setting options of other control parameters, e.g. speed controller and acceleration pilot control, refer to the operating instructions of the frequency inverter.



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



12.4.22 0x5F18/0 M/S Synchronization Offset

Index	Sub- index	Meaning	Data type	Access	Мар	DefVal
0x5F18	0	M/S Synchronization Offset	Integer32	rw	No	0

Object works in:	Object doesn't work in:
Motion Control:	Motion Control:
 Table Travel record mode 	 Profile Positioning mode
	 Velocity mode
	 Profile Velocity mode
	Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	• Non motion Control (conf. ≠ x40)

The M/S Synchronization Offset can be used in the electronic gear functionality to align the Slave drive to the absolute position of the master drive. Comply with chapter 0 "Master/Slave Position Correction".

NOTE

When using this functionality master drive and slave drive have to use the same mechanical characteristics (i.e. gear transmission ratios) and use the same reference system.

The values of Object 0x5F18/0 are limited as follows:

	Object	Set	ting
No.	Object	Min.	Max.
0x5F18/0	M/S Synchronization Offset	-2147483647	2147483647
0,10,10,0	i i i o o y i o i i o i i o i o o c	(= 0x8000 0001)	(= 0x7FFF FFFF)

Alternatively parameter 1284 can be used instead of the Objects.

Object	Parameter		
0x5F18/0 M/S Synchronization Offset	1284	M/S Synchronization Off- set	



12.4.23 0x5FF0/0 Active motion block

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x5FF0	0	Active motion block	Unsigned8	ro	Tx	

Object works in:	Object doesn't work in:
Motion Control:	Motion Control:
 Table Travel record mode 	 Profile Positioning mode
	 Velocity mode
	 Profile Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

Object 0x5FF0 active motion block is only available in table travel record mode in motion control configurations (P.30 = x40). The table travel record mode is activated by object 0x6060 modes of operation set to -1.

The data of *active motion block* displays the active motion block number in *table travel record* mode. The Object refers to parameter *Actual motion block* **1246**. Refer to the application manual "Positioning" for the usage of the motion blocks.

12.4.24 0x5FF1/0 Motion block to resume

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x5FF1	0	Motion block to resume	Unsigned8	ro	Tx	

Object works in:	Object doesn't work in:		
 <u>Motion Control:</u> 	• Motion Control:		
 Table Travel record mode 	 Profile Positioning mode 		
	 Velocity mode 		
	 Profile Velocity mode 		
	 Homing mode 		
	 Interpolated mode 		
	 Cyclic Sync Position mode 		
	 Cyclic Sync Velocity mode 		
	 Move away from Limit 		
	Switch		
	 Electronic Gear: Slave 		
	• Non motion Control (conf. ≠ x40)		

Object 0x5FF1 motion block to resume is only available in table travel record mode in motion control configurations (P.30 = x40). The table travel record mode is activated by object 0x6060 modes of operation set to -1.

The data of *motion block to resume* displays the motion block to resume number in *table travel record* mode. The Object refers to parameter *Motion block to resume* **1249**. Refer to the application manual "Positioning" for the usage of the motion blocks.

12.5 Device Profile Objects (0x6nnn)



12.5.1 0x6007/0 Abort Connection option code

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6007	0	Abort Connection option code	Integer16	rw	No	1

Object *abort connection 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 Local/Remote **412**, the response of the setting of object 0x6007 will change as shown in the following table.

Object 0x6007/0				
Operation mode	Function with "Control via Statemachine"	Function in "Other control"		
0 - No reaction	Operating point is maintained.	Operating point is maintained.		
1 - Error	"Fault" status will be activated immediately. Factory setting .			
2 - Stop	Control command "Disable voltage" and switch to "switch on disabled" status.			
3 - Quick-Stop	Control command "Quick stop" and switch to "switch on disabled d" status.	The controller (state- machine) switches to		
-1 - Ramp-Stop (Minus 1) + Error	Control command "Disable operation" and switch to "Error" status once the drive has been shut down.	"Fault" state immedi- ately.		
-2 - Quick-Stop (Minus 2) + Error	Control command "Quick stop" and switch to "Error" status once the drive has been shut down.			

NOTE

Object *abort connection option code* corresponds to frequency inverter parameter *Bus Error Behaviour* **388**.

The parameter settings $Bus\ Error\ Behaviour\ {\bf 388} = -2...3$ are evaluated depending on parameter $Local/Remote\ {\bf 412}.$



No.	Object	Min.	Max.
0x6007/0	Abort Connection option code	-2	2
		(=0xFFFE)	3

Bus Error behaviour 388	0x6007
0	0
1	1
2	2
3	3
4	-1
5	-2



Writing of parameters *Bus Error Behaviour* **388** and writing of object 0x6007 have the same effect.



When object 0x6007 was written and a parameter saving instruction (Object 0x1010) was generated after that, the value of 0x6007 will be saved in the non-volatile memory. When the frequency inverter is switched on the next time, the value for 0x6007 set before will be activated again and overwrite the setting of Parameter Bus $Error\ Behaviour\ 388$.

For details about possible faults, refer to Chapter 16.4 "Fault messages".

12.5.2 0x603F/0 Error code

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x603F	0	Error code	Unsigned16	ro	No	

In object *error code*, the last error that has occurred will be saved.

According to CANopen[®] DS402, a great number of possible error messages is specified. The following list shows the relation between the error code displayed by the frequency inverter on the control panel and the error saved in object *error code*.

	Error reports					
Device	Device DS402		Meaning			
Error	Error Error code		_			
F00 xx	00	00	No error has occurred			
			Overload			
E0.1	22	4.0				
F01 xx	23	10	Frequency inverter was overloaded			
			Case			
F02 xx	42	10	Case temperature outside the temperature limits			
	Inside					
F03 xx	41	10	Inside temperature outside of temperature limits			
			Motor connection			
F04 xx	43	10	Motor temperature too high or sensor defective			
	Output current					
F05 xx	23	40	Motor phase current above current limit			
			DC link voltage			
F07 xx	32	10	DC link voltage outside the voltage range			



	Electronic voltage			
F08	XX	51	11	Electronic voltage outside the voltage range
	Motor connection			
F13	XX	23	30	Earth fault on frequency inverter output
	Generic error			
Fyy	XX	10	00	Other error messages

If CANopen® DS402 *error code* 1000 = generic-error occurs, the error code can be read via parameter *Current error* **260** (unsigned16). Parameter *Current error* **260** contains the error code in internal product-specific format.

For the error code assignment table of the relevant messages, refer to the operating instructions.

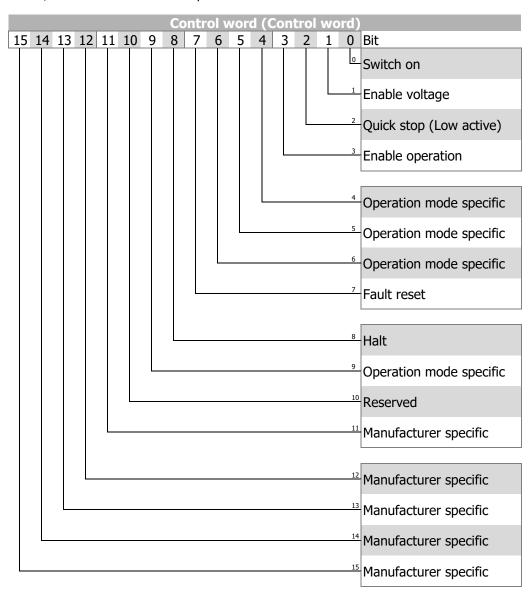
In the emergency message, the error code of the frequency inverter is transmitted in bytes $4\dots 7$ and the DS402 error code in bytes 0 and 1.



12.5.3 0x6040/0 Control word

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6040	0	Control word	Unsigned16	rw	Rx	0

Object 0x6040/0 *controlword* is relevant to the frequency inverter if parameter Lo-cal/Remote **412** is set to "1 - Control via statemachine". Object 0x6040/0 *controlword* is linked to the internal parameter Control word **410**. When using CANopen® use object 0x6040/0 *controlword* instead of parameter Control word **410**.





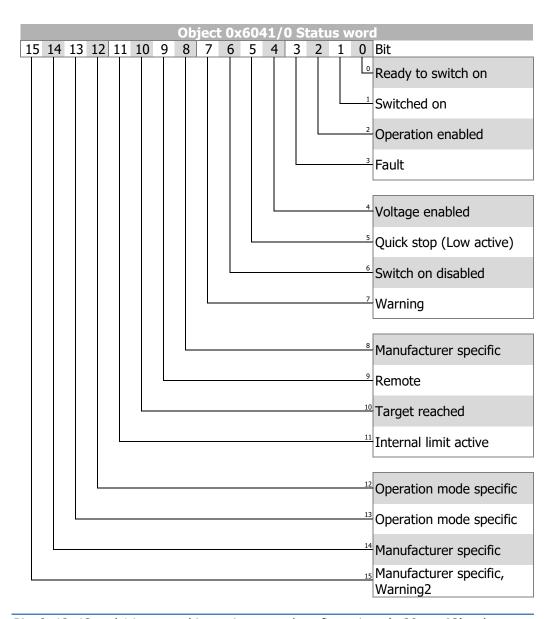
Bits 4, 5, 6 and 9 ... 15 are used in motion control configurations (p.30 = x**40**) only. See chapter 14 "Control of frequency inverter" and 16.1.1 "Control Word overview".



12.5.4 0x6041/0 Status word

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6041	0	Status word	Unsigned16	ro	Tx	

Object 0x6041/0 *statusword* shows the current state of the frequency inverter. Object 0x6041/0 *statusword* is linked to the internal parameter *Status word* **411** . When using CANopen® use object 0x6041/0 *statusword* instead of parameter *Status word* **411**.





Bits 8, 12, 13 and 14 are used in motion control configurations (p.30 = x40) only. See chapter 14 "Control of frequency inverter" and 16.1.2 "Status Word overview (without Sync modes)".



Index Sub-index

12.5.5 0x6042/0 v/target velocity [rpm]

						P	
0x6042	0	VI target velocity		Integer16	rw	Rx	0
Object works in: Object doesn't work in:							
•	Motion Con	<u>trol:</u>	 <u>Motion Control:</u> 				
	o Vel	ocity mode		o Tabl	e Travel r	ecord n	node

Data type | Access | Map | Def.-Val

Meaning

blject works iii.	Object doesn't work in.
 <u>Motion Control:</u> 	Motion Control:
 Velocity mode 	 Table Travel record mode
•	 Profile Velocity mode
 Non motion Control (conf. ≠ x40) 	 Profile Positioning mode
,	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Move away from Limit Switch
	 Electronic Gear: Slave

The object vl target velocity is the reference speed for the frequency inverter. vl target velocity is interpreted as a rotational speed with unit min⁻¹. The internal reference frequency of the frequency inverter is calculated from the target velocity in min⁻¹ considering parameter velocity in velocity i

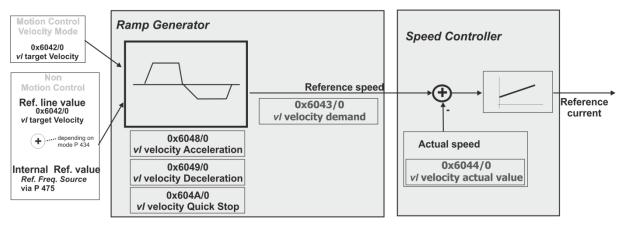


Parameter No. of pole pairs **373** has four different datasets. In applications with Motion control (configuration = x40), only data set 1 is used.

In applications without Motion Control (configuration \neq x40), more than one motor is connected to the frequency inverter in many cases (only one motor will be active at a time, switched via contactor). These motors can have different numbers of pole pairs. In this case, the entry in parameter *No. of pole pairs* **373** will be different in the four datasets. Upon switching to a motor, object *vl target* velocity must be written at least once in order to enable calculation of the reference frequency of the frequency inverter with the right number of pole pairs.

	Parameter	Set	ting	
No.	Object	Min. Max.		
0x6042	v/target velocity	-32768	32767	

In Non motion Control configurations (conf. \neq x40) the *vl target velocity* reference value is product-internally connected to the **Reference line value**. This reference value is combined with the internal reference frequency value from the frequency reference value channel in the input of the ramp function (see chapter 14.3.3 "Reference value / actual value").





12.5.6 0x6043/0 *v*/velocity demand [rpm]

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6043	0	√ velocity demand	Integer16	ro	Tx	

Object *vl* velocity demand is the output quantity of the ramp function in unit min⁻¹. The object has the same notation as object *vl* target velocity and can be read as an actual value. For calculation of *vl* velocity demand, parameter *No.* of pole pairs **373** is considered (in the same way as described for object *vl* target velocity).

12.5.7 $0x6044/0 \ v/$ velocity actual value

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6044	0	VI velocity actual value	Integer16	ro	Tx	

Object *vl* velocity actual value is the current speed of the drive in min⁻¹. The object has the same notation as object *vl* target velocity and can be read as an actual value. For calculation of *vl* velocity actual value demand, parameter *No.* of pole pairs **373** is considered (in the same way as described for object *vl* target velocity).

12.5.8 0x6046/n v/velocity min max amount

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6046	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	v/ velocity min amount (RPM)	Unsigned32	rw	No	See text
	2	v/ velocity max amount (RPM)	Unsigned32	rw	No	See text

Object works in:	Object doesn't work in:
 Motion Control: 	
All modes	
 Non motion Control (conf. ≠ x40) 	

Object vl velocity min max amount comprises Subindex 01 = vl velocity min amount and Subindex 02 = vl velocity max amount.

The unit of 0x6046/n *vl velocity min max amount* is min⁻¹ (positive values only). The value of 0x6046/n *vl velocity min max amount* is converted to a frequency value internally, considering parameter *No. of pole pairs* **373** (in dataset 1).

Writing of object 0x6046/1 *vl velocity min amount* will automatically generate a write instruction for parameter *Minimum frequency* **418** to RAM (\rightarrow dataset 5, all datasets in RAM only).

Writing of object 0x6046/2 *vl velocity max amount* will automatically generate a write instruction for parameter *Maximum frequency* **419** to RAM (\rightarrow dataset 5, all datasets in RAM only).

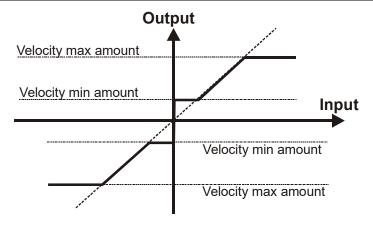
The default setting depends on the motor settings used.



When the reference value specified with object <u>0x6042</u> <u>v/ target velocity</u> is smaller than object value 0x6046/1 <u>v/ velocity min amount</u> or greater than 0x6046/2 <u>v/ velocity max amount</u>, <u>0x6042</u> <u>v/ target velocity</u> is limited to the relevant values.



No.	Object	Min.	Max.
0x6046/1	√ velocity min amount (RPM)	1	32767 (= 0x7FFF)
0x6046/2	v/velocity max amount (RPM)	1	32767 (= 0x7FFF)





When objects 0x6046/1 or 0x6046/2 are written and a save parameters instruction is generated after that (object 0x1010), the object values in the non-volatile memory will be saved. When the frequency inverter is switched on the next time, the values set before will be activated again and overwrite the settings of parameters $Minimum\ frequency\ 418$ and $Maximum\ frequency\ 419$.



In Positioning applications the overall speed can fall below or exceed the limits defined by Minimum and Maximum frequency due to the influence of the Position controller. The output of the Position Controller can be limited by *Limitation* **1118.**

12.5.9 0x6048/n v/velocity acceleration

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6048	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Delta speed (min ⁻¹)	Unsigned32	rw	No	0x96
	2	Delta time (sec)	Unsigned16	rw	No	1

Object works in:	Object doesn't work in:
 Motion Control: 	 Motion Control:
 Velocity mode 	 Table Travel record mode
	 Profile Positioning mode
 Non motion Control (conf. ≠ 	 Profile Velocity mode
x40)	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Move away from Limit Switch
	 Electronic Gear: Slave

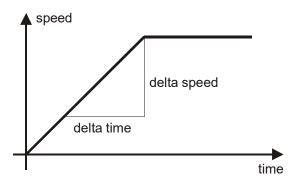
With object 0x6048 *vl velocity acceleration* the change of speed and startup time is set in **velocity mode**. Object 0x6048 *vl velocity acceleration* comprises *delta speed* in min⁻¹ and *delta time* in seconds.

The frequency gradient during startup is written to parameters *Acceleration clockwise* **420** and *Acceleration anticlockwise* **422** (dataset 5, all datasets only in RAM). Both parameters are set to the same value. The values of parameters *Acceleration clockwise* **420** and *Acceleration anticlockwise* **422** are converted to a value in unit frequency/second, considering parameter *No. of pole pairs* **373** (in dataset 1).



The gradient is changed internally by the change in objects *delta-time* or *delta-speed*.

No.	Object	Min.	Max.
0x6048/1	Delta speed (RPM)	1	32767 (= 0x7FFF)
0x6048/2	Delta time (sec)	1	65535 (= 0xFFFF)





When objects 0x6048/1 or 0x6048/2 are written and a save parameters instruction is generated after that (object 0x1010), the object values in the non-volatile memory will be saved. When the frequency inverter is switched on the next time, the values set before will be activated again and overwrite the settings of parameters *Acceleration clockwise* **420** and *Acceleration anticlockwise* **422**.



12.5.10 0x6049/n v/velocity deceleration

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6049	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Delta speed (min ⁻¹)	Unsigned32	rw	No	0x96
	2	Delta time (sec)	Unsigned16	rw	No	1

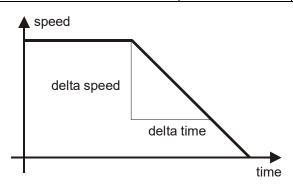
Object works in:	Object doesn't work in:
 <u>Motion Control:</u> 	 <u>Motion Control:</u>
 Velocity mode 	 Table Travel record mode
	 Profile Positioning mode
• Non motion Control (conf. ≠ x40)	 Profile Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Move away from Limit Switch
	 Electronic Gear: Slave

With object 0x6049 *vl velocity deceleration* the change of speed and shutdown time is set. Object 0x6049 *vl velocity deceleration* comprises *delta speed* in min⁻¹ and *delta time* in seconds.

The frequency gradient during shutdown is written to parameters *Deceleration clockwise* **421** and *Deceleration anticlockwise* **423** (dataset 5, all datasets only in RAM). Both parameters are set to the same value. The values of parameters *Deceleration clockwise* **421** and *Deceleration* anticlockwise 423 are converted to a value in unit frequency/second, considering parameter *No. of pole pairs* **373** (in dataset 1).

The gradient is changed internally by the change in objects *delta-time* or *delta-speed*.

	Parameter	Setting		
No.	No. Object Min.			
0x6049/1	Delta speed (RPM)	1	32767 (= 0x7FFF)	
0x6049/2	Delta time (sec)	1	65535 (= 0xFFFF)	





When objects 0x6049/1 or 0x6049/2 are written and a save parameters instruction is generated after that (object 0x1010), the object values in the non-volatile memory will be saved. When the frequency inverter is switched on the next time, the values set before will be activated again and overwrite the settings of parameters Deceleration clockwise **421** and Deceleration anticlockwise 423.



12.5.11 0x604A/n v/velocity quick stop

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x604A	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Delta speed (min ⁻¹)	Unsigned32	rw	No	0x96
	2	Delta time (sec)	Unsigned16	rw	No	1

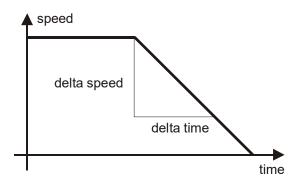
Object works in:	Object doesn't work in:
 Motion Control: 	Motion Control:
 Velocity mode 	 Table Travel record mode
	 Profile Positioning mode
• Non motion Control (conf. 7	 Profile Velocity mode
x40)	 Homing mode
, and the second	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Move away from Limit Switch
	 Electronic Gear: Slave

With object 0x604A *vl velocity quick stop*, you can set the quick stop deceleration. Object 0x604A *vl velocity quick stop* comprises speed change in min⁻¹ and shutdown time in seconds.

The frequency gradient during shutdown is written to parameters *Emergency Stop Clockwise* **424** and *Emergency Stop Anticlockwise* **425** (dataset 5, all datasets only in RAM). Both parameters are set to the same value. The value of parameters *Emergency Stop Clockwise* **424** and *Emergency Stop Anticlockwise* **425** are converted internally to a value in unit frequency/second, considering parameter *No. of pole pairs* **373** (in dataset 1).

The gradient is changed internally by the change in objects *delta-time* or *delta-speed*.

	Parameter	Set	ting
No.	Object	Min.	Max.
0x604A/1	Delta speed (rpm)	1	32767 (= 0x7FFF)
0x604A/2	Delta time (sec)	1	65535 (= 0xFFFF)





When objects 0x604A/1 or 0x604A/2 are written and a save parameters instruction is generated after that (object 0x1010), the object values in the non-volatile memory will be saved. When the frequency inverter is switched on the next time, the values set before will be activated again and overwrite the settings of parameters $Emergency\ Stop\ Clockwise\ 424$ and $Emergency\ Stop\ Anticlockwise\ 425$.



12.5.12 0x6060/0 Modes of operation

All modes

Index	Sub-index	Meaning		Data type	Access	Мар	DefVal
0x6060	0	Modes of operation	I	integer8	wo	Rx	2
Object works in:			Obj	ect doesn't v	vork in:		
Motion Control:			• Non me	otion Con	trol (co	nf. ≠ x40)	

With object 0x6060 *modes of operation*, the designated operation mode of the inverter is set. Depending on the used configuration of the inverter, there are different choices feasible.

Available values for *modes of operation* with inverter in motion control configuration (p.30 = x40 and 412 Local/Remote = "1 - Control via Statemachine"):

Modes of operation				
Dec. Hex.	Mode			
1 0x01 -	Profile position mode			
2 0x02 -	Velocity mode (Default)			
3 0x03 -	Profile velocity mode			
6 0x06 -	Homing mode			
7 0x07 -	Interpolated position mode			
8 ox08	Cyclic sync position mode			
9 0x09 -	Cyclic sync velocity mode			
-1 0xFF -	Table travel record (manufacturer specific mode)			
-2 0xFE -	Move away from Limit switch (manufacturer specific mode)			
-3 0xFD -	Electronic Gear: Slave (manufacturer specific mode)			

Object 0x6060 *modes of operation* is limited like described in the table.

	Parameter	Set	ting
No.	Object	Min.	Max.
0x6060/0	Modes of operation	-3 0xFD	9

Available value for *modes of operation* with inverter in non motion control configuration $(p.30 \neq x40 \text{ or } 412 \text{ } Local/Remote = "1 - \text{Control via Statemachine"})$:

	Modes of operation
2 – velocity mode	

The inverter in non motion control configuration ignores all settings other than "2". When accessing via SDO, an SDO fault message is generated, that prompts the invalid value.

For further information see chapter 14 "Control of frequency inverter".



12.5.13 0x6061/0 Modes of operation display

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6061	0	Modes of operation display	Integer8	ro	Tx	

Object works in:	Object doesn't work in:
 Motion Control: 	• Non motion Control (conf. ≠ x40):
All modes	Value always "2"

Object 0x6061 *modes of operation display* acknowledges the previously set value of *modes of operation* by displaying the same value as *modes of operation*.



After setting 0x6060 <u>modes of operation</u>, the PLC must wait for this acknowledgement before sending any other command to the inverter.

For further information see chapter 14 "Control of frequency inverter".

12.5.14 0x6064/0 Position actual value

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6064	0	Position actual value	Integer32	ro	Tx	

Object works in:	Object doesn't work in:
Motion Control:	• Non motion Control (conf. ≠ x40)
All modes	

Object 0x6064 *position actual value* represents the actual value of the position measurement device in user units.



The dimension of the user units is defined by $\underline{0x6091}$ $\underline{Gear\ ratio}$ and $\underline{0x6092}$ $\underline{Feed\ constant}$. The value is the same like stated in parameter $Actual\ Position\ 1108$.



12.5.15 0x6065/0 Following error window

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6065	0	Following error window	Unsigned32	rw	No	0xFFFF FFFF

Object works in:	Object doesn't work in:
 Motion Control: 	 Non motion Control (conf. ≠ x40)
All modes	

Object 0x6065 *following error window* is used to set the threshold of a device warning when the following error becomes too big.



In the application manual "Positioning", the term "Contouring error" is used instead of the CANopen® term "Following error".

Object 0x6065 *following error window* defines a range of tolerated position values symmetrical to the *position demand value* defined in user units.

The valid value range of object 0x6065/0 *following error window* is 0 ... 0x7FFF FFFF $(2^{31}-1)$. Writing a value of 0x8000 0000 (2^{31}) ... 0xFFFF FFFE $(2^{32}-2)$ results in an SDO abort (value range).

If the value of the *following error window* is set to $0xFFFF FFFF (2^{32}-1) OR 0$, the *following error window* is switched off.

The actual following error is displayed in object 0x60F4 Following error actual value.

The warning is triggered if the Following error window was exceeded for the time specified in Object 0x6066 *following error time out*. No device fault is triggered.



Writing to object *following error window* automatically generates a write command to contouring error parameter *Warning Threshold* **1105** (data set 5, all data sets in RAM only!).



If object 0x6065/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of *Warning Threshold* **1105**.





12.5.16 0x6066/0 Following error time out

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6066	0	Following error time out	Unsigned16	rw	No	0xA (=10)

Object works in:	Object doesn't work in:
Motion Control:	• Non motion Control (conf. ≠ x40)
All modes	

When a following error (Object 0x6065 <u>following error window</u>) occurs longer than the defined value of object 0x6066 <u>following error time out</u> given in milliseconds, the corresponding bit in the Status word (bit 13 <u>following error</u>) is set to one. No device fault is triggered.



Writing to object *following error time out* automatically generates a write command to parameter *Contouring Error Time* **1119** (data set 5, all data sets in RAM only!).



If object 0x6066/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of *Contouring Error Time* **1119**.



12.5.17 0x6067/0 Position window

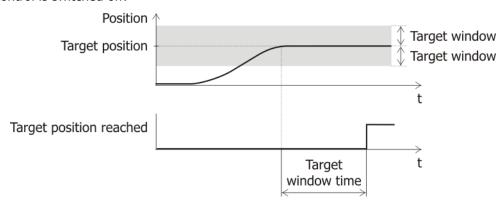
Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6067	0	Position window	Unsigned32	rw	No	0xFFFF FFFF
Object v	works in: Motion Cont		Object doesn't v • Non m	work in: otion Con	trol (co	nf. ≠ x40)

The signal "target position reached" can be changed in accuracy with Object 0x6067 *Position window* for the modes which use Status Word Bit 10 "Target reached" as "Target Position reached" like "Profile Positioning Mode" and "Table Travel Record Mode".

