BONFIGLIOLI
VECTRON

INDUSTRY PROCESS
AND AUTOMATION SOLUTIONS

CANopen Communication module CM-CAN

Frequency Inverter 230V / 400V

ACTIVE Cube

GB

BONFIGLIOLI

General points on the documentation

The present supplement of the documentation is valid for frequency inverters of the device series ACU 201 and ACU 401. The information necessary for the assembly and application of the CANopen® communication module CM-CAN is documented in this guidance.

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

Brief instructions “Quick Start Guide”
The brief instruction “Quick Start Guide” describes the fundamental steps for mechanical and electrical installation of the frequency inverter. The guided commissioning supports you in the selection of necessary parameters and the software configuration of the frequency inverter.

Operating instructions
The operating instructions document the complete functionality of the frequency inverter. The parameters necessary for specific applications for adaptation to the application and the extensive additional functions are described in detail.

Application manual
The application manual supplements the documentation for purposeful installation and commissioning of the frequency inverter. Information on various subjects connected with the use of the frequency inverter is described specific to the application.

Installation instructions
As a complement to the brief instructions and the operating instructions, the installation instructions describe the installation and use of devices.

The documentation and additional information can be requested via your local representation of the BONFIGLIOLI company. The following pictograms and signal words are used for the purposes of the current documentation:

Danger!
means a direct threatening danger. Death, serious damage to persons and considerable damage to property will occur if the precautionary measure is not taken.

Warning!
marks a possible threat. Death, serious damage to persons and considerable damage to property can be the consequence if attention is not paid to the text.

Caution!
refers to an indirect threat. Damage to people or property can be the result.

Attention!
refers to a possible operational behavior or an undesired condition that can occur in accordance with the reference text.

Note
marks information that facilitates handling for you and supplements the corresponding part of the documentation.

Warning! In installation and commissioning, comply with the information in the documentation. You as a qualified person must read the documentation carefully before the start of the activity and obey the safety instructions. For the purposes of the instructions, "qualified person" designates a person acquainted with the installation, assembly, commissioning and operation of the frequency inverters and possessing the qualification corresponding to the activity.

Contents

1 General safety and application information

This documentation has been produced with the greatest of care and extensively and repeatedly checked. For reasons of clarity, not all the detailed information on all types of the product and also not every imaginable case of installation, operation or maintenance has been taken into account. If you require further information or if specific problems which are not dealt with extensively enough in the documentation exist, you can request the necessary information via the local representation of the BONFIGLIOLI company.

We would also point out that the contents of this documentation are not part of a previous or existing agreement, assurance or legal relationship and are not intended to amend the same. All obligations of the manufacturer result from the underlying purchase contract, which also contains the complete and solely valid warranty regulation. These contractual warranty provisions are neither extended nor limited by the production of this documentation.

The manufacturer reserves the right to correct or amend the contents and the product information as well as omissions without prior notification and assumes no kind of liability for damage, injuries or expenditure to be put down to the aforementioned reasons.

1.1 General information

⚠ **Warning!** BONFIGLIOLI VECTRON frequency inverters have high voltage levels during operation, depending on their protection class, drive moving parts and have hot surfaces.

In the event of inadmissible removal of the necessary covers, improper use, wrong installation or operation, there is the risk of serious damage to persons or property.

To avoid any damage, only qualified staff may carry out the transport, installation, setup or maintenance work required. Comply with the standards EN 50178, IEC 60364 (Cenelec HD 384 or DIN VDE 0100), IEC 60664-1 (Cenelec HD 625 or VDE 0110-1), BGV A2 (VBG 4) and national provisions. Qualified persons within the meaning of this principal safety information are people acquainted with the installation, fitting, commissioning and operating of frequency inverters and the possible hazards and in possession of qualifications matching their activities.

1.2 Proper use

Warning! The frequency inverters are electrical drive components intended for installation in industrial plants or machines. Commissioning and start of intended operation are not allowed until it has been established that the machine corresponds to the provisions of the EC machine directive 98/37/EEC and EN 60204. According to the CE sign, the frequency inverters additionally fulfill the requirements of the low-voltage directive 2006/95/EC and standards EN 50178/DIN VDE 0160 and EN 61800-2. Responsibility for compliance with the EMC directive 89/336/EEC is with the user. Frequency inverters are available in a limited way and as components exclusively intended for professional use within the meaning of the EN 61000-3-2.
With the issue of the UL according to UL508c, the requirements of the CSA Standard C22.2-No. 14-95 have also been fulfilled.
The technical data and the information on connection and ambient conditions the rating plate and the documentation be complied with. The instructions must be read and fully understood before starting work on the device.
Do not connect any capacitive loads.

1.3 Transport and storage

Transport and storage are to be carried out in an adequate way in the original packaging. Storage shall be in dry rooms protected against dust and moisture with slight temperature fluctuations. Please observe the climatic conditions according to EN 50178 and the marking on the packaging.
The duration of storage without connection to the admissible reference voltage may not exceed one year.

1.4 Handling and installation

Warning! Damaged or destroyed components may not be put into operation because they may be a health hazard.

The frequency inverters are to be used according to the documentation, the directives and the standards. Handle carefully and avoid mechanical overload. Do not bend the components or change the insulation distances. Do not touch electronic components or contacts. The devices contain electrostatic sensitive components which can easily be damaged by improper handling. Any use of damaged or destroyed components shall be considered as a non-compliance with the applicable standards. Do not remove any warning signs from the device.

1.5 Electrical connection

Warning! Before any assembly or connection work, de-energize the frequency inverter. Make sure that the frequency inverter is de-energized.
Do not touch the sockets, because the capacitors may still be charged.
Comply with the information given in the operating instructions and on the frequency inverter label.

While working on the frequency inverters, obey the applicable standards BGV A2 (VBG 4), VDE 0100 and other national directives. Comply with the information in the documentation on electrical installation and the relevant directives. Responsibility for compliance with and examination of the limit values of the EMC product standard EN 61800-3 for variable-speed electrical drive mechanisms is with the manufacturer of the industrial plant or machine.
The documentation contains information on installation correct for EMC. The cables connected to the frequency inverters may not be subjected to an isolation test with a high test voltage without previous circuit measures.

1.6 Operating information

Warning! The frequency inverter may be connected to the power supply every 60s. Consider this for a jog operation of a mains contactor. For commissioning or after an emergency stop, a non-recurrent, direct restart is permissible.
After a failure and restoration of the power supply, the motor may start unexpectedly if the AutoStart function is activated. Install protective equipment if personal injury or material damage is possible.
Before commissioning and the start of the intended operation, attach all the covers and check the sockets. Check additional monitoring and protective devices pursuant to EN 60204 and the safety directives applicable in each case (e.g. Working Machines Act, Accident Prevention Directives etc.).
No connection work may be performed, while the system is in operation.

1.7 Maintenance and servicing

Warning! Unauthorized opening and improper interventions can lead to physical injury or damage to property. Repairs on the frequency inverters may only be carried out by the manufacturer or persons authorized by the latter. Check protective equipment regularly.

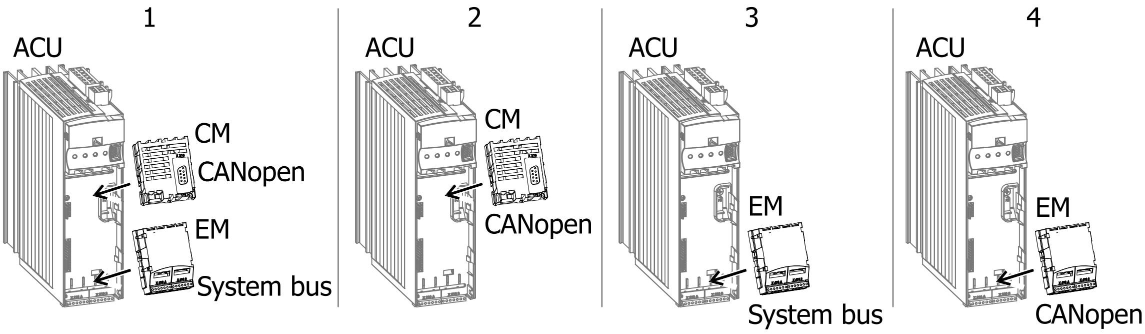
2 Introduction

This document describes the features of the CANopen® communication for frequency inverters of the ACU series.
The CANopen® communication requires software version 5.1.2 or higher.
CANopen® communication is available with modules:

- Communication module CM-CAN
- Expansion module EM-SYS
- Expansion module EM with CAN terminals on board like EM-IO-01

The expansion modules can be used with either System bus or CANopen®, depending of the selection of the CANopen® interface.

Possible combinations



The frequency inverter must be extended by either the CANopen® communication module CM-CAN or a fitting EM module for the CAN connection.
The CM-CAN CANopen® module is enclosed with the frequency inverter as a separate component and must be fitted by the user. This is described in detail in the "Assembly" chapter. For the assembly of the EM modules and System bus protocol description refer to the corresponding manual.

Note:
CM-CAN offers decoupled drivers, while EM modules have coupled drivers. BONFIGLIOLI VECTRON recommends using the CM-CAN module, especially in environments with critical EMC behavior.
For reasons of better readability, in the following chapters CM-CAN module is used representative for all modules able to establish CANopen® communication.

Note:
These instructions are not to be understood as fundamental information on CANopen®. They presuppose underlying knowledge of the methods and mode of effect of CAN open on the part of the user.

In some chapters, as an alternative to the KP500 control unit, the setting and displaying of values is described with the help of the VPlus control software. Operation of a PC with the VPlus control software requires an optional KP232 interface adapter.

In this document, connecting the hardware, relevant parameters and the available objects are shown.

The available objects are sub-divided according to:

Communication objects	(0x1nnn)	to DS301 V4.01
Manufacturer objects	(0x2nnn)	
Standardized objects	(0x6nnn)	to DS402 V1.1

The functions and objects are described as far as necessary in these instructions. For further information, reference is made here to the Draft Standards of the CiA®.
The standards to which reference is made are DS102, DS301 and DS402, which are available from:

CiA, CAN in AUTOMATION
Am Weichselgarten 26
D-91058 Erlangen

Tel.: +49 9131 69086-0
Fax: +49 9131 69086-79

Attention! With the help of the CM-CAN CANopen® communication module, it is possible to access **ALL** parameters of the frequency inverter from the external control unit. Control of the access via the operation level, as with the KP500 control unit or the VPlus PC software, does not exist. A change of parameters with an unknown meaning to the user can lead to the inoperability of the frequency inverter.

Attention! ACTIVE CUBE inverters support two different types of configuration:

- Non motion control configurations
- Motion control configurations

Motion control configurations are set when parameter *configuration* **30** = x40.

The inverter's behavior with respect to *controlword*/*statusword* and *modes of operation*/*modes of operation display* is different in the two different types of configuration.

Refer to chapter 11.3 for inverter control with non motion control and chapter 11.4 for inverter control with motion control.

Attention! If data is written cyclically comply with the instructions in chapter 10.3.1 "Handling of data sets/cyclic writing".

Note: For the operation with a PLC in most cases an EDS file in required. You can find this EDS file on the product documentation CD.

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3 Installation / Disassembly of the communication module

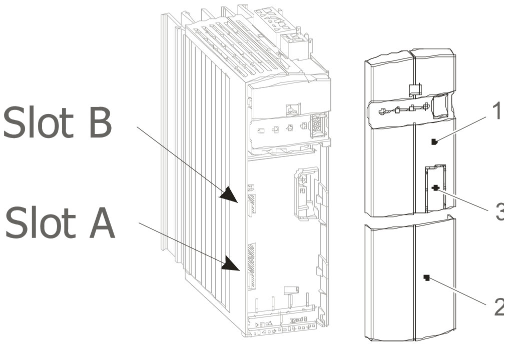
3.1 Installation

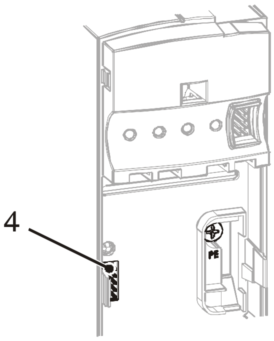
The communication module CM-CAN is pre-assembled in a case. Additionally, a PE spring is enclosed for PE connection (shield).

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

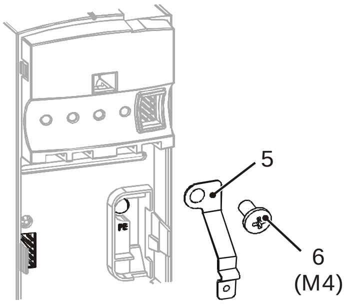
Work steps:

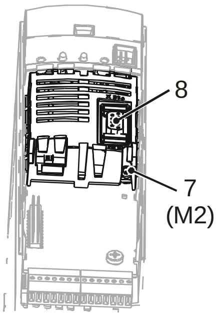
- Disconnect the frequency inverter from the mains voltage and protect it against being energized unintentionally.
- Remove covers **(1)** and **(2)** of the frequency inverter. Slot B **(4)** for the communication module is now accessible.



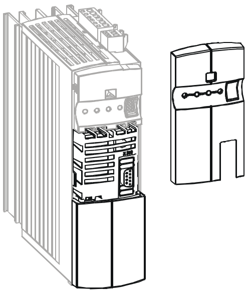


- Mount the supplied PE spring **(5)** using the M4 screw **(6)** in the unit. The spring must be aligned centrally.
- Insert the communication module in slot B **(4)** until it engages audibly.
- Fix the communication module by screwing the M2 screw **(7)** of the module to the PE spring **(5)**.



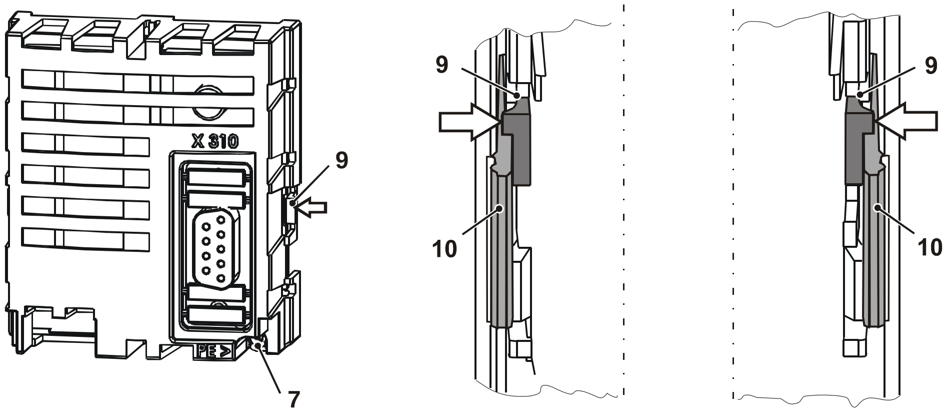


- In the upper cover **(1)**, break out the pre-punched cutout **(3)** for the plug X310 **(8)**.
- Mount the two covers **(1)** and **(2)**.



3.2 Disassembly

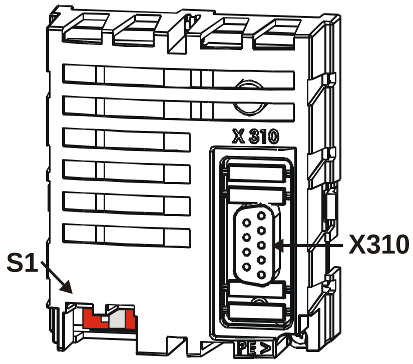
- Disconnect the frequency inverter from mains voltage and protect it against being energized unintentionally.
- Remove covers **(1)** and **(2)** of the frequency inverter.



- 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)**.

4 Connector pin assignment/bus termination/line

The CAN connection is physically designed according to the ISO 11898 standards (CAN High-Speed).

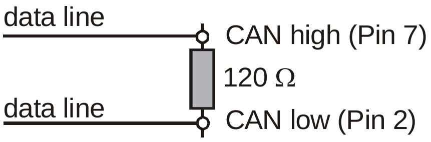


The **X310** (9-pole Sub-D) bus plug has been designed according to DS102 Version 2.0 (Bus node, option A).
Details can be seen from the following table on the occupancy of the bus plug.

The bus termination necessary on a phase in the physically first and last subscriber can be activated via **DIP switch S1** on the communication module.

The factory setting for the bus termination is OFF.

As an alternative, this is also possible via corresponding switching in the bus connection plugs.



Attention! Make absolutely sure that only one of the two possibilities for the bus termination is used and the bus termination is only switched on with the first and last subscriber. Otherwise, operation of the CANopen® communication is not possible. The CAN Controller State is displayed via actual value parameter *CAN-State* **1291**.

Bus plug X310

Pin	Name	Function
Housing	Shield	connected with PE
1	CAN_L	CAN Low bus interface, short-circuit resistant and function-insulated, max. current 60 mA
2	CAN_L	CAN Low bus interface, short-circuit resistant and function-insulated, max. current 60 mA
3	CAN_GND	Earth/GND
4	n.c.	not used
5	n.c.	not used
6	CAN_GND	Earth/GND
7	CAN_H	CAN High bus interface, short-circuit resistant and function-insulated, max. current 60 mA
8	CAN_H	CAN-High Bus-interface, short-circuit resistant and function-insulated, max. current 60 mA
9	-	Do NOT connect.

The drilled and shielded line is to be used for the bus line. The shield is to be implemented as a harness shield (**not a film shield**).

Attention! Connect the line screen with PE at both ends.

5 Baud rate setting / line lengths

The transmission speed of the CANopen® communication module CM-CAN can be set via the parameter *CAN Baud rate* **385.**

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
385	CAN Baud rate	1	8	6

The transmission rate is a function of a variety of application-specific parameters. The line length of the communication network limits the transmission speed due to the signal propagation time of the CANopen® protocols.

CANopen® interface		
Operation mode	**Function**	**max. Line length**
1 - 10 kBaud	Transmission rate 10 kBaud	5000 meter
2 - 20 kBaud	Transmission rate 20 kBaud	2500 meter
3 - 50 kBaud	Transmission rate 50 kBaud	1000 meter
4 - 100 kBaud	Transmission rate 100 kBaud	500 meter
5 - 125 kBaud	Transmission rate 125 kBaud	500 meter
6 - 250 kBaud	Transmission rate 250 kBaud	250 meter
7 - 500 kBaud	Transmission rate 500 kBaud	100 meter
8 - 1000 kBaud	Transmission rate 1000 kBaud	25 meter

Note:
Changing the baud rate causes a restart of the CANopen® system (NOT a reset of the inverter).

6 Setting the node number

The CANopen® protocol supports a maximum of 127 nodes in a communication network. Each frequency inverter is assigned a node ID, which may only exist once in the system, for its unambiguous identification. The node number is set with parameter *CAN Node Number* **387.**

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
387	CAN Node Number	-1	127	-1

Note:
The factory setting *CAN Node Number* **387** = -1 means that the CANopen® interface has been **deactivated.**

The value *Can Node number* **387** = 0 is not allowed and cannot be set.

Note:
Changing the node number causes a restart of the CANopen® system (NOT a reset of the inverter).

7 Assigning the CANopen interface

Normally a CANopen® connection is set up using the CM-CAN module. As an alternative for special applications, the CANopen® connection can be switched to an EM-module with a CAN driver connection via parameter *CAN-Interface* **276.** This is only possible when parameter *Node-Id* **900** of the system bus is set to **-1** and *CAN Node Number* **387** is set to **-1** !!

CAN Interface **276**	
Operation mode	**Function**
1 - CM-CAN	CM-CAN is used for the CANopen® connection. Factory setting.
2 - EM-xxx	EM-xxx is used for the CANopen® connection

Note:
The setting of *CAN interface* **276** = 2 is only possible when an EM-module with CAN system bus is installed.

Even if only an EM-module with CAN system bus is installed, **276** first displays the value "1 – CM-CAN" which must then be changed to "2 – EM-xxx" in order to activate the EM-module for the CANopen® connection.

If *CAN interface* **276** = 2 is set, the transmission speed is set with *CAN Baud rate* **385**. *Baud Rate* **903** (System bus) is deactivated by setting **900** = -1. The same applies to all other parameters which have a function when using the system bus.

8 Operational behavior on bus failure

The operational behavior if the CANopen® system fails due to BusOff, guarding, heartbeat, SYNC error, RxPDO length error or NMT state change (leaving NMT state operational) can be parameterized. The required behavior is set with parameter *CAN Error Behavior* **388**.

Operation mode	Function
0 - No Reaction	Operating point is maintained
1 - Error	Device state machine changes immediately to state "fault" (**factory setting**)
2 - Switch-off	Device state machine processes command '*disable voltage*' and changes to state "switch on disabled"
3 - Quick-Stop	Device state machine processes command '*quick stop*' and changes to state "switch on disabled"
4 - Ramp-Stop + Error	Device state machine processes command '*disable operation*' and changes to state "fault" after the drive is stopped
5 - Quick-Stop + Error	Device state machine processes command '*quick stop*' and changes to state "fault" after the drive is stopped

Attention! The parameter settings *CAN Error Behavior* **388** = 2 … 5 are only relevant if parameter *Local/Remote* **412** = "1 - Control via state machine" has been set as a supplement.

Parameter *CAN Error Behavior* **388** corresponds to the device profile object 0x6007 *abort connection option code*.

For an exact description of the inverter's functional behavior, see chapter 10.5.1 object 0x6007 *abort connection option code*.

The error and warning behavior of the frequency inverter can be parameterized in various ways. If a failure of the bus system occurs in the setting *CAN Error Behavior* **388** = 1, 4 or 5, the frequency inverter reports one of the following errors:

Communication error		
Code		**Meaning**
F20	21	Bus OFF
	22	Guarding failure
	23	Error state
	24	SYNC error (SYNC timing)
	25	NMT state change (operational → xxx)
	26	RxPDO1 length error (number of received bytes different to mapping)
	27	RxPDO2 length error (number of received bytes different to mapping)
	28	RxPDO3 length error (number of received bytes different to mapping)
F23	nn	Heartbeat failure – nn = node address of the failed subscriber (hex)

9 CANopen Overview

CANopen® is used in a wide range of applications and is an especially favoured communication system for motion control applications. The CANopen® based standard DS402 "drives and motion control" describes and defines the necessary objects and functions for motion control systems.

The CANopen® standard DS301 describes the basic communication functions in principle. This chapter will give a short overview of the different functions based on DS301. Detailed information on the CAN physical layer and CANopen® DS301 functions can be found in the respective literature (e. g. "Controller Area Network" by Prof. Dr.-Ing. K. Etschberger) and standards published by CAN-in-Automation CiA® (www.can-cia.org).

Every CANopen® device contains an object dictionary with all supported objects. The objects can be divided into the two main groups – communication objects and application objects. The objects are addressed by their index 0xnnnn (16 bit) and subindex 0xnn (8 bit).

The different functions defined by CANopen® (NMT, SDO, SYNC, PDO, Emergency) use fixed identifier ranges. These identifier ranges are defined by the "Predefined Connection Set". By default every function uses an identifier calculated as the base number plus node-ID (node–ID set by parameter *CAN node number* **387**.

9.1 Communication Objects

The communication objects are located in the index range 0x1nnn. They describe the communication behavior of a CANopen® 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.

9.2 Application Objects

The application objects are divided into two groups again. The index range 0x2000 – 0x5FFF is reserved for manufacturer specific objects and the index range 0x6nnn is reserved for device profile specific objects. Device profile specific objects 0x6nnn are defined by DS402 drives and motion control. They are used for controlling the device application (start/stop, speed, motion control functions).

9.3 SDO Function

The SDO (Service Data Objects) messages are used for reading and writing the objects located in the object dictionary. Objects with up to four bytes of data are transferred with an expedited SDO transfer that uses one request and one response message. Access to objects with more than four bytes of data is accomplished by a segmented domain transfer.

In chapter 10.3 "Manufacturer objects (0x2nnn)" the necessary messages for reading/writing objects with expedited transfer are described in detail. Access to communication, manufacturer and device profile specific objects with up to four bytes of data is accomplished in the same way. The only difference is in the index and sub-index number.

The inverter supports one server SDO. This server SDO is accessed by the client SDO on the PLC side. An SDO message always has a COB-ID followed by 8 data bytes.

SDO-message:

COB-ID	0	1	2	3	4	5	6	7
COB-ID	command specifier (cs)	index		sub-index	data	data	data	data
	nn	LSB	MSB					

Default Identifiers (COB-ID):

TxSDO	0x600 (=1536) + Node-ID
RxSDO	0x580 (=1408) + Node-ID

Depending on the transfer direction and the amount of data bytes, different command specifiers are used.
The error codes are listed in chapter 9.3.3.

9.3.1 Read Access

Client → Server, Upload Request

COB-ID	0	1	2	3	4	5	6	7
0x600 + Node-ID	cs	index		sub- index	data	data	data	data
	0x40	LSB	MSB		00	00	00	00

Server → Client, Upload Response

COB-ID	0	1	2	3	4	5	6	7
0x580 + Node-ID	cs	index		sub- index	data	data	data	data
	0x4x	LSB	MSB		data01	data02	data03	data04

The amount of valid data bytes is coded in the response of the command specifier.

Amount of data bytes	**1**	**2**	**3**	**4**
Command specifier (cs)	0x4F	0x4B	0x47	0x43

9.3.2 Write Access

Client → Server, Download Request

COB-ID	0	1	2	3	4	5	6	7
0x600 + Node-ID	cs	index		sub- index	data	data	data	data
	0x2x	LSB	MSB		00	00	00	00

Server → Client, Download Response

COB-ID	0	1	2	3	4	5	6	7
0x580 + Node-ID	cs	index		sub- index	data	data	data	data
	0x60	LSB	MSB		data01	data02	data03	data04

The amount of valid data bytes is coded in the request of the command specifier.

Amount of data bytes	**1**	**2**	**3**	**4**
Command specifier	0x2F	0x2B	0x27	0x23

9.3.3 Error code table

If an error occurs in reading or writing, the server SDO of the frequency inverter replies with the SDO abort message. This message contains the index/subindex and appropriate error code.

Server → Client Abort SDO Transfer

COB-ID	0	1	2	3	4	5	6	7
0x580 + Node-ID	cs	index		sub- index	abort code low		abort code high	
	0x80	LSB	MSB	LSB	MSB	LSB	MSB	00

Error codes			
Abort code high	**Abort code low**	**Description to 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 harware error	- EEPROM Error (Read/write/checksum)
0x0607	0x0010	Data type does not match	- Parameter has a different data type
0x0609	0x0011	Subindex does not exist	- Data set does not exist
0x0609	0x0030	Value range of parameter exceeded	- Parameter value too large or too small
0x0609	0x0031	Value of parameter written too high.	- Parameter value too large
0x0609	0x0032	Value of parameter written too low.	- Parameter value too small
0x0800	0x0020	Data cannot be transmitted or saved	- Invalid value for operation
0x0800	0x0021	Data cannot be transferred because of local control	- parameter cannot be written in operation

9.4 PDO Function

The PDO (Process Data Objects) messages are messages with up to eight bytes of process data. The process data objects are mapped to the Rx/Tx-PDO's with the help of communication objects (communication/mapping parameter). Active Cube inverters support 3 RxPDO's (PLC ➔ inverter) and 3 TxPDO's (inverter ➔ PLC).

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

PDO-message:

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

The number of data bytes is 1 … 8 and depends on the mapped objects. The byte alignment is in Intel format.

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

Default Identifiers:

	Decimal	Hexadecimal
TxPDO1	384 + Node-ID	180 + Node-ID
RxPDO1	512 + Node-ID	200 + Node-ID
TxPDO2	640 + Node-ID	280 + Node-ID
RxPDO2	798 + Node-ID	300 + Node-ID
TxPDO3	896 + Node-ID	380 + Node-ID
RxPDO3	1024 + Node-ID	400 + Node-ID

9.5 Emergency Function

In the event of a communication error or an error inside the inverter, the inverter sends an emergency message. This emergency message includes the relevant error information. After error acknowledgement (fault reset), an emergency message is sent with all data bytes set to zero.

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x80 (=128)+ Node-ID	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 14.4.

9.6 SYNC

The SYNC message has two meanings.

The SYNC message is necessary for Rx/TxPDO with transmission type synchronous. The SYNC message synchronizes the different devices to communicate with data from the same (defined) time. As soon as the SYNC telegram is received, the data of all devices are "frozen" and then exchanged during the following data telegrams.

The RxPDO telegrams are collected until a SYNC telegram is received. With the reception of the SYNC telegram the data are transferred internally to the application parameters.

TxPDOs defined as synchronous send the actual application data on SYNC reception.

The SYNC message is a message with no data or with one byte data which is ignored. The default Identifer = 0x80 (=128).

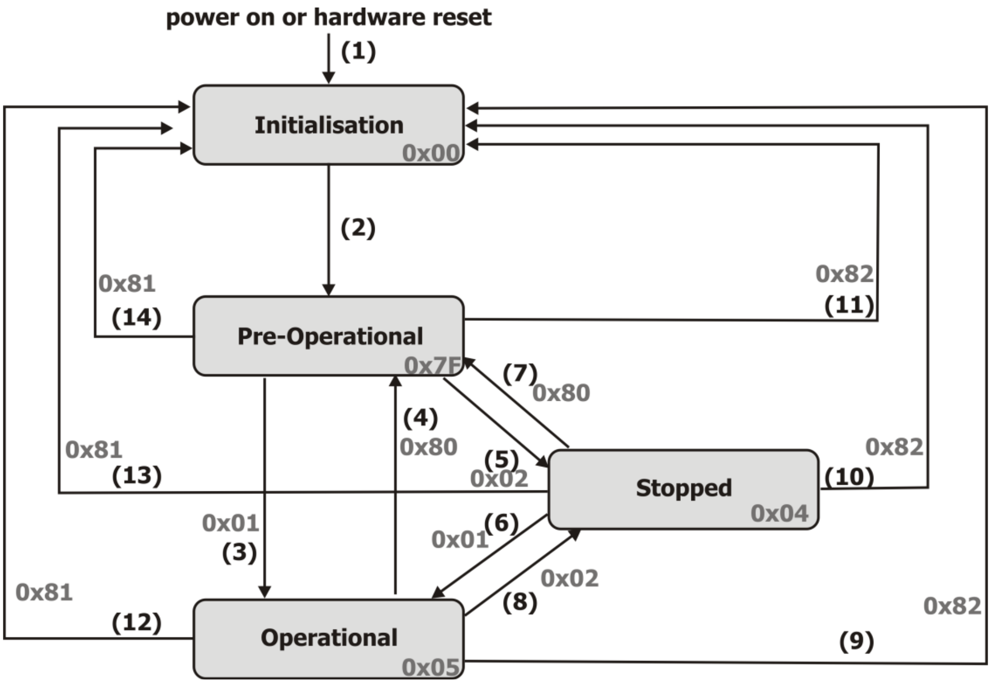
Additionally the SYNC mechanism can be used to synchronize the operating systems (OS) of different drives. This is useful when the electronic gear is used to enhance the performance of the application. The synchronization of the operating systems is described in chapter 9.10.

COB-ID	Byte 0
0x80 (=128)	SYNC

9.7 NMT Functions

The NMT (Network management) functions describe the NMT state machine and NMT error control functions. The NMT state machine is controlled by NMT commands. The error control functions guarding and heartbeat are set up by associated communication objects and controlled by special protocols.
The NMT-State is displayed via the actual value parameter *Node-State* **1290**.

9.7.1 NMT state machine



Note:
A change of NMT-State may also be triggered by a communication (Bus-off, Guarding, etc.). The behavior of the NMT state machine in such a case is described in Chapter 10.2.17 "0x1029/n Error Behavior".

transition	NMT command
(1)	At power on NMT state Initialisation is entered autonomously
(2)	NMT state Initialisation finished → NMT state Pre-Operational entered automatically, device sends Boot-Up message
(3)	Start Remote Node
(4), (7)	Enter Pre-Operational
(5), (8)	Stop Remote Node
(6)	Start Remote Node
(9), (10), (11)	Reset Node. Communication objects 0x1nnn and application objects 0x6nnn are reset.
(12), (13), (14)	Reset Communication. Communication objects 0x1nnn are reset.

In state transition (2) Initialisation ➔ Pre-Operational the device sends the Boot-Up message.

9.7.2 Boot-Up message

Identifier	Byte 0
0x700 (=1792) + Node-ID	0

The Boot-Up message is sent automatically when the device is powered on or reset (i.e. fault reset). This helps the PLC recognizing to switch on a device (i.e. after a power failure and recovery) reliable during operation without Nodeguarding.

If the inverter is switched on after the PLC, the PLC can use this boot-up message to begin the initialization. The boot-up message signals the PLC, that the inverter is ready for the PLC to communicate. Using a NMT telegram "Reset Node" or "Reset Communication" forces a Reset of the node or node communication and results in a Boot-Up message.

9.7.3 NMT commands

	Byte 0	Byte 1
Identifier	Command Specifier	Node-ID
0	cs	id

id = 0	command accepted by **all** devices
id = 1…0x7F (=127)	command accepted by device with Node-ID = id

cs:	1	Start Remote Node
	2	Stop Remote Node
	0x80 (=128)	Enter Pre-Operational
	0x81 (=129)	Reset Node
	0x82 (=130)	Reset Communication

NMT states and active communication objects:

	Pre-Operational	**Operational**	**Stopped**
PDO		**X**	
SDO	**X**	**X**	
SYNC	**X**	**X**	
Emergency	**X**	**X**	
Node control + NMT error control *****	**X**	**X**	**X**

***** NMT commands + Guarding/Heartbeat function

9.8 Guarding

Guarding response:
The inverter responds to every guarding request of the PLC. This is used by some PLCs when powering on to search for available devices. This response is done always independent of the settings of objects 0x100C/0 *Guard Time* and 0x100D/0 *Lifetime Factor.*

Guarding activation:
The Guarding is set whenever objects 0x100C/0 *Guard Time* and 0x100D/0 *Lifetime Factor* are both unequal to zero. The resulting guarding time is *Guard Time* **x** *Lifetime Factor*. Guarding is activated after setting the objects and on reception of the first guarding request.

Guarding fault behavior:
If the inverter does not receive a guarding request within the specified guarding time a guarding event is triggered. The inverter's reaction to this guarding event is defined by objects 0x6007 *abort connection option code* and 0x1029 *error behavior*.

Guarding sequence:
The PLC sends via a RTR (Remote Transmission Request) a guarding request with Identifier 0x700 (= 1792) + Node-ID (no data bytes). This remote frame is answered by the inverter with the same Identifier and one data byte. The data byte contains a toggle bit and the NMT state of the inverter.

PLC:

Identifier	
0x700 (=1792)+ Node-ID	RTR

Inverter:

	Byte 0							
Identifier	NMT state + toggle bit							
0x700 + Node-ID	7	6	5	4	3	2	1	0
	t	NMT state						

t: Toggle bit toggled on each transmission (first transmission t = 0)

NMT state:	0	Boot-Up
	4	Stopped
	5	Operational
	0x7F (=127)	Pre-Operational

9.9 Heartbeat

The heartbeat uses the producer/consumer method. The inverter as heartbeat consumer can monitor up to three heartbeat producers. The inverter can also send the heartbeat message (as heartbeat producer). The heartbeat contains the NMT state of the producer.

The heartbeat consumer function is set by object 0x1016/n *Consumer Heartbeat Time*. After setting the object the Monitoring of the heartbeat message(s) starts with reception of the first heartbeat message.
If the inverter does not receive a producer heartbeat message within the specified consumer heartbeat time, a heartbeat event is triggered. The reaction to this heartbeat event is defined by objects 0x6007 *abort connection option code* and 0x1029 *error behavior*.

The heartbeat producer function is set by object 0x1017 *Producer Heartbeat Time*. If object 0x1017 *Producer Heartbeat Time* is set unequal to zero the inverter sends a heartbeat message periodically.

heartbeat message:

	Byte 0							
Identifier	NMT state							
0x700 (=1792) + Node-ID	7	6	5	4	3	2	1	0
	r	NMT state						

t: reserved (always 0)

NMT state:	0	Boot-Up
	4	Stopped
	5	Operational
	127	Pre-Operational

9.10 OS Synchronization

The operating System (OS) of the frequency inverter can be synchronized to the PLC or other devices. The synchronization of the OS enhances the performance of the complete plant.
Synchronization via CANopen:
When using CANopen without Systembus, the synchronization can be switched on and off. Synchronization can be done with CANopen SYNC telegrams.
Synchronization via Systembus:
When using CANopen simultaneously with Systembus, the synchronization can be set to either CANopen, Systembus or it can be switched off. Synchronization can be done with Systembus SYNC telegrams or Systembus RxPDO telegrams.
Note: When synchronizing the OS via CANopen, the master has to support the synchronization mechanisms of CANopen.

OS_SyncSource **1452**	
Operation mode	**Function**
-1 - off	The OS is not synchronized with other devices.
0 - Auto	The synchronization source is selected automatically by the inverter.
1 - CANopen	The OS is synchronized via CANopen. **Factory setting**.
2 - Systembus	The OS is synchronized via Systembus.

Operation mode **Auto**: The selection is done via this decision table:

CANopen active	Systembus active	Synchronization
Yes	Yes	➔ Synchronization via CANopen
Yes	No	
No	Yes	➔ Synchronization via Systembus
No	No	➔ No Synchronization activated.

The CANopen "active status for synchronization" is recognized by the parameter setting **387** *CAN Node Number* >0 and a running synchronous PDO.
The Systembus "active status for synchronization" is recognized by the parameter setting **900** *Systembus Node ID* >0. Also parameter **1180** *Synchronization* has to be set to SYNC or an RxPDO.
The parameter **1451** *CANopen 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.**	**Fact. sett.**
1451	CANopen OS Synctime	700 us	900 us	800 us

Please refer to objects 0x1005 COB-ID SYNC object, 0x1006 Communication cycle period and 0x1007 Synchronous window length for CANopen Synchronizsation.

1453 *OS SyncSource Act* shows the active Synchronization source

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
852- SysBus SYNC time [us]	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.
854- B: Sync. OS <-> CANopen Ok	1 = Synchronization OS to CANopen OK, 0 = Synchronization OS to CANopen not OK
848- CANopen SYNC time [us]	Shows the Synchronization cycle. Should show the set SYNC time of object 0x1006.
849- CANopen SYNC position 1ms Task [us]	Shows the Synchronization time inside 1 ms. Should remain constant with small fluctuations.

10 Objects

The available objects are marked via Index/Subindex and are to be addressed via this identification. This chapter describes all available objects.

10.1 Objects tabular overview

The objects are displayed in the next tables. The following definitions apply:

Access type			
Read only	The PLC is only allowed to read the data from the ACU.		
Read/write	The PLC is granted full access (read and write) to the ACU data.		
Data type			
Unsigned32	32 Bit-Wert:	0…2^{32}-1 0…0xFFFF FFFF	
Unsigned16	16 Bit-Wert:	0…2^{16}-1 0…0x FFFF	(0…65535)
Unsigned8	8 Bit-Wert:	0…2^{8}-1 0…0xFF	(0…255)
Integer32	Signed 32 Bit-Wert:	-2^{31}…2^{31}-1 0x8000 0000…0x7FFF FFFF	
Integer16	Signed 16 Bit-Wert: -	2^{15}…2^{15}-1 0x8000…0x7FFF	(-32768…32767)
Integer8	Signed 8 Bit-Wert: -	2^{7}…2^{7}-1 0x80…0x7F	(-128…127)
PDO mapping			
No	This object cannot be used for PDO exchange, only SDO is applicable.		
Tx	This object can be transmitted as PDO from ACU.		
Rx	This object can be transmitted as PDO to ACU.		

Note:
"Highest Sub-index supported" displays the highest Sub-index that is supported by this object.

10.1.1 Communication objects

Index	SubIndex	Name	SDO Access	Data type	PDO-mapping
0x1000	0	Device type	Read only	Unsigned32	No
0x1001	0	Error register	Read only	Unsigned8	No
0x1005	0	COB-ID SYNC object	Read/write	Unsigned32	No
0x1006	0	Communication cycle period	Read/write	Unsigned32	No
0x1007	0	Synchronous window length	Read/write	Unsigned32	No
0x1008	0	Manufacturer device name	Read only	Visible string	No
0x1009	0	Manufacturer hardware version	Read only	Visible string	No
0x100A	0	Manufacturer software version	Read only	Visible string	No
0x100C	0	Guard time	Read/write	Unsigned16	No
0x100D	0	Life time factor	Read/write	Unsigned8	No
0x1010	0	Store parameters Highest sub-index supported	Read only	Unsigned8	No
	1	Save all parameters	Read/write	Unsigned32	No
	2	Save communication parameters	Read/write	Unsigned32	No
	3	Save application parameters	Read/write	Unsigned32	No

Index	SubIndex	Name	SDO Access	Data type	PDO-mapping
0x1011	0	Restore default parameters 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
0x1014	0	COB-ID emergency object	Read/write	Unsigned32	No
0x1016	0	Consumer heartbeat time Highest sub-index supported	Read only	Unsigned8	No
	1	Consumer heartbeat time 1	Read/write	Unsigned32	No
	2	Consumer heartbeat time 2	Read/write	Unsigned32	No
	3	Consumer heartbeat time 3	Read/write	Unsigned32	No
0x1017	0	Producer heartbeat time	Read/write	Unsigned16	No
0x1018	0	Identity object 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
	4	Serial number	Read only	Unsigned32	No
0x1029	0	Error behavior	Read only	Unsigned8	No
	1	Communication error	Read/write	Unsigned8	No
0x1200	0	Server SDO parameter	Read only	Unsigned8	
	1	COB-ID Rx	Read only	Unsigned32	No
	2	COB-ID Tx	Read only	Unsigned32	No
0x1400	0	RxPDO1 communication parameter Highest sub-index supported	Read only	Unsigned8	No
	1	COB-ID	Read/write	Unsigned32	No
	2	Transmission type	Read/write	Unsigned8	No
	3	Inhibit time		Unsigned16	No
	4	-	-	-	No
	5	Event time	Read/write	Unsigned16	No
0x1401	0	RxPDO2 communication parameter Highest sub-index supported	Read only	Unsigned8	No
	1	COB-ID	Read/write	Unsigned32	No
	2	Transmission type	Read/write	Unsigned8	No
	3	Inhibit time		Unsigned16	No
	4	-	-	-	No
	5	Event time	Read/write	Unsigned16	No
0x1402	0	RxPDO3 communication parameter Highest sub-index supported	Read only	Unsigned8	No
	1	COB-ID	Read/write	Unsigned32	No
	2	Transmission type	Read/write	Unsigned8	No
	3	Inhibit time		Unsigned16	No
	4	-	-	-	No
	5	Event time	Read/write	Unsigned16	No
0x1600	0	RxPDO1 mapping parameter 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

0x1601	0	RxPDO2 mapping parameter 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
0x1602	0	RxPDO3 mapping parameter 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
0x1800	0	TxPDO1 communication parameter Highest sub-index supported	Read only	Unsigned8	No
	1	COB-ID	Read/write	Unsigned32	No
	2	Transmission type	Read/write	Unsigned8	No
	3	Inhibit time		Unsigned16	No
	4	-	-	-	No
	5	Event time	Read/write	Unsigned16	No
0x1801	0	TxPDO2 communication parameter Highest sub-index supported	Read only	Unsigned8	No
	1	COB-ID	Read/write	Unsigned32	No
	2	Transmission type	Read/write	Unsigned8	No
	3	Inhibit time	Read/write	Unsigned16	No
	4	-	-	-	No
	5	Event time	Read/write	Unsigned16	No
0x1802	0	TxPDO3 communication parameter Highest sub-index supported	Read only	Unsigned8	No
	1	COB-ID	Read/write	Unsigned32	No
	2	Transmission type	Read/write	Unsigned8	No
	3	-inhibit time	Read/write	Unsigned16	No
	4	-	-	-	No
	5	Event time	Read/write	Unsigned16	No
0x1A00	0	TxPDO1 mapping parameter 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
0x1A01	0	TxPDO2 mapping parameter 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

0x1A02	0	TxPDO3 mapping parameter 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

10.1.2 Manufacturer objects

Index	SubIndex	Name	SDO Access	Data type	PDO-mapping
0x2nnn	0, 1, … 9	Manufacturer specific Direct access to inverter parameters Read/write access by SDO transfer only			
0x3000	0	Sync Jitter	Read/write	Unsigned16	No
0x3001	0	Digital In actual values	Read only	Unsigned16	Tx
0x3002	0	Digital Out actual values	Read only	Unsigned16	Tx
0x3003	0	Digital Out set values	Read/write	Unsigned8	Rx
0x3004	0	Boolean Mux	Read only	Unsigned16	Tx
0x3005	0	Boolean Demux	Read/write	Unsigned16	Rx
0x3006	0	Percentage set value	Read/write	Unsigned16	Rx
0x3007	0	Percentage actual value	Read/write	Unsigned16	Tx
0x5FF0	0	Active motion block	Read only	Unsigned8	Tx
0x5FF1	0	Motion block to resume	Read only	Unsigned8	Tx

10.1.3 Device profile objects

Index	Sub-Index	Name	SDO Access	Data type	PDO-mapping	Factory setting	Min…Max	Corresp. param.
0x6007	0	Abort connection option code	Read/write	Integer16	No	1	-2…3	p.388
0x603F	0	Error code	Read only	Unsigned16	No	-	-	-
0x6040	0	controlword	Read/write	Unsigned16	Rx	-	-	p.410
0x6041	0	statusword	Read/only	Unsigned16	Tx	-	-	p.411
0x6042	0	Target velocity	Read/write	Interger16	Rx	0	-32768… 32767	-
0x6043	0	Target velocity demand	Read only	Integer16	Tx	-	-	-
0x6044	0	Control effort	Read only	Integer16	Tx	-	-	-
0x6046		Velocity min max						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Velocity min amount	Read/write	Unsigned32	No	0	0…32767	p.418
	2	Velocity max amount	Read/write	Unsigned32	No	32767	0…32767	p.419
0x6048		Velocity acceleration				-	-	-
	0	Highest sub-index supported	Read only	Unsigned8	No			
	1	Delta speed	Read/write	Unsigned32	No	150	1…32767	p.420
	2	Delta time	Read/write	Unsigned16	No	1	1…65535	p.422
0x6049		Velocity deceleration						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Delta speed	Read/write	Unsigned32	No	150	1…32767	p.421
	2	Delta time	Read/write	Unsigned16	No	1	1…65535	p.423
0x604A		Velocity quick stop						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Delta speed	Read/write	Unsigned32	No	150	1…32767	p.421
	2	Delta time	Read/write	Unsigned16	No	1	1…65535	p.423
0x6060	0	Modes of operation	Write only	Integer8	Rx	2	-1…7	-
0x6061	0	Modes of operation display	Read only	Integer8	Tx	2	-	-
0x6064	0	Position actual value	Read only	Integer32	Tx	-	0x8000.0000 … 0x7FFF.FFFF	p.1108
0x6065	0	Following error window	Read/write	Unsigned32	No	0xFFFF.FFFF	0… 0xFFFF.FFFF	p.1105
0x6066	0	Following error time out	Read/write	Unsigned16	No	10	0…65535	p.1119
0x6067	0	Position window	Read/write	Unsigned32	No	0xFFFF.FFFF	0… 0xFFFF.FFFF	p.1165
0x6068	0	Position window time	Read/write	Unsigned16	No	10	0…65535	p.1166
0x6071	0	Target torque	Read/write	Integer16	Rx			-
0x6077	0	Torque actual value	Read only	Integer16	Tx			p.224
0x6078	0	Current actual value	Read only	Integer16	Tx			p.214
0x6079	0	DClink circuit voltage	Read only	Integer32	Tx			p.222
0x607A	0	Target position	Read/write	Integer32	Rx	0	0x8000.0000 … 0x7FFF.FFFF	p.1202
0x607C	0	Home offset	Read/write	Integer32	No	0	0x8000.0000 … 0x7FFF.FFFF	p.1131

Index	Sub-Index	Name	Access type	Data type	PDO-mapping	Factory setting	Min...max	Corresp. param.
0x6081	0	Profile velocity	Read/write	Unsigned32	Rx	0x0005.0000	1... 0x7FFF.FFFF	p.1203
0x6083	0	Profile acceleration	Read/write	Unsigned32	Rx	0x0005.0000	1... 0x7FFF.FFFF	p.1204
0x6084	0	Profile deceleration	Read/write	Unsigned32	Rx	0x0005.0000	1... 0x7FFF.FFFF	p.1206
0x6085	0	Quick stop deceleration	Read/write	Unsigned32	No	0x000A.0000	1... 0x7FFF.FFFF	p.1179
0x6086	0	Motion profile type	Read/write	Integer16	No	3	0...3	-
0x6091		Gear ratio						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Motor revolutions	Read/write	Unsigned32	No	1	1...65535	p.1116
	2	(Driving) Shaft revolutions	Read/write	Unsigned32	No	1	1...65535	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	
0x6098	0	Homing method	Read/write	Integer8	No	0	0...35	p.1130
0x6099		Homing speeds						
	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
0x609A	0	Homing acceleration	Read/write	Unsigned32	No	0x0005.0000	1... 0x7FFF.FFFF	p.1134
0x60C1		Interpolation data record						
	0	Highest sub-index supported	Read only	Unsigned8	No	-	-	-
	1	Interpolation data record 1	Read/write	Integer32	Rx	0	0x8000.0000 ... 0x7FFF.FFFF	
0x60F4	0	Following error actual value	Read only	Integer32	Tx			p.1109

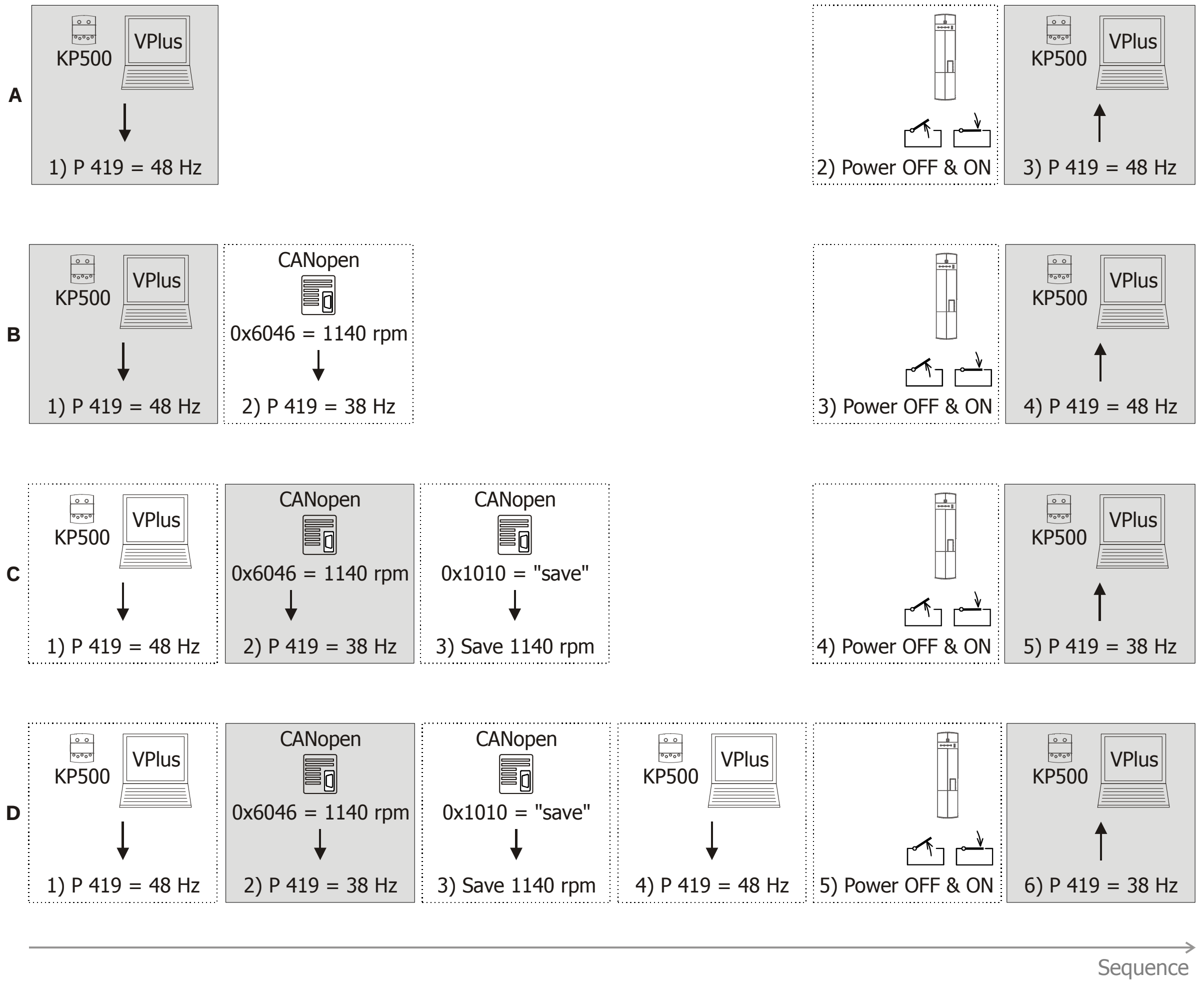
Note:
The notations of CANopen® objects and parameters can be different (refer to the corresponding object description).