Object 0x6067 *position window* defines a symmetrical range of accepted positions relative to the target position in user units. If the actual value of the position measurement device is within the position window, the target position is regarded as reached. "Target reached" is displayed in Bit 10 of the status word. The actual position must be inside the position window during the time specified in Object 0x6068 *Position window time*. If the actual position drifts outside the target window or if a new target position is set, the "Target reached" Bit is reset until the position and time conditions are met again.

The valid value range of object 0x6067/0 *position window* is 0 ... 0x7FFF FFFF $(2^{31}-1)$. Writing a value of 0x8000 0000 (2^{31}) ... 0xFFFF FFFE $(2^{32}-2)$ results in an SDO abort (value range).

If the value of *Position window* is set to 0xFFFF FFFF (2³²-1) OR 0, the position window control is switched off.





Writing to object *position window* automatically generates a write command to parameter *Target Window* **1165** (data set 5, all data sets in RAM only!).



If object 0x6067/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of *Target Window* **1165**.





12.5.18 0x6068/0 Position window time

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6068	0	Position window time	Unsigned16	rw	No	0xA (=10)

Object works in:	Object doesn't work in:
 <u>Motion Control:</u> 	• Non motion Control (conf. ≠ x40)
All modes	

When the actual position is within the *Position window* during the defined *Position window time* (given in milliseconds), then the corresponding bit in the Status word (bit 10 *target reached*) is set to one. This is considered in Modes that use Status Word Bit 10 "Target reached" as "Target Position reached" like "Profile Positioning Mode" and "Table Travel Record Mode".



Writing to object *Position window time* automatically generates a write command to parameter *Target Window Time* **1166** (data set 5, all data sets in RAM only!).



If object 0x6068/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of *Target Window Time* **1166**.

12.5.19 0x606C/0 Velocity actual value [u/s]

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x606C	0	velocity actual value	Integer32	ro	Tx	

Object works in:	Object doesn't work in:
 Motion Control: 	• Non motion Control (conf. ≠ x40)
 All modes 	· · ·

The actual velocity value in $\lceil u/s \rceil$ is displayed.



12.5.20 0x606D/0 Velocity Window

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x606D	0	Velocity Window	Unsigned16	rw	No	1000

Object works in:	Object doesn't work in:
 Motion Control: 	Motion Control:
 Profile Velocity mode 	 Profile Positioning mode
	 Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

Object 0x606D *Velocity window* is used to define the threshold of Bit 10 "Target reached" of the Status word in Profile Velocity mode.

Object 0x606D *Velocity window* defines the symmetric range around the value of Object 0x60FF *Target Velocity* in user units/s.

Bit 10 "Target reached" is set in the Status word when the difference between 0x60FF Target Velocity and 0x606C Velocity Actual value is smaller than the 0x606D Velocity Window for a longer time than 0x606E Velocity Window Time.

The value range of Object 0x606D/0 *Velocity Window* is 0 ... 65535 u/s.

If the value of 0x606D/0 *Velocity Window* is set to 0, bit 10 "Target reached" of the Status word is only set with the exact equality of actual speed and reference speed. It is recommended to set the value large enough to get a reliable status information of Bit 10 "Target reached".



Writing to object 0x606D/0 *Velocity Window* automatically generates a write command to parameter *Velocity Window* **1276** (data set 5, all data sets in RAM only !).



If object 0x606D/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Velocity Window* **1276**.





12.5.21 0x606E/0 Velocity Window Time

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x606E	0	Velocity Window time	Unsigned16	rw	No	0

Object works in:	Object doesn't work in:
 Motion Control: 	Motion Control:
 Profile Velocity mode 	 Profile Positioning mode
	 Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

Object 0x606E *Velocity window Time* defines the time, for which at least reference velocity and Actual velocity must be similar enough to set Bit 10 "Target reached" of the Status word. The similarity ("Hysteresis") is defined via <u>0x606D</u> *Velocity Window*.

<u>0x606D</u> <u>Velocity window</u> defines the symmetric range around the value of Object 0x60FF <u>Target Velocity</u> in user units/s.

Bit 10 "Target reached" is set in the Status word when the difference between 0x60FF <u>Target Velocity</u> and 0x606C <u>Velocity Actual value</u> is smaller than the 0x606D <u>Velocity window</u> for a longer time than 0x606E <u>Velocity Window Time</u>.

If both conditions are not met at the same time, bit 10 "Target reached" of the Status word is reset.

The value range of Object 0x606E/0 Velocity Window Time is 0 ... 65535 ms.



Writing to object 0x606E/0 *Velocity Window Time* automatically generates a write command to parameter *Velocity Window Time* **1277** (data set 5, all data sets in RAM only).



If object 0x606D/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Velocity Window Time* **1277**.





12.5.22 0x606F/0 Velocity Threshold

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x606F	0	Velocity Threshold	Unsigned16	rw	No	100
						_

Object works in:	Object doesn't work in:
 Motion Control: 	 Motion Control:
 Profile Velocity mode 	 Profile Positioning mode
	 Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

Object 0x606F *Velocity Window Threshold* defines a threshold to change Bit 12 "Velocity" of the Status word in Profile Velocity mode. If the absolute value of the Actual Velocity lies for the time given over 0x6070 *Velocity Threshold Time* above the threshold 0x606F *Velocity Threshold*, the bit is reset. If the Actual Velocity falls below the defined threshold of 0x606F *Velocity Threshold*, bit 12 "Velocity" of the Status word is set.

The value range of Object 0x606F/0 Velocity Window Threshold is 0 ... 65535 u/s.



Writing to object 0x606F/0 *Velocity Window Threshold* automatically generates a write command to parameter *Threshold Window* **1278** (data set 5, all data sets in RAM only !).



If object 0x606F/0 *Velocity Threshold* was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory. After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Threshold Window* **1278**.





12.5.23 0x6070/0 Velocity Threshold Time

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6070	0	Velocity Threshold Time	Unsigned16	rw	No	0

Object works in:	Object doesn't work in:
Motion Control:	Motion Control:
 Profile Velocity mode 	 Profile Positioning mode
	 Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

If the absolute value of the Actual Velocity lies for the time given over 0x6070 *Velocity Threshold Time* above the threshold 0x606F *Velocity Threshold*, the bit is reset. If the Actual Velocity falls below the defined threshold of 0x606F *Velocity Threshold*, bit 12 "Velocity" of the Status word is set.

The value range of Object 0x6070/0 Velocity Window Time is 0 ... 65535 ms.



Writing to object 0x606F/0 *Velocity Window Threshold* automatically generates a write command to parameter *Threshold Window Time* **1279** (data set 5, all data sets in RAM only!).



If object 0x606F/0 *Velocity Threshold* was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory. After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Threshold Window Time* **1279**.





12.5.24 0x6071/0 Target Torque

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6071	0	Target Torque	Integer16	rw	Rx	0

The value that can be transmitted via object 0x6071 is selectable as source 808 for various parameters (e.g. *FT input buffer percentage* **1381**).

It is also available as operation mode 95 or inverted operation mode 195 (e.g. for parameter *Reference percentage source* **476**) in configurations with torque control (Configuration **30** = x30).

The value 0x3E8 (=1000) is the rated motor torque (100.0 %).



By default, object 0x6071 is not linked to a device function. In order to use object 0x6071, at least one device function must be linked to the object by setting the relevant parameters.

The value range of object 0x6071 is limited from -3000 to 3000 (= -300.0...300.0 %).

	Parameter	Setting		
No. Object		Min.	Max.	
0x6071/0	Target Torque	-3000	3000	
		(= 0xF448)	(= 0x0BB8)	

Hexadecimal value 0x6071	Decimal value 0x6071	Percentage of Target Torque
0x03E8	1000	100.0
0x0064	100	10.0
0x0001	1	0.1
0xFF18	-1000	-100.0
0xFF9C	-100	-10.0
0xFFFF	-1	-0.1

12.5.25 0x6077/0 Torque actual value

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6077	0	Torque actual value	Integer16	ro	Tx	

Object 0x6077 *Torque actual value* shows the actual torque (see parameter *Torque* **224**).

The value 0x3E8 (=1000) is the rated motor torque (100.0 %). Please also note object 0x6071.

12.5.26 0x6078/0 Current actual value

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6078	0	Current actual value	Integer16	ro	Tx	

Object 0x6078 *Current actual value* shows the actual current value (see parameter R.m.s current **211**).

The value 0x3E8 (=1000) is the rated motor current (100.0 %). The rated motor current is set during commissioning in parameter *Rated current* **371**.



12.5.27 0x6079/0 DC link circuit voltage

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6079	0	DClink circuit voltage	Integer32	ro	Tx	

Object 0x6079 *DC link circuit voltage* shows the actual value of the DC link voltage in mV (see parameter *DC link voltage* **222**).

Value 0x0001 86A0 (=100 000) is equivalent to 100.000 V (three decimal places).

12.5.28 **0x607A/0 Target position**

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x607A	0	Target position	Integer32	rw	Rx	0

Object works in:	Object doesn't work in:
 <u>Motion Control:</u> 	 Motion Control:
 Profile Positioning mode 	 Velocity mode
 Cyclic Sync Position mode 	 Profile Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	• Non motion Control (conf. ≠ x40)

Object 0x607A *target position* defines the position (in user units) that the drive should move to in profile position mode.





12.5.29 0x607C/0 Home offset

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x607C	0	Target position	Integer32	rw	No	0

Object works in:	Object doesn't work in:
• Motion Control:	Motion Control:
\circ Homing mode	 Profile Positioning mode
_	 Velocity mode
	 Profile Velocity mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

Object 0x607C *home offset* defines the offset between the zero position of the position measurement device found during homing and the zero position of the application. All subsequent movements are in relation to the application zero position.



Writing to object *home offset* automatically generates a write command to parameter *Home Offset* **1131** (data set 5, all data sets in RAM only !).



If object 0x607C/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Home Offset* **1131**.





12.5.30 0x6081/0 Profile velocity [u/s]

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6081	0	Profile velocity	Unsigned32	rw	Rx	0x5 0000

Object works in:	Object doesn't work in:
 Motion Control: 	 <u>Motion Control:</u>
 Profile Velocity mode 	 Profile Positioning mode
	 Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

Object 0x6081 *profile velocity* is the velocity (in user units per second) at the end of the acceleration ramp in profile position mode.



The dimension of the user units is defined by 0x6091 <u>Gear ratio</u> and 0x6092 <u>Feed constant</u>.

The values of Object 0x6081 are limited to 1 to 0x7FFF FFFF.

	Parameter		Setting		
No.	Object	Min.	Max.		
0x6081/0	Profile velocity (u/s)	1	2147483647 (= 0x7FFF FFFF)		



12.5.31 0x6083/0 Profile acceleration

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6083	0	Profile acceleration	Unsigned32	rw	Rx	0x5 0000

Object works in: • Motion Control: • Profile Velocity mode • Profile Positioning mode • Interpolated mode • Electronic Gear: Slave Object doesn't work in: • Motion Control: • Velocity mode • Homing mode • Cyclic Sync Position mode • Cyclic Sync Velocity mode • Table Travel record mode • Move away from limit switch

Object 0x6083 profile acceleration is the acceleration in user units per second² [u/s²] in profile position mode.



The dimension of the user units is defined by 0x6091 <u>Gear ratio</u> and 0x6092 <u>Feed constant</u>.

The values of Object 0x6083 are limited to 1 to 0x7FFF FFFF (2^{31} -1).

	Parameter	Setting		
No.	Object	Min.	Max.	
0x6083/0	Profile acceleration (u/s²)	1	2147483647 (= 0x7FFF FFFF)	

12.5.32 0x6084/0 Profile deceleration

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6084	0	Profile deceleration	Unsigned32	rw	Rx	0x5 0000

Object 0x6084 *profile deceleration* is the deceleration in u/s².



The dimension of the user units is defined by 0x6091 <u>Gear ratio</u> and 0x6092 <u>Feed constant</u>.

The values of Object 0x6083 are limited to 1 to 0x7FFF FFFF (2^{31} -1).

	Parameter	Se	etting
No.	Object	Min.	Max.
0x6084/0	Profile deceleration (u/s²)	1	2147483647 (= 0x7FFF FFFF)



12.5.33 0x6085/0 Quick stop deceleration

Index S	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6085	0	Quick stop deceleration	Unsigned32	rw	No	0xA 0000

Object works in:

- Motion Control:
 - Profile Positioning mode
 - Profile Velocity mode
 - Homing mode
 - Interpolated mode
 - Cyclic Sync Position mode
 - Cyclic Sync Velocity mode
 - Table Travel record mode
 - Move away from Limit Switch
 - Electronic Gear: Slave

Object doesn't work in:

- Motion Control:
 - Velocity mode
- Non motion Control (conf. \neq x40)

Object 0x6085 quick stop deceleration is the deceleration (in user units per second²) in profile position mode for quick stop mode (Control word bit 2 = 0).



Writing to object *Quick stop deceleration* automatically generates a write command to parameter *Emergency Ramp* **1179** (data set 5, all data sets in RAM only !).



If object 0x6085/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory. After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Emergency Ramp* **1179**.



The dimension of the user units is defined by 0x6091 <u>Gear ratio</u> and 0x6092 <u>Feed constant</u>.

The values of Object 0x6085 are limited to 1 to 0x7FFF FFFF $(2^{31}-1)$.

	Parameter	Setting		
No.	Object	Min.	Max.	
0x6085/0	Quick stop deceleration (u/s²)	1	2147483647 (= 0x7FFF FFFF)	



12.5.34 0x6086/0 Motion profile type

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6086	0	Motion profile type	Integer16	rw	No	3

Object works in	: Object doesn't work in:			work in:
• Motion Control: • Motion Control:			Control:	
0	Profile Positioning mode		0	Velocity mode
0	Profile Velocity mode		0	Homing mode
0	Interpolated mode		0	Cyclic Sync Position mode
0	Move away from Limit		0	Cyclic Sync Velocity mode
	Switch		0	Table Travel record mode
0	Electronic Gear: Slave			
		•	Non m	notion Control (conf. ≠ x40)

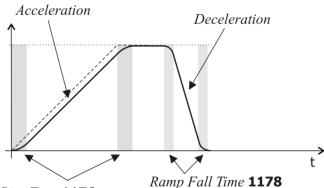
Object 0x6086 *motion profile type* defines the ramp behaviour for acceleration/deceleration.

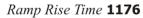
Supported values for motion profile type:

- 0- linear ramp
- 3- jerk limited ramp

In mode 3 "jerk limited ramp", the ramp uses the parameters:

- *Ramp Rise Time* **1176**
- *Ramp Fall Time* **1178**







- The Ramp Rise/Fall time in *Table travel record mode* is defined via parameters **1205** and **1207**.
- The Ramp Rise/Fall time in *Homing mode* is defined via parameter **1135**.
- The Ramp Rise/Fall time in *Velocity mode* and in Non-Motion Control configurations is defined via parameters **430**...**433**.
- The Ramp Rise/Fall times in these modes are independent of the settings of object 0x6086.

12.5.35 0x6091/n Gear ratio

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6091	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Motor shaft revolutions	Unsigned32	rw	No	1
	2	Driving shaft revolutions	Unsigned32	rw	No	1



Object works in:	Object doesn't work in:
Motion Control:	 Non motion Control (conf. ≠ x40)
 All modes 	, , ,

Object 0x6091 *gear ratio* defines the ratio of motor shaft revolutions to driving shaft revolutions.

Gear ratio = $\frac{0x6091/1 \text{ motor shaft revolutions}}{0x6091/2 \text{ driving shaft revolutions}}$

Parameter Gear Box : Motor Shaft Revolutions **1117**Parameter Gear Box : Driving Shaft Revolutions **1116**



Writing to object *motor shaft revolutions* automatically generates a write command to parameter *Gear Box: Motor Shaft Revolutions* **1117** (data set 5, all data sets in RAM only!).



If object 0x6091/1 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of *Gear Box: Motor shaft revolutions* **1117**.



Writing to object *driving shaft revolutions* automatically generates a write command to parameter *Gear Box: Driving Shaft Revolutions* **1116** (data set 5, all data sets in RAM only!).



If object 0x6091/2 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Gear Box: Driving Shaft Revolutions* **1116**.

Alternatively the parameters 1116 and 1117 can be used instead of the Objects.

			Pa	rameter			
0x6091/1	Motor Shaft revolutions	1117	Gear	Box: I	Motor Sho	aft Rev	olutions
0x6091/2	Driving Shaft revolutions	1116	Gear	Box:	Driving	Shaft	Revolu-
			tions				

The values of Objects 0x6091/1 and 6091/2 are limited as follows:

	Parameter	Set	ting
No.	Object	Min.	Max.
0x6091/1	Motor shaft revolutions	1	65535 (= 0x0000 FFFF)
0x6091/2	Driving shaft revolutions	1	65535 (= 0x0000 FFFF)



12.5.36 0x6092/n Feed constant

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6092	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Feed	Unsigned32	rw	No	0x1 0000
	2	(Driving) shaft revolutions	Unsigned32	rw	No	1

Object works in:	Object doesn't work in:
 Motion Control: 	• Non motion Control (conf. ≠ x40)
 All modes 	

Object 0x6092 *feed constant* defines the feed (in user units) per driving shaft revolutions.

Feed constant =
$$\frac{0x6092/1 \, feed}{0x6092/2 \, driving \, shaft \, revolutions}$$



The allowed value for 0x6092/2 *driving shaft revolutions* is **1** only. Writing values other than 1 results in an SDO abort response.



Writing to object *feed* or *driving shaft revolutions* automatically generates a write command to parameter *Feed Constant* **1115** (data set 5, all data sets in RAM only!).



If object 0x6092/1 or 0x6092/2 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory. After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Feed constant* **1115**.

The values of Object 0x6092/1 and 6092/2 are limited as follows:

	Parameter	Set	ting
No.	Object	Min.	Max.
0x6092/1	Feed	1	65535 (= 0x0000 FFFF)
0x6092/2	(Driving) shaft revolutions	1	1

12.5.37 0x6098/0 Homing method

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6098	0	Homing method	Integer8	rw	No	0



Object works in:	Object doesn't work in:
 Motion Control x40: 	 Motion Control x40:
 Homing mode 	 Profile Positioning mode
	 Profile Velocity mode
	 Velocity mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

Object 0x6098/0 *homing method* determines the method that will be used during homing. For a detailed description of the different homing modes see the application manual "Positioning".



Writing to object *homing method* automatically generates a write command to parameter *Homing Mode* **1130** (data set 5, all data sets in RAM only !).



If object 0x6098/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter $Homing\ Mode\ 1130$.

/	Homing Method 0x6098/0	Function
0 -	No Homing	Factory setting. No homing; the current position value is not changed. The current position value is the value saved upon the last disconnection of the power supply.
1 -	Neg. Limit Switch & RefSignal	Homing to negative HW limit switch with detection of encoder ref. signal.
2 -	Pos. Limit Switch & RefSignal	Homing to positive HW limit switch with detection of encoder ref. signal.
3 -	Pos. Home-Sw., RefSignal left of Edge	Homing to positive home switch with detection of encoder ref. signal. Home position is the first encoder ref. signal to the left of the edge of the home switch signal.
4 -	Pos. Home-Sw., RefSignal right of Edge	Homing to positive home switch with detection of encoder ref. signal. Home position is the first encoder ref. signal to the right of the edge of the home switch signal.
5 -	Neg. Home-Sw., RefSignal right of Edge	Homing to negative home switch with detection of encoder ref. signal. Home position is the first encoder ref. signal to the right of the edge of the home switch signal.
6 -	Neg. Home-Sw.: RefSignal left of Edge	Homing to negative home switch with detection of encoder ref. signal. Home position is the first encoder ref. signal to the left of the edge of the home switch signal.



	Homing Method 0x6098/0	Function
	Pos. LimSw., RefSig. left of	Homing to home switch with detection of encoder
7 -	left Edge of Home-Sw.	ref. signal. Homing direction positive (clockwise).
	Pos. LimSw., RefSig. right of	Reversal of direction of rotation when positive HW
8 -	left Edge of Home-Sw.	limit switch is reached.
	Pos. LimSw., RefSig. left of	Home position is the first encoder ref. signal to the
9 -	right Edge of Home-Sw.	left or right of the left or right edge of the home
40	Pos. LimSw., RefSig. right of	switch signal.
10 -	right Edge of Home-Sw.	
	Neg. LimSw., RefSig. right of	Homing to home switch with detection of encoder
11 -	right Edge of Home-Sw.	ref. signal. Homing direction negative (anticlock-
4.0	Neg. LimSw., RefSig. left of	wise). Reversal of direction of rotation when nega-
12 -	right Edge of Home-Sw.	tive HW limit switch is reached.
10	Neg. LimSw., RefSig. right of	Home position is the first encoder ref. signal to the
13 -	left Edge of Home-Sw.	left or right of the left or right edge of the home
1.4	Neg. LimSw., RefSig. left of	switch signal.
14 -	left Edge of Home-Sw.	
17	30: like 1 14, but without encode	er ref. signal
17 -	Neg. Limit Switch	Homing to negative HW limit switch.
18 -	Pos. Limit Switch	Homing to positive HW limit switch.
19 -	Dec Home Cur left of Edge	Homing to positive home switch. Home position is at
19 -	Pos. Home-Sw., left of Edge	the left of the edge of the home switch signal.
20 -	Pos. Home-Sw., right of Edge	Homing to positive home switch. Home position is at
20 -	Pos. Home-sw., right of Edge	the right of the edge of the home switch signal.
21 -	Neg. Home-Sw., right of Edge	Homing to negative home switch. Home position is
21 -	Neg. Home-5w., fight of Lage	at the right of the edge of the home switch signal.
22 -	Neg. Home-Sw., left of Edge	Homing to negative home switch. Home position is
		at the left of the edge of the home switch signal.
23 -	Pos. LimSw., left of left Edge of	Homing to home switch. Homing direction positive
	Home-Sw.	(clockwise). Reversal of direction of rotation when
24 -	Pos. LimSw., right of left Edge	positive HW limit switch is reached.
	of Home-Sw.	Home position is at the left or right of the left or
25 -	Pos. LimSw., left of right Edge	right edge of the home switch signal.
	of Home-Sw.	
26 -	Pos. LimSw., right of right Edge	
	of Home-Sw.	
27 -	Neg. LimSw., right of right	Homing to home switch. Homing direction negative
<u> </u>	Edge of Home-Sw.	(anticlockwise). Reversal of direction of rotation
28 -	Neg. LimSw., left of right Edge	when negative HW limit switch is reached.
	of Home-Sw.	Home position is at the left or right of the left or
29 -	Neg. LimSw., right of left Edge	right edge of the home switch signal.
	of Home-Sw.	
30 -	Neg. LimSw., left of left Edge of	
	Home-Sw.	
33 -	RefSignal left of act. pos.	Home position is the first encoder ref. signal in neg-
		ative (operation mode 33) or positive (operation
34 -	RefSignal right of act. pos.	mode 34) direction.
		Current position is home position. Home offset (Pa-
35 -	Current Position	rameter <i>Home-Offset</i> 1131) is taken over as actual
		position value.
	I .	

12.5.38 0x6099/n Homing speeds

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x6099	0	Highest sub-index supported	Unsigned8	ro	No	2



	1	speed during search for switch	n Unsigned32	rw	No	0x5 0000
	2	speed during search for zero	Unsigned32	rw	No	0x2 0000
Object v	works in:	C	bject doesn't wo	rk in:		
•	Motion Cor	ntrol:	 Motion Co 	ntrol x40:		

- - **Homing mode**
 - Move away from Limit **Switch**
 - Electronic Gear: Slave 1)
- - **Profile Positioning mode**
 - **Profile Velocity mode**
 - **Velocity mode** 0
 - **Interpolated mode**
 - **Cyclic Sync Position mode**
 - **Cyclic Sync Velocity mode**
 - **Table Travel record mode**

Non motion Control (conf. \neq x40)

1) Electronic Gear: Slave uses this object for the Master/Slave Position Correction

Object 0x6099/1 speed during search for switch defines the speed (in user units per second) during search for switch.

Object 0x6099/2 speed during search for zero defines the speed (in user units per second) during search for zero. This speed is also used as reference value in the "Move away from Limit Switch" mode.

The values of Object 0x6099/1 and 6099/2 are limited as follows:

Function, see chapter 0 "Master/Slave Position Correction".

	Parameter	Se	tting
No.	Object	Min.	Max.
0x6099/1	speed during search for switch	1	2147483647 (= 0x7FFF FFFF)
0x6099/2	speed during search for zero	1	2147483647 (= 0x7FFF FFFF)



Writing to object speed during search for switch automatically generates a write command to parameter Fast Speed **1132** into RAM (data set 5, all data sets in RAM only!).



If object 0x6099/1 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Fast speed* **1133**.



Writing to object speed during search for zero automatically generates a write command to parameter Creep speed 1133 into RAM (data set 5, all data sets in RAM only!).



If object 0x6099/2 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Creep speed* **1133**.



The dimension of the user units is set via objects 0x6091 Gear ratio and 0x6092 Feed constant.



12.5.39 0x609A/0 Homing acceleration

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x609A	0	Homing acceleration	Unsigned32	rw	No	0x5 0000

Object works in:	Object doesn't work in:
Motion Control:	 Motion Control:
 Homing mode 	 Profile Positioning mode
 Move away from Limit 	 Profile Velocity mode
Switch	 Velocity mode
 Electronic Gear: Slave 	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	• Non motion Control (conf. ≠ x40)

1) Electronic Gear: Slave uses this object for the Master/Slave Position Correction Function, see chapter 0 "Master/Slave Position Correction".

Object 0x609A/0 *homing acceleration* defines acceleration and deceleration (in user units per second²) during homing.

The set value is also used as reference acceleration and deceleration value in "Move away from Limit Switch" mode.



Writing to object *homing acceleration* automatically generates a write command to parameter *Acceleration* **1134** (data set 5, all data sets in RAM only !).



If object 0x609A/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory.

After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter *Acceleration* **1134**.



The dimension of the user units is set via objects $\underline{0x6091}$ $\underline{Gear\ ratio}$ and $\underline{0x6092}$ \underline{Feeo} $\underline{constant}$.

The values of Object 0x609A/0 are limited as follows:

	Parameter	Set	ting
No.	Object	Min.	Max.
0x609A/0	Homing acceleration	1	2147483647 (= 0x7FFF FFFF)



12.5.40 0x60C1/1 Interpolation data record

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x60C1	0	Highest sub-index supported	Unsigned8	ro	No	1
	1	Interpolation data record 1	Integer32	rw	Rx	0

Object works in:	Object doesn't work in:
 Motion Control: 	 Motion Control:
 Interpolated mode 	 Profile Positioning mode
	 Profile Velocity mode
	 Velocity mode
	 Homing mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

Object 0x60C1/1 *interpolation data record 1* is the target position (in user units) used in interpolation position mode.

Always ensure that a valid position is stored in the Interpolated Data Record.



It is recommended to copy the actual position to the Data Record before starting the Interpolated mode.

Interpolation position mode uses synchronous RxPDOs. The last received value for object 0x60C1/1 is activated with the next SYNC.