Attention!
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 0x1010), 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)
(sequences of writing parameters and objects, examples)



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 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).

Attention!
There are inverter parameters calculated from CANopen® objects which require the no. of pole pairs for calculating the corresponding value for inverter parameters (e. g. deceleration or acceleration parameters). These calculations always use the no. of pole pairs from data set 1. If the no. of pole pairs is different in the data sets, the result of this operation will not be clear for the user. To avoid confusion it is recommended to write the inverter parameters via the SDO channel using the 0x2nnn (manufacturer) objects and not to use the CANopen® objects. This way, inconsistencies are avoided.

All CANopen® objects with corresponding inverter parameters described in this manual have a special information "**Note**".

10.2 Communication Objects (0x1nnn)

The communication objects 0x1nnn contain all parameters for the communication.
Note: For easier usage, the objects are summarized by a table in each paragraph. This table is marked additional by color.

Orange color	= Read Only object
Green color	= Read and Write object
Blue color	= Write only object

Used abbreviations:

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

The Examples show some typical data telegrams, which could be observed or used with a CAN analyzing tool. The order displayed in the examples is the standard CANopen® format, lowest byte left, highest byte right.

10.2.1 0x1000/0 Device Type

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1000	0	Device Type	Unsigned 32	ro	No	0

The device identification is carried out during the start of the network. The information on the device type and the functionality (type) are prescribed by the CANopen® standards.

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

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

Device Profile Number	= 402	drives and motion control
Type	= 1	frequency converter
Type	= 2	servo drive
Mode bits	= 0	unused

Note:
"Type" depends on the setting of parameter *Configuration* **30**.

A motion control configuration (*Configuration* **30** = x**40**) sets type = 2 "servo drive". Other configurations set type = 1 "frequency converter".

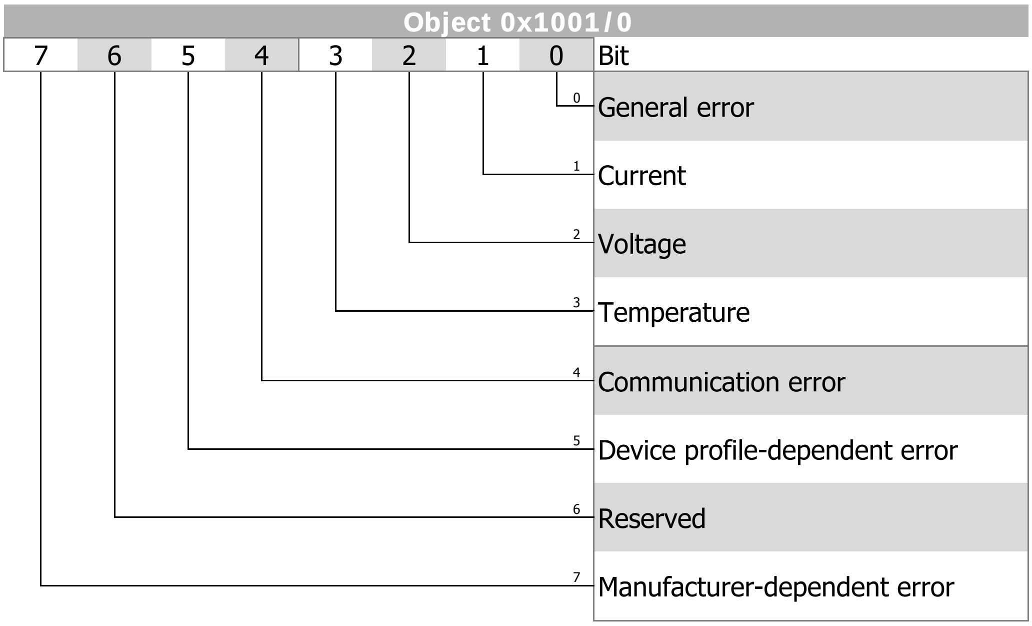
Example:					
	COB ID	CB	Index	SI	Data
Read Request	**601**	40	00 10	00	00 00 00 00
Reply	**581**	43	00 10	00	92 01 41 00

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

10.2.2 0x1001/0 Error Register

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1001	0	Error Register	Unsigned 8	ro	No	0

Object 0x1001/0 is the error register for internal errors of the frequency inverter. The status error-free (0x1001/0 = 0) or error exists (0x1001/0 ≠ 0) is displayed.



Object 0x1001/0	
Bit	
0	General error
1	Current
2	Voltage
3	Temperature
4	Communication error
5	Device profile-dependent error
6	Reserved
7	Manufacturer-dependent error

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	01 10	00	00 00 00 00
Reply	581	4F	01 10	00	00 01 41 00

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

10.2.3 0x1005/0 COB-ID SYNC Message

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1005	0	COB-ID SYNC Message	Unsigned 32	r/w	No	0

Object 0x1005 *COB-ID SYNC message* defines the identifier for the SYNC message as well as whether the CANopen® device generates the SYNC.

The default value of this object is 128 (identifier = 128, SYNC message not generated).

Object 0x1005/0				
Bit 31	Bit 30	Bit 29	Bit 11 ... 28	Bit 0 … 10
X	gen	frame	**0**	11 bit CAN-ID

Bit 31:	X = don't care
Bit 30:	0 = SYNC message not generated 1 = SYNC message generated
Bit 29:	0 = 11 bit ID 1 = 29 bit ID **NOT ALLOWED**
Bit 0 … 10:	11 bit CAN-ID

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	05 10	00	00 00 00 00
Reply	581	43	05 10	00	80 00 00 00
Write Access	601	23	05 10	00	81 00 00 00
Reply	581	60	05 10	00	00 00 00 00

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

10.2.4 0x1006/0 Communication Cycle Period

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1006	0	Communication Cycle Period	Unsigned 32	r/w	No	0

The *communication cycle period* is the time distance between two consecutive SYNC messages. The SYNC message is used by the inverter for synchronisation of the motion control system to the SYNC message. This is especially important for the interpolated position mode.

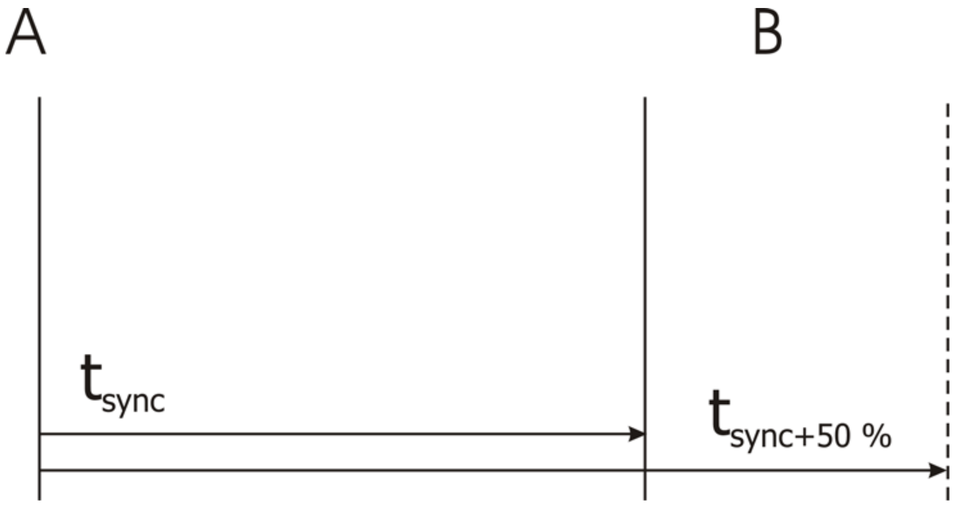
The value for *communication cycle period* is given in multiples of micro seconds. Values smaller than 20000 (20 ms) are allowed.

The synchronization of the inverter to an external clock has to be met under the condition, that at least one RxPDO or TxPDO is defined as synchronous object and is activated. The definitions of the TxPDO / RxPDO objects can be changed via objects 0x1400 / 0x1800.

Note:
The inverter can only process the SYNC mechanism in multiples of milliseconds. For this reason the allowed values for object 0x1006/0 *communication cycle period* are multiples of milliseconds.

E.g.: 0x1006/0 = 4000 = 4 ms

If the *communication cycle period* is NOT set (0x1006/0 = 0), the inverter measures the time distance between the SYNC messages over the first 11 messages. Please note, that the monitoring function is deactivated for setting "0". The measurement is solely for internal uses of the frequency inverter. The time must not change after the measreument.



Note:
The time distance between two consecutive SYNC messages is monitored.
If object 0x1006/0 *communication cycle period* is set to a value other than zero, then a communication error event is triggered whenever the time defined by 0x1006/0 is exceeded by more than 50%.

After SYNC telegram "A", SYNC telegram "B" has to be received latest after the set SYNC time + 50 %.

If object 0x1006/0 *communication cycle period* is not set (= zero), then this monitoring function is **not** active.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	06 10	00	00 00 00 00
Reply	581	43	06 10	00	00 00 00 00
Write Access	601	23	06 10	00	A0 0F 00 00
Reply	581	60	06 10	00	00 00 00 00

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

10.2.5 0x1007/0 Synchronous window length

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1007	0	Synchronous window length	Unsigned 32	r/w	No	See Text

Synchronous window length is the time span after a SYNC message in which the inverter is supposed to update its data from receive PDOs and to send transmit PDOs. If either of these actions is not possible in the specified time an emergency message is sent and all remaining synchronous PDOs are discarded until the next SYNC message.

The value for *synchronous window length* is given in multiples of micro seconds.
E.g.: 0x1007/0 = 2000 = 2 ms

Note:
If object 0x1007/0 *synchronous window length* is not set (= zero), then this monitoring function is **not** active.

To avoid unnecessary bus load, the emergency message is sent once only. The next emergency message concerning this problem will be sent after the successful processing of all synchronous PDOs within the *synchronous window length* and a new violation of *synchronous window length*.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	07 10	00	00 00 00 00
Reply	581	43	07 10	00	00 00 00 00
Write Access	601	23	07 10	00	D0 07 00 00
Reply	581	60	07 10	00	00 00 00 00

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

10.2.6 0x1008/0 Manufacturer Device Name

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
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**"

The object 0x1008/0 supports the segmented SDO transfer.

10.2.7 0x1009/0 Manufacturer Hardware Version

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
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**"

The object 0x1009/0 supports the segmented SDO transfer.

10.2.8 0x100A/0 Manufacturer Software Version

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x100A	0	Manufacturer Software version	Visible string	ro	No	See Text

The software version is displayed as a sequence of ASCII characters.
Example : "**5.1.2**"

The object 0x100A/0 supports the segmented SDO transfer.

10.2.9 0x100C/0 Guard Time

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x100C	0	Guard time	Unsigned 16	r/w	No	0

The response monitoring time is calculated by the multiplication of the objects g*uard time* and *lifetime factor*. Object 0x100C/0 defines the *guard time* in units of one millisecond. *Guard time* = 0 deactivates the guarding function.
If the response monitoring time is exceeded, the node reacts as defined by the setting of object 0x6007 *abort connection option code*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	0C 10	00	00 00
Reply	581	4B	0C 10	00	00 00
Write Access	601	2B	0C 10	00	D0 07
Reply	581	60	0C 10	00	00 00

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

10.2.10 0x100D/0 Lifetime Factor

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x100D	0	Lifetime factor	Unsigned 8	r/w	No	0

The object "Lifetime Factor" is the multiplier for *guard time. Lifetime factor* = 0 deactivates the guarding function.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	0D 10	00	00
Reply	581	4F	0D 10	00	00
Write Access	601	2F	0D 10	00	05
Reply	581	60	0D 10	00	00

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

10.2.11 0x1010/n Store Parameters

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
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 3 sub-indexes with different functions.

Writing “save” to 0x1010/3 stores all application parameters (0x6nnn) to non-volatile memory.

Specification of write “save” command

LSB			**MSB**
“s”	**“a”**	**“v”**	**“e”**
0x73	0x61	0x76	0x65

Note:
Writing a value other than "save" results in an SDO abort. The store command is **not** processed.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	10 10	01	00 00 00 00
Reply	581	43	10 10	01	01 00 00 00
Write Access	601	23	10 10	01	73 61 76 65
Reply	581	60	10 10	01	00 00 00 00

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

10.2.12 0x1011/n Restore default Parameters

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1011	0	Highest sub-index supported	Unsigned8	ro	No	3
	1	Restore all parameters	Unsigned32	r/w	No	See text
	2	Restore communication parameters	Unsigned32	r/w	No	See text
	3	Restore application parameters	Unsigned32	r/w	No	See text

With object 0x1011/n parameters/objects can be set to their default values. This object supports 3 sub-indexes with different functions.

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

Specification of write "load" command

LSB			MSB
"l"	**"o"**	**"a"**	**"d"**
0x6C	0x6F	0x61	0x64

Note:
Writing a value other than "load" results in an SDO abort. The restore defaults command is **not** processed.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	11 10	01	00 00 00 00
Reply	581	43	11 10	01	01 00 00 00
Write Access	601	23	11 10	01	6C 6F 61 64
Reply	581	60	11 10	01	00 00 00 00

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

10.2.13 0x1014/0 COB-ID Emergency Message

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1014	0	COB-ID Emergency Message	Unsigned32	r/w	No	See text

The identifier and thus the definition of the priority for the emergency message can be set with object 0x1014/0.

The default value of the identifier is 128 + Node ID (valid).

Object 0x1014/0				
Bit 31	Bit 30	Bit 29	Bit 11 **...** 28	Bit 0 … 10
valid	**0**	frame	**0**	11 bit CAN-ID

Bit 31: 0 = EMCY existent / valid
1 = EMCY non-existent / not valid

Bit 29: 0 = 11 Bit ID
1 = 29 Bit ID **NOT ALLOWED**

Bit 0 … 10: 11 bit CAN-ID

The emergency message is transmitted with the emergency message COB-ID and comprises eight bytes. This object is generated in individual cases and the fault acknowledgement signaled by an emergency message with the data contents equal to zero. The contents are coded according to the following table:

Emergency Message	
Byte	**Contents**
0	Low-byte error code (0x603F)
1	High-byte error code (0x603F)
2	Error register (0x1001)
3	**0**
4	**0**
5	**0**
6	Low-byte, internal error code
7	High-byte, internal error code

Bytes 0, 1 and 2 have a fixed definition within the emergency object. Bytes 6 and 7 are used product-specifically on the basis of the specification.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	14 10	00	00 00 00 00
Reply	581	43	14 10	00	81 00 00 00
Write Access	601	23	14 10	00	81 00 00 00
Reply	581	60	14 10	00	00 00 00 00

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

10.2.14 0x1016/n Consumer Heartbeat Time

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1016	0	Highest sub-index supported	Unsigned8	ro	No	3
	1	Consumer Heartbeat Time 1	Unsigned32	r/w	No	See text
	2	Consumer Heartbeat Time 2	Unsigned32	r/w	No	See text
	3	Consumer Heartbeat Time 3	Unsigned32	r/w	No	See text

Up to three heartbeat producers can be monitored with object 0x1016/n (controlled via sub-indexes n = 1 ... 3). Setting "Consumer Heartbeat Time" = 0 means no monitoring.

Node ID identifies the device to be monitored. The *Heartbeat Time* states the maximum time in milliseconds between two heartbeat messages of the heartbeat producer to be monitored. If this time is exceeded, the monitoring node reacts as defined by the setting of object 0x6007 *abort connection option code*.

Value of the consumer heartbeat time		
Bit 24 to Bit 31	Bit 16 to Bit 23	Bits 0 to Bit 15
not used	Node ID	Heartbeat Time

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	16 10	01	00 00 00 00
Reply	581	43	16 10	01	02 00 00 00
Write Access	601	23	16 10	01	20 00 03 00
Reply	581	60	16 10	01	00 00 00 00

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

10.2.15 0x1017/0 Producer Heartbeat Time

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1017	0	Producer Heartbeat Time	Unsigned16	r/w	No	0 ms

The time for the transmission of a heartbeat object is set with object 0x1017/0. The setting "Producer Heartbeat Time" = 0 means that no heartbeat object is transmitted.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	17 10	00	00 00
Reply	581	4B	17 10	00	00 00
Write Access	601	23	17 10	00	20 00
Reply	581	60	17 10	00	00 00

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

10.2.16 0x1018/n Identity Object

The identity object provides information on the device manufacturer as well as the device itself.

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
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

The vendor ID "**0xD5**" identifies the manufacturer **Bonfiglioli Vectron GmbH.** This vendor ID has been assigned by the CANopen® users' organization "CAN in Automation" (CiA®) in Erlangen/Germany (*www.can-cia.org*).

Product code displays the inverter's type code.
Revision number displays the inverter's CANopen® system revision.
Serial number displays the inverter's serial number.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	18 10	01	00 00 00 00
Reply	581	43	18 10	01	05 00 00 00

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

10.2.17 0x1029/n Error Behavior

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1029	0	Highest sub-index supported	Unsigned8	ro	No	1
	1	Communication error	Unsigned8	r/w	No	0

The Error Behavior object defines the behavior of the NMT state machine in the event of a communication error (BusOff, Guarding, Heartbeat, SYNC, RxPDO-length).

Value	Function
0	Change to NMT state Pre-Operational (default) (only if currently in NMT state Operational)
1	No change of NMT state
2	Change to NMT state Stopped

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	29 10	01	00 00 00 00
Reply	581	43	29 10	01	05 00 00 00

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

10.2.18 0x1200/n SDO Server Parameter

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1200	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	COB-ID client → server (Rx)	Unsigned32	ro	No	See text
	2	COB-ID server → client (Tx)	Unsigned32	ro	No	See text

Object 0x1200 defines the SDO server parameters. The values are read-only and pre defined according to the device node address.

COB-ID client → server (Rx) = 1536 + node address

COB-ID server → client (Tx) = 1408 + node address

Object 0x1200/1, 2				
Bit 31	Bit 30	Bit 29	Bit 11 ... 28	Bit 0 … 10
valid	**0**	frame	**0**	11 bit CAN-ID

Bit 31: **0** = SDO existent / valid

Bit 29: **0** = 11 Bit ID

Bit 0 … 10: 11 bit CAN-ID

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	00 12	02	00 00 00 00
Reply	581	43	00 12	02	01 06 00 00

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

10.2.19 0x1400/n, 0x1401/n, 0x1402/n RxPDO Communication Parameters

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1400 0x1401 0x1402	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	COB ID	Unsigned32	rw	No	See text
	2	Transmission type	Unsigned8	rw	No	See text
	3	Inhibit time	Unsigned16	rw	No	See text
	4	-	-	-	-	-
	5	Event time	Unsigned16	rw	No	See text

RxPDO Communication parameters:

0x1400/n RxPDO1	COB-ID Default value: 0x200 (=512) +Node ID
0x1401/n RxPDO2	COB-ID Default value: 0x300 (=768) +Node ID
0x1402/n RxPDO3	COB-ID Default value: 0x400 (=1024) +Node ID

These communication parameters define the COB-ID and transmission type used by the RxPDOs. Only sub-index 1,2 and 5 are used for RxPDOs. The default setting for the used COB-ID depends on the Node ID and can be changed. The default value for transmission type is 255 (event driven) and can also be changed (see table).

Object 0x1400/0x1401/0x1402 COB-ID				
Bit 31	Bit 30	Bit 29	Bit 11 ... 28	Bit 0 … 10
valid	**0**	frame	**0**	11 bit CAN-ID

Bit 31: 0 = PDO existent/valid
1 = PDO non-existent/not valid

Bit 29: 0 = 11 Bit ID
1 = 29 Bit ID **NOT ALLOWED**

Bit 0 … 10: 11 bit CAN-ID

RxPDO1 factory setting = valid
RxPDO2/3 factory setting = not valid

Object 0x1400/0x1401/0x1402 transmission type		
value	**meaning**	**description**
0	synchronous	Update RxPDO data on **each** SYNC
1 … 240	synchronous	Update RxPDO data on **each** SYNC
~~241 … 251~~	reserved	Value not allowed
~~252~~	synchronous/RTR	Value not allowed
~~253~~	asynchronous/RTR	Value not allowed
254	asynchronous	Event driven (manufacturer specific)
255	asynchronous	Event driven (profile specific) **default value**

Values 254 & 255 are handled identically. Update RxPDO data on each Rx.

Inhibit time:
The inhibit time for RxPDO is without function. Values can be entered, but are without further function.

Event time:
The event time is used as monitoring function for RxPDO's. If during the set time no RxPDO is received, one of the following faults is triggered:
202A Fault RxPDO1
202B Fault RxPDO2
202C Fault RxPDO3

Example*:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	00 14	02	00
Reply	581	4F	00 14	02	FF
Read Request	601	40	00 14	01	00
Reply	581	4F	00 14	01	01 02 00 00
Write Access	601	23	00 14	01	01 02 00 80
Reply *	581	60	00 14	01	00 00 00 00
Write Access	601	2F	00 14	02	05
Reply *	581	60	00 14	02	00
Write Access	601	23	00 14	01	01 02 00 00
Reply *	581	60	00 14	01	00 00 00 00

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

* Note, that Object 1400/1 Highest has to be deactivated first for the correct Write access for Object 1400/2.

10.2.20 0x1600/n, 0x1601/n, 0x1602 RxPDO Mapping Parameters

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

RxPDO Mapping parameters:
0x1600/n RxPDO1
0x1601/n RxPDO2
0x1602/n RxPDO3

0x1600/0 = 0 = no objects mapped

0x1600/0 = 1 … 8 = 1 … 8 objects mapped

Mapping entry:

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

Examples:

Mapping of 0x6040/0 *controlword* (unsigned16 = 10_{hex}) to 1st mapped object in RxPDO1:

0x1600/1 = 0x60400010

Mapping of 0x60C1/1 *interpolation data record 1* (integer32 = 20_{hex}) to 2nd mapped object in RxPDO1:

0x1600/2 = 0x60C10120

Refer to chapter 10.1 for a tabular overview of all objects and their corresponding data types.

Default mapping

RxPDO1	0x1600/0	0x1600/1	0x1600/2	0x1600/3…8
	2	0x6040 controlword	0x6042 target velocity	0x00000000
RxPDO2	0x1601/0			
	0	No mapping		
RxPDO3	0x1602/0			
	0	No mapping		

Example*:

	COB ID	CB	Index	SI	Data
Read Request	601	40	00 16	01	00 00 00 00
Reply	581	43	00 16	01	10 00 40 60
Write Access	601	2F	00 16	00	00
Reply *	581	60	00 16	00	00 00

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

* Note, that Object 1400/1 Highest bit has to be deactivated first for the correct Write access for Object 1600/n. See also the Mapping sequence described in the following.

Mapping Sequence

The mapping sequence requires five steps:

Step 1: Set PDO to "not valid" (0x1400, Subindex 1, Bit 31 = 1)

Step 2: Set sub index 0 to 0 (deactivate current mapping, 0x1600, Sub index 0 = 0)

Step 3: Set sub index 1 … n to the new objects (0x1600, Subindex 1..n = new object)

Step 4: Set sub index 0 to the number of mapped objects (activate new mapping, 0x1600, Subindex 0 = n)

Step 5: Set PDO valid (0x1400, Subindex 1, Bit 31 = 0)

TxPDO 0x1600 is used exemplary above. The same procedure applies to 0x1601 and 0x1602. In these cases, 0x1400 has to be substituted accordingly with 0x1401 or 0x1402.

Example (Node ID = 1):

	COB ID	Control byte	Index	Subindex	Data	Data
			LSB MSB	Subindex	LSB …	… MSB
Step 1:	601	23	00 14	01	01 02	00 80
Response	581	60	00 14	01	00 00	00 00
Step 2:	601	2F	00 16	00	00	
Response	581	60	00 16	00	00	
Step 3.1:	601	23	00 16	01	10 00	42 60
Response	581	60	00 16	01	00 00	00 00
Step 3.2	601	23	00 16	02	10 00	40 60
Response	581	60	00 16	02	00 00	00 00
Step 3.3	601	23	00 16	03	08 00	60 60
Response	581	60	00 16	03	00 00	00 00
Step 4:	601	2F	00 16	00	03	
Response	581	60	00 16	00	00	
Step 5:	601	23	00 14	01	01 02	00 00
Response	581	60	00 14	01	00 00	00 00

Resulting mapping

Target velocity (0x6042)	Control word (0x6040)	Modes of operation (0x6060)
00 00	00 00	00

This example shows the necessary telegrams with the according responses of the device.
The mapping is only stored in RAM and therefore are lost after a power restart. To store the mapping into EEPROM (power-fail safe) refer to chapter 10.2.11.

Note:
The number of mappable objects depends on the object's length.
The maximum number of bytes that can be mapped is 8.

10.2.21 0x1800/n, 0x1801/n, 0x1802/n TxPDO Communication Parameters

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x1800 0x1801 0x1802	0	Highest sub-index supported	Unsigned8	ro	No	5
	1	COB ID	Unsigned32	rw	No	See text
	2	Transmission type	Unsigned8	rw	No	255
	3	Inhibit time	Unsigned16	rw	No	See text
	4	-	-	-	-	-
	5	Event time	Unsigned16	rw	No	See text

TxPDO Communication parameters:

0x1800/n TxPDO1	COB-ID Default value: 0x180 (=384) +Node ID
0x1801/n TxPDO2	COB-ID Default value: 0x280 (=640) +Node ID
0x1802/n TxPDO3	COB-ID Default value: 0x380 (=896) +Node ID

These communication parameters define the COB-ID and transmission type used by the TxPDOs. The default setting for the COB-ID depends on the Node ID and can be changed. The default value for the transmission type is 255 (event driven) and can also be changed (see table).

Object 0x1800/0x1801//1802 COB-ID				
Bit 31	Bit 30	Bit 29	Bit 11 ... 28	Bit 0 … 10
valid	**0**	frame	**0**	11 bit CAN-ID

Bit 31: 0 = PDO existent / valid
1 = PDO non-existent / not valid

Bit 29: 0 = 11 Bit ID
1 = 29 Bit ID **NOT ALLOWED**

Bit 0 … 10: 11 bit CAN-ID

TxPDO1 factory setting = valid
TxPDO2/3 factory setting = not valid

Object 0x1800/0x1801/0x1802 transmission type		
value	**meaning**	**description**
0	Synchronous	Update TxPDO data and send on SYNC **only** when data has changed
1 … 240	Synchronous	Update TxPDO data and send on **each** "n" SYNC
~~241 … 251~~	Reserved	Value not allowed
252	synchronous/RTR	Update TxPDO data on SYNC and send **on following** RTR
253	asynchronous/RTR	Update TxPDO data and send on RTR
254	asynchronous	Event driven (manufacturer specific)
255	asynchronous	Event driven (profile specific) **default value**

Values 254 + 255 are handled identically. Send TxPDO on data change or event time.

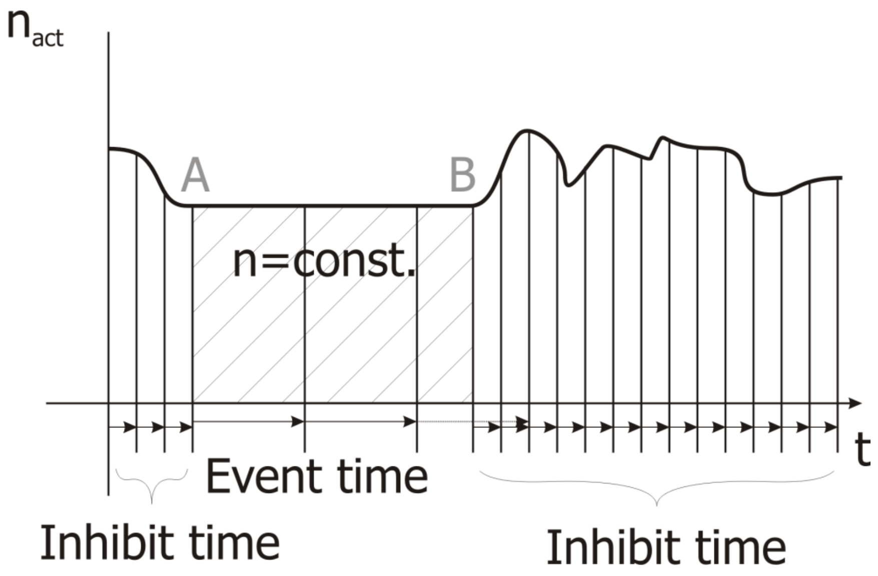
Inhibit time: The inhibit time is the minimum time distance between two consecutive TxPDOs for asynchronous TxPDOs. During the inhibit time, the TxPDO is not send again. Therefore a value change occurring in this time is send earliest after the inhibit time has elapsed. The value range is 0…65535.
The inhibit time is set in hundreds of microseconds, e. g. a value of 300 is 300 *100 us = 30 ms.

Note: The internal time resolution for the inhibit time is in milliseconds. An inhibit time value = 37 is truncated to 30 [3.7 ms → 3 ms].
Values less then 10 are interpreted as 0.

Event time: The event time is the time distance between two consecutive TxPDOs whenever the TxPDO data has not changed (cycle time). If the inhibit time is set to zero the TxPDO is only sent on a change of the TxPDO's data. The value range is 0…65535.
The event time is set in milliseconds, e.g. a value of 2000 = 2000 ms.

Example Event time & Inhibt time:

The actual speed value is transferred via TxPDO. The value is updated after the inhibit time has elapsed. At time A, the value remains constant. During this time, the value is updated after the Event time has elapsed. At time B, the value changes and is transmitted via TxPDO. The value changes again frequently and is only updated after the inhibit time has elapsed



Sub index 4:

Sub-index 4 is included for compatibility reasons. An SDO read/write access to sub index 4 results in an SDO abort.

Example*:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	00 18	02	00
Reply	581	4F	00 18	02	FF
Read Request	601	40	00 18	01	00
Reply	581	4F	00 18	01	81 01 00 00
Write Access	601	23	00 18	01	81 01 00 80
Reply *	581	60	00 18	01	00 00 00 00
Write Access	601	2F	00 18	02	05
Reply *	581	60	00 18	02	00
Write Access	601	23	00 18	01	81 01 00 00
Reply *	581	60	00 18	01	00 00 00 00

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

* Note, that Object 1800/1 Highest has to be deactivated first for the correct Write access for Object 1800/2.

10.2.22 0x1A00/n, 0x1A01/n, 0x1A02/n TxPDO Mapping Parameters

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

Mapping entry:

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

Examples:

Mapping of 0x6041/0 *statusword* (unsigned16) to 1st mapping object inTxPDO1:

0x1A00/1 = 0x60410010

Mapping of 0x6064/0 *position actual value* (integer32) to 2nd mapping object in TxPDO1:

0x1A00/2 = 0x60640020

Default mapping

TxPDO1	0x1A00/0	0x1A00/1	0x1A00/2	0x1A00/3…8
	2	0x6041 statusword	0x6044 control effort	0x00000000
TxPDO2	0x1A01/0			
	0	No mapping		
TxPDO3	0x1A02/0			
	0	No mapping		

Example*:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	00 1A	01	00 00 00 00
Reply	581	43	00 1A	01	10 00 41 60
Write Access	601	2F	00 1A	00	00
Reply *	581	60	00 1A	00	00

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

* Note, that Object 1400/1 Highest has to be deactivated first for the correct Write access for Object 1600/n. See also the Mapping sequence described in the following.

Mapping Sequence

The mapping sequence requires five steps:

Step 1: Set PDO to "not valid" (0x1800, subindex 1, Bit 31 = 1)

Step 2: Set subindex 0 to 0 (deactivate current mapping, 0x1A00, subindex 0 = 0)

Step 3: Set subindex 1 … n to the new objects (0x1A00, subindex 1..n = new object)

Step 4: Set subindex 0 to the number of mapped objects (activate new mapping, 0x1A00, subindex 0 = n)

Step 5: Set PDO valid (0x1800, subindex 1, Bit 31 = 0)

TxPDO 0x1A00 is used exemplary above. The same procedure applies to 0x1A01 and 0x1A02. In these cases, 0x1800 has to be substituted accordingly with 0x1801 or 0x1802.

Example (Node ID = 1):

	COB ID	Control byte	Index	Sub index	Data	Data
			LSB MSB	Sub index	LSB …	… MSB
Step 1:	601	23	00 18	01	84 01	00 80
Response	581	60	00 18	01	00 00	00 00
Step 2:	601	2F	00 1A	00	00 00	
Response	581	60	00 1A	00	00 00	
Step 3.1:	601	23	00 1A	01	10 00	44 60
Response	581	60	00 1A	01	00 00	00 00
Step 3.2	601	23	00 1A	02	10 00	41 60
Response	581	60	00 1A	02	00 00	00 00
Step 3.3	601	23	00 1A	03	10 00	01 30
Response	581	60	00 1A	03	00 00	00 00
Step 3.4	601	23	00 1A	04	10 00	02 30
Response	581	60	00 1A	04	00 00	00 00
Step 4:	601	2F	00 1A	00	04 00	
Response	581	60	00 1A	00	00 00	
Step 5:	601	23	00 18	01	84 01	00 00
Response	581	60	00 1A	00	00 00	00 00

Resulting mapping			
Control effort (0x6044)	Status word (0x6041)	Digital In actual values (0x3001)	Digital In actual values (0x3002)
00 00	00 00	00	00

Note:

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

10.3 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)

Note:
The mapping of numeric data is always in integer or long data type. Values which contain decimal places are extended accordingly:
(e.g. value 17.35 is transmitted as 1735)

10.3.1 Handling of data sets/cyclic writing

Access to the parameter values is carried out on the basis of the parameter number and the required data set. 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 is reported.

⚠ **Caution!** The values are entered automatically into the EEPROM on the controller. If values are to be written cyclically, there must be no entry into the EEPROM, as it only has a limited number of admissible writing cycles (about 1 million cycles). If the number of admissible writing cycles is exceeded, the EEPROM is destroyed.

To avoid this, cyclically written data can be entered exclusively into the RAM without a writing cycle taking place on the EEPROM. The data are volatile, i.e., they are lost on power-off and have to be written again after power-on.
This mechanism is activated by the target data set being increased by five in the specification of the data set.

Writing to a virtual data set in the 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

10.3.2 SDO examples (expedited transfer only)

Writing parameters:

Client ➔ Server SDO Download (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
		LSB	MSB	0xnn				
	0x2B	**uint/int**			LSB	MSB	--	--
	0x23	**long**			LSB	...	...	MSB

Server ➔ Client Download Response ➔ writing process free of errors

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
	0x60	LSB	MSB	0xnn	-			

Server ➔ Client Abort SDO Transfer ➔ writing process with error

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
	0x80	LSB	MSB	0xnn	Error code			

If an error occurs during the writing process, the corresponding error code is given in Bytes 4 … 7.

Reading parameters:

Client ➔ Server SDO Upload (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
	0x40	LSB	MSB	0xnn	-			

Server ➔ Client Upload Response ➔ reading process without errors

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
		LSB	MSB	0xnn	LSB			MSB
	0x4B	**uint/int**			LSB	MSB	--	--
	0x43	**long**			LSB	...	...	MSB

Server ➔ Client Abort SDO Transfer ➔ reading process faulty

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
	0x80	LSB	MSB	0xnn	Error code			

If an error occurs during the reading process, the corresponding error code is given in Bytes 4 … 7. Check chapter9.3.3 for the error code list for SDO abort.

10.3.3 Examples of writing parameters

Writing parameter *Rated Speed* **372** (type: uint) in data set 2 with the parameter value 2980.
Index = 372 + 0x2000 = 0x2174, value = 2980 = 0x0BA4

Client ➔ Server SDO Download (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x601	**0x2B**	0x74	0x21	0x02	0xA4	0x0B	--	--

Writing parameter *Warning Limit Heat Sink Temp.* **407** (type: int) in data set 0 with the parameter value -15.
Index = 407 + 0x2000 = 0x2197, value = -15 = 0xFFF1

Client ➔ Server SDO Download (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x601	**0x2B**	0x97	0x21	0x00	0xF1	0xFF	--	--

Writing parameter *Fixed frequency 1* **480** (type: long) in data set 1 with the parameter value 100.00 Hz.
Index = 480 + 0x2000 = 0x21E0, value = 10000 = 0x00002710

Client ➔ Server SDO Download (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x601	**0x23**	0xE0	0x21	0x01	0x10	0x27	0x00	0x00

Writing parameter *Fixed Frequency 1* **480** (type: long) in data set 3 with the parameter value -50.00 Hz.
Index = 480 + 0x2000 = 0x21E0, value = -5000 = 0xFFFFEC78

Client ➔ Server SDO Download (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x601	**0x23**	0xE0	0x21	0x03	0x78	0xEC	0xFF	0xFF

If an error occurs during the reading process, the corresponding error code is given in Bytes 4 … 7. Check chapter 9.3.3 for the error code list for SDO abort.

10.3.4 Examples of reading parameters

Reading parameter *Rated speed* **372** (type: uint) in data set 2 with the current parameter value 1460.
Index = 372 + 0x2000 = 0x2174, value = 1460 = 0x05B4

Client ➔ Server SDO Upload (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x601	**0x40**	0x74	0x21	0x02	--	--	--	--

Server ➔ Client Upload Response

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x581	**0x4B**	0x74	0x21	0x02	0xB4	0x05	--	--

Reading parameter *Warning Limit Heat Sink Temp.* **407** (type: int) in data set 0 with the current parameter value -5.
Index = 407 + 0x2000 = 0x2197, value = -5 = 0xFFFB

Client ➔ Server SDO Upload (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x601	**0x40**	0x97	0x21	0x00	--	--	--	--

Server ➔ Client Upload Response

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x581	**0x4B**	0x97	0x21	0x00	0xFB	0xFF	--	--

Reading parameter *Fixed Frequency 1* **480** (type: long) in data set 1 with the current parameter value 75.00 Hz.
Index = 480 + 0x2000 = 0x21E0, value = 7500 = 0x00001D4C

Client ➔ Server SDO Upload (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x601	**0x40**	0xE0	0x21	0x01	--	--	--	--

Server ➔ Client Upload Response

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x581	**0x43**	0xE0	0x21	0x01	0x4C	0x1D	0x00	0x00

Reading parameter *Fixed Frequency 1* **480** (type: long) in data set 3 with the current parameter value -10.00 Hz.
Index = 480 + 0x2000 = 0x21E0, value = -1000 = 0xFFFFFC18

Client ➔ Server SDO Upload (expedited)

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x601	**0x40**	0xE0	0x21	0x03	--	--	--	--

Server ➔ Client Upload Response

	0	1	2	3	4	5	6	7
COB ID	Control byte	Index		Subindex	Data			
0x581	**0x43**	0xE0	0x21	0x03	0x18	0xFC	0xFF	0xFF

If an error occurs during the reading process, the corresponding error code is given in Bytes 4 … 7. Check chapter 9.3.3 for the error code list for SDO abort.

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

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

10.4.1 0x3000/0 SYNC Jitter

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x3000	0	SYNC Jitte	Unsigned16	rw	No	See Text

DS301 does not include an object for monitoring the jittering of the SYNC message. ACTIVE CUBE inverters monitor SYNC message jittering with object 0x3000/0 *SYNC Jitter* (given in multiples of micro seconds).

If the SYNC message is received outside the time defined by:

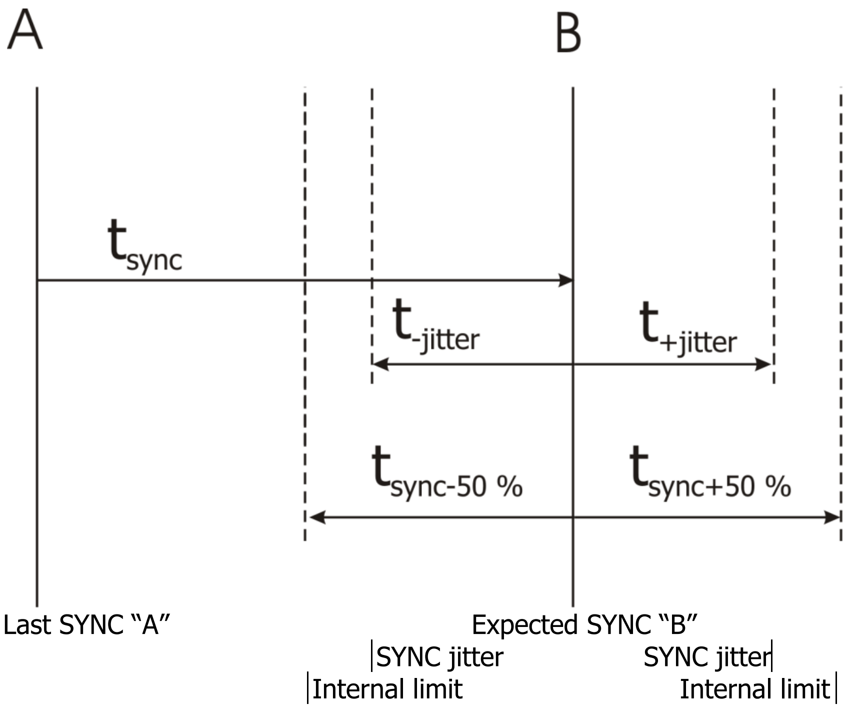
0x1006/0 *communication cycle period* +/- 0x3000/0 *SYNC Jitter*

a communication error event is triggered.

The value for object 0x3000/0 *SYNC Jitter* depends on the CANopen® master's capability for time accuracy. The value range is 0 … 17.000 (µs) and is in addition internally restricted to 50% of the *communication cycle period* (object 0x1006/0 or the measured value).

If object 0x3000/0 *SYNC Jitter* is set to 0, there is no monitoring of the SYNC message time.

If object 0x3000/0 *SYNC Jitter* is set to ≠ 0 then monitoring of the SYNC message time is active. The jitter monitoring is independent of how the communication cycle period is determined (either set with object 0x1006/0 or by measuring).



Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	00 30	00	00 00
Reply	581	4B	00 30	00	00 00
Write Access	601	2B	00 30	00	10 00
Reply	581	60	00 30	00	00 00

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

Note:
Object 0x3000 *SYNC Jitter* is located in the application object area and is saved by objects 0x1010/3 *save application objects* and 0x1010/1 *save all objects*.

10.4.2 0x3001/0 Digital In actual value

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x3001	0	Digital In actual value	Unsigned16	ro	Tx	

Object 0x3001 *Digital In actual value* displays the current state of the digital inputs and of the multifunctional input 1 (if in *Operation mode* **452**-digital input) as described in parameter *Digital Inputs* **250**.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	01 30	00	00 00
Reply	581	4B	01 30	00	06 00

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

10.4.3 0x3002/0 Digital Out actual value

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

Object 0x3002 *Digital Out actual value* displays the current state of the up to 4 - depending on optional hardware - digital outputs and of the multifunctional output 1 (if in *Operation mode* **550** – digital) as described in parameter *Digital Outputs* **254**.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	02 30	00	00 00
Reply	581	4B	02 30	00	03 00

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

10.4.4 0x3003/0 Digital Out set values

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x3003	0	Digital Out set values	Unsigned8	rw	Rx	0

Via object 0x3003 there are 5 digital sources available for use with parameters, which require digital values.

Object 0x3003			
Bit	Source no.	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
5	-	-	-
6	-	-	-

Digital outputs use these sources as operation mode 90 … 94 *Obj 0x3003 DigOut 1 … 5* respectively inverted as 190 **…** 194 *inv. Obj 0x3003 DigOut 1 … 5* (see e.g. parameter *Op. Mode Digital Output 1* **530***).* The mapping of this object bits to the outputs is arbitrary.

Example:

Function	Parameter no.	Choice list (excerpt)
Op. Mode Digital Output 3	532	0 - OFF 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 …

The sources can be chosen directly by the selection of 810…814 *Obj 0x3003 DigOut 1 … 5* from the parameters choice list. This can be used e.g. for direct setting of Boolean inputs.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	03 30	00	00
Reply	581	4F	03 30	00	03
Write Access	601	2F	03 30	00	10
Reply	581	60	03 30	00	00

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

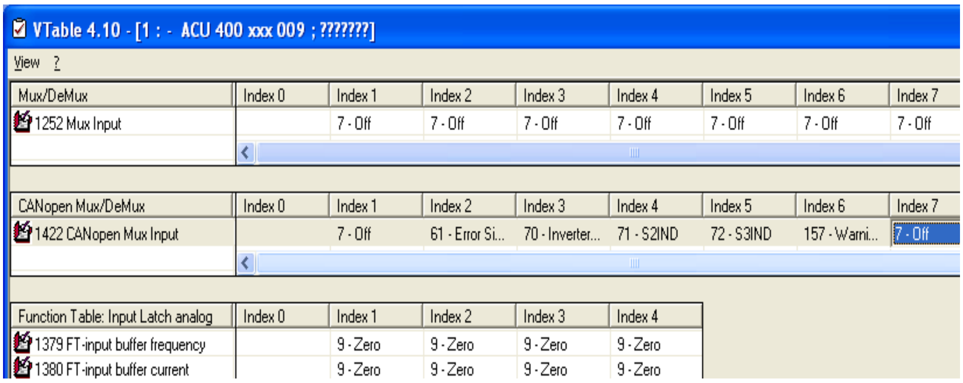
10.4.5 0x3004/0 Boolean Mux

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x3004	0	Boolean Mux	Unsigned16	ro	Tx	

Via object 0x3004 up to 16 boolean values can be read in a compressed manner. Each bit in 16 bit object 0x3004 displays the actual value of the connected boolean source.

Note:
Bit number 0 … 15 corresponds with index number 1 … 16!

The sources for the 16 bits can be chosen from a choice list via the index parameter *CANopen® Mux Input*. **1422.** Parameters **1420** and **1421** are the associated write and read parameters which you have to set prior to writing/reading parameter **1422.** By using VTable this process is easier and more clearly laid out.



VTable 4.10 - [1 : - ACU 400 xxx 009 ; ???????]

Mux/DeMux	Index 0	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7
1252 Mux Input		7 - Off	7 - Off	7 - Off	7 - Off	7 - Off	7 - Off	7 - Off

CANopen Mux/DeMux	Index 0	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7
1422 CANopen Mux Input		7 - Off	61 - Error Si...	70 - Inverter...	71 - S2IND	72 - S3IND	157 - Warni...	7 - Off

Function Table: Input Latch analog	Index 0	Index 1	Index 2	Index 3	Index 4
1379 FT-input buffer frequency		9 - Zero	9 - Zero	9 - Zero	9 - Zero
1380 FT-input buffer current		9 - Zero	9 - Zero	9 - Zero	9 - Zero

Default value is 7 – Off

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	04 30	00	00 00
Reply	581	4B	04 30	00	03 00

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

10.4.6 0x3005/0 Boolean DeMux

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x3005	0	Boolean DeMux	Unsigned16	rw	Rx	0

Via object 0x3005 up to 16 boolean values can be written in a compressed manner. These values are available as sources which can be chosen by the selection of 832 … 847 *Obj 0x3005 Demux Out 1…16* from a parameters choice list.