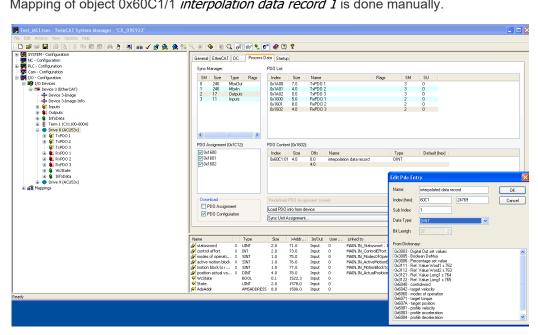
The dimension of the user units is set via objects $\underline{0x6091}$ $\underline{Gear\ ratio}$ and $\underline{0x6092}$ \underline{Feea} $\underline{constant}$.



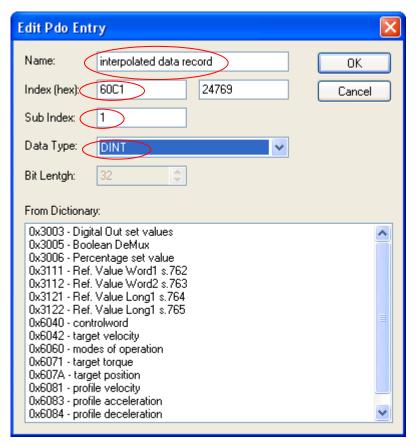


Mapping of object 0x60C1/1 interpolation data record 1 is **not** via a selection list. If a subindex were selected via a selection list, conformity inconsistencies in the test specification would be the result.

Mapping of object 0x60C1/1 interpolation data record 1 is done manually.



First, select RxPDO, after right clicking on RxPDO, select "Insert...". This will open a dialogue for object mapping.



Object 0x60C1 is **not** displayed in the selection list, but must be entered as shown in the illustration.



12.5.41 0x60F4/0 Following error actual value

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x60F4	0	Following error actual value	Integer32	ro	Tx	

Object works in:	Object doesn't work in:
 <u>Motion Control:</u> 	• Non motion Control (conf. ≠ x40)
 All modes 	



In the application manual "Positioning", the term "Contouring error" is used instead of the CANopen® term "Following error".

Object 0x60F4 shows the *following error actual value*. The value is the same like stated in parameter *Actual Contouring error* **1109**.

The allowed following error is defined by object <u>0x6065</u> *Following error window*.

The Contouring error can be monitored internally to trigger a device fault if a set threshold was reached. Please refer to the Application manual "Positioning" for details concerning the parameters *Fault reaction* **1120**, *Warning threshold* **1105**, *Error Threshold* **1106** and *Contouring error Time* **1119**.



12.5.42 0x60F8/0 Max Slippage [u/s]

Index	Sub-index	Meaning	Data type	Access	Мар	DefVal
0x60F8	0	Max Slippage	Integer32	rw	No	0

Object works in:	Object doesn't work in:
 <u>Motion Control:</u> 	Motion Control:
 Profile Velocity mode 	 Profile Positioning mode
	 Velocity mode
	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Cyclic Sync Velocity mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave
	 Non motion Control (conf. ≠ x40)

Object 0x60F8/0 *Max Slippage* can be used to trigger a warning in bit 13 "maximum slip fault" in the status word when a too high slip occurs. When the difference of stator frequency and actual speed exceeds the value set in 0x60F8 Max Slippage, Bit 13 "Max Slippage" of the Status word is set, otherwise reset.



Writing to object 0x60F8 *Max Slippage* automatically generates a write command to parameter *Max Slippage* **1275** (data set 5, all data sets in RAM only !).



If object 0x60F8/0 was written and then a save parameters command (object 0x1010) processed, the object value is stored in non-volatile memory. After the next power on of the inverter, the previously set value is reactivated and overwrites the setting of parameter $Max\ Slippage\ 1275$.





Map Def.-Val

12.5.43 0x60FF/0 Target Velocity [u/s]

Index Sub-index

bject works in:	Object doesn't work in:
Motion Control:	Motion Control:
 Profile Velocity mode 	 Profile Positioning mode
 Cyclic Sync Velocity 	 Velocity mode
mode	 Homing mode
	 Interpolated mode
	 Cyclic Sync Position mode
	 Table Travel record mode
	 Move away from Limit Switch
	 Electronic Gear: Slave

Meaning

Object 0x60FF *Target Velocity* defines the reference velocity in Profile velocity mode and Cyclic Synchronous Velocity mode.

Data type | Access

12.5.44 0x6502/0 Supported drive modes

Index	Sub-Index	Meaning	Data Type	Access	Мар	DefVal
0x6502	0	Supported drive modes	Unsigned32	ro	No	

Object 0x6502 Supported drive modes displays the supported 0x6060 Modes of Operation.

The value 0x0000 0202 means:

Bit 0: "Profile Positioning mode" is supported.

Bit 1: "Velocity mode" is supported.

Bit 2: "Profile Velocity mode" is supported.

Bit 5: "Homing mode" is supported.

Bit 6:,,"nterpolated Position mode" is supported.

Bit 7: "Cyclic Synchronous Positioning mode" is supported.

Bit 8: "Cyclic Synchronous Velocyit mode" is supported.

Bit 16: Manufacturer mode -1 "Table Travel record mode" is supported.

Bit 17: Manufacturer mode -2 "Move away from limit switch" is supported.

Bit 18: Manufacturer mode -3 "Electronic Gear: Slave" is supported.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	02 65	00	00 00 00 00
Response	581	43	02 65	00	02 02 00 00

CB: Control byte SI: Sub-Index All values in hexadecimal without leading "0x"



13 Motion Control Interface (MCI)

The Motion Control Interface (MCI) is a defined interface of the ACU device for positioning control via Field bus. Typically this interface is used via a Field bus like CANopen. With the Motion Control Interface, the user can carry out a positioning operation via a field bus using a positioning profile typically including the target position, speed, acceleration, deceleration, quick stop and mode-specific information.

The Motion Control interface uses object <u>Ox6060 Modes of Operation</u> for switching between the different modes. The supported modes as per CANopen[®] Standard DS402 are:

- 1 Profile Position mode
- 2 Velocity mode [rpm]
- 3 Profile Velocity mode [u/s]
- 6 Homing
- 7 Interpolated mode
- 8 Cyclic sync position mode
- 9 Cyclic sync velocity mode

Bonfiglioli Vectron specific modes

- -1 (or 0xFF) Table Travel record mode
- -2 (or 0xFE) Move Away from Limit Switch
- -3 (or 0xFD) Electronic Gear: Slave (electronic gear as slave)

The actual mode is displayed in <u>0x6061</u> <u>Modes of Operation Display</u>.

All above mentioned modes are usable with EtherCAT® through CoE (CANopen® over EtherCAT®).

The mode of operation can be switched in any operating state of the ACU.



It is recommended that a currently active momvement be stopped by the PLC first, then to switch 0x6060 Modes of Operation and restart in the new mode.

In order to use the Motion Control Interface, **412** Local/Remote = "1 - Control via statemachine" must be set. In configurations without Motion control (<math>Configuration **30** \neq x40), only velocity mode vI is available.

For a description of the positioning parameters please refer to the "Positioning Application manual".



"Move away from Limit Switch mode" and "Electronic Gear: Slave mode" requires firmware 5.3.0 or newer.

"Cyclic Sync Position mode" and "Cyclic Sync Velocity mode" requires firmware 5.4.0 or newer.



13.1 Object and parameter relationships

Depending on the selected object 0x6060 Modes of, various objects and parameters are used. The various objects and parameters must be set specifically for the different modes of operation. Use of "Deceleration" and "Quick Stop" depends on the modes of operation, control commands and behavior in the case of communication errors (see object 0x6007/0 abort connection option code).

The following tables provide an overview of the different objects and parameters. The object / parameter mentioned first in a cell will typically be used. If an object is related to a parameter, the parameter will be specified.

Parameters **1292** *Modes of Operation* and following (**1293**, **1294**, **1295**, **1296** & **1297**) and **1285** *S.Target velocity pv* [*u/s*] are used for linking the internal functions to CANopen®objects. Usually, these need not to be changed when using CANopen®.

Mode	Homing	Velocity Mode	Profile Velocity Mode
Modes of Operation 1)2)	6	2	3
Target Posi- tion			
Speed	Obj. 0x6099/1 & /2 Homing Speeds → 1132 & 1133	1297 S. Target velocity ²⁾ Default: 806 - Obj. 0x6042 v/ Target Velocity	pv [u/s] ²⁾ Default: 816 - Obj. 0x60FF Target Velocity
Limitation ³⁾	Obj. 0x6046/1 & /2	Obj. <u>0x6046/1</u> & /2 v/velocity min max amount amount = 418 & 419	Obj. 0x6046/1 & /2 // velocity min max amount amount = 418 & 419
Acceleration	Obj. <u>0x609A/0</u> Acceleration → 1134	Obj. 0x6048/0 // velocity acceleration = 420 (&422)	1295, Acceleration 2) Default: 804 - Obj. 0x6083 Profile Acceleration
Deceleration	Obj. 0x609A/0 Acceleration → 1134	Obj. 0x6049/0 // velocity deceleration = 421 (& 423)	1296, Deceleration ²⁾ Default: 805 - Obj. 0x6084 Profile Deceleration
Emergency stop ⁴⁾ Quick Stop	Obj. 0x6085/0 Quick stop deceleration → 1179 Emergency Ramp	Obj. <u>0x604A/0</u> Velocity Quick Stop = 424 (& 425)	Obj. 0x6085/0 Quick stop deceleration → 1179 Emergency Ramp
Homing Method	Obj. <u>0x6098/0</u> Homing method → 1130		

¹⁾ Modes of Operation is set via **1292** *S.Modes of Operation*. Default setting: 801 - Obj. 0x6060 Modes of Operation.

²⁾ Parameters **1285**, **1292**, **1293**, **1294**, **1295**, **1296** & **1297** are used for the connection between CANopen Objects and internal functions. For CANopen, these do not have to be changed.

³⁾ The limitation results from *Minimum frequency* **418** and *Maximum frequency* **419**. Through *Limitation* **1118** of the position controller in Configuration x40, an increase above the maximum frequency can occur, because the output of the position controller is added to the maximum frequency.

⁴⁾ Emergency stop or Deceleration is used depending on the stopping behavior *Mode of operation* **630** or the behavior in the case of communication errors 0x6007/0 abort connection option code.



Mode	Profile Positioning mode
Modes of Operation 1)2)	1
Target Posi- tion	1293 , <i>S.Target Pos.</i> ²⁾⁾ <u>Default:</u> 802 - Obj. <u>0x607A</u> Target Position
Speed	1294 , <i>S.Profile Vel</i> . ²⁾ <u>Default:</u> 803 - Obj. <u>0x6081</u> Profile Velocity
Limitation ³⁾	Obj. <u>0x6046/1</u> & /2 Velocity min max amount = 418 & 419
Acceleration	1295, Acceleration 2) Default :804 - Obj. 0x6083 Profile Acceleration
Deceleration	1296, Deceleration 2) Default: 805 - Obj. 0x6084 Profile Deceleration
Emergency stop ⁴⁾ Quick Stop	Obj. <u>0x6085/0</u> Quick stop deceleration → 1179 Emergency Ramp

- 1) Modes of Operation is set via **1292** *S.Modes of Operation*. Default setting: 801 Obj. 0x6060 Modes of Operation.
- 2) Parameters **1285**, **1292**, **1293**, **1294**, **1295**, **1296** & **1297** are used for the connection between CANopen Objects and internal functions. For CANopen, these do not have to be changed. Please refer to chapter 13.3 for a description.
- 3) The limitation results from *Minimum frequency* **418** and *Maximum frequency* **419**. Through *Limitation* **1118** of the position controller in Configuration x40, an increase above the maximum frequency can occur, because the output of the position controller is added to the maximum frequency.
- 4) Emergency stop or Deceleration is used depending on the stopping behavior *Mode of operation* **630** or the behavior in the case of communication errors <u>0x6007/0</u> <u>abort connection option code</u>.



Mode	Interpolated position mode	Cyclic Sync Position mode	Cyclic Sync Velocity mode
Modes of Operation 1)2)	7	8	9
Target Posi- tion	0x60C1/1 interpolation data record	1293 , S. Target Pos. ²⁾ Default: 802 - Obj. <u>0x607A</u> Target Position	
Speed			1285 <i>S.Target velocity pv</i> $[u/s]^{2)}$ <u>Default</u> : 816 - Obj. <u>0x60FF</u> Target Velocity
Limitation ³⁾	Obj. 0x6046/1 & /2 // velocity min max amount amount = 418 & 419	Obj. 0x6046/1 & /2	Obj. <u>0x6046/1</u> & /2
Acceleration	1295, Acceleration 2) Default: 804 - Obj. 0x6083 Profile Acceleration		
Deceleration	1296, Deceleration ²⁾ Default: 805 - Obj. 0x6084 Profile Deceleration		
Quick Stop 4)	Obj. 0x6085/0 Quick stop deceleration → 1179 Emergency Ramp	Obj. <u>0x6085/0</u> Quick stop deceleration → 1179 <i>Emergency Ramp</i>	Obj. <u>0x6085/0</u> Quick stop deceleration → 1179 <i>Emergency Ramp</i>

¹⁾ Modes of Operation is set via **1292** *S.Modes of Operation*. Default setting: 801 - Obj. 0x6060 Modes of Operation.

- 2) Parameters **1285**, **1292**, **1293**, **1294**, **1295**, **1296** & **1297** are used for the connection between CANopen Objects and internal functions. For CANopen, these do not have to be changed. Please refer to chapter 13.3 for a description.
- 3) The limitation results from *Minimum frequency* **418** and *Maximum frequency* **419**. Through *Limitation* **1118** of the position controller in Configuration x40, an increase above the maximum frequency can occur, because the output of the position controller is added to the maximum frequency.
- 4) Emergency stop or Deceleration is used depending on the stopping behavior *Mode of operation* **630** or the behavior in the case of communication errors <u>0x6007/0</u> <u>abort connection option code</u>.



Mode	Table Travel Record	Move away from limit	Electronic Gear: Slave
Mode	mode	switches	<u>Electroffic Gear. Slave</u>
Modes of Operation ¹⁾²⁾	-1	-2	-3
Target Posi- tion	1202 Target Position		
Speed	1203 Target Speed	Obj. 0x6099/1 & /2 Homing Speeds → 1132 & 1133	pv [u/s] ²⁾ Default: 816 - Obj. 0x60FF Target Velocity
Limitation ³⁾	Obj. 0x6046/1 & /2	Obj. 0x6046/1 & /2 // velocity min max amount = 418 & 419	Obj. 0x6046/1 & /2 v/velocity min max amount = 418 & 419
Acceleration	1204 Acceleration	Obj. <u>0x609A/0</u> Acceleration → 1134	1295, Acceleration 2) Default: 804 - Obj. 0x6083 Profile Acceleration
Deceleration	1205 Deceleration	Obj. 0x609A/0 Acceleration → 1134	1296, Deceleration 2) Default: 805 - Obj. 0x6084 Profile Deceleration
Emergency stop ⁴⁾ Quick Stop	Obj. 0x6085/0 Quick stop deceleration → 1179 Emergency Ramp	Obj. 0x6085/0 Quick stop deceleration → 1179 Emergency Ramp	Obj. <u>0x6085/0</u> Quick stop deceleration → □ 1179 Emergency Ramp
Motion Block	Selected via Control Word.		
Gear factor			1123 Gear Factor Numerator; 0x5F10/1 Gearfactor Numerator 1124 Gear Factor Denominator; 0x5F10/2 Gearfactor Denominator
Phasing ⁵⁾			1125 Phasing: Offset; 0x5F11/1 Phasing 1 Offs. 1126 Phasing: Speed; 0x5F11/2 Phasing 1 Speed 1127 Phasing: Acceleration 0x5F11/3 Phasing 1 Acceleration

¹⁾ Modes of Operation is selected via **1292** *S.Modes of Operation*. <u>Default setting</u>: 801 - Obj. <u>0x6060</u> Modes of Operation.

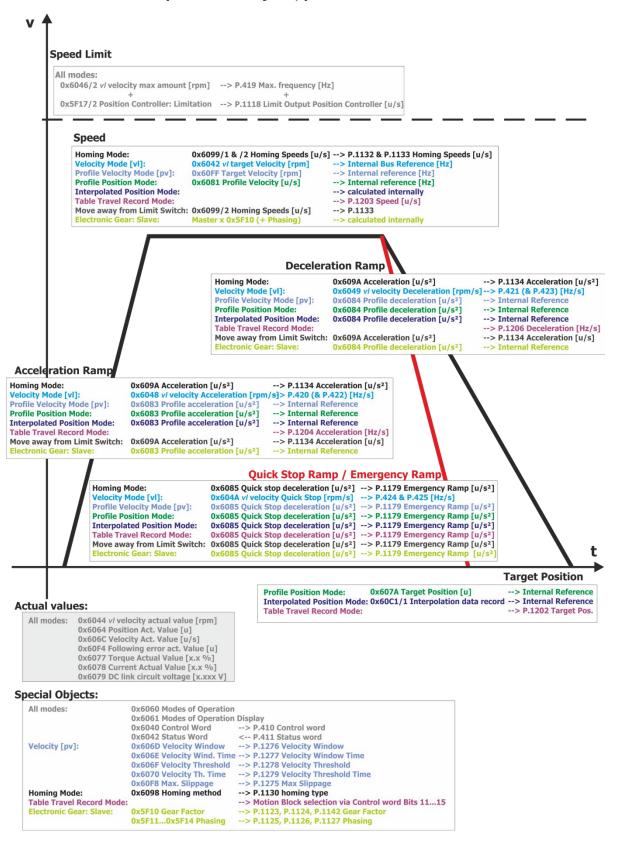
²⁾ Parameters **1285**, **1292**, **1293**, **1294**, **1295**, **1296** & **1297** are used for the connection between CANopen Objects and internal functions. For CANopen, these do not have to be changed. Please refer to chapter 13.3 for a description.

³⁾ The limitation results from *Minimum frequency* **418** and *Maximum frequency* **419**. Through *Limitation* **1118** of the position controller in Configuration x40, an increase above the maximum frequency can occur, because the output of the position controller is added to the maximum frequency.

⁴⁾ Emergency stop or Deceleration is used depending on the stopping behavior *Mode of operation* **630** or the behavior in the case of communication errors <u>0x6007/0</u> <u>abort connection option code</u>. 5) Phasing is available with 4 profiles in objects 0x5F11...0x5F14.



Relationships between objects, parameters and conversions



Velocity [vl] → Velocity mode [rpm] Velocity [pv] → Profile Velocity mode [u/s]





The graphical overview shows the most important objects which are used. Other objects are available in the different modes; for additional information, refer to the descriptions of the objects and modes.

The modes "Cyclic synchronous position mode" and "Cyclic synchronous velocity mode" are not shown for reasons of better readability. Please refer when using these modes to the tables and the corresponding chapters.

The Motion Control Interface (MCI) is a defined interface of the ACU device for position control. This interface is typically used in combination with a field bus such as CANopen.

13.2 Functions of the Motion Control Interface (MCI)

Via the Motion Control Interface, numerous positioning functions can be addressed by a PLC directly.

13.2.1 Reference system

In many modes, the Motion Control Interface uses user units [u]. These user units [u] result from the conversion of the gear factor parameters **1115**, **1116**, **1117** and *No.* of pole pairs **373**.

Conversion between "user units" [u] and frequencies [Hz]

$$f\left[Hz\right] = v\left[\frac{u}{s}\right] \cdot \frac{\textit{No.of pole pairs } \textbf{373} \cdot \textit{Gear Box : Driving shaft revolutions } \textbf{1116}}{\textit{Feed Constant } \textbf{1115}} \underbrace{\left[u\right]}_{U} \cdot \textit{Gear Box : Motor shaft revolutions } \textbf{1117}}$$

$$v \left[\frac{u}{s}\right] = f[Hz] \cdot \frac{\textit{Feed Constant 1115}}{\textit{No.of pole pairs 373} \cdot \textit{Gear Box : Motor shaft revolutions 1117}}{\textit{No.of pole pairs 373} \cdot \textit{Gear Box : Driving shaft revolutions 1116}} \cdot \frac{u}{\textit{No.of pole pairs 373} \cdot \textit{Gear Box : Driving shaft revolutions 1116}} \cdot \frac{u}{\textit{No.of pole pairs 373}} \cdot \frac{u}{\textit{No.of$$



Gear Box: Motor shaft revolutions **1116** \Rightarrow 0x6091/1 motor shaft revolutions *Gear Box: Driving shaft revolutions* **1117** \Rightarrow 0x6091/2 driving shaft revolutions



The same formulas can be used for the conversion from acceleration a [Hz/s] to a $[u/s^2]$ and vice versa. Replace in the formulas the velocities f[Hz] and v[u/s] with a [Hz/s] and a $[Hz/s^2]$.

For more details about the reference system, refer to the "Positioning" application manual.



13.2.2 Homing

When the drive is started, a defined starting position must be specified for absolute positioning modes. In a homing operation, the point of reference of the positioning operation is determined. All positioning data relates to this point of reference. Once the homing operation is started, the drive moves until it reaches a home switch or limit switch and stops there. The limit switches limit the motion path. The direction of movement (search direction) at the start of the homing operation is defined by the homing mode. Additional the reaching of a limit switch will change the direction of the drive (dependent on the homing mode). The limit switches can also be used as the point of reference.

Relative positioning and velocity operations are possible without homing.

Homing can be started:

- via a digital input
- by a control word via system bus or field bus ¹⁾
- automatically before the start of a motion block positioning operation
- 1) Extension module with system bus or field bus interface required



When using an Absolute Encoder with an Absolute Encoder Module (in example EMABS-01) a Homing after power on is not necessary. This is defined by parameter *Operation Mode* **1220**.

Further details of the Homing functions are described in the application manual "Positioning".

13.2.2.1 Start position after homing

After homing:

P. $1185 = -1 \rightarrow$ Drive remains in "coast to stop" position

P. $1185 \neq -1 \rightarrow$ Drive is moved actively to set position.

13.2.2.2 Flying homing

The Flying homing can be used to update the reference position during a running motion. This function is described in the application manual "Positioning".

13.2.3 Position Controller

The position controller evaluates the positioning operation (target/actual position) and tries to control the drive such that it comes as close as possible to the specifications.



Further details of the Position controller are explained in chapter 12.4.21 "0x5F17/n Position Controller" with a description of Object 0x5F17.



13.2.4 Move away from Hardware limit switches

When a hardware limit switch is triggered, an error message will be triggered depending on the settings of parameter $Fault\ reaction\$ **1143** and the relevant direction of rotation will be disabled.

After an error reset, it is possible to move in the direction that is still enabled. Generally, any mode of operation can be used for clearing, as long as the travel command has the enabled direction.

As long as the limit switch is triggered, the limit switch warning in the status word and actual value parameters *Warnings* **269**, *Warnings Application* **273** and *Controller status* **275** will remain. Once the limit switch is cleared, the warning will be deleted in the status word and actual value parameters.

For simple clearing of the limit switches, you can use mode "-2 Move away from limit switch" (see Chapter 14.4.9 "Move away from limit switch mode").

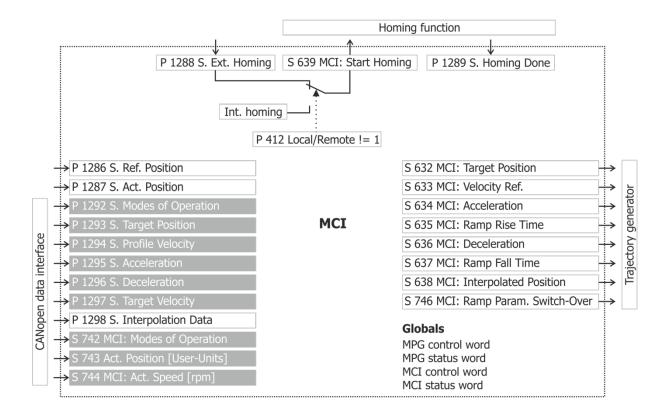


13.3 Motion Control Interface for Experts

With the Motion Control Interface, the user can edit the sources which the Motion Control Interface accesses. By default, the sources are set to CANopen®.. Experienced users can change these in example to Systembus sources.

	Parameter			Setting		
No.	Description	Min.	Max.	Default setting		
1292	S. Modes of Operation	Sele	ction	801 – Obj. <u>0x6060</u> Modes of Operation		
1293	S. Target Position	Sele	ction	802 – Obj. <u>0x607A</u> Target Position		
1294	S. Profile Velocity 1)	Selection		803 – Obj. 0x6081 Profile Velocity		
1295	S. Acceleration ²⁾	Sele	ction	804 – Obj. <u>0x6083</u> Profile Acceleration		
1296	S. Deceleration 3)	Sele	ction	805 – Obj. <u>0x6084</u> Profile Deceleration		
1297	S. Target Velocity [rpm]	Sele	ction	806 – Obj. 0x6042 v/target Velocity		
1299	S. Special Function Generator	Sele	ction	9-Zero		
1285	S. Target Velocity pv [u/s]	Sele	ction	816 – Obj. <u>0x60FF</u> Target Velocity		

The following graph shows the parameters (P) and sources (S) which are used for defining the Motion Control Interface. For CANopen®, the settings don't have to be changed. The source outputs are linked to the Trajectory generator by default and also need not be changed in standard applications.





13.4 Motion Control Override

The Motion Control Override feature can be used for specifying a travel profile via serial communication (VABus or Modbus). This enables testing of a travel profile in the VPlus user software for Windows when the controller has not yet been completely programmed. This function can also be used as a simulation mode.



The Function Motion Control Override do not support the following modes:

- Interpolated Mode.
- Cyclic Synchronous Position Mode
- Cyclic Synchronous Velocity Mode

Parameter		Setting				
No.	Description	Min.	Max.	Factory setting		
1454	Override Modes Of Operation	Sele	ction	0		
1455	Override Target Position	-2 ³¹ -12 ³¹ -1 u		-2 ³¹ -12 ³¹ -1 u -1 u		-1 u
1456	Override Profile Velocity	-12 ³¹ -1 u/s		-1 u/s		
1457	Override Acceleration	-12 ³¹ -1 u/s	S ²	-1 u/s²		
1458	Override Deceleration	-12 ³¹ -1 u/s	S ²	-1 u/s²		
1459	Override Target Velocity vl [rpm]	-32768327	767 rpm	-1 rpm		
1460	Override Target Velocity pv [u/s]	-2 ³¹ -12 ³¹ -1	L u/s	-1 u/s		

Based on the standard settings of the Motion Control Interface (Parameters **1292**...**1297**) the following cross reference results between Override Parameters and CANopen®Objects:

1454 Override Modes Of Operation	or	0x6060 Modes of Operation
1455 Override Target Position	or	0x607A
1456 Override Profile Velocity	or	0x6081 Profile Velocity
1457 Override Acceleration	or	0x6083 Profile Acceleration
1458 Override Deceleration	or	0x6084 Profile Deceleration
1459 Override Target Velocity vl [rpm]	or	0x6042
1460 Override Target Velocity pv [u/s]	or	0x60FF Target Velocity

With the default settings "-1" in parameters **1455**...**1460** and "0" in parameter **1454** *Override Modes Of Operation*, the values of the Motion Control from the links of parameters **1292**...**1297** are used. If the parameter settings deviate from the factory settings, the value of the relevant parameter will be used. It is possible to define certain ranges of the trajectory via the override function and other values via the Motion Control Interface.