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

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	05 30	00	00 00
Reply	581	4B	05 30	00	05 00
Write Access	601	2B	05 30	00	20 00
Reply	581	60	05 30	00	00 00

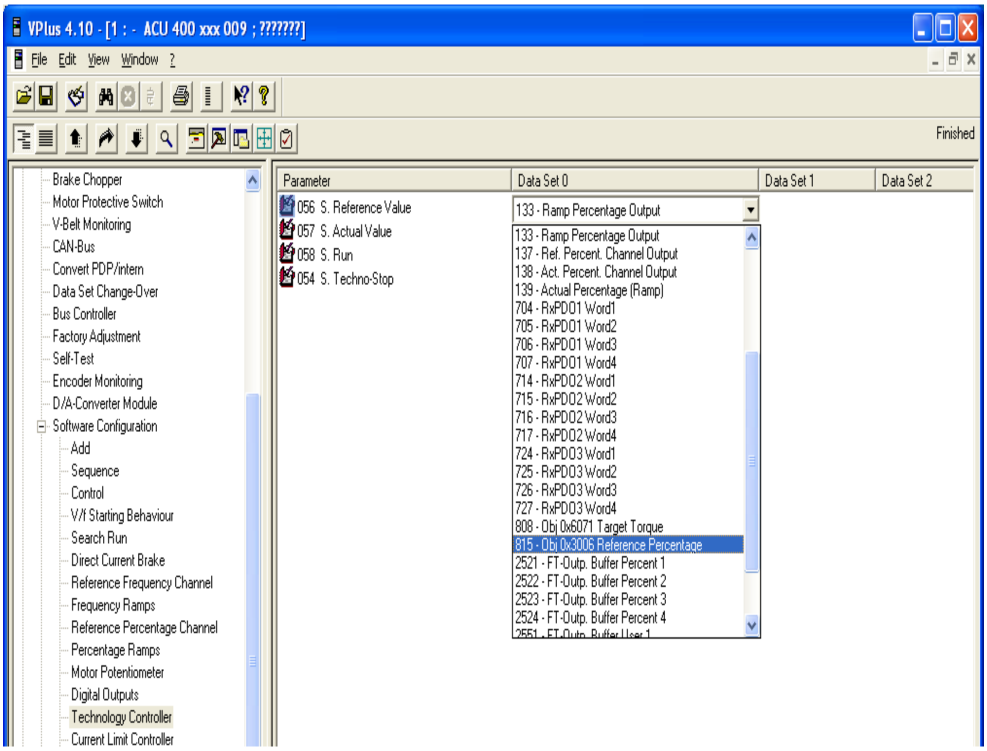
CB: Control byte SI: Sub Index All values in hexadecimal without leading 0x

10.4.7 0x3006/0 Percentage set value

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x3006	0	Percentage set value	Unsigned16	rw	Rx	0

Via object 0x3006 it is possible to write to a percentage source like parameter *S. Reference Value* **056**.
The value of object 0x3006 is available as source which can be chosen by the selection of "815 - Obj 0x3006 Reference Percentage" from a parameters choice list.

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



- Brake Chopper
- Motor Protective Switch
- V-Belt Monitoring
- CAN-Bus
- Convert PDP/intern
- Data Set Change-Over
- Bus Controller
- Factory Adjustment
- Self-Test
- Encoder Monitoring
- D/A-Converter Module
- Software Configuration
  - Add
  - Sequence
  - Control
  - V/f Starting Behaviour
  - Search Run
  - Direct Current Brake
  - Reference Frequency Channel
  - Frequency Ramps
  - Reference Percentage Channel
  - Percentage Ramps
  - Motor Potentiometer
  - Digital Outputs
  - Technology Controller
  - Current Limit Controller

Parameter	Data Set 0	Data Set 1	Data Set 2
056 S. Reference Value	133 - Ramp Percentage Output		
057 S. Actual Value			
058 S. Run			
054 S. Techno-Stop			

133 - Ramp Percentage Output
137 - Ref. Percent. Channel Output
138 - Act. Percent. Channel Output
139 - Actual Percentage (Ramp)
704 - RxPDO1 Word1
705 - RxPDO1 Word2
706 - RxPDO1 Word3
707 - RxPDO1 Word4
714 - RxPDO2 Word1
715 - RxPDO2 Word2
716 - RxPDO2 Word3
717 - RxPDO2 Word4
724 - RxPDO3 Word1
725 - RxPDO3 Word2
726 - RxPDO3 Word3
727 - RxPDO3 Word4
808 - Obj 0x6071 Target Torque
815 - Obj 0x3006 Reference Percentage
2521 - FT-Outp. Buffer Percent 1
2522 - FT-Outp. Buffer Percent 2
2523 - FT-Outp. Buffer Percent 3
2524 - FT-Outp. Buffer Percent 4
2551 - FT-Outp. Buffer User 1

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

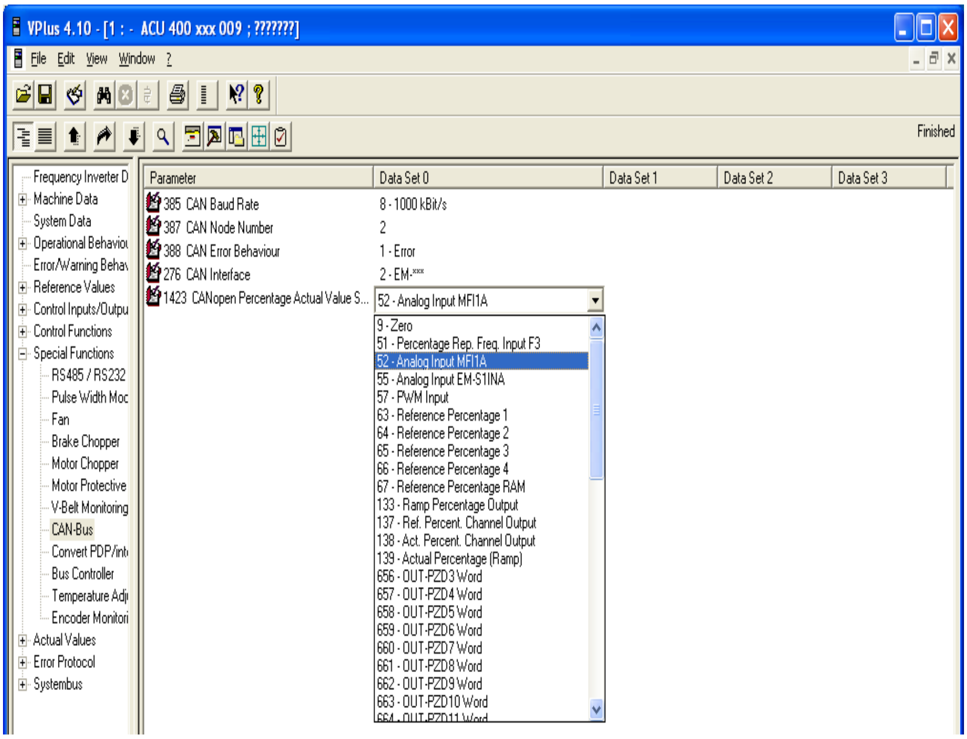
Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	06 30	00	00 00
Reply	581	4B	06 30	00	05 00
Write Access	601	2B	06 30	00	20 00
Reply	581	60	06 30	00	00 00

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

10.4.8 0x3007 / 0 Percentage actual value

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x3007	0	Percentage actual value	Unsigned16	ro	Tx	

Object 0x3007 displays the value of a percentage source which is selectable via parameter *CANopen® Percentage Actual Value Source* **1423**.
Default source is 52 – Analog Input MFI1A.



Parameter	Data Set 0	Data Set 1	Data Set 2	Data Set 3
385 CAN Baud Rate	8 - 1000 kBit/s			
387 CAN Node Number	2			
388 CAN Error Behaviour	1 - Error			
276 CAN Interface	2 - EM-***			
1423 CANopen Percentage Actual Value S...	52 - Analog Input MFI1A			

9 - Zero
51 - Percentage Rep. Freq. Input F3
52 - Analog Input MFI1A
55 - Analog Input EM-S1INA
57 - PWM Input
63 - Reference Percentage 1
64 - Reference Percentage 2
65 - Reference Percentage 3
66 - Reference Percentage 4
67 - Reference Percentage RAM
133 - Ramp Percentage Output
137 - Ref. Percent. Channel Output
138 - Act. Percent. Channel Output
139 - Actual Percentage (Ramp)
656 - OUT-PZD3 Word
657 - OUT-PZD4 Word
658 - OUT-PZD5 Word
659 - OUT-PZD6 Word
660 - OUT-PZD7 Word
661 - OUT-PZD8 Word
662 - OUT-PZD9 Word
663 - OUT-PZD10 Word
664 - OUT-PZD11 Word

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

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	07 30	00	00 00
Reply	581	4B	07 30	00	8F 13

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

10.4.9 0x5FF0 / 0 Active motion block

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x5FF0	0	Active motion block	Unsigned8	ro	Tx	

Object 0x5FF0 *active motion block* is only available in *table travel record* mode in motion control configurations (P.30 = x**40**). 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.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	F0 5F	00	00
Reply	581	4B	F0 5F	00	01

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

10.4.10 0x5FF1 / 0 Motion block to resume

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x5FF1	0	Motion block to resume	Unsigned8	ro	Tx	

Object 0x5FF1 *motion block to resume* is only available in *table travel record* mode in motion control configurations (P.30 = x**40**). 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.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	F1 5F	00	00
Reply	581	4B	F1 5F	00	01

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

10.5 Device Profile Objects (0x6nnn)

10.5.1 0x6007/0 Abort Connection option code

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6007	0	Abort Connection option code	Integer16	rw	No	1

Object *abort connection option code* specifies the operational behavior of the frequency inverter if the bus connection fails due to BusOff, guarding, heartbeat, SYNC error, RxPDO length error or NMT state change (leaving NMT state operational).

Object 0x6007/0	
Operation mode	**Function**
0 - No reaction	Operating point is maintained
1 - Error	Device state machine changes to state “fault” immediately (**factory setting**)
2 - Switch-off	Device state machine processes command ‘*disable voltage*’ and changes to state “switch on disabled”
3 - Quick stop	Device state machine processes command ‘*quick stop*’ and changes to state “switch on disabled”
-1 - Ramp stop + Error (minus 1)	Device state machine processes command ‘*disable operation*’ and changes to state “fault” after the drive is stopped
-2 - Quick stop + Error (minus 2)	Device state machine processes command ‘*quick stop*’ and changes to state “fault” after the drive is stopped

The object *abort connection option code* corresponds to the inverter parameter *CAN Error behavior* **388**.

p.388	0x6007
0	0
1	1
2	2
3	3
4	-1
5	-2

Note:
Writing P.388 or writing object 0x6007 has the same effect.
If object 0x6007 was written and then a save parameters command (object 0x1010) processed, the value of 0x6007 is stored in non volatile memory. After the next power on of the inverter the previously set value for 0x6007 is reactivated and overwrites the setting of P.388.

Note:
The behavior described above is ONLY relevant if parameter *Local/Remote* **412** is set to **1** “Control via Statemachine”.
Otherwise the functional behavior is different. If *abort connection option code* is set to 0 “Operating point is maintained”, there is no reaction. For EVERY other setting the inverter reacts with an immediate change to state "fault" if a CAN error occurs.

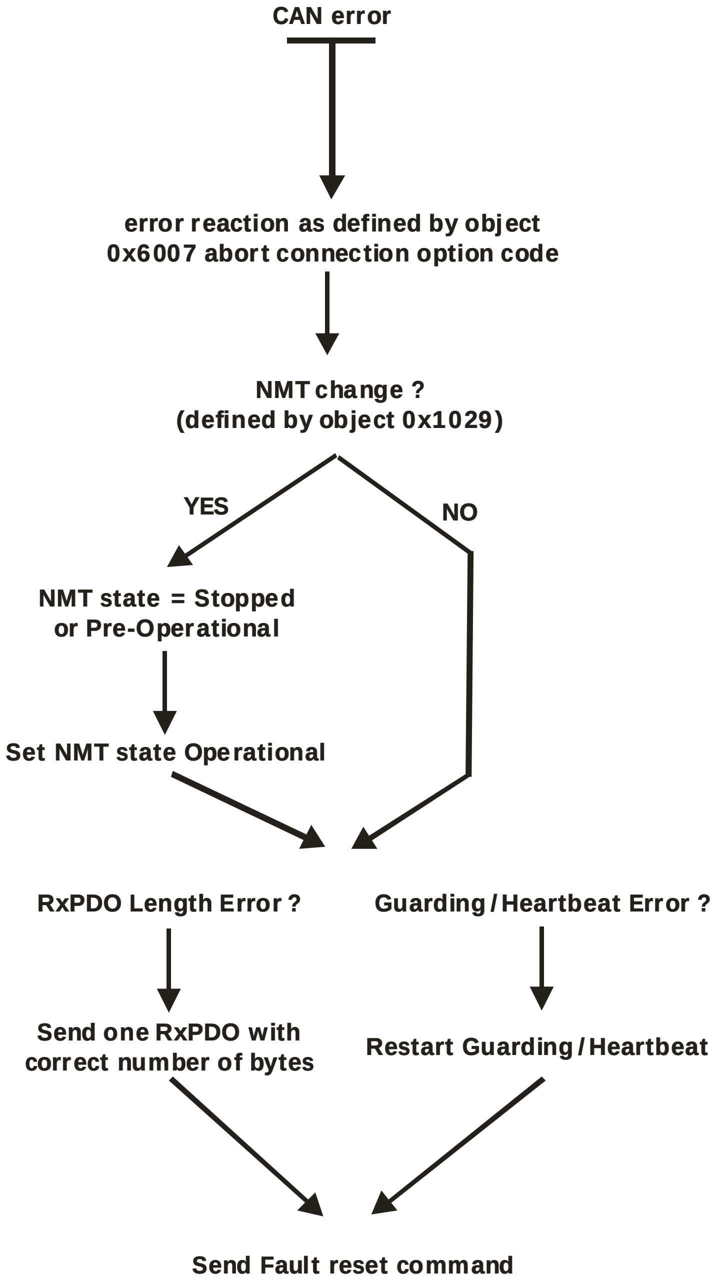
Attention! The behavior for fault reset corresponds to object 0x1029 *Error Behavior*. Depending on the setting of object *Error behavior,* the NMT state may change (leaving NMT state operational). In this case the NMT state must be set to operational again before a fault reset command is accepted by the inverter.

In addition, the error reason must also be reset. E.g. for a guarding error, guarding must be started again before a fault reset command is accepted by the inverter. In the case of a RxPDO length error, a RxPDO frame with the correct number of bytes must be received before new RxPDO data is accepted.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	07 60	00	00 00
Reply	581	4B	07 60	00	01 00
Write Access	601	2B	07 60	00	FE FF
Reply	581	60	07 60	00	00 00

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

Typical recovery sequence after CAN error:


CAN error
error reaction as defined by object
0x6007 abort connection option code
NMT change ?
(defined by object 0x1029)
YES
NO
NMT state = Stopped
or Pre-Operational
Set NMT state Operational
RxPDO Length Error ?
Guarding / Heartbeat Error ?
Send one RxPDO with
correct number of bytes
Restart Guarding / Heartbeat
Send Fault reset command

Warning! With the setting of object 0x6007 *abort connection option code* = 0 (no reaction), the inverter does not react to any CAN error and remains in its current state (e. g. drive running).

It is strongly recommended to use a setting for object 0x6007 *abort connection option code* that forces the inverter into the Fault state (setting = 1, -1 or -2).

10.5.2 0x603F/0 Error code

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x603F	0	Error code	Unsigned16	ro	No	

The object *error code* is used to store the last error that occurred.

In DS402, a large number of possible error codes are specified. The following list shows the relationship between the error code displayed internally by the frequency inverter and on the KP500 control unit, and the error secured in object *error code*.

Error reports				
Inverter Error		**DS402 Error code**		**Meaning**
F00	xx	00	00	No error has occurred
Overload				
F01	xx	23	10	Frequency inverter has been overloaded
Case				
F02	xx	42	10	Case temperature outside the temperature limits
Inside				
F03	xx	41	10	Inside temperature outside the 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 the 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 reports

If the value 1000 (= generic error) appears as the error code, then the inverter error code can be read via parameter *Current error* **260** (unsigned16). This parameter contains the error code in the product-internal format.

The assignment table of the error code can be taken from the operating instructions.

In the emergency message, the error code of the frequency inverter is transmitted in bytes 4 ... 7 and the DS402 error code in bytes 0 and 1. Please refer to object 0x1014 *COB-ID Emergency Message* for further explanations.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	3F 60	00	00 00
Reply	581	4B	3F 60	00	00 00

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

10.5.3 0x6040/0 Controlword

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6040	0	Controlword	Unsigned16	rw	Rx	0

Object 0x6040/0 *controlword* is relevant to the inverter remote state machine whenever parameter *LocalRemote* **412** is set to **1** (remote state machine). See chapter 12 "Inverter Control" and chapter 13.1 "Control Word overview".

Controlword

Bit	
0	Switch on
1	Enable voltage
2	Quick stop
3	Enable operation
4	Operation mode specific
5	Operation mode specific
6	Operation mode specific
7	Fault reset
8	Halt
9	Operation mode specific
10	Reserved
11	Manufacturer specific
12	Manufacturer specific
13	Manufacturer specific
14	Manufacturer specific
15	Manufacturer specific

Bits 9 … 15 unused

Bits 4, 5, 6 *operation mode specific* and bit 8 *halt* are used in motion control configurations (p.30 = x**40**) only.

Example:

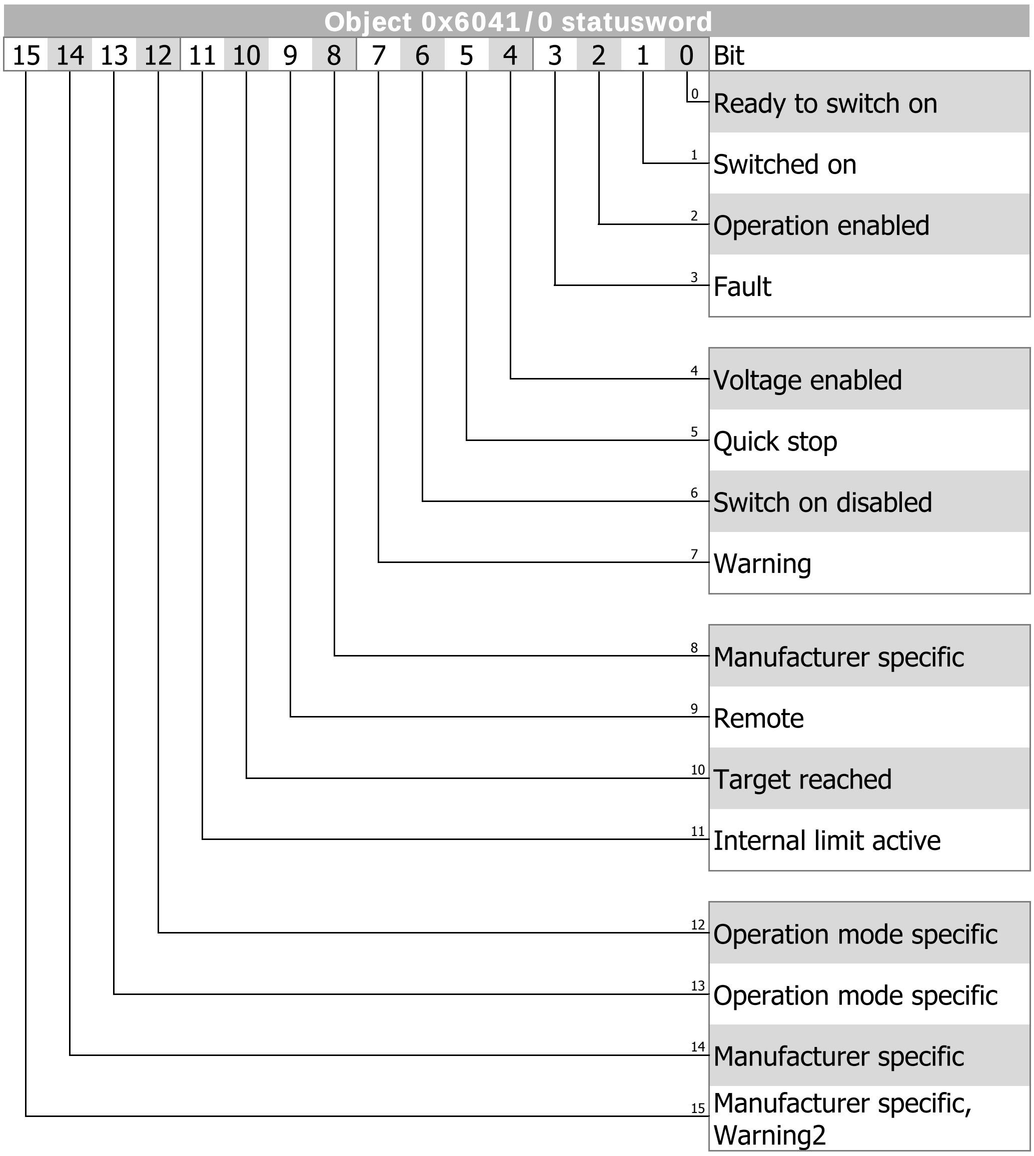
	COB ID	CB	Index	SI	Data
Read Request	601	40	40 60	00	00 00
Reply	581	4B	40 60	00	01 00
Write Access	601	2B	40 60	00	06 00
Reply	581	60	40 60	00	00 00

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

10.5.4 0x6041/0 Statusword

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6041	0	Statusword	Unsigned16	ro	Tx	

Object 0x6041/0 *statusword* displays the actual state of the inverter.



Object 0x6041/0 statusword

Bit	
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Manufacturer specific
9	Remote
10	Target reached
11	Internal limit active
12	Operation mode specific
13	Operation mode specific
14	Manufacturer specific
15	Manufacturer specific, Warning2

Bits 8 and 14 unused

Bits 12 and 13 *operation mode specific* are used in motion control configurations (p.30 = x**40**) only.
See chapter 11 "Inverter Control" and chapter 13.2 "Status Word overview".

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	41 60	00	00 00
Reply	581	4B	41 60	00	31 00

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

10.5.5 0x6042/0 Target velocity

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6042	0	Target velocity	Integer16	rw	Rx	0

Object *target velocity* is the speed reference value for the frequency inverter in velocity mode. *Target velocity* is interpreted as a speed with the unit RPM. The inverter's internal reference frequency is calculated from the target velocity in RPM taking into account parameter *No. of Pole Pairs* **373** (value of P.373 data set 1).

Parameter		Setting	
No.	**Object**	**Min.**	**Max.**
0x6042	Target velocity	-32768	32767

The 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.

Note:
The parameter *No. of Pole Pairs* **373** has four different data sets. In motion control applications only the data set 1 is used.
Non motion control applications sometimes have more than one motor connected to the inverter (only one at a time, switched over by contactor). These motors may have a different no. of pole pairs. The entry in *No. of Pole Pairs* **373** is then different in the four data sets. After change-over of the motor, the object *target velocity* must be written at least once in order to recalculate the internal reference frequency of the inverter using the correct no. of pole pairs.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	42 60	00	00 00
Reply	581	4B	42 60	00	00 00
Write Access	601	2B	42 60	00	DC 05
Reply	581	60	42 60	00	00 00

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

10.5.6 0x6043/0 Target velocity demand

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6043	0	Target velocity demand	Integer16	ro	Tx	

Object *target velocity demand* is the output value of the ramp function in RPM. The object has the same notation as the object *target velocity* and can be read as an actual value. For calculating *target velocity demand* the parameter *No. of Pole Pairs* **373** (value of P.373 in active data set) is taken into account in the same way as described for object target velocity.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	43 60	00	00 00
Reply	581	4B	43 60	00	AB 01

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

10.5.7 0x6044/0 Control effort

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6044	0	Control effort	Integer16	ro	Tx	

Object *control effort* is the actual speed of the drive in RPM. The object has the same notation as the object *target velocity* and can be read as an actual value. For calculating *control effort* the parameter *No. of Pole Pairs* **373** (value of P.373 in the active data set) is taken into account in the same way as described for object target velocity.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	44 60	00	00 00
Reply	581	4B	44 60	00	DE 01

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

10.5.8 0x6046/n Velocity min max amount

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6046	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Velocity min amount (RPM)	Unsigned32	rw	No	See text
	2	Velocity max amount (RPM)	Unsigned32	rw	No	See text

Object velocity min max amount comprises the sub-index 1 = velocity min amount and sub-index 2 = velocity max amount.

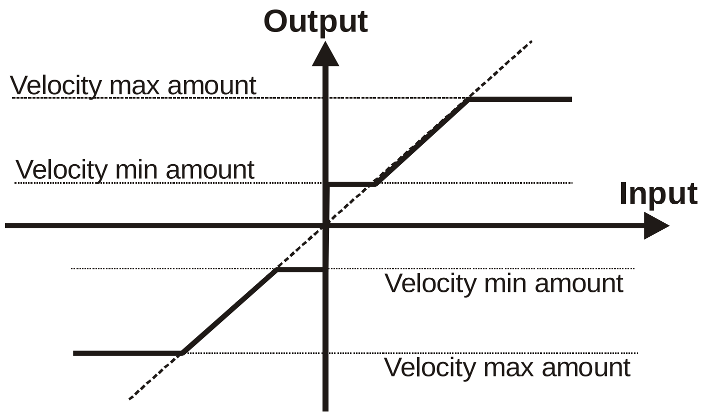
The unit of 0x6046/1 *velocity min amount* is in RPM (positive values only). Writing to object 0x6046/1 *velocity min amount* automatically generates a write command to parameter *Minimum Frequency* **418** (data set 5, all data sets in RAM only !). The value of 0x6046/1 *velocity min amount* is converted internally to a frequency value, taking into account the parameter *No. of Pole Pairs* **373** (in data set 1 !).

The unit of 0x6046 *velocity max amount* is in RPM (positive values only). Writing to object 0x6046/2 *velocity max amount* automatically generates a write command to parameter *Maximum Frequency* **419** (data set 5, all data sets in RAM only !). The value of 0x6046/2 *velocity max amount* is converted internally to a frequency value, taking into account parameter *No. of Pole Pairs* **373** (in data set 1 !).

The default values depend on the used motor settings.

If the input reference value of object 0x6042 *target velocity* is less than the object value 0x6046/1 *velocity min amount* or greater than 0x6046/2 *velocity max amount*, then 0x6042 *target velocity* is limited accordingly.

No.	Object	Min.	Max.
0x6046/1	Velocity min amount (RPM)	0	32767
0x6046/2	Velocity max amount (RPM)	0	32767



Note:
If objects 0x6046/1 or 0x6046/2 were written and then a save parameters command (object 0x1010) processed, the object values are stored in non volatile memory. After the next power on of the inverter, the previously set values are reactivated and overwrite the settings of parameters 418/419.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	46 60	01	00 00 00 00
Reply	581	43	46 60	01	00 00 00 00
Write Access	601	23	46 60	01	DC 05 00 00
Reply	581	60	46 60	01	00 00 00 00

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

10.5.9 0x6048/n Velocity acceleration

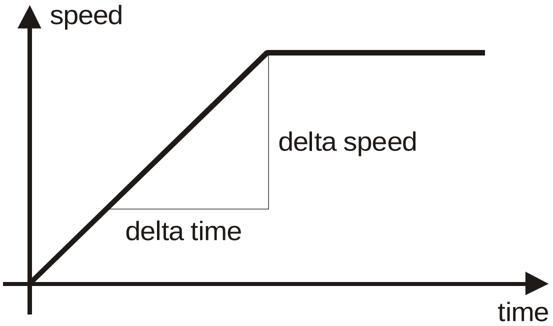
Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6048	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Delta speed (RPM)	Unsigned32	rw	No	0x96
	2	Delta time (sec)	Unsigned16	rw	No	1

The acceleration in velocity mode is set with object *velocity acceleration*. The object *velocity acceleration* consists of *delta speed* in RPM and *delta time* in seconds.

The gradient of the frequency in the acceleration period is written to parameters *Acceleration (clockwise)* **420** and *Acceleration (anti-clockwise)* **422** (data set 5, all data sets in RAM only !). Both parameters are set to the same value.
The values of p.420 and p.422 are converted internally to a frequency/sec value, taking into account parameter *No. of Pole Pairs* **373** (in data set 1 !).

The gradient is changed internally by altering the objects delta time or delta speed.

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



Note:
If objects 0x6048/1 or 0x6048/2 were written and then a save parameters command (object 0x1010) processed, the object values are stored in non volatile memory. After the next power on of the inverter, the previously set values are reactivated and overwrite the settings of p.420/422.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	48 60	01	00 00 00 00
Reply	581	43	48 60	01	96 00 00 00
Write Access	601	23	48 60	01	50 50 00 00
Reply	581	60	48 60	01	00 00 00 00

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

10.5.10 0x6049/n Velocity deceleration

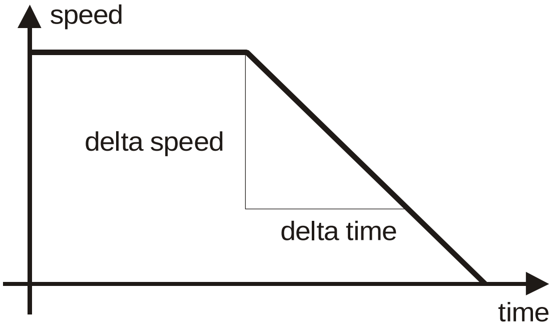
Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6049	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Delta speed (RPM)	Unsigned32	rw	No	0x96
	2	Delta time (sec)	Unsigned16	rw	No	1

The deceleration in velocity mode is set with object *velocity deceleration*. The object *velocity deceleration* consists of *delta speed* in rpm and *delta time* in seconds.

The gradient of the frequency in the deceleration period is written to parameters *Deceleration (clockwise)* **421** and *Deceleration (anti-clockwise)* **423** (data set 5, all data sets in RAM only !). Both parameters are set to the same value.
The values of p.421 and p.423 are converted internally to a frequency/sec value, taking into account the parameter *No. of Pole Pairs* **373** (in data set 1 !).

The gradient is changed internally by altering the objects delta time or delta speed.

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



Note:
If objects 0x6049/1 or 0x6049/2 were written and then a save parameters command (object 0x1010) processed, the object values are stored in non volatile memory. After the next power on of the inverter, the previously set values are reactivated and overwrite the settings of p.421/423.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	49 60	01	00 00 00 00
Reply	581	43	49 60	01	96 00 00 00
Write Access	601	23	49 60	01	40 50 00 00
Reply	581	60	49 60	01	00 00 00 00

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

10.5.11 0x604A/n Velocity quick stop

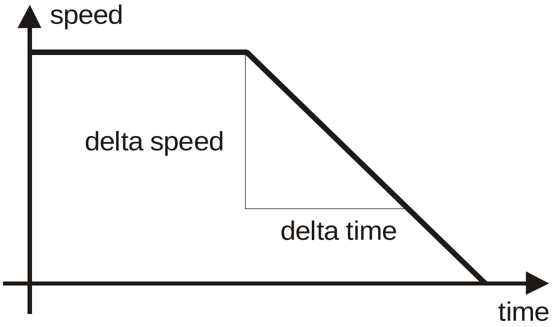
Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x604A	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	Delta speed (RPM)	Unsigned32	rw	No	0x96
	2	Delta time (sec)	Unsigned16	rw	No	1

The quick stop deceleration in velocity mode is set with object *velocity quick stop*. Object *velocity quick stop* consists of *delta speed* in RPM and *delta time* in seconds.

The gradient of the frequency in the deceleration period is written to parameters *Emergency Stop (clockwise)* **424** and *Emergency Stop (anti-clockwise)* **425** (data set 5, all data sets in RAM only !). Both parameters are set to the same value.
The values of p.424 and p.425 are converted internally to a frequency/sec value, taking into account the parameter *No. of Pole Pairs* **373** (in data set 1 !).

The gradient is changed internally by altering the objects delta time or delta speed.

Parameter		Setting	
No.	**Object**	**Min.**	**Max.**
0x604A/1	Delta speed (RPM)	1	32767
0x604A/2	Delta time (sec)	1	65535



Note:
If objects 0x604A/1 or 0x604A/2 were written and then a save parameters command (object 0x1010) processed, the object values are stored in non volatile memory. After the next power on of the inverter, the previously set values are reactivated and overwrite the settings of p.424/425.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	4A 60	01	00 00 00 00
Reply	581	43	4A 60	01	96 00 00 00
Write Access	601	23	4A 60	01	20 50 00 00
Reply	581	60	4A 60	01	00 00 00 00

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

10.5.12 0x6060/0 Modes of operation

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6060	0	Modes of operation	Integer8	wo	Rx	2

With object *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 = x**40**):

Modes of operation
1 – position profile mode
2 – velocity mode **(Default)**
6 – homing mode
7 – interpolated position mode
-1 – table travel record (manufacturer specific mode)

Available value for *modes of operation* with inverter in non motion control configuration (p.30 ≠ x**40**):

Modes of operation
2 – velocity mode

The inverter in non motion control configuration ignores all settings other than "**2**".

For further information see chapter 11 "Inverter Control".

Example:	COB ID	CB	Index	SI	Data
Write Access	601	2F	60 60	00	01
Reply	581	60	60 60	00	00

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

10.5.13 0x6061/0 Modes of operation display

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6061	0	Modes of operation display	Integer8	ro	Tx	

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

Note:
After setting 0x6060 *modes of operation*, the PLC must wait for this acknowledgement before sending any other command to the inverter.

For further information see chapter 11 "Inverter Control".

Example:	COB ID	CB	Index	SI	Data
Read Request	601	40	61 60	00	00
Reply	581	4F	61 60	00	02

10.5.14 0x6064/0 Position actual value

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6064	0	Position actual value	Integer32	ro	Tx	

Object 0x6064 *position actual value* represents the actual value of the position measurement device in user units. The dimension of the user units is defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	64 60	00	00
Reply	581	4F	64 60	00	02

10.5.15 0x6065/0 Following error window

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6065	0	Following error window	Unsigned32	rw	No	0xFFFF FFFF

Note:
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.

Note:
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 p.1105.
The dimension of the user units is defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	65 60	00	00 00 00 00
Reply	581	43	65 60	00	FF FF FF FF
Write Access	601	23	65 60	00	03 E8 00 00
Reply	581	60	65 60	00	00 00 00 00

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

10.5.16 0x6066/0 Following error time out

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6066	0	Following error time out	Unsigned16	rw	No	0xA (=10)

When a following error (contouring error) occurs longer than the defined value of object 0x6066 *following error time out* given in milliseconds, the corresponding bit in the statusword (bit 13 *following error*) is set to one.

Note:
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 p.1119.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	66 60	00	00 00
Reply	581	4B	66 60	00	0A 00
Write Access	601	2B	66 60	00	03 E8
Reply	581	60	66 60	00	00 00

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

10.5.17 0x6067/0 Position window

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6067	0	Position window	Unsigned32	rw	No	0xFFFF FFFF

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 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 (2^{32}-1) OR 0, the position window control is switched off.

Note:
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 p.1165.
The dimension of the user units is defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	67 60	00	00 00 00 00
Reply	581	43	67 60	00	FF FF FF FF
Write Access	601	23	67 60	00	10 27 00 00
Reply	581	60	67 60	00	00 00 00 00

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

10.5.18 0x6068/0 Position window time

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6068	0	Position window time	Unsigned16	rw	No	0xA (=10)

When the actual position is within the *position window* during the defined *position window time* (given in milliseconds), then the corresponding bit in the statusword (bit 10 *target reached*) is set to one.

Note:
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 p.1166.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	68 60	00	00 00
Reply	581	4B	68 60	00	0A 00
Write Access	601	2B	68 60	00	C8 00
Reply	581	60	68 60	00	00 00

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

10.5.19 0x6071/0 Target Torque

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6071	0	Target Torque	Integer16	rw	Rx	0

The value transmitted via Object 0x6071 is selectable as source Q.808 for various parameters (e.g. *FT Input buffer percentage* **1381**).
It is also available as operation mode 95 or inverted as 195 (e.g. for parameter *Reference Percentage Source* **476** in configurations with torque control p.**30** = **x30**).

A value of 0x3E8 (=1000) corresponds to rated motor torque (100.0 %).

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

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	71 60	00	00 00
Reply	581	4B	71 60	00	00 00
Write Access	601	2B	71 60	00	64 00
Reply	581	60	71 60	00	00 00

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

10.5.20 0x6077/0 Torque actual value

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6077	0	Torque actual value	Integer16	ro	Tx	

Object 0x6077 *Torque actual value* displays the torque actual value.

A value of 0x3E8 (=1000) corresponds to rated motor torque (100.0 %). Please refer as well to Object 0x6071.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	77 60	00	00 00
Reply	581	4B	77 60	00	00 00

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

10.5.21 0x6078/0 Current actual value

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6078	0	Torque actual value	Integer16	ro	Tx	

Object 0x6078 *Current actual value* displays the current actual value.

A value of 0x3E8 (=1000) corresponds to the rated motor current (100.0 %).

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	78 60	00	00 00
Reply	581	4B	78 60	00	00 00

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

10.5.22 0x6079/0 DClink circuit voltage

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6079	0	DClink circuit voltage	Integer32	ro	Tx	

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

A value of 0x0001 86A0 (=100 000) corresponds to 100.000 V (three decimal points).

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	79 60	00	00 00 00 00
Reply	581	43	79 60	00	CA E8 04 00

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

10.5.23 0x607A/0 Target position

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x607A	0	Target position	Integer32	rw	Rx	0

Object 0x607A *target position* defines the position (in user units) that the drive should move to in profile position mode.
The dimension of the user units is defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	7A 60	00	00 00 00 00
Reply	581	43	7A 60	00	00 00 00 00
Write Access	601	23	7A 60	00	40 E2 01 00
Reply	581	60	7A 60	00	00 00 00 00

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

10.5.24 0x607C/0 Home offset

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x607C	0	Target position	Integer32	rw	No	0

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.

Note:
Writing to object *home offset* automatically generates a write command to parameter *Home Offest* **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 overwrites the setting of parameter *Home Offest* **1131.**
The dimension of the user units is defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	7C 60	00	00 00 00 00
Reply	581	43	7C 60	00	00 00 00 00
Write Access	601	23	7C 60	00	80 38 01 00
Reply	581	60	7C 60	00	00 00 00 00

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

10.5.25 0x6081/0 Profile velocity

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6081	0	Profile velocity	Unsigned32	rw	Rx	0x5 0000

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 defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	81 60	00	00 00 00 00
Reply	581	43	81 60	00	00 00 05 00
Write Access	601	23	81 60	00	40 E2 01 00
Reply	581	60	81 60	00	00 00 00 00

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

10.5.26 0x6083/0 Profile acceleration

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6083	0	Profile acceleration	Unsigned32	rw	Rx	0x5 0000

Object 0x6083 *profile acceleration* is the acceleration (in user units per second^2) in profile position mode.
The dimension of the user units is defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	83 60	00	00 00 00 00
Reply	581	43	83 60	00	00 00 05 00
Write Access	601	23	83 60	00	40 E2 01 00
Reply	581	60	83 60	00	00 00 00 00

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

10.5.27 0x6084/0 Profile deceleration

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6084	0	Profile deceleration	Unsigned32	rw	Rx	0x5 0000

Object 0x6084 *profile deceleration* is the deceleration (in user units per second^2) in profile position mode.
The dimension of the user units is defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	84 60	00	00 00 00 00
Reply	581	43	84 60	00	00 00 05 00
Write Access	601	23	84 60	00	C0 D4 01 00
Reply	581	60	84 60	00	00 00 00 00

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

10.5.28 0x6085/0 Quick stop deceleration

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6085	0	Quick stop deceleration	Unsigned32	rw	No	0xA 0000

Object 0x6085 *quick stop deceleration* is the deceleration (in user units per second^2) in profile position mode for quick stop mode (controlword bit 2 = 0).

Note:
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 defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	85 60	00	00 00 00 00
Reply	581	43	85 60	00	00 00 0A 00
Write Access	601	23	85 60	00	00 00 0B 00
Reply	581	60	85 60	00	00 00 00 00

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

10.5.29 0x6086/0 Motion profile type

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6086	0	Motion profile type	Integer16	rw	No	3

Object 0x6086 *motion profile type* defines the ramp behavior 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**

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	86 60	00	00 00
Reply	581	4B	86 60	00	03 00
Write Access	601	2B	86 60	00	03 00
Reply	581	60	86 60	00	00 00

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

10.5.30 0x6091/n Gear ratio

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
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 0x6091 *gear ratio* defines the ratio of motor shaft revolutions to driving shaft revolutions.

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

$$\widehat{=} \frac{\text{Parameter } \textit{Gear Box : Motor Shaft Revolutions } \mathbf{1117}}{\text{Parameter } \textit{Gear Box : Driving Shaft Revolutions } \mathbf{1116}}$$

Note:
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 p.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 1116.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	91 60	01	00 00 00 00
Reply	581	43	91 60	01	01 00 00 00
Write Access	601	23	91 60	01	64 00 00 00
Reply	581	60	91 60	01	00 00 00 00

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

10.5.31 0x6092/n Feed constant

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
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 0x6092 *feed constant* defines the feed (in user units) per driving shaft revolutions.

$$\text{Feed constant} = \frac{\text{0x6092/1 } \textit{feed}}{\text{0x6092/2 } \textit{driving shaft revolution s}}$$

$$\triangleq \frac{\text{Parameter } \textit{Feed Constant } \mathbf{1115}}{1}$$

Note:
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 1115.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	92 60	01	00 00 00 00
Reply	581	43	92 60	01	00 00 01 00
Write Access	601	23	92 60	01	A0 8C 00 00
Reply	581	60	92 60	01	00 00 00 00

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

10.5.32 0x6098/0 Homing method

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6098	0	Homing method	Integer8	rw	No	0

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

Note:
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 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 & Ref. -Signal	Homing to negative HW limit switch with detection of encoder ref. signal.
2 -	Pos. Limit Switch & Ref. -Signal	Homing to positive HW limit switch with detection of encoder ref. signal.
3 -	Pos. Home-Sw., Ref.-Signal 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., Ref.-Signal 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., Ref.-Signal 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.: Ref.-Signal 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.
7 -	Pos. Lim.-Sw., Ref.-Sig. left of left Edge of Home-Sw.	Homing to home switch with detection of encoder ref. signal. Homing direction positive (clockwise). Reversal of direction of rotation when positive HW limit switch is reached. Home position is the first encoder ref. signal to the left or right of the left or right edge of the home switch signal.
8 -	Pos. Lim.-Sw., Ref.-Sig. right of left Edge of Home-Sw.	
9 -	Pos. Lim.-Sw., Ref.-Sig. left of right Edge of Home-Sw.	
10 -	Pos. Lim.-Sw., Ref.-Sig. right of right Edge of Home-Sw.	
11 -	Neg. Lim.-Sw., Ref.-Sig. right of right Edge of Home-Sw.	Homing to home switch with detection of encoder ref. signal. Homing direction negative (anticlockwise). Reversal of direction of rotation when negative HW limit switch is reached. Home position is the first encoder ref. signal to the left or right of the left or right edge of the home switch signal.
12 -	Neg. Lim.-Sw., Ref.-Sig. left of right Edge of Home-Sw.	
13 -	Neg. Lim.-Sw., Ref.-Sig. right of left Edge of Home-Sw.	
14 -	Neg. Lim.-Sw., Ref.-Sig. left of left Edge of Home-Sw.	

Homing Method **0x6098/0**		Function
17 … 30: like 1 … 14, but without encoder ref. signal		
17 -	Neg. Limit Switch	Homing to negative HW limit switch.
18 -	Pos. Limit Switch	Homing to positive HW limit switch.
19 -	Pos. Home-Sw., left of Edge	Homing to positive home switch. Home position is at 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 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 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. Lim.-Sw., left of left Edge of Home-Sw.	Homing to home switch. Homing direction positive (clockwise). Reversal of direction of rotation when positive HW limit switch is reached. Home position is at the left or right of the left or right edge of the home switch signal.
24 -	Pos. Lim.-Sw., right of left Edge of Home-Sw.	
25 -	Pos. Lim.-Sw., left of right Edge of Home-Sw.	
26 -	Pos. Lim.-Sw., right of right Edge of Home-Sw.	
27 -	Neg. Lim.-Sw., right of right Edge of Home-Sw.	Homing to home switch. Homing direction negative (anticlockwise). Reversal of direction of rotation when negative HW limit switch is reached. Home position is at the left or right of the left or right edge of the home switch signal.
28 -	Neg. Lim.-Sw., left of right Edge of Home-Sw.	
29 -	Neg. Lim.-Sw., right of left Edge of Home-Sw.	
30 -	Neg. Lim.-Sw., left of left Edge of Home-Sw.	
33 -	Ref.-Signal left of act. pos.	Home position is the first encoder ref. signal in negative (operation mode 33) or positive (operation mode 34) direction.
34 -	Ref.-Signal right of act. pos.	
35 -	Current Position	Current position is home position. Home offset (Parameter *Home-Offset* **1131**) is taken over as actual position value.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	98 60	00	00
Reply	581	4F	98 60	00	00
Write Access	601	2F	98 60	00	23
Reply	581	60	98 60	00	00

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

10.5.33 0x6099/n Homing speeds

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x6099	0	Highest sub-index supported	Unsigned8	ro	No	2
	1	speed during search for switch	Unsigned32	rw	No	0x5 0000
	2	speed during search for zero	Unsigned32	rw	No	0x2 0000

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.

Note:
Writing to object *speed during search for switch* automatically generates a write command to parameter *Fast Speed* **1132** (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 1132.

Writing to object *speed during search for zero* automatically generates a write command to parameter *Creep speed* **1133**(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 1133.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	99 60	01	00 00 00 00
Reply	581	43	99 60	01	00 00 05 00
Write Access	601	23	99 60	01	B0 AD 01 00
Reply	581	60	99 60	01	00 00 00 00

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

10.5.34 0x609A/0 Homing acceleration

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x609A	0	Homing acceleration	Unsigned32	rw	No	0x5 0000

Object 0x609A/0 *homing acceleration* defines acceleration and deceleration (in user units per second^2) during homing.

Note:
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 1134.
The dimension of the user units is defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	9A 60	00	00 00 00 00
Reply	581	43	9A 60	00	00 00 05 00
Write Access	601	23	9A 60	00	90 5F 01 00
Reply	581	60	9A 60	00	00 00 00 00

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

10.5.35 0x60C1/1 Interpolation data record

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x60C1	0	Highest sub-index supported	Unsigned8	ro	No	1
	1	Interpolation data record 1	Integer32	rw	Rx	0

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. Bonfiglioli Vectron recommends copying 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 defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:					
	COB ID	CB	Index	SI	Data
Read Request	601	40	C1 60	01	00 00 00 00
Reply	581	43	C1 60	01	00 00 05 00
Write Access	601	23	C1 60	01	18 73 01 00
Reply	581	60	C1 60	01	00 00 00 00

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

10.5.36 0x60F4/0 Following error actual value

Index	Sub-index	Meaning	Data type	Access	Map	Def.-Val
0x60F4	0	Following error actual value	Integer32	ro	Tx	

Note:
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 0x6065 *Following error window*.
The dimension of the user units is defines by 0x6091 *Gear ratio* and 0x6092 *Feed constant*.

Example:

	COB ID	CB	Index	SI	Data
Read Request	601	40	C1 60	00	00 00 00 00
Reply	581	43	C1 60	00	05 00 00 00

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

11 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. The Motion Control Interface allows the direct access for a Field bus to change a Position Profile, which usually consists of Target Position, Speed, Acceleration, Deceleration, Quick-Stop and mode depending additional information.
The Motion Control interface uses object 0x6060 *Modes of Operation* to change between the different modes. The supported modes according to CANopen standard DS402 are:

- 1 – Profile Position mode
- 2 – Velocity mode
- 6 – Homing
- 7 – Interpolated mode
- -1 – Table Travel record mode (Bonfiglioli Vectron defined mode)

The actual mode is displayed in 0x6061 *Modes of Operation Display*.

Changing between the Modes of Operation is possible in every operation point of the ACU. Bonfiglioli Vectron recommends stopping a running operation by the PLC first, then changing 0x6060 Modes of Operation and starting again the new mode.

To use the Motion Control Interface, set **412** *Local/Remote* = „1 – Control via Statemachine". In configurations without Position control (*Configuration* **30** ≠ x40) only the velocity mode is available.

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

11.1 Object and parameter dependencies

Depending on the object 0x6060 Modes of Operation the used objects and parameters differ. Because the different objects and parameters are used they can an must be set individually.
Using the Deceleration and Quick Stop is depends on the actual mode of operation, control commands and error reaction to communication errors (see object 0x6007/0 *abort connection option code*).

The following tables contain an overview of the different used objects and parameters. The first mentioned object or parameter mentioned in a cell is usually used. If an object relates to a parameter, this parameter is mentioned.

Parameters **1292** *Modes of Operation and following* (**1293**, **1294**, **1295**, **1296** & **1297**) are used to link internal functions to CANopen objects. Usually, these need not to be changed when using CANopen.

Mode	Homing	Velocity Mode	Table Travel Record mode
Modes of Operation [1][2]	**6**	**2**	**-1**
Target Position			**1202** *Target Position*
Speed	Obj. 0x6099/1 & /2 Homing Speeds ▪ **1132** & **1133**	**1297** *S.Target velocity*[2] Default: 806 - Obj. 0x6042 Target Velocity	**1203** *Target Speed*
Limitation[3]	Obj. 0x6046/1 & /2 Velocity min max amount = **418 & 419**	Obj. 0x6046/1 & /2 Velocity min max amount = **418 & 419**	Obj. 0x6046/1 & /2 Velocity min max amount = **418 & 419**
Acceleration	Obj. 0x609A/0 Acceleration ▪ **1134**	Obj. 0x6048/0 Velocity acceleration = **420** (&422)	**1204** *Acceleration*
Deceleration	Obj. 0x609A/0 Acceleration ▪ **1134**	Obj. 0x6049/0 Velocity deceleration = **421** (& 423)	**1205** *Deceleration*
Quick Stop [4]	Obj. 0x6085/0 Quick stop deceleration ▪**1179** *Emergency Ramp*	Obj. 0x604A/0 Velocity Quick Stop = **424** (& 425)	Obj. 0x6085/0 Quick stop deceleration **1179** *Emergency Ramp*
Homing Method	Obj. 0x6098/0 Homing method ▪**1130**		
Motion Block			Selected via Control word

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

2) Parameters **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 is always restricted by **418** *Minimum frequency* and **419** *Maximum frequency.*.
1118 *Limitation* of the Position controller in configuration x40 can result in a boost above maximum frequency.