The target position "-1 u" cannot be used as target position, because **1455** Override $Target\ Position = -1$ deactivates the Override Function.



14 Control of frequency inverter

The frequency inverter can generally be controlled via three operation modes. The operation modes can be selected via the data set switchable parameter Local/Remote **412**.

	Parameter	Setting			
No.	Description	Min.	Max.	Factory set- ting	
412	Local/Remote	0	44	44	

For operation with EtherCAT $^{\otimes}$, only the settings 0, 1 and 2 are relevant. The other settings refer to the control option via the KP500 control unit.

Operation mode	Function
0 - Control contacts	The Start and Stop commands as well as the direction of
(chapter 14.1)	rotation are controlled via digital signals.
	The frequency inverter is controlled via the control word. Only in this control mode are the motion control functions supported by Control word and modes of operation as defined with CANopen® DS402.
Control via 2 - remote contacts (chapter 14.1)	The Start and Stop commands as well as the direction of rotation are controlled via virtual digital signals of the control word.



Parameter *Local/Remote* **412** is dataset switchable, i.e. you can switch between the different operation modes by selecting another data set. For example, a frequency inverter can be controlled via the bus, and emergency mode can be activated locally when the bus master fails. This switch-over is also identified by the status word (remote bit).

Data set switching can be effected locally via control contacts at the digital inputs of the frequency inverter or via the bus. For data set switching via the bus, parameter *Data set selection* **414** is used.

	Parameter		Setting	
No.	Description	Min.	Max.	Factory set- ting
414	Data set selection	0	4	0

With $Data\ set\ selection\ \mathbf{414}=0$, data set switching via contact inputs will be active. If $Data\ set\ selection\ \mathbf{414}$ is set to 1, 2, 3 or 4, the selected data set is activated and data set switching via the contact inputs is deactivated.

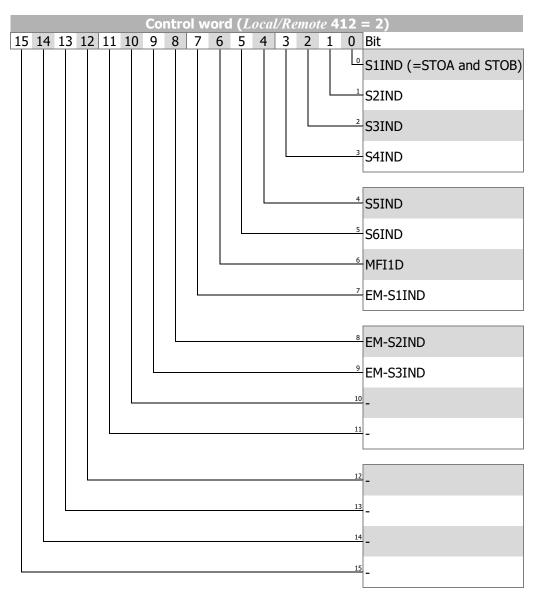
If *Data set selection* **414** is set to 5, data set switching via contact inputs will be active if the frequency inverter is not enabled.

Via parameter *Active data set* **249**, the currently selected data set can be read. *Active data set* **249**, indicates the active data set (value 1, 2, 3 or 4). This is independent of whether the data set switching was done via contact inputs or *Data set selection* **414**.

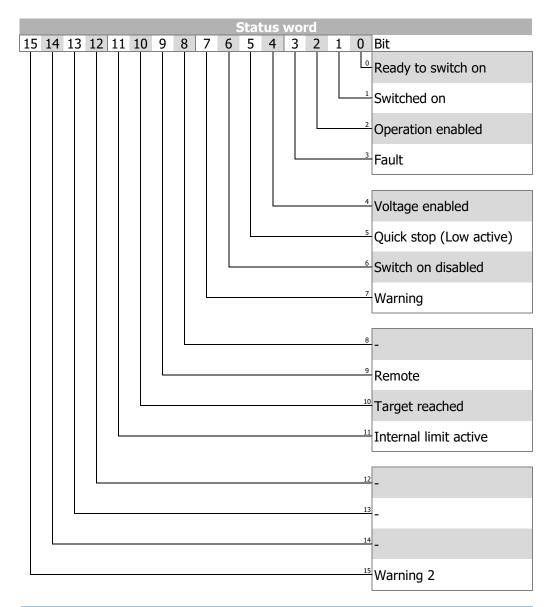


14.1 Control via contacts/remote contacts

In operation mode "Control via contacts" or "Control via remote contacts" (Parameter Local/Remote **412** = 0 or 2), the frequency inverter is controlled directly via digital inputs S1IND (STOA and STOB), S2IND to EM-S3IND or via the individual bits of the virtual digital signals in the control word. The function of these inputs is described in the frequency inverter operating instructions.









If operation mode "Control via remote contacts" is used, controller release must be turned on at STOA (Terminal X210A.3) and STOB (Terminal X210B.2) **and** Bit 0 of the control word must be set in order to be able to start the drive.

Operation modes "Control via contracts" and "Control via remote contacts" support operation mode "Speed vl" (*modes of operation* = "velocity mode").



ACTIVE CUBE frequency inverters support an external 24 V power supply for the frequency inverter control electronics. Even when mains voltage is disconnected, communication between the controller (PLC) and the frequency inverter is still possible.

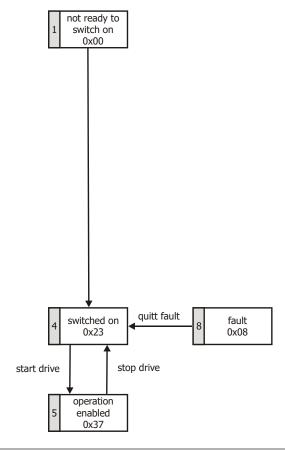
Bit 4 "Voltage enabled" of the *Status word* displays the current state of the mains power supply.

Bit 4 "Voltage enabled" = 0 signals "no mains voltage" and drive start is disabled.

Bit 4 "Voltage enabled" = 1" signals "mains voltage switched on" and drive start is enabled..



14.1.1 Device State machine Statemachine:



Status word	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Switched on	1	0	0	0	1	1
Operation enabled	1	1	0	1	1	1
Fault	Х	Х	1	Х	Х	Х



[&]quot;x" means any value.

Bit 7 "**Warning**" can display a device-internal warning message at any time. The current warning is evaluated by reading the warning status with parameter *Warnings* **270**.

Bit 10 "**Target reached**" is set when the specified reference value is reached. In the special case of power failure regulation, the bit is also set when the power failure regulation reaches the frequency 0 Hz (see frequency inverter Operating Instructions). For "target reached" a hysteresis (tolerance range) applies. It can be set via parameter *Max. control deviation* **549** (see frequency inverter operating instructions).

Bit 11 "Internal limit value active" indicates that an internal limit is active. This may be the current limit, the torque limit or the overvoltage control. All of these limit functions will result in the reference value being left or not reached.

Bit 15 "Warning 2" signals a critical operating state which will result in a fault switch-off of the frequency inverter within a short time. This bit is set if there is a delayed warning relating to the motor temperature, heat sink/inside temperature, Ixt monitoring or mains phase failure.



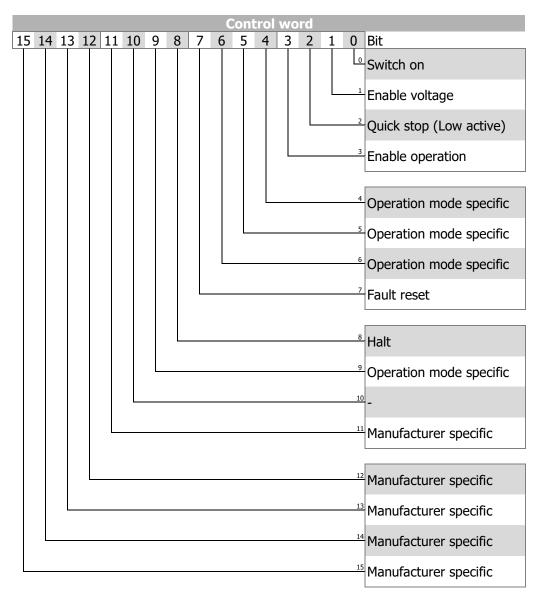
14.2 Control via state machine

In the operation mode "Control via state machine (Local/Remote **412** = 1), the frequency inverter is controlled via the *Control word* of the state machine.

Transition 4 to status "Operation enabled" is only possible:

- if, in a configuration for Motion Control (parameter Configuration 30 = x40), the controller release is set via STOA and STOB,
- if, in other configurations (parameter Configuration 30 ≠ x40) the controller release is set via STOA and STOB and if one of the digital inputs S2IND or S3IND is set. (Typically: S2IND = Start clockwise/S3IND = Start anticlockwise)

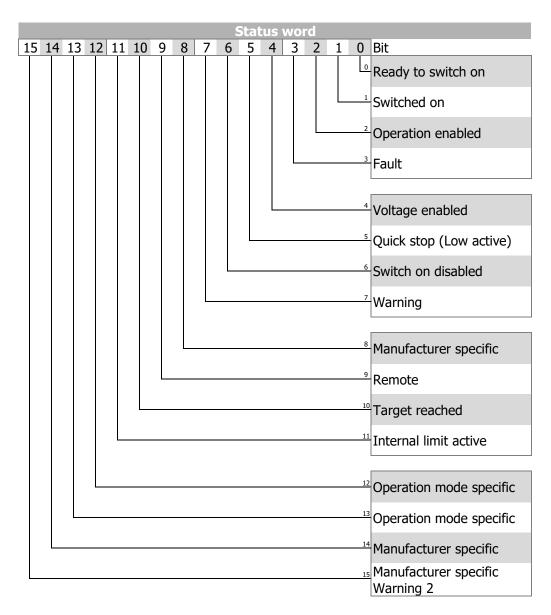
Object 0x6040 *Controlword* is applicable to the frequency inverter if parameter *Local/Remote* **412** is set to "1 – Control via statemachine".



Bits 9 ... 15 are used depending on the configuration and on 0x6060 <u>Mode of Operation</u>.

Control word bits 4, 5, 6 operation mode specific and bit 8 halt are used in motion control configurations (Parameter Configuration 30 = x40) only.





Bit 14 is not used.

Status word bits 12 and 13 "Depending on mode of operation" are only used in Motion Control configurations (Parameter Configuration **30** = x40).



ACTIVE CUBE frequency inverters support an external 24 V power supply for the frequency inverter control electronics. Even when mains voltage is disconnected, communication between the controller (PLC) and the frequency inverter is still possible.

Bit 4 "Voltage enabled" of the *Status word* displays the current state of the mains power supply.

Bit 4 "Voltage enabled" = 0 signals "no mains voltage" and drive start is disabled.

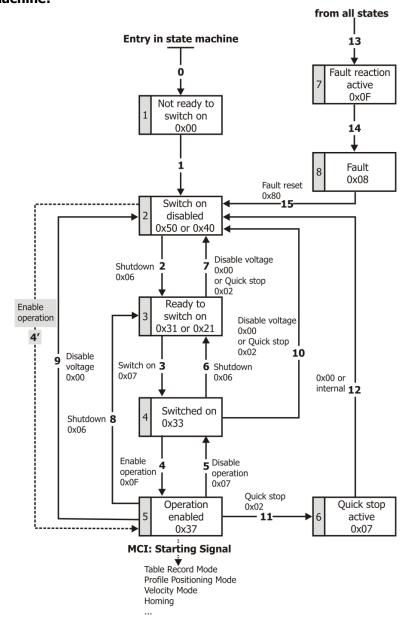
Bit 4 "Voltage enabled" = 1" signals "mains voltage switched on" and drive start is enabled..



ACTIVE CUBE and ACTIVE frequency inverters may indicate different states because, in ACTIVE CUBE, bit 4 of the status word is used as shown above.



14.2.1 State machine diagram State machine:





Control word:

The device control commands are triggered by the following bit patterns in the *Control word*:

Control	

Command	Bit 7 Fault reset	Bit 3 Enable operation	Bit 2 Quick stop (Low active	Bit 1 Enable voltage	Bit 0 Switch on	Transitions
Shutdown	Χ	Х	1	1	0	2, 6, 8
Switch on	Χ	0	1	1	1	3
Enable operation	Χ	1	1	1	1	4
Disable voltage	Χ	Χ	Χ	0	Χ	7, 9, 10, 12
Quick stop (Low active)	Χ	Χ	0	1	Χ	7, 10, 11
Disable operation	Χ	0	1	1	1	<u>5</u>
Fault reset	0 ⇒ 1	X	X	Х	Х	15

[&]quot;X" means any value.



Transition 3 (command "Switch on" [0x07]) is only processed if bit 4 "Voltage enabled" of the Status word is set.



Transition 4 (Command "Enable operation" [0xF]) will only be processed if the release is set via the hardware contacts STO.

If the hardware release via STO is not set, the frequency inverter will remain in status "Switched On" [0x33] until the hardware release via STO is present.

In status "Operation enabled" [0x37], the device will switch to status "Switched On" [0x33] internally once the hardware release via STO is reset.



In configurations **with** Motion Control (parameter Configuration **30** = x40), the following must be noted:

- Transition 4' is not available.
- In status "5-Operation enabled [0x37]" an additional start signal must be provided via bits from the "High Byte" of the control word in order to start a movement of the motor. For a description of the start signal for this "Motion Control Interface" (MCI), refer to chapter 14.4. Object 0x6060 Modes of Operation is available for switching to other MCI modes.
- Digital inputs (STOA and STOB) must be set. Start clockwise and Start anticlockwise have no function in these configurations.



In configurations **without** Motion Control (parameter *Configuration* **30** \neq x40), the following must be noted:

- Transition 4' will only be processed if Bit 4 "Voltage enabled" of the status word is set. This feature is downward-compatible with older software versions.
- The frequency inverter can only be controlled if the logic operation is true. The logic inputs for Start Clockwise and Start anticlockwise can be connected directly with "On" or "Off" (parameter *Start Clockwise* **68** and *Start Anticlockwise* **69**).

Digital inputs (STOA and STOB) must be set.

This results in:

Release: (= STOA and STOB) **AND** (Start clockwise **OR** Start Anticlockwise)



Status word:

The status word indicates the operating status.

Status word						
	Bit 6	Bit 5	Bit 3	Bit 2	Bit 1	Bit 0
State	Switch on disabled	Quick stop (Low active)	Fault	Operation enabled	Switched on	Ready to switch on
Switch on disabled	1	Χ	0	0	0	0
Ready to switch on	0	1	0	0	0	1
Switched on	0	1	0	0	1	1
Operation enabled	0	1	0	1	1	1
Quick stop active (Low active)	0	0	0	1	1	1
Fault reaction active	0	Χ	1	1	1	1
Fault	0	Χ	1	0	0	0

[&]quot;X" means any value.

Bit 7 **"Warning"**can be set at any time. It reports a device-internal warning. The cause of the warning is evaluated by reading the warning status with parameter *Warnings* **270**.

Bit 9 "**Remote"** is set if the operation mode is set to "Control via state machine" (Lo-cal/Remote **412** = 1) **and** controller release is turned on.

Bit 10 "**Target reached**" is set when the specified reference value is reached. In configurations without Motion Control (parameter $Configuration 30 \neq x40$) "target reached" refers to the reference speed fromVI target the reference speed (ν / target speed) 0x6042. In the special case of power failure regulation, the bit is also set when the power failure regulation reaches the frequency 0 Hz (see frequency inverter operating instructions).

For "target reached", there is a hysteresis (tolerance range) which can be set via the parameter *Max. control deviation* **549** see frequency inverter Operating Instructions).

Bit 11 "Internal limit value active" indicates that an internal limit is active. This may be the current limit, the torque limit or the overvoltage control. All functions will result in the reference value being left or not reached.

Bit 15 "Warning 2" signals a critical operating state which will result in a fault switch-off of the frequency inverter within a short time. This bit is set if there is a delayed warning relating to the motor temperature, heat sink/inside temperature, Ixt monitoring or mains phase failure.

14.3 Configurations without motion control

In configurations without Motion Control (Configuration 30 \neq x40) object $\underline{0x6060}$ $\underline{modes\ of\ operation}$ is set permanently to "2 - $velocity\ mode"$ (velocity mode vI) Object $\underline{0x6061}\ \underline{modes\ of\ operation\ display}$ will also be "2 - $velocity\ mode"$ (velocity mode vI). These settings cannot be changed.

Relevant Relevant objects:

<u>0x6040</u>	Control word
0x6041	Status word
<u>0x6042</u>	v/ target velocity



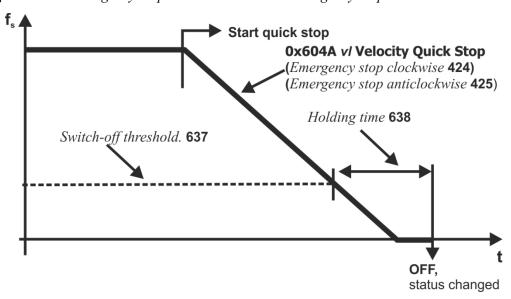
<u>0x6043</u>	Velocity demand	
<u>0x6044</u>	v∕ velocity actual value	
<u>0x6046</u>	√ velocity min max amount	
<u>0x6048</u>	√ velocity acceleration	
<u>0x6049</u>	√ velocity deceleration	
<u>0x604A</u>	√ Velocity quick stop	

The Ramp Rise/Fall times are set up via parameters 430...433.

14.3.1 Behavior in the case of a quick stop

In quick stop, the parameters *Switch-off threshold* **637** (percent of parameter *Maximum Frequency* **419**) and *Holding time* **638** (holding time after falling short of the switch-off threshold) are relevant. In the case of a quick stop, the drive is stopped via emergency stop ramps.

The emergency stop ramps are set up via Object <u>0x604A</u> <u>v/ Velocity Quick Stop</u> or parameters *Emergency Stop Clockwise* **424** and *Emergency Stop Anticlockwise* **425**.



If frequency/speed reaches the value zero during the switch-off time, the drive continues to be supplied with current until the switch-off time has elapsed. This ensures that the drive is at a standstill when the state changes.



The quick stop behavior is only relevant for configurations without Motion Control (parameter $Configuration 30 \neq x40$).

14.3.2 Behavior in the case of transition 5 (disable operation)

The *behaviour in transition 5* of the statemachine from "Operation enabled" to "Started" can be configured via parameter *State transition 5***392**.

Parameter			Setting	
No.	Description	Min.	Max.	Factory set- ting
392	State transition 5	0	2	2

Operation mode	Function	



0 - Coast to stop	Immediate transition from "Operation enabled" to "Switched On", drive coasts to a standstill
1 - DC brake	Activation of DC brake, at the end of DC deceleration, there is the change from "Operation enabled" to "Switched On"
2 - Ramp	Transition at normal ramp, when the drive has come to a standstill, there is the change from "Operation enabled" to "Switched On"



Setting 1 "Direct current brake" is only possible with applications with U/f characteristic control (e.g. configuration 110). Other configurations do not support this operation mode.

If the frequency inverter is operated with a configuration which does not support the operation mode Direct Current Brake (e.g. configuration 210, field-oriented control), value "1" cannot be used.

In this case, the operation mode is not offered in the selection menus of the control unit KP500 and the control software VPlus.



By default, *State transition 5* **392** is set to operation mode "2 - Ramp" For configurations with torque control, the default value is "0 - coasting".

If the configuration is changed, the value set for Transition 5 **392** is also changed, if necessary.



The behavior in transition 5 is only relevant for configurations without Motion Control (parameter $Configuration 30 \neq x40$).

If *State Transition 5* **392** was triggered with "1 - DC brake", a new control word will only be accepted after completion of the transition process. The change of state from "Operation enabled" to "Switched On" is done after the *Braking time* **632** parameterized for the DC brake has elapsed.

If parameter *State Transition* **392** = "2 - Ramp" is set, the control word can be set to "Operation enabled" again, while the drive is decelerating. In this way, the drive accelerates to its set reference value again and remains in the state "Operation enabled".

The change of state from "Operation enabled" to "Switched On" is done after the value has dropped below the set switch-off threshold and the set holding time has elapsed (equivalent to the behavior in the case of a quick stop). In this context, parameters *Switch-off threshold* **637** (percentage of parameter *Maximum frequency* **419**) and *Holding time* **638** (holding time after passing of threshold) are relevant.

14.3.3 Reference value / actual value

The controller (PLC) can define the reference frequency for the frequency inverter via object 0x6042/0 vl target velocity in the used RxPDO and receive the actual value via object 0x6044/0 vl velocity actual value in the used TxPDO.

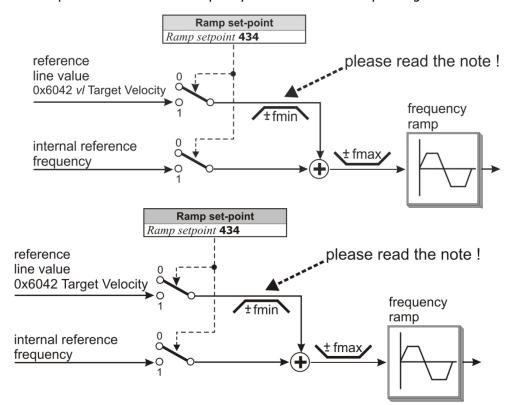
The use of the reference/actual value channel depends on the set configuration (control method). The actual value is generated according to the control method used.



The reference value in object 0x6042/0 <u>v/ target velocity</u> and the actual value in object 0x6044/0 <u>v/ velocity actual value</u> are interpreted in the notation RPM. Conversion into a frequency (reference value), or from a frequency (actual value) is carried out in the frequency inverter.



The reference value for the frequency inverter from object 0x6042/0 <u>vl target velocity</u> is supplied via the reference line value. This reference value is combined with the internal reference value from the reference frequency value channel in the input of the ramp function. Reference frequency value channel: see operating instructions.



The internal reference value from the reference frequency value channel and the reference line value can be fed to the ramp individually or as an added variable. Setting is carried out via the data set change-over capable parameter *Ramp setpoint* **434**.

Parameter		Setting		
No.	Description	Min.	Max.	Factory set- ting
434	434 Ramp setpoint		3	3

Operation mode	Function
	Reference value from the sources of the reference fre-
frequency value	quency value channel
2 - Reference line value	Reference value via a communication interface
Internal reference	Sum of internal reference frequency value and reference
3 - frequency value +	line value
reference line value	



This function is only relevant for non motion control configurations (Parameter *Configuration* **30** \neq x40)



If $Ramp\ setpoint\ \mathbf{434} = 2$ (reference line value only), this reference line value is limited to $Minimum\ Frequency\ \mathbf{418}$ (fmin).

The sign in front of fmin with reference value = 0 is derived from the sign in front of the last reference line value which was not 0.

After Mains On, the reference line value is limited to +fmin.



For $Ramp\ set\text{-}point\ \mathbf{434}=3$, the sign in front of the overall reference value results from the sum of the internal reference frequency value and the reference line value.

The reference values can be read out from the frequency inverter with the help of the KP500 control unit or VPlus operating software.

Actual values			
Parameter	Contents	Format	
3	Internal reference value from the reference frequency channel	xxx.xx Hz	
Reference bus frequen- cy 282	Reference line value from the Fieldbus	xxx.xx Hz	
	= sum of internal reference frequency + reference line value	xxx.xx Hz	

14.3.4 Sequence example

In configurations without Motion Control ($Configuration 30 \neq x40$), the PLC must send the correct sequence:

1	Control word =	0x0000	Disable voltage
3	Control word =	0x0006	Shutdown
4	Control word =	0x0007	Switch On
5	Control word =	0x000F	Enable Operation

OR

1	Control word =	0x0000	Disable voltage
5	Control word =	0x000F	Enable Operation



In configurations without Motion Control ($Configuration 30 \neq x40$), the second (shortened) sequence can be used, because transition 4 is available in these configurations.



14.4 Motion control configurations



⚠ WARNING

Dangerous state due to new mode!

If 0x6060 modes of operation is changed during operation (control word = 0xnnnF), a dangerous state may occur in the new mode.

 Before changing <u>0x6060</u> <u>modes of operation</u>, check the status word (e.g. for state 0xnn33).



Motion Control Definition

For the full function of the Motion Control Interface, you will have to set Local/Remote **412** = "1-Control via state machine". In all other operation modes of parameter Local/Remote **412**, there are major restrictions. The descriptions in this chapter and of all objects used are based on the setting Local/Remote **412** = "1-Control via state machine".



The usage of Positioning for setting Local/Remote **412** \neq 1 is described in the "Positioning" application manual.

The function of the state machine describes the basic operating behaviour of the frequency inverter in configurations with position control (Configuration **30** = x40). The objects *control word* and *status word* described above support the bits marked as operation mode specific.

These bits and bit "Target reached" has different meanings in the different position control operation modes – defined by 0x6060 modes of operation. The following chapters describe the application of the operation mode specific bits in the control word and status word, depending on the different position control operation modes. Default value: 0x6060 modes of operation = 2 – velocity mode.

Basic functions:

The state machine must be set to "operation enabled", before the position command can be issued via the operation mode specific bits of the *control word*.

Once a *mode of operation* has been set by the PLC, no commands will be accepted for this operation mode until this operation mode is displayed in the *modes of operation display* object.

The bits in the *control word* and *status word* marked as operation mode specific are only supported in configurations with position control (Configuration **30** = x40).



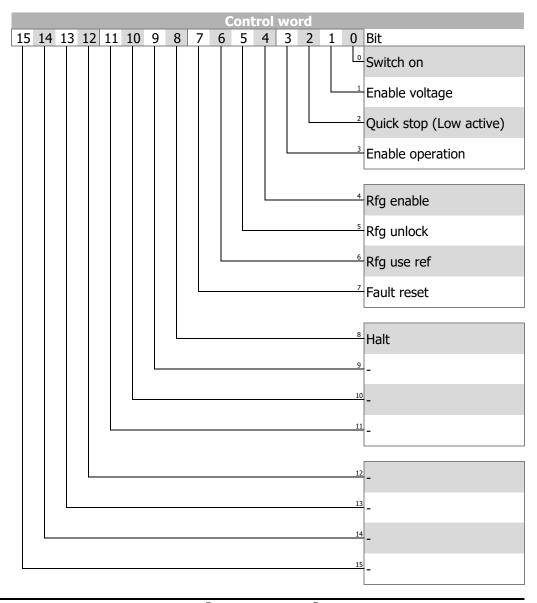
14.4.1 Velocity mode [rpm]

Velocity mode [rpm] can be selected via object 0x6060/0 <u>Modes of operation</u> = **2**. In velocity mode the "operation mode specific" bits of the *Control word* word control the ramp generator (RFG – Ramp Function Generator). The block diagram illustrates the function.

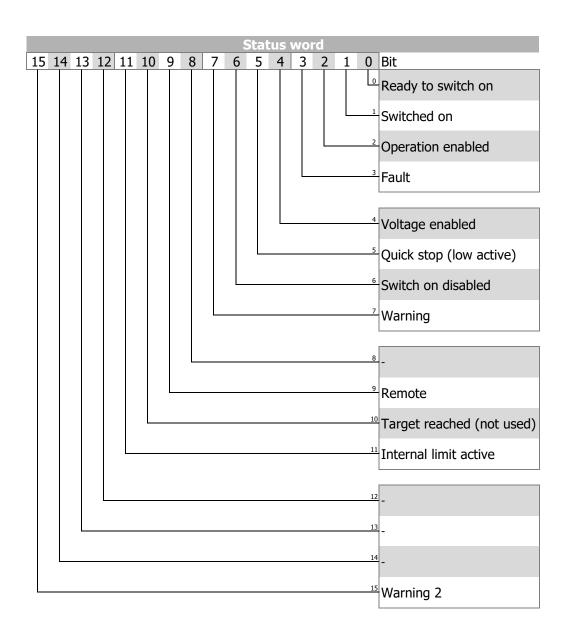
Relevant objects:

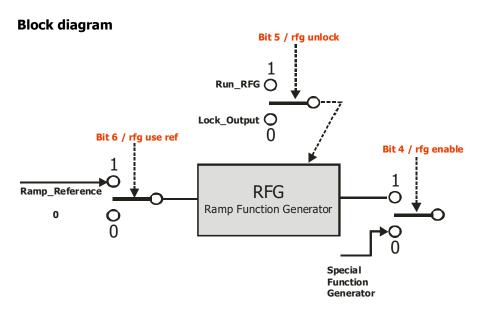
<u>0x6040</u>	Control word	
<u>0x6041</u>	Status word	
0x6042	√ target velocity	
<u>0x6043</u>	Velocity demand	
<u>0x6044</u>	√ velocity actual value	
0x6046	√ velocity min max amount	
	amount	
<u>0x6048</u>	√ velocity acceleration	
<u>0x6049</u>	√ velocity deceleration	
<u>0x604A</u>	Velocity quick stop	
<u>0x6060</u>	Modes of operation	
<u>0x6061</u>	Modes of operation display	

The Ramp Rise/Fall times are set up via parameters 430...433.











Bit 4/rfg enable

Rfg enable = 0 the reference speed comes from a manufacturer-specific special function.

Rfg enable = 1 The reference speed corresponds to the ramp output.



The special function is evaluated only if **1299** *S. Special Function Generator* \neq "9-Zero".

If **1299** *S. Special Function Generator* = "9-Zero", the value of the ramp output will always be used.

Bit 5/rfg unlock

Rfg unlock = 0 The last speed will be maintained and used.

Rfg unlock = 1 The ramp function is active and changes according to the reference value and the ramp.

Bit 6/rfg use ref

Rfg use ref = 0 Reference value "0" is used.

Rfg use ref = 1 The setpoint of 0x6042 vl <u>target Velocity</u> is used.

Bit 8 Halt

 $HALT = 0 \rightarrow Execute positioning.$

HALT = 1 → **Stop axis.** (The frequency inverter remains enabled in "Operation enabled" state.)

If special function generator **1299** Q. Special Function Generator \neq "9-Zero", the reference value from the ramp output will also be used if bit 4 "rfg enable" = 1, and if bit 4 "rfg enable" = 0, the reference value from the source specified in **1299** Q. Special Function Generator will be used.

Reference value source			
	1299 <i>Q. Special Function Genera-</i>	1299 <i>Q. Special Function Genera-</i>	
	<i>tor</i> ≠ "9-Zero"	<i>tor</i> = "9-Zero"	
Bit 4 rfg enable = 0	Reference value from special func-		
	tion	Reference value from ramp output	
Bit 4 rfg enable = 1	Reference value from ramp output	, ,	



Sequence example

In order to start "velocity mode", the correct sequence must be sent by the PLC.

1	Control word =	0x0000	Disable voltage
1	Status word =		Switch On Disabled
2	Modes of Operation =	: Z	(Velocity mode)
3	Control word =	0x0006	Shutdown
	Status word =	0x0031	Ready to switch on
4	Control word =	0x0007	Switch On
	Status word =	0x0033	Switched On
5	Control word =	0x000F	Enable Operation, no change to previous
			state if already enabled.
	Status word =		Operation enabled
6a	Control word =	0x007F	Start Velocity mode with Reference speed
		0 0=	from object <u>0x6042</u> ν / target velocity.
CL	Status word =		Operation enabled
6b	Control word =	0x006F	1299 <i>Q. Special Function Generator</i> : = "9-Zero"
			→ Starts "Velocity mode" with reference
			value from Object 0x6042 v/target ve-
			locity.
			1299 Q. Special Function Generator:
			≠ "9-Zero"
			→ Starts "Velocity mode" with reference
			value from 1299 <i>Q. Special Function</i>
			Generator
			Starts with reference value from source from
			1299 <i>Q. Special Function Generator</i>
	Status word =		Operation enabled
6c	Control word =	0x003F	Starts "Velocity mode" with reference value "0".
	Status word =	0xnn37	Operation enabled
6d	Control word =	0x002F	1299 <i>Q. Special Function Generator</i> : = "9-Zero"
			→ Starts "Velocity mode" with reference
			value "0".
			1299 <i>Q. Special Function Generator</i> : ≠ "9-Zero"
			Starts with reference value from source from
			1299 <i>Q. Special Function Generator</i>
	Status word =	0xnn37	Operation enabled
6e	Control word =	0x005F	Starts "Velocity mode" at current speed –
-			current ramps will be canceled.
L	Status word =	0xnn37	Operation enabled
6f	Control word =	0x004F	1299 Q. Special Function Generator:
			= "9-Zero" Starts "Velocity mode" with actual speed
			 Starts "Velocity mode" with actual speed a running ramp is interrupted.
			1299 Q. Special Function Generator:
			unequal "9-Zero"
			Starts with reference value from source from
			1299 <i>Q. Special Function Generator</i>
	Status word =	0xnn37	Operation enabled



7	Control word =	0x01xx	HALT: The drive is stopped with ramp
			0x6049 vl velocity deceleration.
	Status word =	0xnn37	Operation enabled



⚠ WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing <u>0x6060</u> <u>Modes of Operation</u> (i.e. check state 0xnn33).



Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).

In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).

With control word transition from 0xnnnF to 0x0007, "Velocity mode" will be stopped. Then, the mode can be restarted via 0xnnnF.

As long as 0x0007 is active, the mode of operation can be edited safely. Once $\underline{0x6060}$ $\underline{modes\ of\ operation}$ has been set to another value, operation can be started with a corresponding sequence.



14.4.2 Profile Velocity mode [u/s]

The profile velocity mode is selected via object 0x6060/0 <u>Modes of operation</u> =**3**. In profile position mode the inverter receives a reference speed in [u/s].

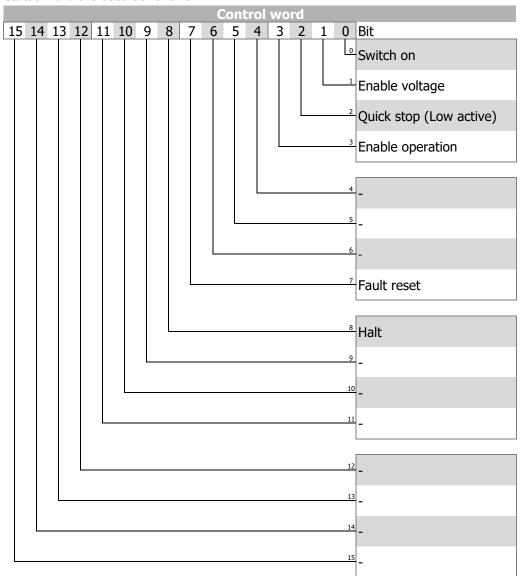
Relevant objects:

	-
<u>0x6040</u>	Control word
<u>0x6041</u>	Status word
<u>0x6046</u>	√ velocity min max amount
<u>0x6060</u>	Modes of operation
<u>0x6061</u>	Modes of operation display
<u>0x606C</u>	Velocity Actual value
0x606D	Velocity Window
0x606E	Velocity Window Time

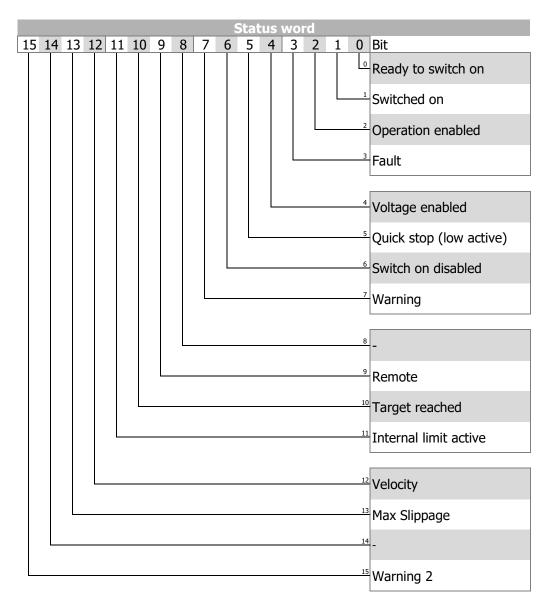
<u>0x606F</u>	Velocity Threshold
<u>0x6070</u>	Velocity Threshold Time
<u>0x6083</u>	Profile acceleration
0x6084	Profile deceleration
<u>0x6085</u>	Quick stop deceleration
0x6086	Motion Profile Type
0x60F8	Max Slippage
<u>0x60FF</u>	Target Velocity

The Ramp Rise/Fall times are set up via parameters **1176** and **1178** and object <u>0x6086</u>.

In profile velocity mode, the operation mode specific bits of the control word and the status word are used as follows:







The Profile Velocity Mode is used to set the reference speed in user units [u/s]. The reference speed 0x60FF <u>Target Velocity</u> is taken over in mode "operation enabled" immediately (0xnn37). The acceleration and deceleration ramp are specified by objects 0x6083 <u>Profile acceleration</u> and 0x6084 <u>Profile deceleration</u>.

Setting Bit 8 "Halt" of the control word delays the drive with ramp <u>0x6084</u> <u>Profile deceleration</u> and holds the drive at standstill. Resetting Bit 8 results in an acceleration with ramp <u>0x6083</u> <u>Profile acceleration</u> to the actual reference velocity.

Control word Bit 8: Halt

HALT = 0 → **Execute Profile Velocity Mode.**

HALT = 1 → **Halt Axis.** (The Frequency inverter remains in state "Operation enabled".)



The actual velocity in [u/s] can be displayed in a PLC via map able Object 0x606D.

Via Objects <u>0x606D</u> <u>Velocity Window</u> and <u>0x606E</u> <u>Velocity Window time</u> Bit 10 "Target reached" of the status word is set.

Via Objects <u>0x606F</u> <u>Velocity Threshold</u> and <u>0x6070</u> <u>Velocity Threshold time</u> Bit 12 "Velocity" of the status word is set.



Via Object <u>0x60F8</u> <u>Max Slippage</u> a slip monitoring via Bit 13 "Max Slippage" of the status word can be set up.

Status word Bit 10: Target reached

Target reached = 0 → The actual velocity doesn't match the reference velocity.

Target reached = 1 → The actual velocity matches the reference velocity.

The actual velocity differs at least from the defined time period in object ox606E_velocity_Window_time up to the defined amount [us] in Object ox606D_velocity_Window.

Status word Bit 12: Velocity

Velocity → The Actual Velocity matches the comparison speed.

= 0 The Actual Velocity has exceeded for a defined time (Object

<u>0x6070</u> <u>Velocity Threshold time</u>) a defined Velocity in user units per seconds [u/s] (Object <u>0x606F</u> <u>Velocity Threshold</u>).

Velocity → The Actual Velocity doesn't match the Comparison Velocity.

= 1

Status word Bit 13: Maximum Slippage

Maximum Slippage \rightarrow The actual Slippage speed is smaller than defined.

0 The comparison value of the slippage speed is defined Object

0x60F8 Max Slippage.

Maximum Slippage → The actual Slippage speed is bigger than defined.

The comparison value of the slippage speed is defined Object

0x60F8 Max Slippage.

Sequence example

To start the Profile Velocity mode, the correct sequence has to be sent from the PLC.

		2 2222	D. I.I. II
1	Control word =	0x0000	Disable voltage
1	Status word =	0x005	0 Switch On Disabled
2	Modes of Operation =	3	(Profile Velocity mode)
3	Control word =	0x0006	Shutdown
	Status word =	0x003	1 Ready to switch on
4	Control word =	0x0007	Switch On
	Status word =	0x003	3 Switched On
5	Control word =	0x0007	Enable Operation, no change to previous
		+	state if already enabled. The Profile Veloc-
		0x000F	ity mode is started with reference velocity
		OXOGOI	0x60FF <i>Target Velocity</i> and Ramp profile
			0x6084 Profile acceleration and 0x6084
			<u>Profile deceleration</u> . Changes to Target
			Velocity and Ramps are taken over imme-
			diately.
	Status word =		7 Operation enabled

- 1) A profile consists of the following entries. If a value is not changed, the old value will still be active.
 - 0x6081 Profile velocity
 - 0x6083 Profile acceleration
 - 0x6084 Profile deceleration
 - 0x60FF Target Velocity





⚠ WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing <u>0x6060</u> <u>Modes of Operation</u> (i.e. check state 0xnn33).



Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).

In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).

With control word transition from 0xnnnF to 0x0007, "Profile position mode" will be stopped. Then, the mode can be restarted via 0xnnnF.

While 0x0007 is active, it is also possible to change the modes of operation without any danger. After changing 0x6060 <u>modes of operation</u> to another value you can start the new operation mode with the according sequence.



14.4.3 Profile position mode

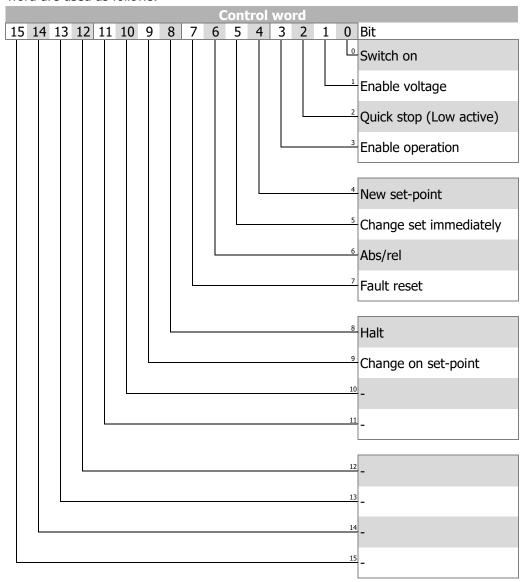
Profile position mode can be selected via object 0x6060/0 *Modes of operation* = **1**. In profile position mode, the frequency inverter receives a vl target position, followed by the command to travel to this target.

Relevant objects:

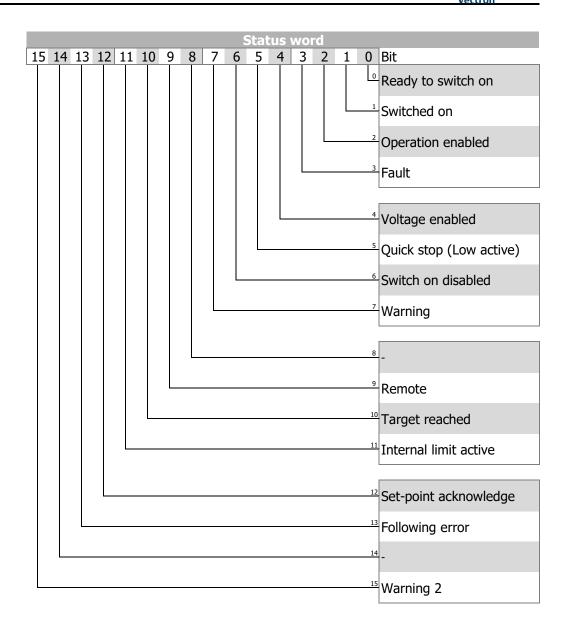
0x6040 Control word	<u>0x607A</u> Target position
<u>0x6041</u> Status word	<u>0x6081</u> Profile velocity
<u>0x6046</u> v/ velocity min max amount	<u>0x6083</u> Profile acceleration
0x6060 Modes of operation	<u>0x6084</u> Profile deceleration
<u>0x6061</u> Modes of operation display	0x6085 Quick stop deceleration

The ramp times are specified via parameters **1176** and **1178** and object <u>0x6086</u>.

In profile position mode, the mode-specific bits of the control word and the status word are used as follows:







Control word

Change on set-point Bit 9	Change set- point imme- diately Bit 5	New set- point Bit 4	Description
0	0	0 → 1	Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).vl target
Х	1	0 → 1	In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).
1	0	0 → 1	With control word transition from 0xnnnF to 0x0007, "Profile position mode" will be stopped. Then, the mode can be restarted via 0xnnnF.



Identification	Value	Description		
Abs/rel	0	The target position is an absolute value		
Bit 6	1	The target position is a relative value		
Halt	0	Execute positioning operation.		
Bit 8	1	Stop axle with <i>profile deceleration</i> (if not supported by <i>pro-</i>		
		file acceleration), the frequency inverter will remain in sta-		
		tus "Operation enabled".		

Status word

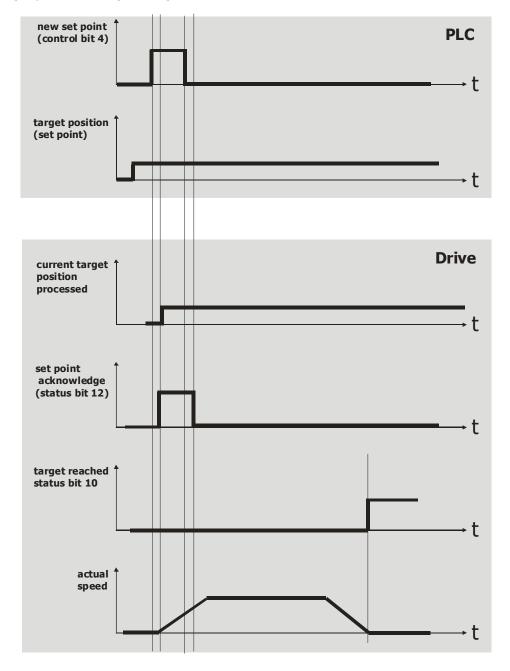
Identification	Value	Description
VI target	0	Stop = 0: target position (still) not reached
reached		Stop = 1: Axis decelerated
Bit 10	1	Stop = 0: target position reached vl target
		Stop = 1: Speed of axis is 0
Set-point acknowledge	0	The travel profile calculation has not applied the position value (yet).
Bit 12	1	The travel profile calculation has applied the position value.
Following error	0	No following error
Bit 13	1	Following error



Example: single set-point

control bit *change on set-point* = **0** control bit *change set immediately* = **0**

Once a reference value has been transmitted to the drive, the controller signals a permissible value in the control word by a rising signal edge for the bit "New reference value". The drive responds by setting the bit "Reference value confirmed" and starts moving to the new vI target position. After that, the controller resets the bit "New reference value", and the drive resets the bit "Reference value confirmed". Once the bit "Reference value confirmed" has been reset, the drive is ready for receiving a new vI target position.vI targetvI target

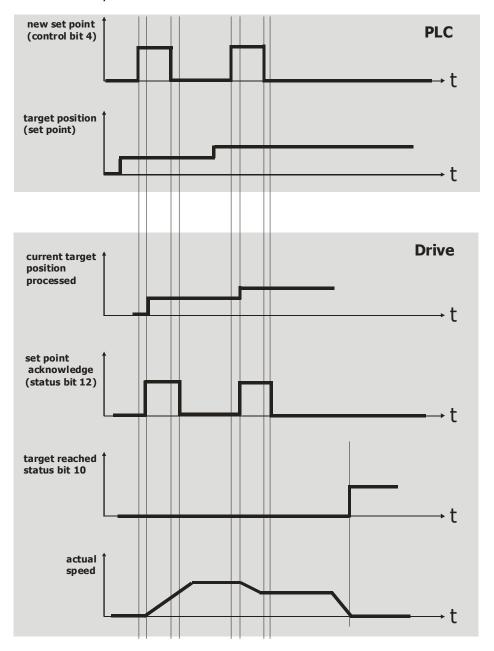




Example: single set-point

control bit *change on set-point* = **0** control bit *change set immediately* = **1**

A new reference value is confirmed by the control bit "New reference value" (rising edge) while a reference value is being processed. The new reference value is processed immediately.





Example: set of set-points

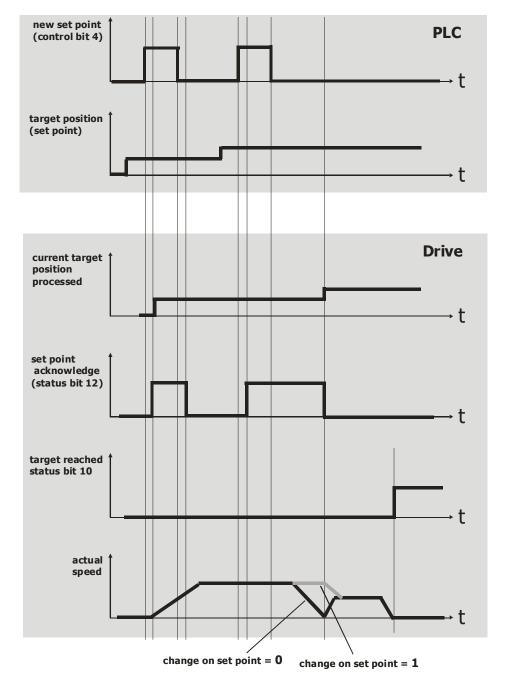
control bit *change on set-point* = **0/1** control bit *change set immediately* = **0**

The travel profile is changed during an active positioning operation.

Change on set point = 0 The current target position is approached with a **Stop**. Once the position has been reached, the new reference value is set.vl target

Change on set point = 1 The current target position is approached at the active speed. Once the current vI target position has been reached, the new reference value is applied without reducing the speed to zero.vI target

The gray line in the segment "Actual speed" shows the speed behaviors when the control bit "Switch at reference value" is set to 1.





In order to start "Profile position mode", the correct sequence must be sent by the PLC.

4	Cambual	00000	D:
1	Control word = Status word =	0x0000	Disable voltage Activation disabled
2		1	
2	Modes of	1	Profile position mode
	Operation =		
_			a.
3	Control word =	0x0006	Stop
	Status word =		Ready for activation
4	Control word =	0x0007	Start
	Status word =	0x0033	Active
5	Control word =	0x0007	Enable operation. Positioning operation is
		\	not started.
		0x000F	
	Status word =	0xnn37	Operation enabled
6a	Control word =	0x0007 or 0x000F	Operation enabled, start absolute posi-
			tioning with profile ¹⁾ .
		0x001F	If a positioning operation is already in
			process, this operation will be completed.
			Then, the new profile will be used.
	Status word =	0xnn37	
6b	Control word =	0x0007 or 0x000F	Operation enabled, start relative posi-
			tioning with profile ¹⁾ .
		0x005F	If a positioning operation is already in
		0,00031	process, this operation will be completed.
			Then, the new profile will be used.
	Status word =	0xnn37	Operation enabled
6c	Control word =	0x0007 or 0x000F	Operation enabled, start absolute posi-
000	Control word –	0,0007 OI 0,000F	tioning with profile ¹⁾ .
		0x003F	Running positioning operations will
		UXUUSE	
	Ctatus word	0,,,,,27	change and apply the new profile
C -I	Status word =	0xnn37	
6d	Control word =	0x0007 or 0x000F	Operation enabled, start relative posi-
		00075	tioning with profile ¹⁾ .
		0x007F	Running positioning operations will
	6	0 0=	change and apply the new profile
	Status word =		Operation enabled
7	Control word =	0x01nF	HALT: The drive is stopped with ramp
			0x6049 vl velocity deceleration.
	Status word =	0xnn37	Operation enabled

- 1) A profile consists of the following entries. If a value is not changed, the old value will still be active.
 - 0x607A <u>Target Position</u>
 - 0x6081 Profile velocity
 - 0x6083 Profile acceleration
 - 0x6084 Profile deceleration





⚠ WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing <u>0x6060</u> <u>Modes of Operation</u> (i.e. check state 0xnn33).



After the sequence of the first four Control word s was processed correctly, the ACU is enabled (dark marked table area).

In "Operation enabled" state (0xnnnF) the Motion Control states can be changed (white marked area in table).

With the control word transition from 0xnnnF to 0x0007 the velocity mode is stopped. After that it is possible to start again with 0xnnnF.

While 0x0007 is active, it is also possible to change the modes of operation without any danger. After changing 0x6060 modes of operation to another value you can start the new operation mode with the according sequence.



In order to start a profile, you don't have to set the control word to 0x0007 first before switching to 0xnnnF.

Once a profile has been processed, a new profile can be started with the bit "New Setpoint" (bit 4) in control word 0xnnnF.

While a profile is being processed, you can start a new profile without stopping by using the bits "Change Setpoint immediately" (bit 5) and "New Setpoint" (bit 4).



14.4.4 Interpolated position mode

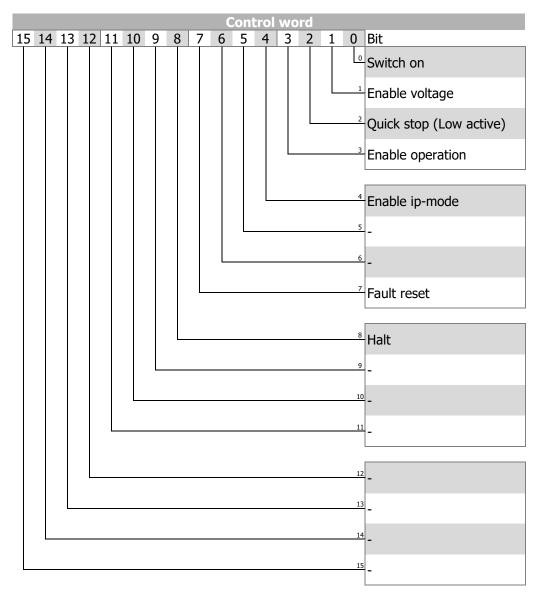
The interpolated position mode is selected via object $\underline{0x6060/0}$ <u>Modes of operation</u> = **7**. In interpolated position mode the inverter receives a target position at equidistant time intervals.