4) Quick Stop or Deceleration is used depending on Stopping behavior **630** *Operation mode* or Communication fault reaction 0x6007/0 *abort connection option code*.

Mode	Profile Positioning mode	Interpolated position mode
Modes of Operation 1)2)	1	7
Target Position	**1293**, *S.Target Pos.* 2)) Default: 802 - Obj. 0x607A Target Position	0x60C1/1 interpolation data record
Speed	**1294**, *S.Profile Vel.* 2) Default: 803 - Obj. 0x6081 Profile Velocity	
Limitation3)	Obj. 0x6046/1 & /2 Velocity min max amount = **418 & 419**	Obj. 0x6046/1 & /2 Velocity min max amount = **418 & 419**
Acceleration	**1295**, *Acceleration* 2) Default :804 - Obj. 0x6083 Profile Acceleration	**1295**, *Acceleration* 2) Default :804 - Obj. 0x6083 Profile Acceleration
Deceleration	**1296**, *Deceleration* 2) Default : 805 - Obj. 0x6084 Profile Deceleration	**1296**, *Deceleration* 2) Default : 805 - Obj. 0x6084 Profile Deceleration
Quick Stop 4)	Obj. 0x6085/0 Quick stop deceleration ·**1179** *Emergency Ramp*	Obj. 0x6085/0 Quick stop deceleration ·**1179** *Emergency Ramp*
Homing Method		
Motion Block		

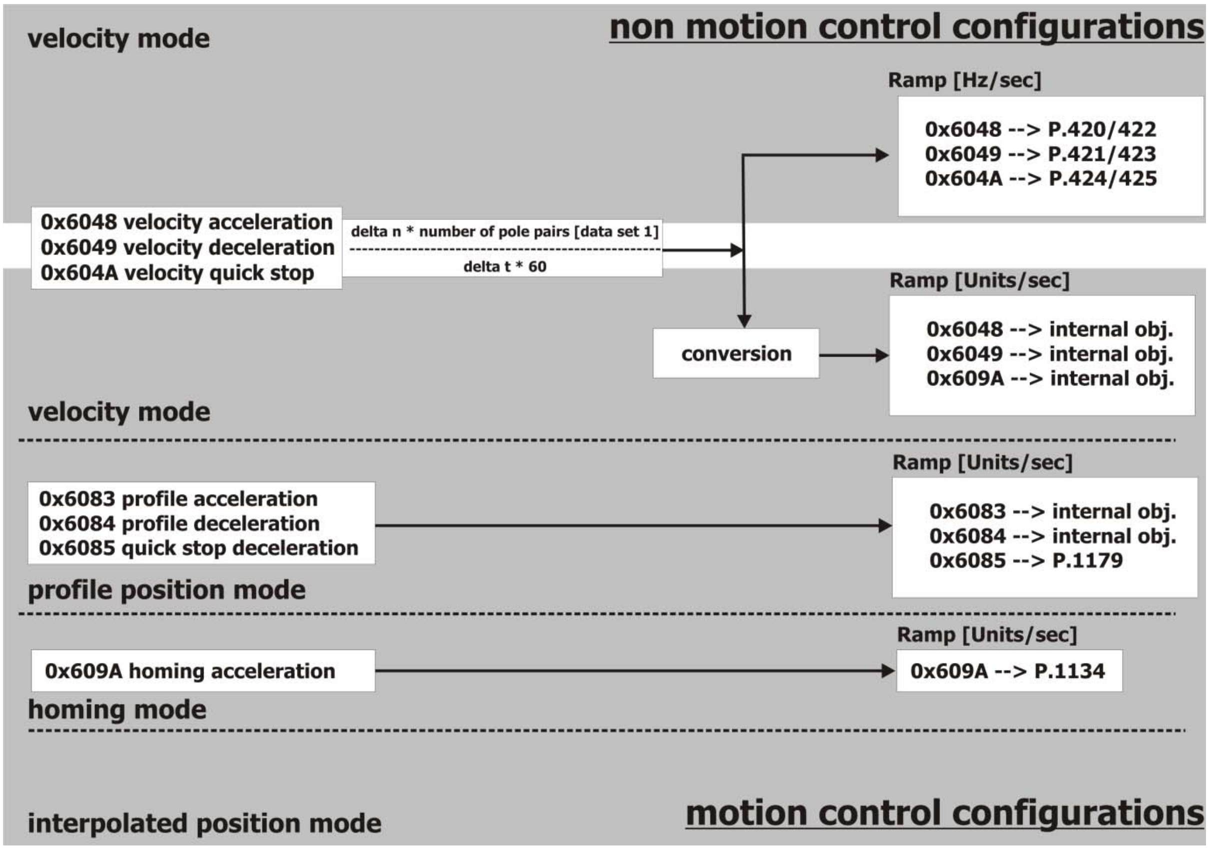
1) Modes of Operation is selected via **1292** *S.Modes of Operation.*
Default setting: 801 - Obj. 0x6060 Modes of Operation.

2) Parameters **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 11.2 for a description.

3) The limitation is always restricted by **418** *Minimum frequency* and **419** *Maximum frequency..* **1118** *Limitation* of the Position controller in configuration x40 can result in a boost above maximum frequency..

4) Quick Stop or Deceleration is used depending on Stopping behavior **630** *Operation mode* or Communication fault reaction 0x6007/0 *abort connection option code*.

Correlation of objects, parameters and value conversion:



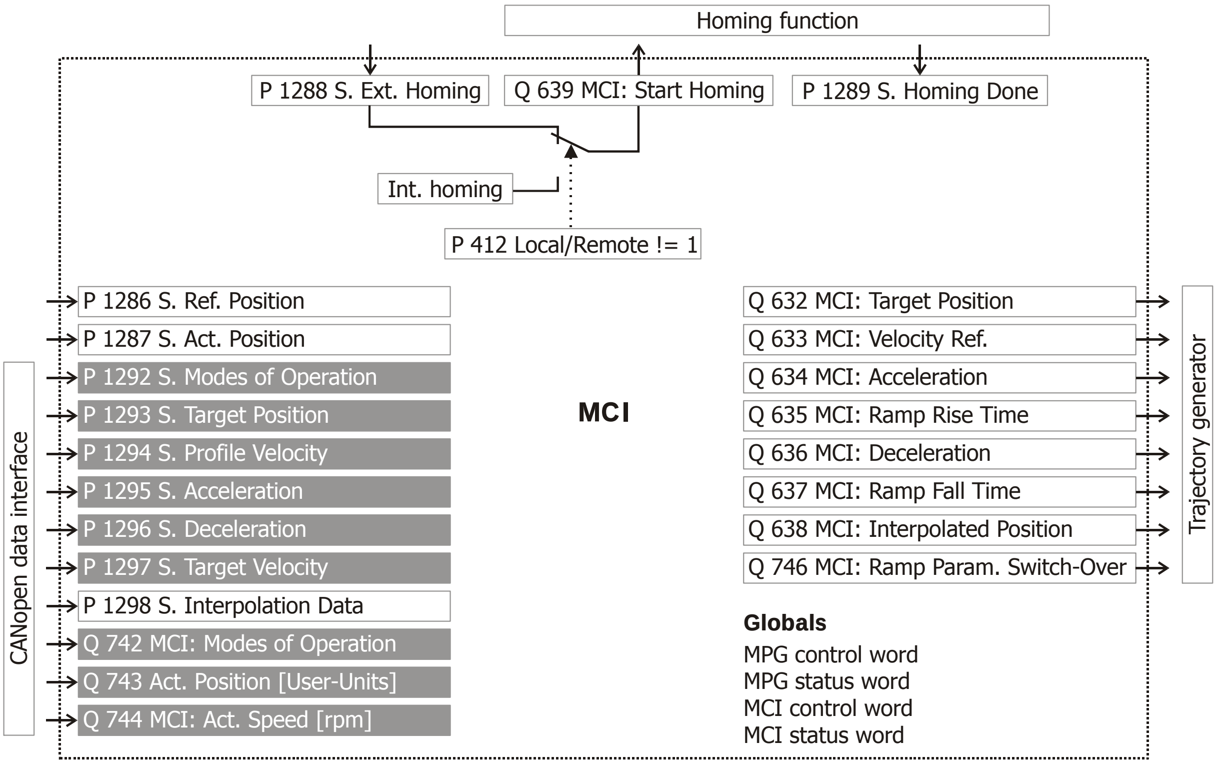
The Motion Control Interface (MCI) is a defined interface of the ACU device for positioning control. Typically this interface is used via a Field bus like CANopen.

11.2 Motion Control Interface for Experts

The Motion Control Interface offers the experienced user the possibility to change the sources which will be used by the Motion Control Interface. By default, these are set to CANopen. Experienced users can change these in example to Systembus sources.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
1292	S. Modes of Operation	Selection		801 – Obj. 0x6060 Modes of Operation
1293	S. Target Position	Selection		802 – Obj. 0x607A Target Position
1294	S. Profile Velocity	Selection		803 – Obj. 0x6081 Profile Velocity
1295	S. Acceleration	Selection		804 – Obj. 0x6083 Profile Acceleration
1296	S. Deceleration	Selection		805 – Obj. 0x6084 Profile Deceleration
1297	S. Target Velocity	Selection		806 – Obj. 0x607A Target Velocity

The figure below shows the parameters (P) and sources (Q) that are defined in the Motion Control Interface. For CANopen, the settings have not to be changed. The source outputs are linked to the Trajectory generator by default and also need not be changed in standard applications.



12 Inverter Control

The control of the frequency inverter can, in principle, be carried out using three operation modes. These are set via the data set change-over capable parameter *Local/Remote* **412**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
412	Local/Remote	0	44	44

For operation with CANopen®, only the settings 0, 1 and 2 are relevant. The remaining settings relate to the possibilities of control via the KP500 control unit.

Control mode		Function
0 -	Control via digital inputs (chapter12.1)	The Start and Stop command as well as the statement of the direction of rotation are via digital input signals.
1 -	Control via state machine (chapters 12.2, 12.3, 12.4)	The inverter is controlled by the *controlword*. **Only in this control mode are the motion control functions supported by *controlword* and *modes of operation* as defined with CANopen® DS402.**
2 -	Control via remote digital inputs (chapter12.1)	The Start and Stop command as well as the statement of the direction of rotation are via digital input signals emulated by the bits of the *controlword*.

Note:
Parameter *Local/Remote* **412** is data set change-over capable. Thus, it is possible to switch over between the various control modes via the data set selection.

The data set change-over can be carried out locally on the frequency inverter via digital inputs or via the bus. For data set change-over via the bus, parameter *Data set selection* **414** is used.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
414	Data set selection	0	4	0

With *Data set selection* **414** = 0, the data set change-over via digital inputs is active. If *Data set selection* **414** has been set to 1, 2, 3, or 4, the corresponding data set is activated. Data set change-over via the digital inputs is then disabled.

Via parameter *Active data set* **249,** the currently selected data set can be read out. *Active data set* **249** states the activated data set with the value 1, 2, 3 or 4. This is independent of whether the data set change-over was carried out via digital inputs or via *Data set selection* **414**.

12.1 Control via digital inputs/remote digital inputs

In the operation mode Control via Contacts or Control via Remote-Contacts (parameter *Local/Remote* **412** = 0 or 2), the frequency inverter is controlled via the digital inputs S1IND (STOA AND STOB), S2IND to EM-S3IND directly, or by digital input emulation with help of the individual bits in the *controlword*. The meaning of these inputs can be taken from the operating instructions.

Controlword (p.412 = 2)

Bit	
0	S1IND (=STOA and STOB)
1	S2IND
2	S3IND
3	S4IND
4	S5IND
5	S6IND
6	MFI1D
7	EM-S1IND
8	EM-S2IND
9	EM-S3IND
10	-
11	-
12	-
13	-
14	-
15	-

Statusword

Bit	
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	-
9	Remote
10	Target reached
11	Internal limit active
12	-
13	-
14	-
15	Warning 2

Note:
When using the control mode control via remote digital inputs, the digital inputs STOA AND STOB at X210A.3/X210B.2 must be set AND bit 0 of *controlword* must be set in order to get the drive started.

The two control modes, digital inputs and remote digital inputs, are only relevant to the *mode of operation* "velocity mode".

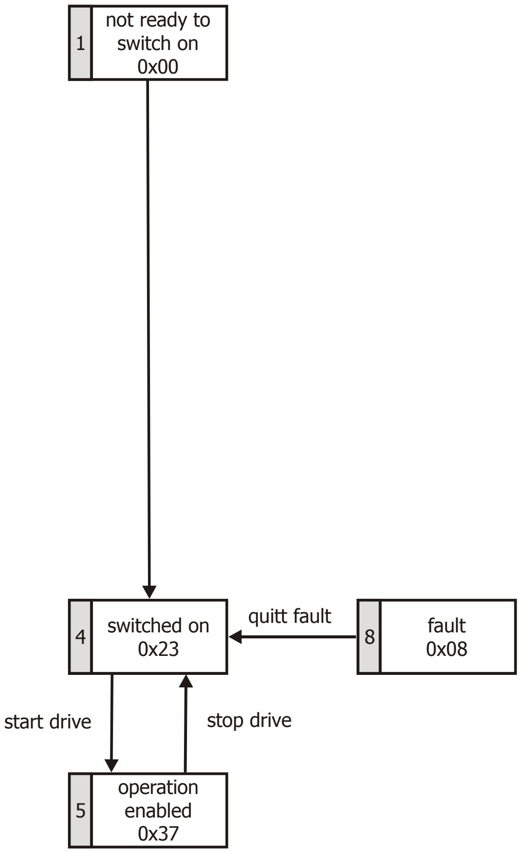
Note:
ACTIVE CUBE inverters support an external 24V supply for control logic. Even if the mains are not switched on, communication between the PLC and the inverter can still be established.

Bit 4 "Voltage enabled" of the *statusword* 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.

State machine:



Stateword	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	x	x	1	x	x	x

Note:
Bits marked "x" are don't care.

Bit no. 7, **Warning**, can be set at any time. It indicates a device-internal warning message. The evaluation of the present warning is carried out by reading out the warning status with parameter *Warnings* **270**.

Bit no. 10, **Target reached,** is set when the specified reference value has been reached. In the special case of power failure regulation, the bit is also set if the power failure regulation has reached the frequency 0 Hz (see operating instructions). For "Reference value reached" there is a hysteresis (tolerance range), which can be set via parameter *max. Control deviation* **549** (see operating instructions).

Bit no. 11, Internal limit active, indicates that an internal limit is active. This can, for example, be the present current limit, the torque limit or the over-voltage limit. All of these limit functions lead to the reference value being quit or not reached.

Bit no. 15, **Warning 2**, indicates a warning which leads to a fault switch-off of the frequency inverter within a short period of time. This bit is set if there is a warning for motor temperature, heat sink/inside temperature, Ixt monitoring or mains phase failure.

12.2 Control via state machine

In the operation mode “control via state machine” (parameter *Local/Remote* **412** = **1**), the frequency inverter is controlled via the *controlword*.

State transition 4 to state “Operation enabled” is only possible when:

- In Motion control configuration (parameter *Configuration* **30** = x**40**) digital input S1IND (= STOA AND STOB) is set.
- In other control configurations (parameter *Configuration* **30** ≠ x**40**) digital input S1IND (= STOA AND STOB) AND (S2IND OR S3IND) is set; S2IND = start clockwise, S3IND = start anticlockwise

Object 0x6040/0 *controlword* is relevant to the inverter whenever parameter *Local/Remote* **412** is set to 1 (remote state machine).

Controlword

Bit	
0	Switch on
1	Enable voltage
2	Quick stop
3	Enable operation
4	Operation mode specific
5	Operation mode specific
6	Operation mode specific
7	Fault reset
8	Halt
9	Operation mode specific
10	Reserved
11	Manufacturer specific
12	Manufacturer specific
13	Manufacturer specific
14	Manufacturer specific
15	Manufacturer specific

Bits 9 … 15 unused

Controlword bits 4, 5, 6 *operation mode specific* and bit 8 *halt* are used in motion control configurations (p.30 = x**40**) only.

Bit	Statusword
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Manufacturer specific
9	Remote
10	Target reached
11	Internal limit active
12	Operation mode specific
13	Operation mode specific
14	Manufacturer specific
15	Manufacturer specific Warning 2

Bit 14 unused

Statusword bits 12 and 13 *operation mode specific* are used in motion control configurations (p.30 = x**40**) only.

Note:
ACTIVE CUBE inverters support an external 24V supply for control logic. Even if the mains are not switched on, communication between the PLC and the inverter can still be established.

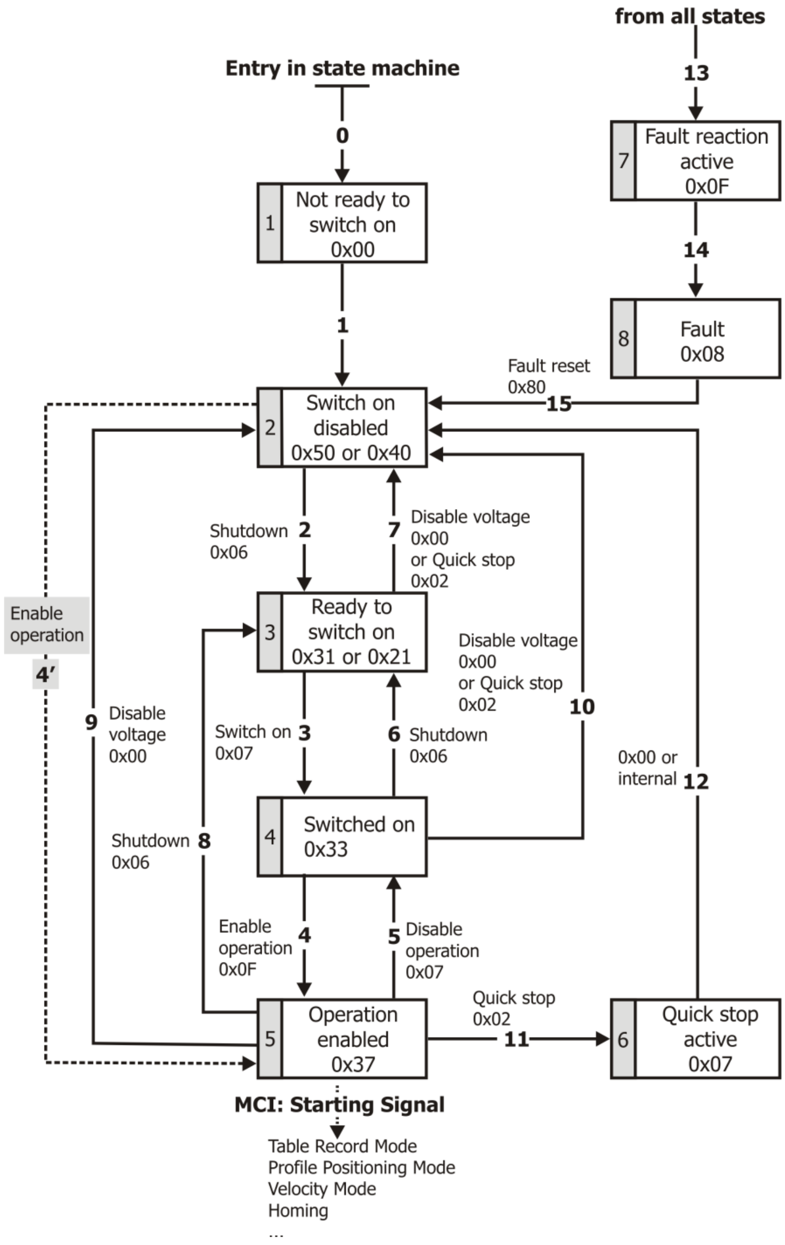
Bit 4 "**Voltage enabled**" of the *statusword* indicates the current state of the mains power supply.

Bit 4 "**Voltage enabled**" **= 0** signals "no mains voltage" and the state transition "Ready to switch on" ➔ "Switched on" is **not possible.**

Bit 4 "**Voltage enabled**" **= 1** signals "mains voltage switched on" and the state transition "Ready to switch on" ➔ "Switched on" is **possible.**

Note:
ACTIVE CUBE inverters and ACTIVE inverters can show different states, because bit 4 of the Status word is used additionally in ACTIVE CUBE like described above.

State machine:



Controlword:

The device control commands are triggered by the following bit pattern in the *controlword*:

Controlword

Command	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0	Transitions
	Fault reset	**Enable operation**	**Quick stop**	**Enable voltage**	**Switch on**	
Shutdown	X	X	**1**	**1**	**0**	2, 6, 8
Switch on	X	**0**	**1**	**1**	**1**	3
Switch on	X	**1**	**1**	**1**	**1**	3
Disable voltage	X	X	X	0	X	7, 9, 10, 12
Quick stop	X	X	**0**	**1**	X	7, 10, 11
Disable operation	X	**0**	**1**	**1**	**1**	5
Enable operation	X	**1**	**1**	**1**	**1**	4
Fault reset	**0 ⇨ 1**	x	x	x	x	15

Bits marked **X** are irrelevant

Note:
State transition 3 (command "Switch on") is only processed if bit no. 4 "Voltage enabled" of the statusword is set.

Note:
In configurations **with** motion control (p.30 = x**40**) consider the following points:

- State transition **4'** is **not** available.
- In status "5 – Operation enabled 0x37" an additional start signale has to be set via the "High-Byte" of the control word to start a motion of the motor. The start signal of this Motion Control Interface (MCI) is described in chapter 12.4. To change into another MCI operation mode Object 0x6060 Modes of operation can be used.
- The controller release (STOA and STOB) must be set. Start clockwise and start anticlockwise have no function in motion control configurations.

Note:
In configurations **without** motion control (p.30 ≠ x**40**) consider the following points:

- State transition **4'** is available and is only processed if bit no. 4 "Voltage enabled" of the statusword is set. This function is for downward compatibility to older software versions.
- The inverter can only be controlled via the state machine if the logic linking is true. The logic inputs for Start clockwise / Start anticlockwise can be connected directly to ON/OFF (p.68, p.69).
  The controller release (STOA and STOB) must be set.
  Therefore this results in:
  Release: (= STOA AND STOB) **AND** (Start clockwise **OR** Start anticlockwise)

Statusword:
The *statusword* displays the current operation state.

Statusword

	Bit 6	Bit 5	Bit 3	Bit 2	Bit 1	Bit 0
state	**Switch on disabled**	**Quick stop**	**Fault**	**Operation enabled**	**Switched on**	**Ready to switch on**
Switch on disabled	**1**	X	**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	**0**	**0**	**0**	**1**	**1**	**1**
Fault reaction active	**0**	X	**1**	**1**	**1**	**1**
Fault	**0**	X	**1**	**0**	**0**	**0**

Bits marked **X** are irrelevant

Bit 7, **Warning**, can be set at any time. It indicates a device-internal warning message. The evaluation of the warning reason is carried out by reading out the warning status with the parameter *Warnings* **270.**

Bit 9, **Remote**, is set if the operation mode "control via state machine" (*Local/Remote* **412** = 1) has been set **and** the hardware release is available.

Bit 10, Target reached, is set whenever the specified reference value has been reached.
In non motion control configurations (p.30 ≠ x**40**), target reached is related to the reference speed object 0x6042 *target velocity*. In the special case of power failure regulation, the bit is also set if the power failure regulation has reached the frequency 0 Hz (see operating instructions).
For "Target reached‟ there is a hysteresis (tolerance range), which can be set via parameter *max. Control deviation* **549** (see operating instructions).

Bit 11, Internal limit active, indicates that an internal limit is active. This can, for example, be the present current limit, the torque limit or the over-voltage limit. All of these limit functions lead to the reference value being quit or not reached.

Bit 15, Warning 2, indicates a warning which leads to a fault switch-off of the frequency inverter within a short period of time. This bit is set if there is a warning for motor temperature, heat sink/inside temperature, Ixt monitoring or mains phase failure.

12.3 Non motion control configurations

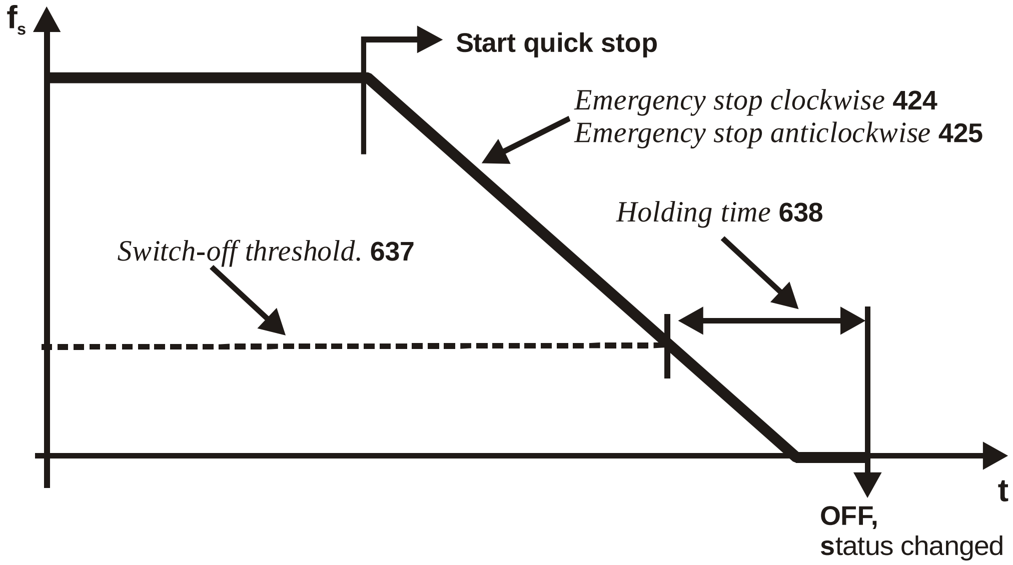
In non motion control configurations (p.30 ≠ x**40**), object 0x6060 *modes of operation* is fixed to "2" *velocity mode*. Object 0x6061 *modes of operation display* is always "2" *velocity mode*. This cannot be changed.