Relevant objects:

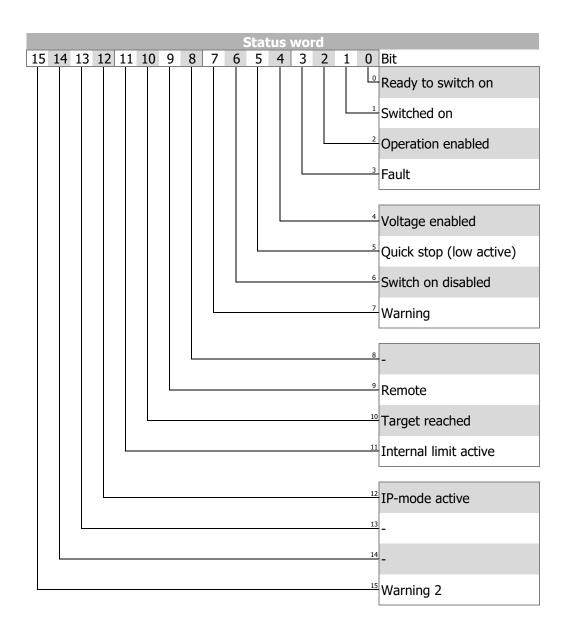
<u>0x6040</u>	Control word
<u>0x6041</u>	Status word
<u>0x6046</u>	√ velocity min max amount
<u>0x6060</u>	Modes of operation
0x6061	Modes of operation display
<u>0x6083</u>	Profile acceleration
0x6084	Profile deceleration
0x6085	Quick stop deceleration
0x60C1	Interpolation data record

The Ramp Rise/Fall times are set up via parameters **1176** and **1178** and object 0x6086.

In interpolated position mode the "operation mode specific" bits of *Control word* and *Status word* are used as shown:







Only linear interpolation is available (for this, object <a href="Most of Superior Content of Superior Con

The activation of interpolated position mode is displayed by status bit 12 *ip mode active*.

With each SYNC message a new target position is transmitted to the drive by object <a href="https://dx.ncbi.nlm





- 0x6083 <u>Profile acceleration</u> is only used when the interpolated mode is activated (rising edge of Bit 4 "enable ip-mode"). Then this acceleration is used to synchronize from the actual speed to the calculated speed of the interpolated trajectory.
- <u>0x6084</u> <u>Profile deceleration</u> is used when the interpolated mode is switched off (falling edge of Bit 4 "enable ip-mode") or a HALT signal (Bit 8) is set.
- <u>0x6085</u> <u>Quick stop deceleration</u> or <u>0x6084</u> <u>Profile deceleration</u> is used when a fault occurred. This can be changed via Stopping behavior **630** <u>Operation mode</u> and Communication fault reaction <u>0x6007/0</u> <u>abort connection option code</u>.
- Please set the acceleration values big enough, so that for switching on and switching off of the IP mode the motion is synchronized with the PLC.

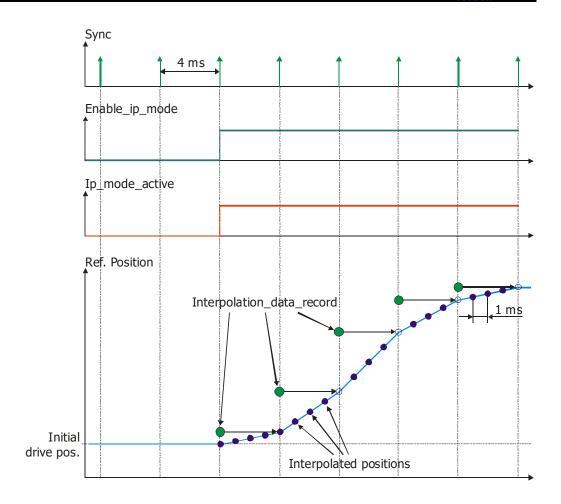
Control word

Identifica- tion	Value	Description
Enable IP-	0	Interpolated position mode inactive
mode Bit 4	1	Interpolated position mode active
Halt	0	Execute the instruction of bit 4 "enable ip-mode"
Bit 8	1	Stop axle , inverter remains in state "operation enabled" 0x6084 <u>Profile deceleration</u> is used for deceleration.

Status word

Identifica- tion	Value	Description
Target	0	Halt (Control word bit 8)= 0: position not (yet) reached
reached		Halt (Control word bit 8)= 1: axle decelerates
Bit 10	1	Halt (Control word bit 8)= 0: position reached
		Halt (Control word bit 8)= 1: axle has velocity 0
IP-mode ac-	0	Interpolated position mode inactive
tive	1	Interpolated position mode active
Bit 12		







Sequence Example

To start the Interpolated position mode, the correct sequence has to be sent from the PLC.

1	Control word =	0x0000		Disable voltage
1	Status word =		0x0050	Switch On Disabled
2	Modes of Operation =	7		(Interpolated Positon mode)
3	Control word =	0x0006		Shutdown
	Status word =		0x0031	Ready to switch on
4	Control word =	0x0007		Switch On
	Status word =		0x0033	Switched On
5a	Control word =	0x000F		Enable Operation.
	Status word =		0xnn37	Operation enabled
5b	Control word =	0x001F		Enable Operation and start Interpolated
				Mode (IP).
	Status word =		0x1n37	Operation enabled



⚠ WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing <u>0x6060</u> <u>Modes of Operation</u> (i.e. check state 0xnn33).



After the sequence of the first four Control word s was processed correctly, the ACU is enabled (dark marked table area).

In "Operation enabled" state (0xnnnF) the Motion Control states can be changed (white marked area in table).

With the control word transition from 0xnnnF to 0x0007 the velocity mode is stopped. After that it is possible to start again with 0xnnnF.

While 0x0007 is active, it is also possible to change the modes of operation without any danger. After changing 0x6060 <u>modes of operation</u> to another value you can start the new operation mode with the according sequence.



Always ensure that a valid Position is contained in "Interpolated Data Record". It is recommended to copy the Actual Position into the "Data Record" before starting the Interpolated Mode.

14.4.5 Homing mode

Homing mode can be selected via object 0x6060/0 Modes of operation = **6**. In homing mode, the frequency inverter moves the drive to a reference position. The method used for this movement is defined by parameter 0x6098 homing method.

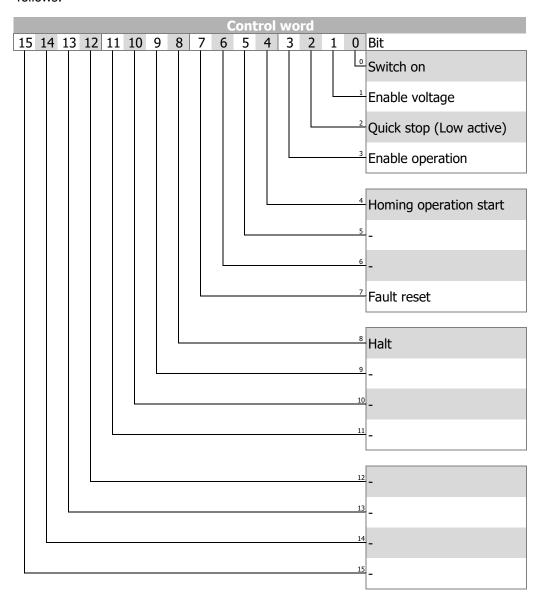


Relevant objects:

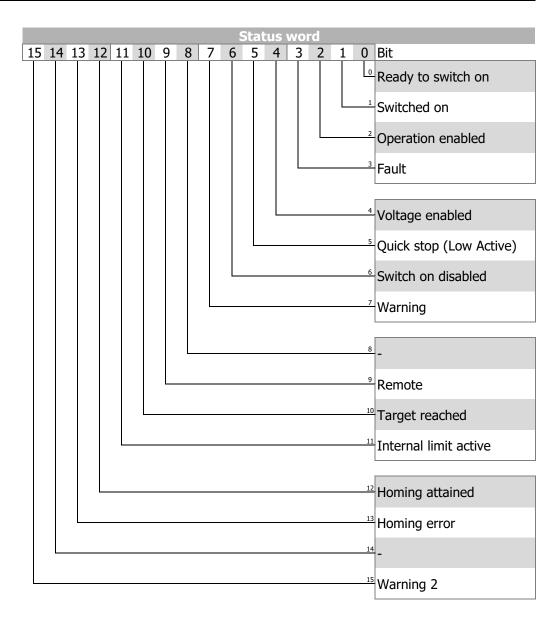
Control word
Status word
√ velocity min max amount
Modes of operation
Modes of operation display
Homing method
Homing speeds
Homing acceleration

The Ramp Rise/Fall times are set up via parameters 1135.

In homing, the mode-specific bits of the control word and the status word are used as follows:







Control word

Identificati- on	Value	Description	
Homing op-	0	Homing not active	
eration start	$0 \rightarrow 1$	Start homing	
Bit 4	1	Homing active	
	$1 \rightarrow 0$	Stop homing	
Halt	0	Execute command from bit 4 "Start homing"	
Bit 8	1	Stop axis with acceleration value (as deceleration) for	
		homing. (The frequency inverter remains enabled in	
		"Operation enabled" status.)	



Status word

Identificati-	Value	Description	
on			
VI target	0	Stop = 0: Home position (still) not reached	
reached		Stop = 1: Axle decelerated	
Bit 10	1	Stop = 0: Home position reached	
		Stop = 1: Axle has speed 0	
Homing at-	0	Homing not completed yet	
tained	1	Homing completed successfully	
Bit 12			
Homing error	0	No homing error	
Bit 13	1	Homing error occurred,	
		homing not completed successfully	

For an exact description of the various homing modes refer to the application manual "Positioning".

Sequence example

In order to start "homing mode", the correct sequence must be sent by the PLC.

1	Control word =	0x0000	Disable voltage
1	Status word =	0x0050	Switch On Disabled
2	Modes of Operation =	6	(Homing)
3	Control word =	0x0006	Shutdown
	Status word =	0x0031	Ready to switch on
4	Control word =	0x0007	Switch On
	Status word =	0x0033	Switched On
5	Control word =	0x000F	Enable Operation.
	Status word =	0xnn37	Operation enabled
6a	Control word =	0x001F	Enable Operation and start Homing.
	Status word =	0x1n37	Operation enabled and homing attained.



⚠ WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing <u>0x6060</u> <u>Modes of Operation</u> (i.e. check state 0xnn33).



Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).

In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).

With control word transition from 0x0007 (or 0x000F) to 0x001F the homing operation is started. Bit "Homing attained" (Bit 12) returns the status in the status word. As long as 0x0007 is active, the mode of operation can also be changed safely. Once *modes of operation* has been set to another value, operation can be started with a corresponding sequence.



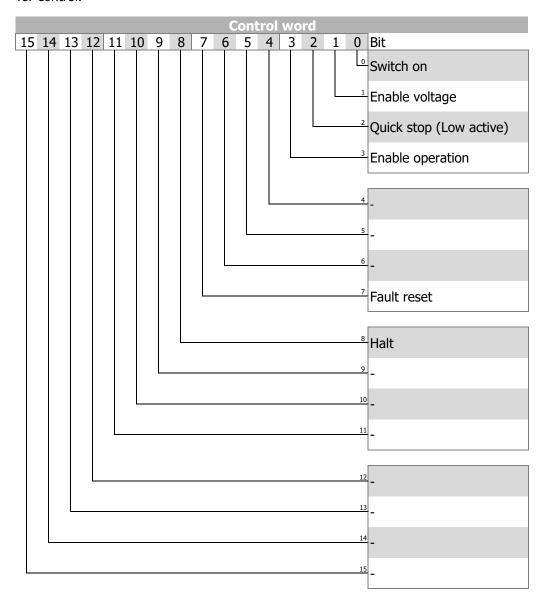
14.4.6 Cyclic Synchronous position mode

The Cyclic Synchronous position mode is selected via object 0x6060/0 <u>Modes of operation</u> = **8**. In Cyclic Synchronous position mode the inverter receives a target position at equidistant time intervals.

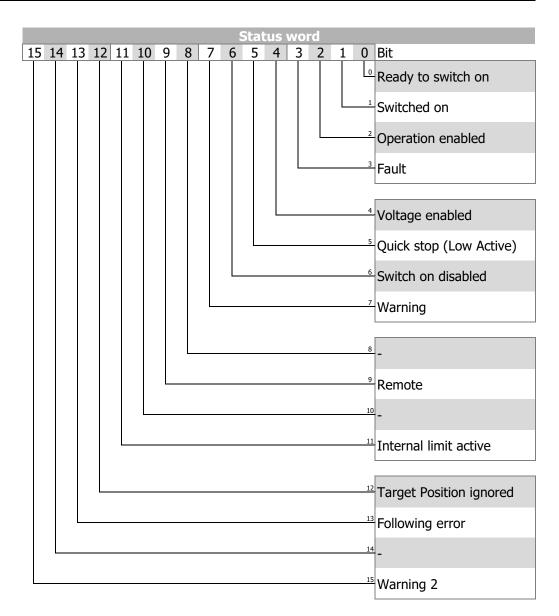
Relevant objects:

<u>0x6040</u>	Controlword	
<u>0x6041</u>	Statusword	
0x6046	v/ velocity min max amount	
0x6060	Modes of operation	
<u>0x6061</u>	Modes of operation display	
<u>0x607A</u>	Target Position	
0x6085	Quick stop deceleration	

In Operation mode *Cyclic Synchronous position mode* only the 4 lowest bity are used for control.







Status word

Identification	Value	Description
Target position ignored	0	Target Position is ignored.
Bit 12	1	Target Position is used as Reference value.
Following error	0	No following error
Bit 13	1	Following error



No ramp limits are active inside the frequency inverter. Limit the dynamic actions suitable by the PLC.



- First copy before the Start inside the SPS the actual Position 0x6064 to the target position.
- Start the Control Sequence in the PLC (0x0,0x6,0x7, 0xF).
- Wait until in the Status word Bit 12 is active.
- Now update the target Position in the PLC program.



Sequence Example

To start "Cyclic synchronous position mode", the correct sequence has to be sent from the PLC.

1	Control word =	0x0000		Disable voltage
1	Status word =		0x0050	Switch On Disabled
2	Modes of Operation =	8		(Cyclic synchronous position mode)
3	Control word =	0x0006		Shutdown
	Status word =		0x0031	Ready to switch on
4	Control word =	0x0007		Switch On
	Status word =		0x0033	Switched On
5	Control word =	0x000F		Enable Operation.
	Status word =		0xnn37	Operation enabled



⚠ WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing 0x6060 Modes of Operation (i.e. check state 0xnn33).



Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).

In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).

With control word transition from 0x0007 (or 0x000F) to 0x001F the homing operation is started. Bit "Homing attained" (Bit 12) returns the status in the status word. As long as 0x0007 is active, the mode of operation can also be changed safely. Once *modes of operation* has been set to another value, operation can be started with a corresponding sequence.



Always ensure that a valid Position is contained in "Target Position". It is recommended to copy the Actual Position into the "Target Position" before starting.



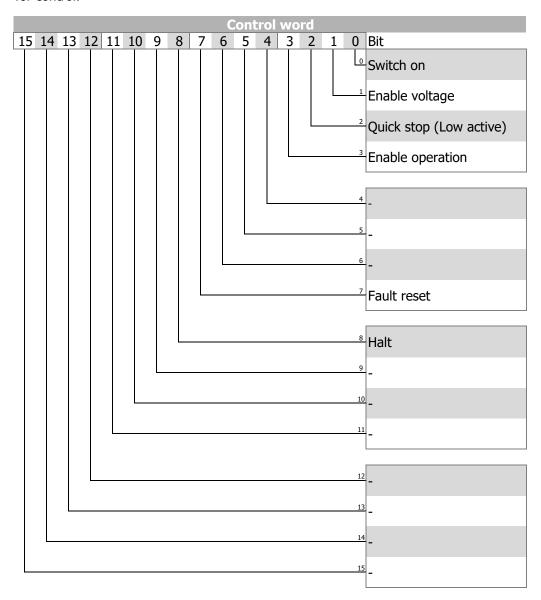
14.4.7 Cyclic Synchronous Velocity mode

The Cyclic Synchronous Velocity mode is selected via object 0x6060/0 <u>Modes of operation</u> = **9**. In Cyclic Synchronous Velocity mode the inverter receives a reference speed in equidistant time intervals.

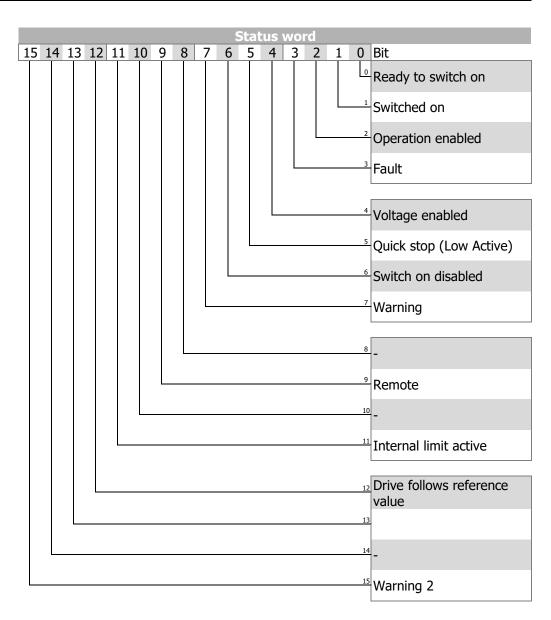
Relevant objects:

<u>0x6040</u>	Controlword
<u>0x6041</u>	Statusword
0x6046	√ velocity min max amount
	amount
0x6060	Modes of operation
<u>0x6061</u>	Modes of operation display
0x6085	Quick stop deceleration
0x60FF	Target Velocity

In Operation mode *Cyclic Synchronous position mode* only the 4 lowest bity are used for control.







Status word

Identification	Value	Description
Drive follows reference value	0	Drive does not follow the reference value.
Bit 12	1	Drive follows the reference value.
Following error	0	No following error
Bit 13	1	Following error



No ramp limits are active inside the frequency inverter. Limit the dynamic actions suitable by the PLC.



- Start the Control Sequence in the PLC (0x0,0x6,0x7, 0xF).
- Wait until in the Status word Bit 12 is active.
- Now update the Reference speed in the PLC program.



Sequence Example

To start "Cyclic Synchronous Velocity mode", the correct sequence has to be sent from the PLC.

1	Control word =	0x0000		Disable voltage
1	Status word =		0x0050	Switch On Disabled
2	Modes of Operation =	9		(Cyclic Synchronous Velocity mode)
3	Control word =	0x0006		Shutdown
	Status word =		0x0031	Ready to switch on
4	Control word =	0x0007		Switch On
	Status word =		0x0033	Switched On
5	Control word =	0x000F		Enable Operation.
	Status word =		0xnn37	Operation enabled



⚠ WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing <u>0x6060</u> <u>Modes of Operation</u> (i.e. check state 0xnn33).



After the sequence of the first four Control word s was processed correctly, the ACU is enabled (dark marked table area).

With the control word transition from 0xnnnF to 0x0007 the "Cyclic Synchronous Position mode" is stopped. After that it is possible to start again with 0xnnnF.

While 0x0007 is active, it is also possible to change the modes of operation without any danger. After changing 0x6060 modes of operation to another value you can start the new operation mode with the according sequence.



Always ensure that a valid Position is contained in "Target Position". It is recommended to copy the Actual Position into the "Target Position" before starting.



14.4.8 Table travel record

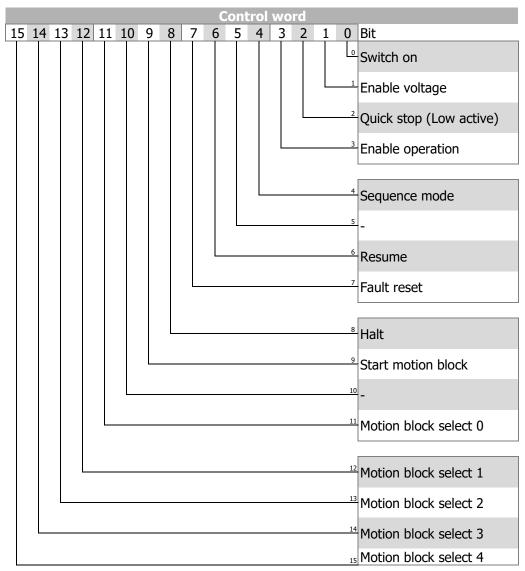
Table travel record mode can be selected via object 0x6060/0 <u>Modes of operation</u> = 0xFF = -1. Table travel record mode used pre-defined positions. Each vI target position is defined by a motion block. Several motion blocks can be defined.

For a description of motion blocks, refer to the "Positioning" application manual.

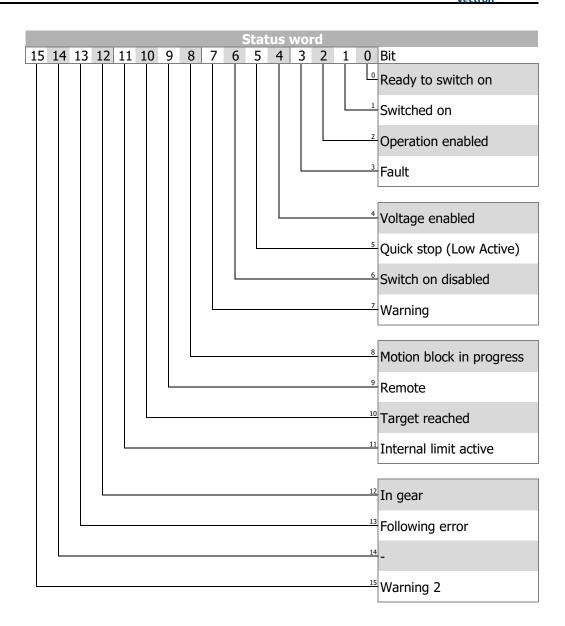
Relevant Relevant objects:

<u>0x6040</u>	Control word	<u>0x6064</u>	Position actual value
<u>0x6041</u>	Status word	0x6065	Following error window
<u>0x6046</u>	√ velocity min max amount	<u>0x6066</u>	Following error time
<u>0x6060</u>	Modes of operation	0x6067	Position window
0x6061	Modes of operation display	0x6068	Position window time
<u>0x5FF0</u>	Active motion block	0x6085	Quick stop deceleration
0x5FF1	Motion block to resume		

In table travel record mode, the mode-specific bits of the control word and the status word are used as follows:









Control word

Identification	Value	Description
Sequence mode	0	Single motion block
Bit 4	1	Automatic sequence
Resume	0	Start motion block = motion block switch-
Bit 6		ing
	1	Start motion block = last active motion block
Halt Bit 8	0	Execute command from bit 4 "Sequence mode"
	1	Stop axis with ramp of current motion block The frequency inverter remains in "Operation – enabled" status.
Start motion block Bit 9	0	Stop axis with ramp of current motion block
	$0 \rightarrow 1$	Execute motion block(s)
Motion block select 04 Bit 1115	n	Start motion block = n + 1

Motion block select:

	Control word														
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Motion block select Sta Halt Res						Seq									
4	3	2	1	0											

Start motion block = motion block select + 1:

Mot	ion bl	ock s	elect	resulting	
4	3	2	1	0	start motion block
0	0	0	0	0	1
0	0	0	1	1	4
1	0	0	0	0	17
1	1	1	1	1	32

Status word

Identification	Value		Description	
Motion block in pro- gress	0	Single motion Automatic Sequence	Motion block complete Sequence completed	
Bit 8	1	Single motion/automa	tic sequence active	
Target reached Bit 10	0		position not reached yet (only motion ith positioning)vl target	
		Halt = 1: Axle dece	elerated	
	1		position reached (only motion blocks tioning)vl target	
		Halt = 1: Axle has	velocity 0	
In gear	0	Electronic gear not co	upled	
Bit 12	1	Electronic gear couple	d	
Following error	0	No following error		
Bit 13	1	Following error		



Basic functions

The control bit "Automatic sequence" defines if a single motion (*Automatic sequence* = 0) or and automatic motion block sequence (*Automatic sequence* = 1) is to be executed.

In both cases, the selection of the required motion block (motion block number of single motion or start motion block number of automatic sequence) is calculated by the motion block switching feature with the rising edge of "Start motion block".

"Motion block is being processed" is set to "1" while a selected motion block or an automatic sequence is being executed. "Motion block is being processed" will remain set to "1" until the motion block sequence is complete. When a single motion block is executed, "Motion block is being processed" will be set to "0" once the single motion block is complete. When an automatic sequence is executed, "Motion block is being processed" will be set to "0" once a motion block with setting 0 for Next motion block (end of motion block), -1 (error stop), -2 (Stop, error) or -3 (emergency stop, error) is reached.

During the automatic processing of motion blocks, the currently processed motion block is indicated by object 0x5FF0 active motion block.

If the execution of motion blocks is interrupted by setting "Start motion block" to "0", the drive will stop with the ramp set in the current motion block. The interrupted motion block or automatic motion block sequence can be continued by setting "Resume" and a rising signal edge for "Start motion block". If "Resume" is set to "1" and no valid motion block is available, the motion block selected by the motion block switching function will be used. A valid motion block is indicated by object Ox5FF1 motion block to resume. Motion block to resume displays reads -1, if no valid motion block is present or if the last motion block or motion block sequence was not interrupted.

"VI target reached" is set if the actual position of motion blocks with absolute or relative positioning reaches the *position window*.

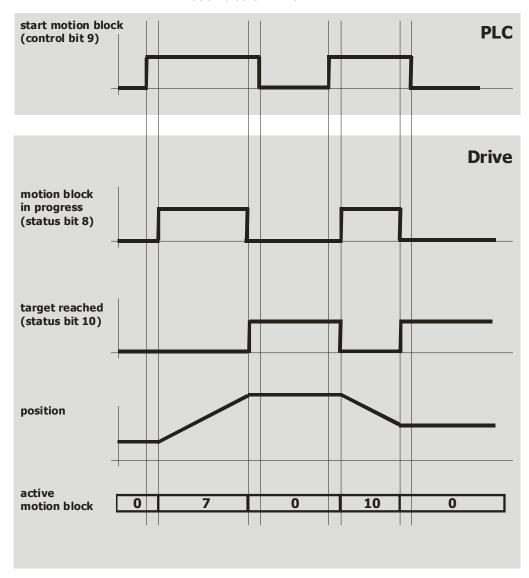
"In Gear" is set when the electronic gear function is used and the electronic gear is coupled (synchronous running).

Setting *Halt* to "1" will stop a currently executed motion block. The axle is stopped th the ramp set in the current motion block. "VI target reached" is set to "1" when the speed reaches value 0. The drive remains in "Operation – enabled" status. To continue the interrupted motion block, reset *Halt* to "0".



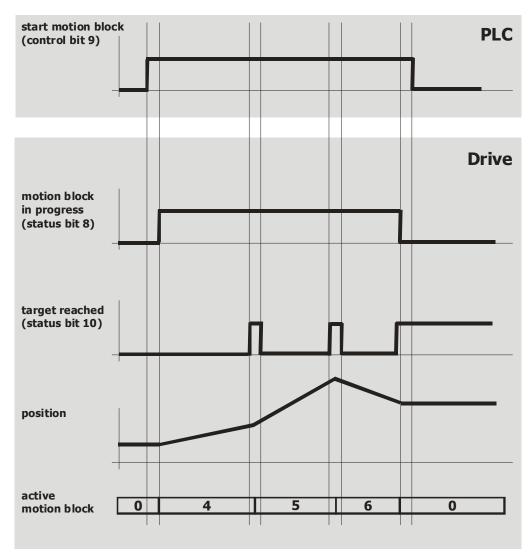
Examples:

"single motion block" sequence mode (control bit 4) = 0 2 motion blocks 7 + 10



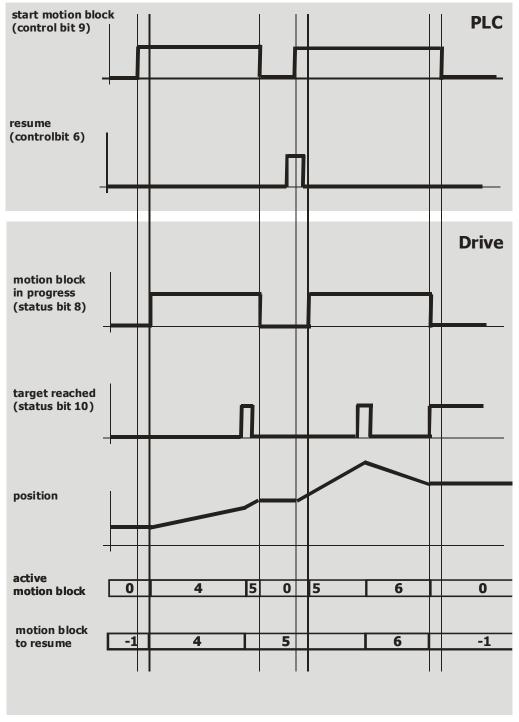


"<u>motion block sequence</u>" sequence mode (control bit 4) = 1 sequence = motion block 4, 5, 6





"interrupted motion block sequence" sequence mode (control bit 4) = 1 sequence = motion block 4, 5, 6 motion block 5 interrupted





Sequence Example

In order to start "Table travel record mode", the correct sequence must be sent by the PLC.

1	Control word =	0x0000	Disable voltage
1	Status word =		Switch On Disabled
2	Modes of Operation =		(Table travel record mode)
	·		,
3	Control word =	0x0006	Shutdown
	Status word =	0x0031	Ready to switch on
4	Control word =	0x0007	Switch On
	Status word =	0x0033	Switched On
5a	Control word =	0x000F	Enable Operation.
	Status word =	0xnn37	Operation enabled
5b	Control word =	0x020F	Start Motion Block 1 as Single Motion Block.
	Status word =		Operation enabled and Positioning active.
	Status word =	0xn637	Operation enabled and Target reached.
5c	Control word =	0x0A0F	Start Motion Block 2 as Single Motion Block.
	Status word =		Operation enabled and Positioning active.
	Status word =	0xn637	Operation enabled and Target reached.
5d	Control word =	0x120F	Start Motion Block 3 as Single Motion Block.
	Status word =		Operation enabled and Positioning active.
	Status word =		Operation enabled and Target reached.
5e	Control word =	0x021F	Start Motion Block 1 in Sequence Mode
	Status word =		Operation enabled and Positioning active.
	Status word =		Operation enabled and Target reached.
5f	Control word =	0x004F	Resume last Motion Block as Single Motion
			Block
	Status word =		Operation enabled and Positioning active.
	Status word =		Operation enabled and Target reached.
5g	Control word =	0x005F	Resume last Motion Block in Sequence Mode
	Status word =		Operation enabled and Positioning active.
	Status word =	0xn637	Operation enabled and Target reached.



WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing <u>0x6060</u> <u>Modes of Operation</u> (i.e. check state 0xnn33).



Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).

In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).

Bit 9 "Start motion block" must be active during positioning. If bit 9 is reset to "0", the positioning operation is interrupted.

As long as 0x0007 is active, the mode of operation can also be changed safely. Once 0x6060 <u>modes of operation</u> has been set to another value, operation can be started with a corresponding sequence.



14.4.9 Move away from limit switch mode

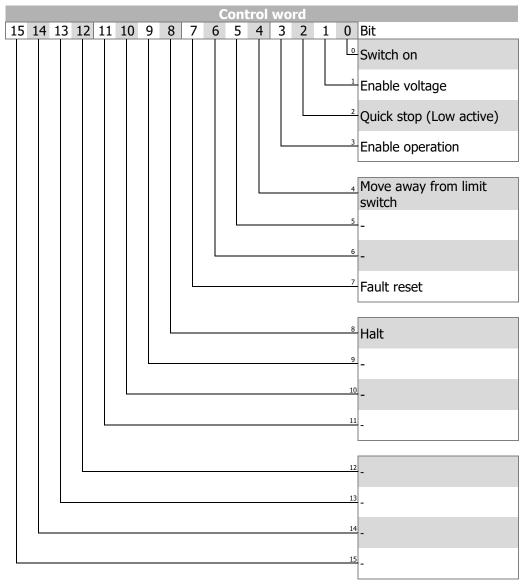
Move away from limit switch mode can be selected via object 0x6060/0 Modes of operation = 0xFE = -2.

In *Move away from limit switch mode*, the drive moves back from a triggered limit switch to the permissible travel range.

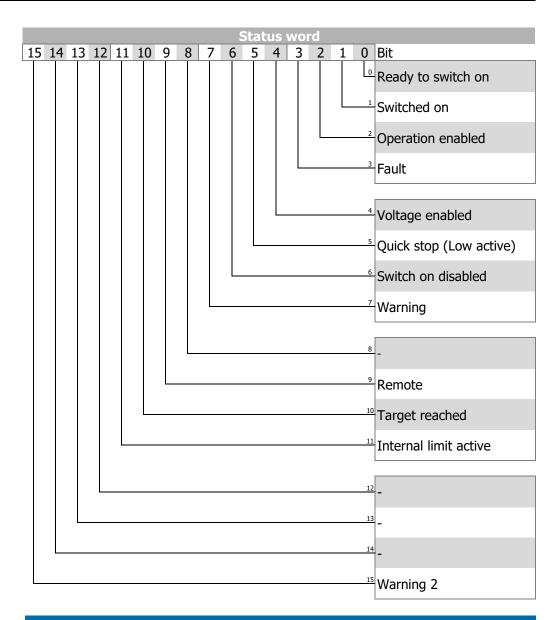
Relevant Relevant objects:

 <u>0x6040</u>	Control word	<u>0x6085</u>	Quick stop deceleration
<u>0x6041</u>	Status word	0x6099/2	Homing: Creep Speed
 0x6046	√ velocity min max amount	0x609A	Homing: Acceleration
	amount		
<u>0x6060</u>	Modes of operation	<u>0x6085</u>	Quick stop deceleration
0x6061	Modes of operation display		

In table travel mode the "operation mode specific" and "manufacturer specific" bits of *Control word* and *Status word* are used as shown:







NOTE

"Move away from limit switch mode" will always work with hardware limit switches. In the case of software limit switches, the mode will only work if a software limit switch $Fault\ reaction\ 1144$ with error stop was selected. If a setting with warning (e.g. "10-Warning") was selected, the software limit switch will not trigger an error, thus "Move away from limit switch mode" will not clear the software limit switch.

NOTE

"Move away from limit switch mode" must not be used when one of the following error messages occurs:

- F1444 Pos. limit switch < Neg. limit switch
- F1445 Both limit switches at the same time
- F1446 Wrong limit switch wiring

If one of these errors has occurred, the wiring and parameter settings must be checked first before resuming operation.



Control word

Identification	Value	Description
Move away from	0	Do not start or stop movement
limit switch Bit 4	1	Start (or resume) movement from limit switch to travel range
Halt Bit 8	0	Execute command from bit 4 "Move away from limit switch"
	1	Stop axis with ramp of current motion block (The frequency inverter remains enabled in "Operation enabled" status.)

Status word

Name	Value		Description
Target reached	0	Halt = 0:	Limit switch still active
Bit 10	U	Halt = 1:	Axle decelerated
	1	Halt = 0:	Limit switch cleared
	1	Halt = 1:	Axle has speed 0

Basic functions

In mode -2 "Move away from limit switch", the drive is cleared from a triggered hardware limit switch or software limit switch. The direction of rotation depends on the active limit switch: If the positive limit switch is active, the drive moves to negative direction and vice versa.

"Move away from limit switch" mode is started in status "Operation enabled" by control word bit 4 "Move away from limit switch". The drive is accelerated with the ramp from Object Ox609A Homing acceleration to the speed set in Object Ox6099 Homing speeds / Subindex 2 "Homing Speed 2 - search for zero" Once the active limit switch has been cleared, the drive is stopped. Once speed 0 has been reached, status word bit 10 "VI target reached" will be set.vI target

When both directions of rotation are blocked, e.g. due to simultaneous triggering of positive and negative limit switch, error message "F1449 Both directions locked". In this case, the function "Move away from limit switch" cannot be used.

NOTE

In the clearing phase of a hardware limit switch, the hysteresis defined in parameter *Hysteresis* **1149** will be active. After detection of the limit switch edge, the axis will be moved on, at least by the defined hysteresis distance.

Setting *Halt* to "1" will stop the started clearing operation. The axis will be stopped. Status bit "VI target reached" is set to "1" when the speed reaches value 0. The drive remains in "Operation enabled" status. By resetting *Halt* to "0", the interrupted clearing operation will be continued, and "VI target reached" will be reset to "0".vI targetvI target



Sequence example

In order to clear the limit switches, the correct sequence must be sent by the PLC.

1	Control word =	0x0000	Disable voltage
1	Status word =	0x0050	Switch On Disabled
2	Modes of Operation =	-2	(Move away from limit switch)
3	Control word =	0x0006	Shutdown
	Status word =	0x0031	Ready to switch on
4	Control word =	0x0007	Switch On
	Status word =	0x0033	Switched On
5	Control word =	0x000F	Enable Operation.
	Status word =	0xnn37	Operation enabled
6	Control word =	0x001F	Move away from limit switch.
	Status word =	0xn2B7	Operation enabled and Positioning active.
	Status word =	0xn637	Operation enabled and Limit switch no long-
			er active (Target reached).



⚠ WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing <u>0x6060</u> <u>Modes of Operation</u> (i.e. check state 0xnn33).



Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).

In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).

Bit 4 "Move away from limit switch" must be active in the clearing phase. If bit 4 is reset to "0", the clearing operation is interrupted.

As long as 0x0007 is active, the mode of operation can also be changed safelyOnce 0x6060 modes of operation has been set to another value, operation can be started with a corresponding sequence.



14.4.10 Electronic Gear: Slave

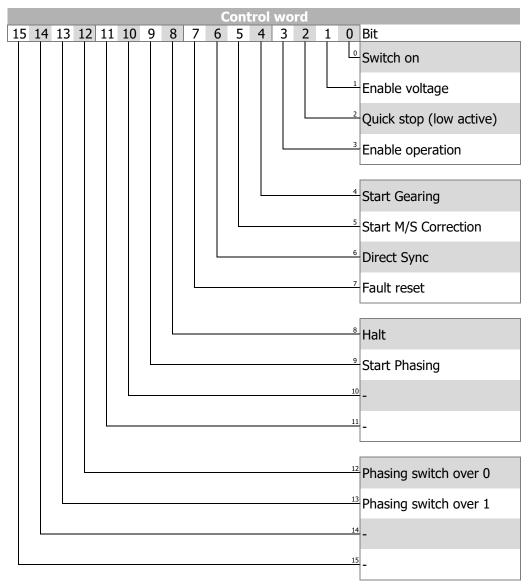
The mode *Electronic gear: Slave* can be selected via $modes\ of\ operation = \mathbf{0xFD} = \mathbf{-3}$.

In *Electronic gear slave mode* the drive follows a master drive as a slave drive.

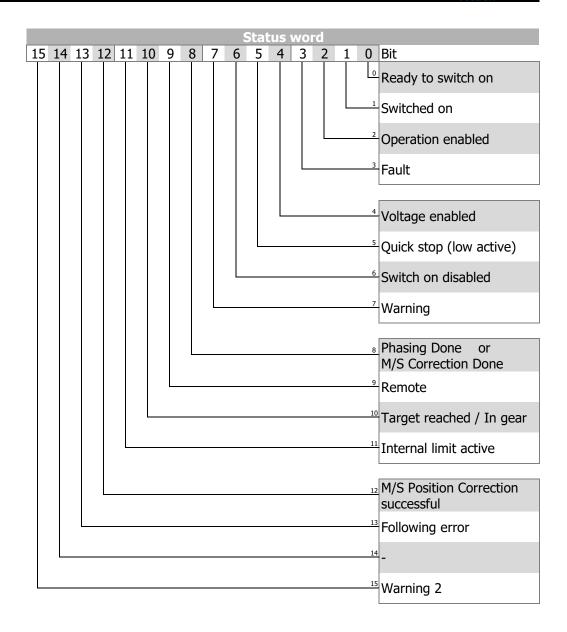
Relevant objects:

<u>0x6040</u>	Control word	<u>0x6064</u>	Position actual value
<u>0x6041</u>	Status word	0x6065	Following error window
<u>0x6060</u>	Modes of operation	0x6066	Following error time
<u>0x6046</u>	√ velocity min max amount	<u>0x6067</u>	Position window
<u>0x6061</u>	Modes of operation display	0x6068	Position window time
<u>0x5F10</u>	Electronic Gear: Gear factor	0x6085	Quick stop deceleration
0x5F11	Electronic Gear: Phasing 1	0x5F18	M/S Synchronization offset
<u>0x5F14</u>	Electronic Gear: Phasing 4		

In *Electronic gear: Slave* mode, the operation mode specific bits of the control word and the status word are used as follows:









⚠ WARNING

Dangerous state due to faulty parameterization

 The function Mater/Slave Position Correction is only allowed to be used after complete setup of this function. Check for parameter setup chapter 0 "Master/Slave Position Correction".



Control word

Name	Value	Description	
Start El. Gear	0	Stop drive with ramp <u>0x6084</u>	
Bit 4		Start electronic gear with master speed reference value with ramp <u>0x6083</u>	
Start M/S Correc-	0	M/S Correction not started.	
tion	1	Start Master/Slave Position correction.	
Bit 5		See chapter 0.	
Direct Sync 0 Di		Direct Synchronisation enabled.	
Bit 6	1	Direct Synchronisation disabled.	
Halt 0 Execute comma		Execute command from bit 4 "Start el. gear"	
Bit 8	1	Stop axis with ramp of current motion block The fre-	
		quency inverter remains in "Operation enabled" status.	
Start Phasing (Phasing disabled / aborted	
Bit 9	1	Start Phasing with profile defined by Bits 12 & 13	
Phasing select n Phasing Profile= n + 01 Bit 1213		Phasing Profile= n + 1	

Phasing select

	Control word														
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Ph	Sel.			Pha	Halt		DS		SG				
		1	0												

Phasing Profile= Phasing switch over +1

Phasing s	select	Phasing Profile
Bit 13	Bit 12	
0	0	1
0	1	2
1	0	3
1	1	4

Status word

Identification	Value	Description					
Phasing Done Bit 8	0	Phasing in process or not started yet. or M/S correction in process or not started yet.					
	1	Phasing done. or M/S correction done.					
Target reached/InGear	0	Halt (Control bit 8) = 0: Electronic gear (still) not in gear VI target					
Bit 10		Halt (Control bit 8) = 1: Axis decelerated					
	4	Halt (Control bit 8) = 0: Electronic gear in gear					
	1	Halt (Control bit 8) = 1 Axis has speed 0					
M/S Position Cor-	0	M/S Correction is running or wasn't started yet.					
rection successful Bit 12	1	M/S Correction finished. See chapter 0.					
Following error	0	No following error					
Bit 13	1	Following error					



Basic functions

Mode "-3 Electronic gear: Slave" implements a mode for a slave drive in the electronic gear to a master drive. The master of the electronic gear must be connected to the slave via signal cables or System Bus (recommended). The master input is selected in the Slave via parameter $Master\ position\ source\ 1122$.

Master Position Sout	rce Function
0 - Off	No source selected.
1 - Encoder 1	The current speed and position of the master drive is taken over from encoder input 1.
2 - Encoder 2 / R solver	e- The current speed and position of the master drive is taken over from encoder input 2 or resolver.
11 - RxPDO1.Long extrapolated	The current position of the master drive is taken over by the process data channel RxPDO1.Long1 of the system bus. Additionally, the data received are extrapolated, even for slow settings of TxPDO Time of the master. Depending on the application, select a setting of the corresponding TxPDO.Long of the master: "606 – Internal act. Position (16/16)", mechanical position of master drive. Value will not change abruptly when a homing operation of the master drive is completed. "607 – Act. Position (16/16)", mechanical position of

In setting "11 - RxPDO1.Long1 extrapolated" of parameter *Master position source* **1122**, the *Operation mode* **1180** of the system bus synchronization must be set to 1 or 10 to ensure reliable functional operation.

Operation mode 1180					
0 - Off 1)					
1 - RxPDO1 ²⁾					
2 - RxPDO2 ³⁾					
3 - RxPDO3 ³⁾					
10 - SYNC					

¹⁾ If the error message "F1453 Systembus-Synchronization not activated" is displayed when the slave drive is started, one of the operation modes 1, 2, 3 or 10 must be selected.

²⁾ Synchronization of processing with data message or cyclic sending of SYNC message.

³⁾ Not recommended for el. gear because no extrapolation carried out.



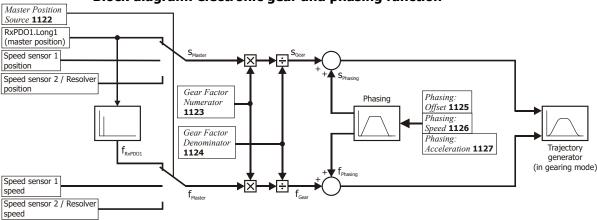
Synchronization between several drives must be performed at high updating rates in order to guarantee optimum results. In the transmitter of the TxPDO object, set a low value for the time (e.g. *TxPDO1 Time* **931**). If you use the SYNC function of System Bus, set parameter *SYNC time* **919** to a lower value.

Note that, due to these settings, the bus load of the system bus must provide for sufficient reserves for proper operation.



System Bus is described in the manuals of the extension modules with System Bus interface.

Block diagram: electronic gear and phasing function



The master position and speed are multiplied by the *gear factor*. When phasing is started, the phasing profile is added to the master speed until the phasing offset is reached.

The *gear factor* is defined by the following Objects or parameters:

_	Object	Parameter
0x5F10/1	Gear factor Numerator	1123 Gear Factor Numerator
0x5F10/2	Gear factor Denominator	1124 Gear Factor Denominator
0x5F10/3	Gear factor Resync on change	1142 Resync. on Change of Gear-Factor

The *Phasing* is defined by the following Objects or parameters:

	Object	.9 02,000	Parameter
0x5F11/1	Phasing 1: Offset	1125.1	Phasing: Offset
0x5F12/1	Phasing 2: Offset	1125.2	
0x5F13/1	Phasing 3: Offset	1125.3	
<u>0x5F14/1</u>	Phasing 4: Offset	1125.4	
0x5F11/2	Phasing 1: Speed	1126.1	Phasing: Speed
0x5F12/2	Phasing 2: Speed	1126.2	
0x5F13/2	Phasing 3: Speed	1126.3	
<u>0x5F14/</u> 2	Phasing 4: Speed	1126.4	
0x5F11/3	Phasing 1: Acceleration	1127.1	Phasing: Acceleration
0x5F12/3	Phasing 2: Acceleration	1127.2	
0x5F13/3	Phasing 3: Acceleration	1127.3	
0x5F14/3	Phasing 4: Acceleration	1127.4	

Start Electronic Gear and Status bits

The electronic gear is started with Bit 4 "Start Electronic Gear". The drive accelerates as specified in Object 0x6083 <u>Profile acceleration</u>. Once the slave speed is coupled into the master, status word bit 10 "target reached/Gear in" is set. The conditions for "In Gear" status are set via Objects 0x5F15 <u>In gear threshold</u> and 0x5F16 <u>In gear time</u>.



"Target reached/In Gear" is set when the electronic gear function is used and electronic gear synchronous running is reached.

Phasing

With the phasing function, the slave position is offset from the master position received by the value of one phasing position 1125.

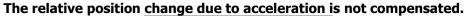
The Phasing is described in chapter 12.4.18 "0x5F11/n...0x5F14/n Phasing 1...4".

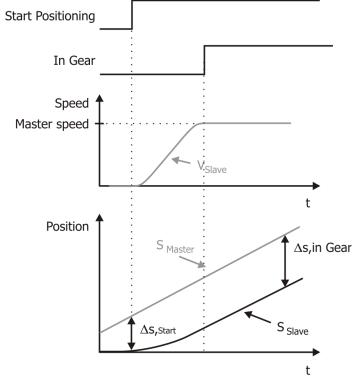
Direct Synchronization

Function without Direct Synchronisation ("Standard Synchronisation")

The drive accelerates the master speed with the ramps parameterized in the motion block. As soon as the master speed is reached for the first time, the drive is synchronized with the master drive. The slave is engaged at the current position and operates at a synchronous angle to the master. In the case of a relative positioning operation, this engaging position is used as the start position.

The acceleration and deceleration for synchronizations follow an S-curve.





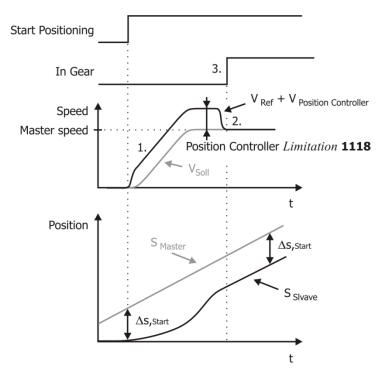


Function with Direct Synchronisation

The drive accelerates the master speed with the ramps parameterized in the motion block. When the motion block is started, the drive is synchronized with the master drive directly. The master position is processed directly by the position controller.

The acceleration and deceleration for synchronizations follow an S-curve.

The relative position change due to acceleration is compensated by the position controller.





Master/Slave Position Correction

NOTE

When using this functionality master drive and slave drive have to use the same mechanical characteristics (i.e. gear transmission ratios) and use the same reference system.

The Master/Slave Position Correction offers as part of the Electronic Gear the possibility to synchronize the absolute Position of the Slave to the absolute Position of the master.

This function is helpful in example in applications, in which drives often work independentely from each other and have to work together for certain activities. In example this could be the case in crane applications, where normal loads are operated indentely from each other and which are switched together for heavy loads. To speed up the switching together process, the Master/Slave Position correction can be used to synchronize the absolute position of the Slave with the absolute position of the

Additionally by using an Offset a relative reference can be set up in the target position.

Preparations Master drive

The Master drive must be set up as follows:

 $TxPDO2 \ Identifier$ **927 =** 640 (or a different not used Identifier)

TxPDO2 Function **932** = 1 – controlled by time or 2 – controlled by SYNC

TxPDO2.Long1 **964** = 743 – Act. Position [User Units]

Additionally the following parameters must be set according to the electronic gear: TxPDO1.Long1 **954** corresponding to the description of *Master Position Source* **1122**

 $TxPDO1 \ Identifier$ **925 =** 384 (or a different not used Identifier) $TxPDO1 \ Function$ **930 =** 1 – controlled by time or 2 – controlled by SYNC

Preparations Slave drive

The Slave drive must be set up as follows: $RxPDO2\ Function\$ **926** = 640 (or the Identifier defined in the Master drive)

Additionally the following parameters must be set according to the electronic gear: $RxPDO1\ Function\ 924 = 384$ (or the Identifier defined in the Master drive) $Source\ Master\ position\ 1122 = 11 - RxPDO1.Long$



The function Master/Slave Position Correction expects the Target Position [u] always in RxPD2.Long. When using this function RxPD02.Long1 and also RxPD02.Word1, RxPD02.Word2, RxPD02.Boolean1 and RxPD02.Boolean2 are not allowed to be used for any other purpose.



Starting of Master/Slave Position Correction in Slave drive

To start the Master/Slave Position correction at first Bit 4 and then Bit 5 have to be set in the Control word. Bit 5 is only allowed to be set when Bit 10 In Gear is shown in the Status word.

By setting Bit 5 in the Control word the Slave drive is started to position to the Master position + Offset.

The acceleration is done with the object 0x609A/0 0Homing acceleration (or Parameter *Acceleration* **1134**). The used velocity can be set up via 0x6099/1 Homing speed (or Parameter *Fast Speed* **1132**).

As long as the Master/Slave Position correction is executed, Bit 12 is deactivated in the Status word. When the Master/Slave Position correction was finished successfully Bit 12 is set.

During the Correction sequence the Status word bit 8 "Master/Slave Position correction" is set to "Low". As soon as the Master/Slave Position correction is finished or cancelled, the Bit is set to "High". After first switch-on (or after a device reset) the "Phasing Done" bit is also "Low".

Since Bit 8 is also used for Phasing, always the last started function is signalled by this bit.

Offset Reference

The Offset for the M/S Synchronization can be set via Object 0x5F18/0.

Object	Parameter		
0x5F18/0 M/S Synchronization offset	1284 M/S Synchronization offset		



Application limitations

The function can be used in most of all applications without any limitations. In applications with very long travelling distances the following must be checked:

- The position difference to be compensated must not be greater than 2¹⁵-1 motor revolutions.
- The position difference to be compensated must not be greater than 2³¹-1 user units.

Depending on the used reference system it can vary, which limit is decisive. Always the smaller limit must be complied with.

A motor with a reference speed of 6000 rpm would have to travel for around 5.5 minutes into one direction to exceed this limit.

Sequence example

To start the Electronic Gear: Slave mode, the correct sequence has to be sent from the PLC.

1	Control word =	0x0000	Disable voltage
1	Status word =	0x0050	Switch On Disabled
2	Modes of Operation =	-3	(Electronic Gear: Slave mode)
3	Control word =	0x0006	Shutdown
	Status word =	0x0031	Ready to switch on
4	Control word =	0x0007	Switch On
	Status word =	0x0033	Switched On
5	Control word =	0x000F	Enable Operation, Reference speed "0".
	Status word =	0xnn37	Operation enabled



6a	Control word =	0x001F	Start Electronic Gear without Direct Syn-
			chronisation
	Status word =	0xn327	Operation enabled, Slave not coupled (yet),
	Ctatus word	0,,,,,227	Phasing not finished.
	Status word =	UX11337	Operation enabled, Slave not coupled (yet), Phasing finished.
	Status word =	0vn727	Operation enabled, Slave coupled, Phasing
	Status Woru –	UXII/Z/	not (yet) finished.
	Status word =	0xn737	Operation enabled, Slave coupled, Phasing
	Status Word —	0,117,37	finished.
6b	Control word =	0x005F	Start Electronic Gear with Direct Synchroni-
			sation
	Status word =		See 6a
7a	Control word =	0x021F	Start Electronic Gear without Direct Syn-
			chronisation and Phasing Profile 1
	Status word =		See 6a
7b	Control word =	0x121F	Start Electronic Gear without Direct Syn-
			chronisation and Phasing Profile 2
	Status word =		See 6a
7c	Control word =	0x221F	Start Electronic Gear without Direct Syn-
			chronisation and Phasing Profile 3
	Status word =		See 6a
/d	Control word =	0x321F	Start Electronic Gear without Direct Syn-
	Ctatus word	Coo 65	chronisation and Phasing Profile 4
0.5	Status word = Control word =	0x025F	See 6a
8a	Control word =	UXUZSF	Start Electronic Gear with Direct Synchronisation and Phasing Profile 1
	Status word =	Soo 63	See 6a
8b	Control word =	0x125F	Start Electronic Gear with Direct Synchroni-
OD	Control Word –	UVIZN	sation and Phasing Profile 2
	Status word =	See 6a	See 6a
8c	Control word =	0x225F	Start Electronic Gear with Direct Synchroni-
	Control of Hold —	UNE 201	sation and Phasing Profile 3
	Status word =	See 6a	See 6a
8d	Control word =	0x325F	Start Electronic Gear with Direct Synchroni-
	-		sation and Phasing Profile 4
	Status word =	See 6a	Disable voltage
9	Control word =	0x001F	Enable Operation, the Slave drive synchro-
		0x003F	nizes to the Master position.
	Status word =		Operation enabled
		0x1n37	M/S Position Correction finished.



⚠ WARNING

Dangerous state due to new mode!

- When <u>0x6060</u> <u>Modes of Operation</u> is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode.
- Checking the status word before changing <u>0x6060</u> <u>Modes of Operation</u> (i.e. check state 0xnn33).





Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).

In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).

Bit 4 "Start electronic gear" must be active during the movement. If bit 4 is reset to "0", the movement is interrupted.

As long as 0x0007 is active, the mode of operation can also be changed safely. Once 0x6060 <u>modes of operation</u> has been set to another value, operation can be started with a corresponding sequence.



Bit 5 "Start Position Correction" is only allowed to be used when the Slave is in gear (Status word Bit 10).

Bit 5 "Start Position Correction" should be used for optimum results when the master drive doesn't move.

When Bit 5 of the Control word is reset to "0" the movement is interrupted.



15 Parameter list

The parameter list is structured according to the menu branches of the operating unit. For better clarity, the parameters have been marked with pictograms:

- ☐ The parameter is available in the four data sets
- ☑ The parameter value is set by the SET-UP routine

15.1 Actual values

No.	Description	Unit	Display range	Chapter
	Actual values of the freq	uency in	verter	
<u>228</u>	Internal reference frequency	Hz	-1000.00 1000.00	14.3.3
<u>249</u>	Active data set	-	1 4	14
260	Current error	-	0 0xFFFF	12.5.2
				16.4
<u>270</u>	<u>Warnings</u>	-	0 0xFFFF	16.2
<u>274</u>	Application Warnings	-	0 0xFFFF	16.3
<u>282</u>	Reference bus frequency	Hz	-1000.00 1000.00	14.3.3
<u>283</u>	Reference ramp frequency	Hz	-1000.00 1000.00	14.3.3
<u>144</u> 3	Node-State (NMT)	-	0 127	11.7
<u>1453</u>	OS SyncSource Act	-	Selection	11.8
	Actual values of the Motion	Control 3	Interface	
1108	Actual Position	u	2147483647	12.5.14
1100	Actual 1 Osition	u	2147483647	12.3.17
1109	Act. Contouring Error	u	2147483647 2147483647	12.5.41



Parameters *Current error* **260,** *Warnings* **270** and *Application warnings* **274** are only accessible via objects 0x2nnn Manufacturer objects. It cannot be accessed via the VPlus program or the KP500 control unit.



15.2 Parameter

[No.	Description	Unit	Setting range	Default value	Chapter
	388	Bus Error Behaviour	CAI	N Bus Selection	1 - Error	10,12.5.1
1	<u> 300</u>		ted moto	or parameters	I LITOI	10,12.3.1
a	373	No. of Pole Pairs	-	1 24	2	12.5
			Bus	control		
	<u>392</u>	State-transition 5	-	Selection	2 - Ramp	14.3.2
				_	44 - Ctd.	
	<u>412</u>	<u>Local/Remote</u>	-	Selection	Cont.+KP, Dir.	14
L			ala aska	h - m - m - m - m - m - m - m - m - m -	Cont.+KP	
ſ	414	Data set selection	ata set c	change-over 0 4	0	14
-	717	Data set selection	Frequer	ncy ramps		17
a	420	Acceleration (Clockwise)	Hz/s	0.00 9999.99	5.00	12.5.9
	421	Deceleration (Clockwise)	Hz/s	0.01 9999.99	5.00	12.5.11
	422	Acceleration Anticlockwise	Hz/s	-0.01 9999.99	-0.01	12.5.9
				-0.01 9999.99	-0.01	
	<u>423</u>	<u>Deceleration Anticlockwise</u>	Hz/s	-0.01 9999.99	-0.01	12.5.11
						12.5.11,
	<u>424</u>		Hz/s	0.01 9999.99	5.00	14.3.1
_		Emergency Stop Clockwise				10 5 11
	<u>425</u>	Emorgona, Stop Anticlockwice	Hz/s	0.01 9999.99	5.00	12.5.11, 14.3.1
•		Emergency Stop Anticlockwise			3 - Internal +	
	<u>434</u>	Ramp set point	-	Selection	Line Setpoint	14.3.3
			Digital	outputs	Zine Seeponie	
Ī	<u>549</u>	Max. Control deviation	%	0.01 20.00	5.00	14.1,14.2
Ì			Stopping	behaviour		
	637		%	0.0 100.0	1.0	14.3.1,
	<u>007</u>	Switch-off threshold	70	0.0 100.0	1.0	14.3.2
7	638	Halding times	S	0.0 200.0	1.0	14.3.1,
L		Holding time	Floctro	onic Gear		14.3.2
	1115	Feed constant	Electio	1 2147483647		
•		Gear: Shaft revolutions		1 65535		13.2.1
		Gear: Motor revolutions		1 65535		10.2.1
Ì			Electro	nic Gear		
Ī	1122	Source Master Position	-	Selection	0-Off	14.4.10
		Syste	embus S	ynchronization		
Į	1180	Operation mode	-	Selection	0-Off	14.4.10
ļ			/Slave Po	osition Correction		ı
	1284	Master/Slave Synchronization	-	Selection	0 u	0
l		<u>Offset</u>	tion Con	tual Tutaufa aa		
Ī	120F		tion Con	trol Interface	916 - 0v60EE	12.2
}		S. Target velocity pv [u/s] S. Modes of Operation		Selection Selection	816 – <u>0x60FF</u> 801 – <u>0x6060</u>	13.3 13.3
}		S. Target Position		Selection	802 – 0x607A	13.3
		S. Profile Velocity	_	Selection	$803 - 0 \times 6081$	13.3
•		S. Acceleration	-	Selection	804 - 0x6083	13.3
ŀ		S. Deceleration	-	Selection	805 – <u>0x6084</u>	13.3
		S. Target Velocity vl [rpm]	-	Selection	806 – <u>0x6042</u>	13.3
ŀ		S. Special Function Generator		Selection	9-Zero	13.3
Ì			ANopen I	Mux/Demux		
	1420	CANopen Mux Input Index	-	EEPROM: 0 16	1	12.4.5



No.	Description	Unit	Setting range	Default value	Chapter
	(Write) 1)		RAM: 17 33		
<u>1421</u>	CANopen Mux Input Index (Read) 1)	-	EEPROM: 0 16 RAM: 17 33	1	12.4.5
1422	CANopen Mux Inputs	-	Selection	7 - Off	12.4.5
<u>1423</u>	<u>CANopen Percentage Actual</u> <u>Value Source</u>	ı	Selection	52 - Analog Input MFI1A	12.4.7
<u>1451</u>	OS Synctime	-	700900 us	800 us	9.10
<u>1452</u>	OS SyncSource	-	Selection	52 - Analog Input MFI1A	11.8
	Mo	tion Con	trol Override		
<u>1454</u>	Override Modes Of Operation	-	Selection	0	13.4
<u>1455</u>	Override Target Position	-		-1 u	13.4
<u>1456</u>	Override Profile Velocity	-		-1 u/s	13.4
<u>1457</u>	Override Profile Acceleration	-		-1 u/s²	13.4
<u>1458</u>	Override Profile Deceleration	-		-1 u/s²	13.4
1459	II rnm I	-		-1 rpm	13.4
1460	Override Target velocity pv [u/s]	-		-1 u/s	13.4

1)	Non vol	atile (fixed Parameterization)	Volatile	
	0:	All indexes in EEPROM	17:	All indexes in RAM
	116:	One Index in EEPROM	1833:	One Index 116 in RAM



Setting "0" for *CANopen Mux input index (write)* **1420** changes all data in EEPROM and/or RAM.



Parameter *Data set selection***414** is only accessible via Manufacturer objects 0x2nnn. It cannot be addressed via the VPlus control software or the control panel.

For Positioning and using the Motion Control Interface comply with the application manual "Positioning".



16 Annex

In the Annex different overviews and Tools are displayed for the usage of the communication interface.

16.1 Control Word/Status word Overview

16.1.1 Control Word overview (without Sync Modes)

The tables on this page list in an overview the functionality of the **Control Word** bits.

Bit	Standard (No Positioning)	Positioning without MCI	MCI: Velocity Mode	MCI: Profile Ve- locity Mode	MCI: Profile Position Mode
0	Switch On	Switch On	Switch On	Switch On	Switch On
1	Enable Voltage	Enable Voltage	Enable Voltage	Enable Voltage	Enable Voltage
2	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)
3	Enable Operation	Enable Operation	Enable Operation	Enable Operation	Enable Operation
4			Rfg enable		New setpoint
5			Rfg unlock		Change set immediately
6			Rfg use ref		Abs/rel
7	Fault reset	Fault reset	Fault reset	Fault reset	Fault reset
8	Halt	Halt	Halt	Halt	Halt
9					Change on setpoint
10					
11					
12					
13					
14					
15					

Bit	MCI: Interpol. Position Mode	MCI: Homing Mode	MCI: Table travel record Mode	MCI: Move away from Limit Sw.	
0	Switch On	Switch On	Switch On	Switch On	Switch On
1	Enable Voltage	Enable Voltage	Enable Voltage	Enable Voltage	Enable Voltage
2	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)
3	Enable Operation	Enable Operation	Enable Operation	Enable Operation	Enable Operation
4	Enable ip-mode	Homing operat.start	Sequence mode	Move away from LS	Start Gearing
5					
6			Resume		Direct Sync
7	Fault reset	Fault reset	Fault reset	Fault reset	Fault reset
8	Halt	Halt	Halt	Halt	Halt
9			Start motion block		Start Phasing
10					
11			Motion Block Select 0		
12			Motion Block Select 1		Phasing Profile Sel. 1
13			Motion Block Select 2		Phasing Profile Sel. 2
14			Motion Block Select 3		
15			Motion Block Select 4		



16.1.2 Status Word overview (without Sync modes)

The tables on this page list in an overview the functionality of the **Status Word** bits.

Bit	Standard (No Positioning)	Positioning without MCI	MCI: Velocity Mode	MCI: Profile Velocity Mode	MCI: Profile Po- sition Mode
0	Ready to Switch On	Ready to Switch On	Ready to Switch On	Ready to Switch On	Ready to Switch On
1	Switched On	Switched On	Switched On	Switched On	Switched On
2	Operation enabled	Operation enabled	Operation enabled	Operation enabled	Operation enabled
3	Fault	Fault	Fault	Fault	Fault
4	Voltage enabled	Voltage enabled	Voltage enabled	Voltage enabled	Voltage enabled
5	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)
6	Switch On Disabled	Switch On Disabled	Switch On Disabled	Switch On Disabled	Switch On Disabled
7	Warning	Warning	Warning	Warning	Warning
8		Homing done			
9	Remote	Remote	Remote	Remote	Remote
10	Target reached	Target reached	Target reached	Target reached	Target reached
11	Internal limit active	Internal limit active	Internal limit active	Internal limit active	Internal limit active
12				Speed	Set-point acknowl.
13				Max slippage error	Following error
14		Target Pos. reached			
15	Warning 2	Warning 2	Warning 2	Warning 2	Warning 2

Bit	MCI: Interpol. Position Mode	MCI: Homing Mode	MCI: Table travel record Mode	MCI: Move away from Limit Sw.	MCI: Electronic Gear: Slave
0	Ready to Switch On	Ready to Switch On	Ready to Switch On	Ready to Switch On	Ready to Switch On
1	Switched On	Switched On	Switched On	Switched On	Switched On
2	Operation enabled	Operation enabled	Operation enabled	Operation enabled	Operation enabled
3	Fault	Fault	Fault	Fault	Fault
4	Voltage enabled	Voltage enabled	Voltage enabled	Voltage enabled	Voltage enabled
5	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)
6	Switch On Disabled	Switch On Disabled	Switch On Disabled	Switch On Disabled	Switch On Disabled
7	Warning	Warning	Warning	Warning	Warning
8			Motion Block in Progress		Phasing Done
9	Remote	Remote	Remote	Remote	Remote
10	Target reached	Target reached	Target reached	Target reached	Target reached
11	Internal limit active	Internal limit active	Internal limit active	Internal limit active	Internal limit active
12	IP-mode active	Homing attained	In gear		
13		Homing error	Following error		Following error
14					
15	Warning 2	Warning 2	Warning 2	Warning 2	Warning 2



16.1.3 Control Word overview for Sync Modes

The table on this page list in an overview the functionality of the **Control Word** bits.

Bit	MCI: Sync Position Mode	MCI: Sync Velocity Mode
0	Switch On	Switch On
1	Enable Voltage	Enable Voltage
2	Quick Stop (Low active)	Quick Stop (Low active)
3	Enable Operation	Enable Operation
4		
5		
6		
7	Fault reset	Fault reset
8	Halt	Halt
9		
10		
11		
12		
13		
14		
15		

16.1.4 Status Word overview for Sync modes

The table on this page list in an overview the functionality of the **Status Word** bits.

Bit	MCI: Sync Position Mode	MCI: Sync Velocity Mode
0	Ready to Switch On	Ready to Switch On
1	Switched On	Switched On
2	Operation enabled	Operation enabled
3	Fault	Fault
4	Voltage enabled	Voltage enabled
5	Quick Stop	Quick Stop
6	Switch On Disabled	Switch On Disabled
7	Warning	Warning
8		
9	Remote	Remote
10		
11		
12	Target Position ignored	Target velocity ignored
13	Following error	
14		
15	Warning 2	Warning 2



16.2 Warning messages

The different control methods and the hardware of the frequency inverter include functions for continuous monitoring of the application. In addition to the messages documented in the frequency inverter Operating Instructions, further warning messages are activated by the Field Bus communication.

The bit-coded warning reports are issued via parameter *Warnings* **270** according to the following pattern:

Parameter $\overline{Warnings}$ **269** indicates the warnings as plain text in the VPlus PC software and Keypad KP500.

Warning messages				
Bit no.	Warning code	Meaning		
0	0x0001	Warning Ixt		
1	0x0002	Warning Short Term - Ixt		
2	0x0004	Warning Long Term - Ixt		
3	0x0008	Warning Heat sink Temperature Tc		
4	0x0010	Warning Inside Temperature Ti		
5	0x0020	Warning Limit		
6	0x0040	Warning Init		
7	0x0080	Warning Motor Temperature		
8	0x0100	Warning Mains Failure		
9	0x0200	Warning Motor Protective Switch		
10	0x0400	Warning Fmax		
11	0x0800	Warning Analog Input MFI1A		
12	0x1000	Warning Analog Input A2		
13	0x2000	Warning System bus		
14	0x4000	Warning Udc		
15	0x8000	Warning Application warning status 273		



The meaning of the individual warnings are described in detail in the Operating Instructions.



16.3 Application warning Messages

The "Warning Message Application" is an additional information to the Warning bit. The Application warning messages are given via parameter *Application Warnings* **274**, bit-coded according to the following scheme.

Parameter *Application Warnings* **273** shows the warnings in clear text on the operator panel and the PC software tool VPlus.

Use Parameter Application Warnings 274 to access the Application warning codes via Field bus.

Warning Messages Application				
Bit-No.	Warning	Description		
	Code			
0	0x0001	BELT	- Belt	
1	0x0002	SW-LIM CW	 SW Limit Switch Positive 	
2	0x0004	SW-LIM CCW	- SW Limit Switch Negative	
3	0x0008	HW-LIM CW	– HW Limit Switch Positive	
4	0x0010	HW-LIM CCW	- HW Limit Switch Negative	
5	0x0020	CONT	 Contouring Error 	
6	0x0040	ENC	 Warning Absolute encoder 	
7	0x0080	User 1	– User Warning 1	
8	0x0100	User 2 — User Warning 2		
9	0x0200	(reserved)		
10	0x0400	(reserved)		
11	0x0800	(reserved)		
12	0x1000	(reserved)		
13	0x2000	(reserved)		
14	0x4000	(reserved)		
15	0x8000	(reserved)		



For details on the warnings, refer to the frequency inverter Operating Instructions and the "Positioning" application manual.

The Warning Bit 6 "Absolute encoder" can be read out via Parameter **1274** in VPlus or **1273** via field bus. The Absolute encoder warnings are described in detail in the Extension manual EM-ABS-01.



16.4 Fault messages

The fault code that is stored after a fault occurs is made up of the fault group FXX (high Byte, hexadecimal) followed by the code number XX (low Byte, hexadecimal).

Motion Control Interface

	Communication fault			
Co	de	Meaning		
F04	04	Control Deviation Position Controller		
F14	42	Pos. SW-Limit Switch		
	43	Neg. SW-Limit Switch		
	44	Pos. SW-Lim. Switch < Neg. SW-Lim. Switch		
	45	Pos. and Neg. HW-Lim Switch Simultaneously		
	46	Limit Switch Incorrect Wired!		
	47	Pos. HW Limit Switch		
	48	Neg. HW Limit Switch		
	51	Clockwise Operation Locked		
	52	Anti-Clockwise Operation Locked		
	53	System bus-Synchronization not activated		
	60	Pos. HW-Lim. Switch: Illegal Signal Source		
	61	Pos. HW-Lim. Switch: Input disabled by PWM-/FF-Input		
	62	Pos. HW-Lim. Switch: Input disabled by Index-Contr.		
	63	Pos. HW-Lim. Switch: Wrong OpMode for MFI1		
	64	Pos. HW-Lim. Switch: Input disabled by Encoder 1		
	65	Pos. HW-Lim. Switch: Input disabled by Encoder 2		
	66	Pos. HW-Lim. Switch: Wrong OpMode for EM-S1IOD		
	Neg. HW-Lim. Switch: Illegal Signal Source			
	Neg. HW-Lim. Switch: Input disabled by PWM-/FF-Input			
	Neg. HW-Lim. Switch: Input disabled by Index-Contr.			
	73	Neg. HW-Lim. Switch: Wrong OpMode for MFI1		
	74	Neg. HW-Lim. Switch: Input disabled by Encoder 1		
	75	Neg. HW-Lim. Switch: Input disabled by Encoder 2		
	76	Neg. HW-Lim. Switch: Wrong OpMode for EM-S1IOD		
F15	XX	User-Defined Error in Motion Block $xx (1 \le xx \le 32)$		
	70	No Homing Done		
	71	Homing: Encoder-Mode w.o. Z-Impulse		
	72	Both Directions Locked		
	73	No Touch Probe Signal Detected		
	74	M/S Position Correction: Master Position source not set		
F27	01	CRC-Error in communication EtherCAT® Module/inverter		
	02	Timeout-Error in communication EtherCAT® Module/inverter		
	14	Communication loss to PLC		

EtherCAT®

The Actual error message can be read out by parameter access via parameter *Actual Error* **260** and via the Emergency Message or Object 0x1014.

Parameter *Actual Error* **259** shows the actual error in clear text on the operator panel and the PC software tool VPlus.

In addition to the fault messages stated, there are further fault messages described in the Operating Instructions. The faults of the Motion Control Interface (F14xx, F15xx) are described detailed in the application manual "Positioning".

16.5 Conversions

The speeds can be converted into other speed formats using the formulas in this chapter:

Frequency [Hz] to	Speed [rpm]	See chapter 16.5.2
	Speed in user units [u/s]	See chapter 16.5.4
Speed [rpm] to	Frequency [Hz]	See chapter 16.5.1
	Speed in user units [u/s]	See chapter 16.5.6
Speed in user units [u/s]	Speed [rpm]	See chapter 16.5.5
	Frequency [Hz]	See chapter 16.5.3



16.5.1 Speed [rpm] to Frequency [Hz]

$$f[Hz] = \frac{n[\min^{-1}] \times No. \, of \, pole \, pairs \, (P.373)}{60}$$

16.5.2 Frequency [Hz] to Speed [rpm]

$$n[rpm] = \frac{f \text{ [Hz]} \times 60}{\text{No. of pole pairs (P. 373)}}$$

16.5.3 Speed in user units [u/s] to Frequency [Hz]

$$f \text{ [Hz]} = v \left[\frac{u}{s}\right] \times \frac{\textit{No. of pole pairs (P. 373)}}{\textit{Feed Constant (P. 1115)}} \times \frac{\textit{Gear Box: Motor Shaft Revolutions (P. 1117)}}{\textit{Gear Box: Driving Shaft Revolutions (P. 1116)}}$$

16.5.4 Frequency [Hz] to Speed in user units [u/s]

$$v\left[\frac{\mathsf{u}}{\mathsf{s}}\right] = f\left[\mathsf{Hz}\right] \times \frac{Feed\ Constant\ (P.1115)}{No.\ of\ pole\ pairs\ (P.373)} \times \frac{Gear\ Box:\ Driving\ Shaft\ Revolutions\ (P.1116)}{Gear\ Box:\ Motor\ Shaft\ Revolutions\ (P.1117)}$$

16.5.5 Speed in user units [u/s] to Speed [rpm]

$$n \ [\mathit{rpm}] = v \ [\frac{\mathsf{u}}{\mathsf{s}}] \times \frac{60}{\mathit{Feed Constant} \ (P.\,1115)} \times \frac{\mathit{Gear Box} : \mathit{Motor Shaft Revolutions} \ (P.\,1117)}{\mathit{Gear Box} : \mathit{Driving Shaft Revolutions} \ (P.\,1116)}$$

16.5.6 Speed [rpm] to Speed in user units [u/s]

$$v\left[\frac{\mathsf{u}}{\mathsf{s}}\right] = n\left[\mathit{rpm}\right] \times \frac{\mathit{Feed\ constant}\ (P.\,1115)}{60} \times \frac{\mathit{Gear\ Box:Driving\ Shaft\ Revolutions}\ (P.\,1116)}{\mathit{Gear\ Box:Motor\ Shaft\ Revolutions}\ (P.\,1117)}$$



16.6 Object support in the Software versions and XML files

The support of CANopen was extended in various steps in the firmware. The following table lists, which objects are supported with the different software versions and the corresponding XML file for EtherCAT®. Objects, that were added or where changes were made are marked in light blue colour.



Long Object names are shortened sensible in the table to maintain the overview.

Firmware	5.3.0	5.4.0
XML	BVACU530 V2.xml	BVACU540.xml
0x1000 Device Type	x	×
0x1001 Error register	x	X
0x1008 Manuf. Device name	x	X
0x1009 Manuf. Hardw. Vers.	x	X
0x100A Manuf. Softw. Vers.	x	X
0x1010 Store parameters	x	Х
0x1011 Restore parameters	x	X
0x1018 Identity object	x	X
0x1600 RxPDO1 map. param.	x	X
0x1601 RxPDO2 map. param.	x	X
0x1602 RxPDO3 map. param.	x	X
0x1A00 TxPDO1 map. param.	x	X
<u>0x1A01</u> TxPDO2 map. param.	X	X
<u>0x1A02</u> TxPDO3 map. param.	x	X
<u>0x2nnn</u> ACU parameter access	X	X
0x3001Digital In actual values	x	X
0x3002Digital Out act. values	X	X
0x3003Digital Out set values	X	X
<u>0x3004</u> Boolean Mux	x	X
<u>0x3005</u> Boolean DeMux	X	X
<u>0x3006</u> Percentage Set value	x	X
<u>0x3007</u> Percentage Act. value 1	x	X
<u>0x3008</u> Percentage Act. value 2	x	X
<u>0x3011</u> Act. Value Word 1	x	X
<u>0x3012</u> Act. Value Word 2	X	X
0x3021Act. Value Long 1	x	X
0x3022Act. Value Long 2	x	X
<u>0x3111</u> Ref. Value Word 1	x	X
0x3112Ref. Value Word 2	x	X
0x3121Ref. Value Long 1	x	X
0x3122Ref. Value Long 2	x	X
0x5F18 M/S Synchronization Offset		X
0x5FF0 Active motion block	x	X
0x5FF1Motion block to resume	X	X



P*	F 2 0
Firmware	5.3.0
XML	BVACU530_V2.xml
0x6007 Abort connect. option c.	X
0x603F Error code	X
0x6040 Control word	X
0x6041 Status word	X
0x6042 v/ target velocity	X
0x6043 v/ velocity demand	X
0x6044 v/velocity actual value	X
0x6046 v/ velocity min max amount	X
0x6048 v/ velocity acceleration	X
0x6049 v/velocity deceleration	X
0x604A Velocity quick stop	X
0x6060 Modes of Operation	X
0x6061 Modes of Op. display	X
0x6064 Position actual value	X
0x6065 Following error window	X
0x6066 Following error timeout	X
0x6067 Position Window	X
0x6068 Position Window time	X
0x606C Velocity act. value	X
0x606D Velocity window	X
0x606E Velocity window time	X
0x606F Velocity Threshold	X
0x6070 Velocity Threshold time	X
0x6071 Target Torque	X
0x6077 Torque Actual value	X
0x6078 Current Actual value	X
0x6079 DC link circuit voltage	X
0x607A Target Position	X
0x607C Home Offset	X
0x6081 Profile Velocity	X
0x6083 Profile Acceleration	X
0x6084 Profile Deceleration	X
0x6085 Quick Stop deceleration	X
0x6086 Motion Profile type	X
0x6091 Gear ratio	X
0x6092 Feed constant	X
0x6098 Homing method	X
0x6099 Homing speeds	X
0x609A Homing acceleration	X
0x60C1 Interpol. Data record	X
0x60F4 Following err. Act. Val.	X
0x60F8 Max. Slippage	X
0x60FF Target Velocity	X
0x6502 Supported Drive modes	X



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