Related objects:

0x6040	Controlword
0x6041	Statusword
0x6042	Target velocity
0x6043	Velocity demand
0x6044	Control effort
0x6046	Velocity min max amount
0x6048	Velocity acceleration
0x6049	Velocity deceleration
0x604A	Velocity quick stop

12.3.1 Behavior in quick stop

In quick stop, the parameters *Switch-off threshold* **637** (percent of fmax) and *Holding time* **638** (holding time after falling short of the switch-off threshold) are relevant. In a quick stop the drive is shutdown via the emergency stop ramps. The emergency ramps are set up via Object 0x604A *Velocity Quick Stop* or parameters *Emergency stop clockwise* **424** and *Emergency stop anti-clockwise* **425**.



If frequency/speed zero has been reached during the holding time, the drive continues to be supplied with direct current until the switch-off time has expired. With this measure, there is an assurance that the drive is stationary in a change of state.

Note:
"Behavior in quick stop" is only relevant for non motion control configurations (p.30 ≠ x**40**).

12.3.2 Behavior in transition 5 (Disable operation)

The *behavior in transition 5* from "Operation enabled" to "Switched on" can be parameterized. The behavior is set via parameter *State transition 5* **392**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
392	State transition 5	0	2	2

Operation mode	Function
0 - Coast to stop	immediate transition from "Operation enabled‟ to "Switched on‟, free stoppage of the drive
1 - DC brake	activation of DC brake; at the end of DC braking there is a change of state from "Operation enabled‟ to "Switched on‟
2 - Ramp	transmission with normal stop ramp; after reaching standstill, there is a change of state from "Operation enabled‟ to "Switched on‟

Note:
Setting operation mode "1 - DC brake‟ is only possible in applications with v/f characteristic (e.g. configuration 110), as other applications do not know such an operation mode.
If the frequency inverter is operated with a configuration which does not know the DC braking operation mode (e.g. configuration 210, field-orientation speed controlled), value "1" cannot be set. It is also not offered in the selection menus of the KP500 control unit or the VPlus program.

Note:
The default value for parameter *State transition 5* **392** is operation mode "2 - Ramp". For configurations with torque control, the default value is operation mode "0 - Coast to stop". If the configuration is changed, the value set for *State transition 5* **392** is also altered, if necessary.

Note:
"Behavior in transition 5" is only relevant for non motion control configurations (p.30 ≠ x**40**).

If transition 5 has been triggered with *State transition 5* **392** = "1 - DC brake‟, a new control word is only accepted after the completion of the transition process. The change of state from "Operation enabled‟ to "Ready‟ is carried out after the time parameterized for the DC brake *Braking time* **632** has expired.

If the parameter *State transition 5* **392** = "2 - Ramp‟ has been set, the *controlword* can be set back to "Enable operation" during the stoppage of the drive. In this way, the drive runs back up to its set reference value and remains in the state "Operation enabled‟.

The change of state from "Operation enabled‟ to "Switched on‟ is carried out after the set switch-off threshold has been reached **and** the set holding time (equivalent to the behavior in a quick stop) has expired. In this, the parameters *Switch-off threshold* **637** (percent of fmax) and *Holding time* **638** (holding time after switch-off threshold reached) are relevant.

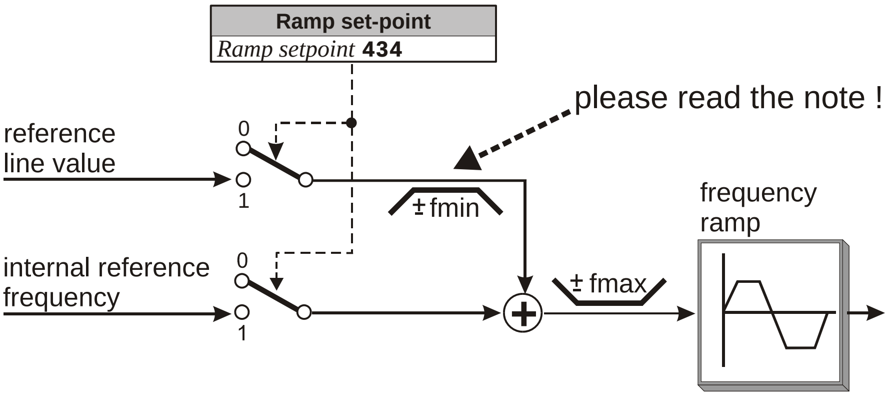
12.3.3 Reference value / actual value

The PLC gives its reference value to the frequency inverter via object 0x6042/0 *target velocity* in the RxPDO used and receives the information on its actual value back via object 0x6044/0 *control effort* in the TxPDO used.

The use of the reference/actual value channel depends on the set configuration (control system). The actual value is generated from the appropriate source depending on the control system used.

Note:
The reference value in object 0x6042/0 *target velocity* and the actual value in object 0x6044/0 *control effort* 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 *target velocity* is connected to 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.**	**Fact. sett.**
434	Ramp setpoint	1	3	3

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

Note:
This function is only relevant for non motion control configurations (p.30 ≠ x**40**).

Note:
If *Ramp set-point* **434** = 2 (only reference line value), then this reference line value is limited to fmin. Please remember that the sign in front of fmin at reference value = 0 is derived from the sign in front of the last reference line value ≠ 0.
After Power On, the reference line value is limited to +fmin!

For *Ramp set-point* **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**
Internal reference frequency **228**	Internal reference value from the frequency reference value channel	xxx.xx Hz
Reference bus frequency **282**	Reference line value from the CANopen® bus	xxx.xx Hz
Reference ramp frequency **283**	Sum of internal + reference line value	xxx.xx Hz

12.3.4 Example Sequence

To start the drive without Position control (*configuration* **30** ≠ x40), the correct sequence has to be sent from the PLC.

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

Note: In non motion control configurations (p.30 ≠ x**40**) the second (shortened) sequence can be used because state transition **4‘** is available in these configurations.

12.4 Motion control configurations

The function of the state machine describes the basic behavior of the inverter. In motion control configurations (p.30 = 0x**40**). The previously described objects *controlword* and *statusword* support the bits marked as "operation mode specific".
The meaning of these bits and the bit "Target reached" are different for the different motion control modes set by object 0x6060 *modes of operation*. The following chapters describe the use of the operation mode specific bits in *controlword* and *statusword* depending on the different motion control modes. The default value of 0x6060 *modes of operation* = **2** - velocity mode.

Principle functions:

Before a motion control command can be set by the "operation mode specific" bits of the *controlword,* the state machine must be set to "Operation enabled".

After the PLC has set a mode to object *modes of operation,* commands for this mode are not accepted until this mode is displayed in object *modes of operation display*.

The bits in *controlword* and *statusword* marked "operation mode specific" are only supported in motion control configurations (p.30 = x40).

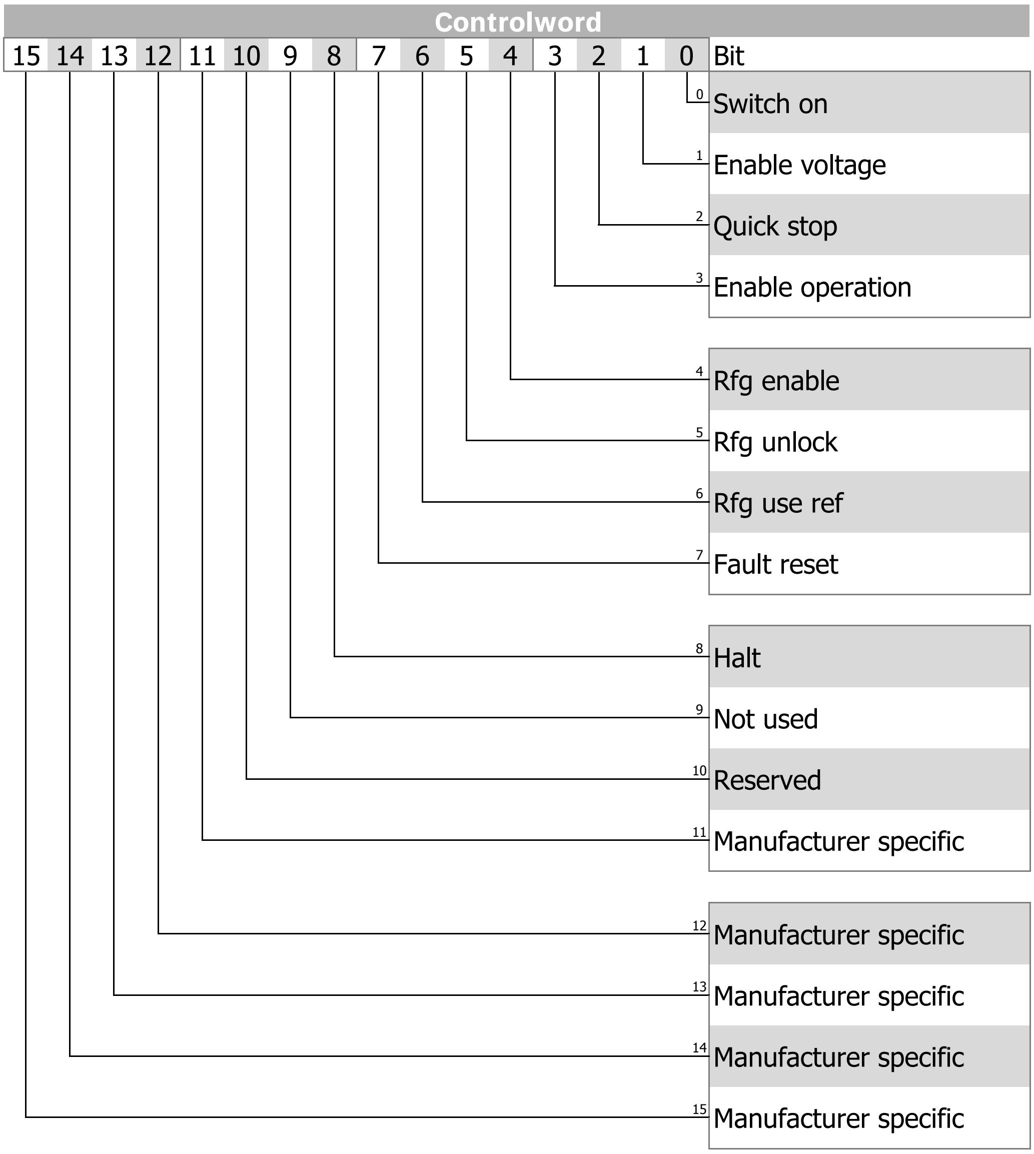
12.4.1 Velocity mode

The velocity mode is selected via object 0x6060/0 *Modes of operation* = **2.**
In velocity mode the "operation mode specific" bits of the *controlword* control the ramp function generator "**rfg**". The function is explained in the block diagram.

Related objects:

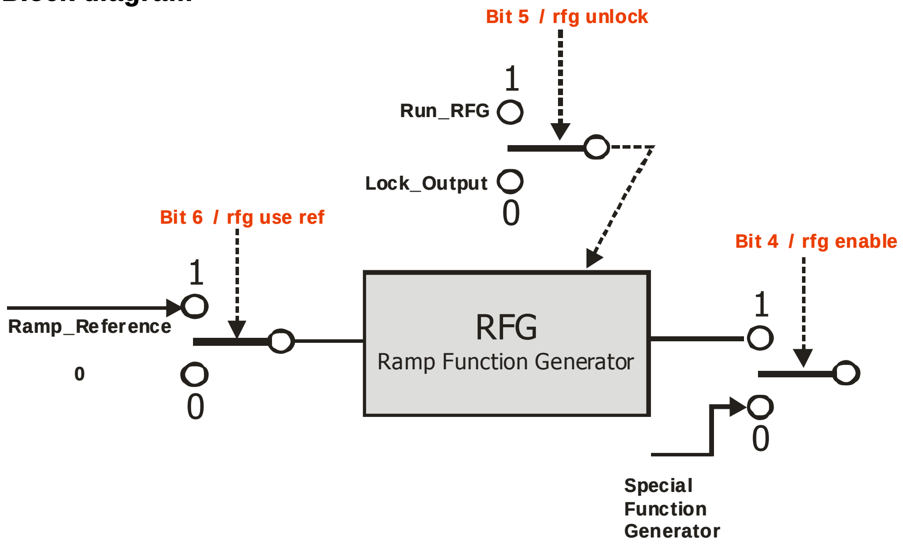
0x6040	Controlword
0x6041	Statusword
0x6042	Target velocity
0x6043	Velocity demand
0x6044	Control effort
0x6046	Velocity min max amount
0x6048	Velocity acceleration
0x6049	Velocity deceleration
0x604A	Velocity quick stop
0x6060	Modes of operation
0x6061	Modes of operation display

1



Statusword	
Bit	
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Manufacturer specific
9	Remote
10	Target reached (not used)
11	Internal limit active
12	Not used
13	Not used
14	Manufacturer specific
15	Manufacturer specific Warning2

Block diagram



Bit 4:rfg enable
The "rfg enable" bit (bit 4) is not supported by the inverter and has no function.
Bit 5:rfg unlock
Rfg unlock = 0 The last speed value is hold and used.
Rfg unlock = 1 The ramp function is active and will change the speed according to the setpoint and the ramp.
Bit 6: rfg use ref
Rfg use ref = 0 The setpoint "0" is used.
Rfg use ref = 1 The setpoint of 0x6042 *Target Velocity* is used.
Bit 8: Halt
HALT = 0 → **execute motion**
HALT = 1 → **stop axle** (inverter remains in state "operation enabled")

12.4.1.1 Example Sequence

To start the velocity mode, the correct sequence has to be sent from the PLC.

1	Control word = Status word =	0x0000 0x0050	Disable voltage Switch On Disabled
2	Modes of Operation =	2	(Velocity mode)
3	Control word = Status word =	0x0006 0x0031	Shutdown Ready to switch on
4	Control word = Status word =	0x0007 0x0033	Switch On Switched On
5	Control word = Status word =	0x000F 0xnn37	Enable Operation, no change to previous state if already enabled. Operation enabled
6a	Control word = Status word =	0x007F or 0x006F 0xnn37	Start Velocity mode with Reference speed from object 0x6042 Target velocity. Operation enabled
6b	Control word = Status word =	0x003F or 0x002F 0xnn37	Start Velocity mode with Reference speed "0". Operation enabled
6c	Control word = Status word =	0x005F or 0x004F 0xnn37	Start Velocity mode with actual speed – a ramping process is cancelled.. Disable voltage
7	Control word = Status word =	0x01xx 0xnn37	HALT: The drive is stopped with ramp 0x6049 *Velocity deceleration*. Operation enabled

Note: 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.
Danger: When 0x6060 *Modes of Operation* is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode. Bonfiglioli Vectron recommends checking the status word before changing 0x6060 *Modes of Operation* (i.e. check state 0xnn33).

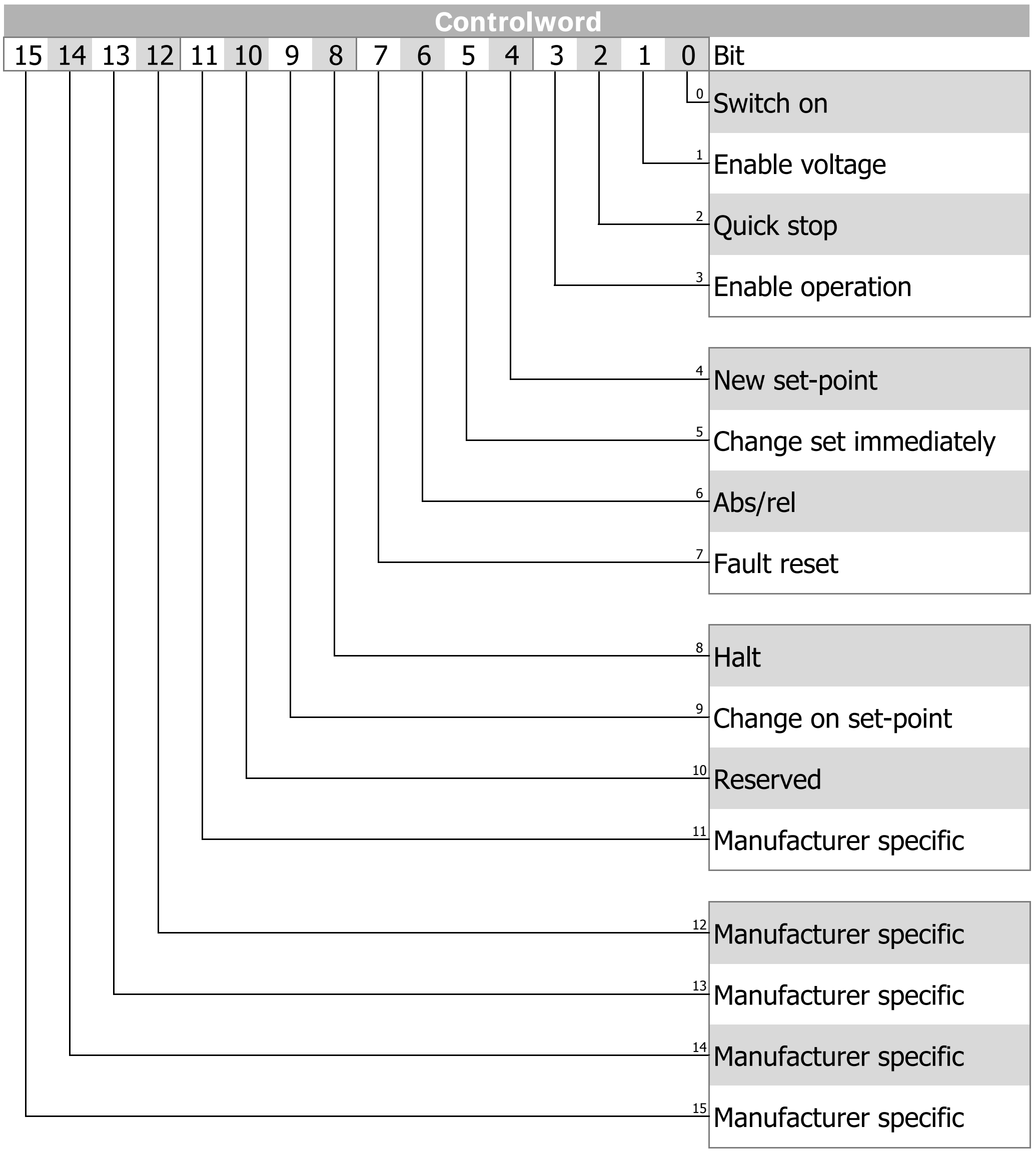
12.4.2 Profile position mode

The profile position mode is selected via object 0x6060/0 *Modes of operation* =**1.**
In profile position mode the inverter receives a target position followed by a command to move to this position.

Related objects:

0x6040	Controlword
0x6041	Statusword
0x6046	Velocity min max amount
0x6060	Modes of operation
0x6061	Modes of operation display
0x607A	Target position
0x6081	Profile velocity
0x6083	Profile acceleration
0x6084	Profile deceleration
0x6085	Quick stop deceleration

In profile position mode the "operation mode specific" bits of controlword and statusword are used as shown:



Controlword

Bit	
0	Switch on
1	Enable voltage
2	Quick stop
3	Enable operation
4	New set-point
5	Change set immediately
6	Abs/rel
7	Fault reset
8	Halt
9	Change on set-point
10	Reserved
11	Manufacturer specific
12	Manufacturer specific
13	Manufacturer specific
14	Manufacturer specific
15	Manufacturer specific

Statusword

Bit	
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Manufacturer specific
9	Remote
10	Target reached
11	Internal limit active
12	Set-point acknowledge
13	Following error
14	Manufacturer specific
15	Manufacturer specific Warning 2

Controlword

Change on set-point Bit 9	Change set-point immediately Bit 5	New set-point Bit 4	Description
0	0	0 → 1	Positioning shall be completed (target reached) before the next one is started
X	1	0 → 1	Next position shall be started immediately
1	0	0 → 1	Positioning with the current profile velocity up to the current set-point shall be proceeded and then the next positioning shall be applied

Name	Value	Description
Abs/rel **Bit 6**	0	*Target position* is an absolute value
	1	*Target position* is a relative value
Halt **Bit 8**	0	Execute positioning
	1	Stop axle with *profile deceleration* (if not supported with *profile acceleration*), the inverter remains in state "operation enabled"

Statusword

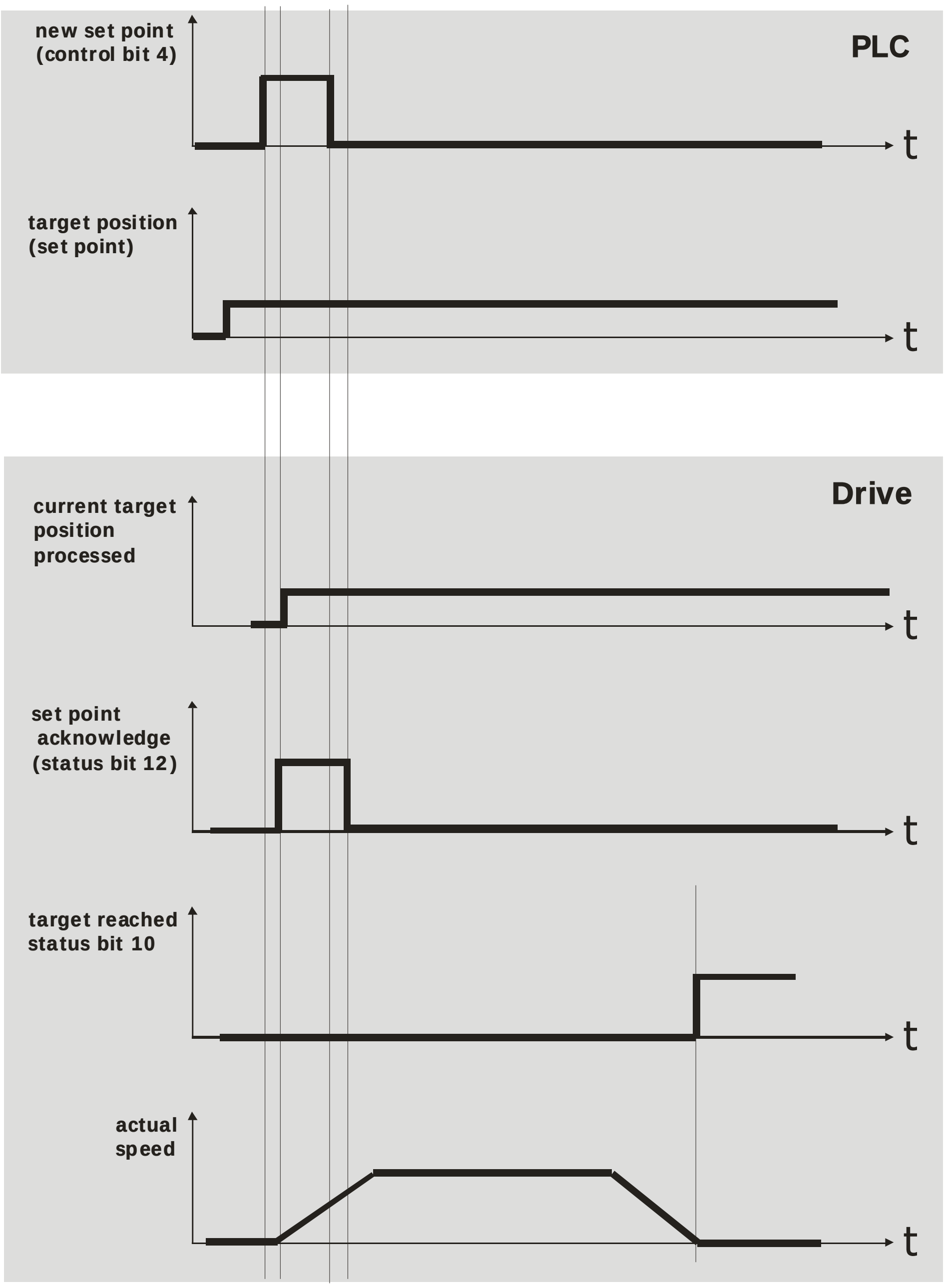
Name	Value	Description
Target reached **Bit 10**	0	Halt = 0: *target position* not reached
		Halt = 1: axle decelerates
	1	Halt = 0: *target position* reached
		Halt = 1: velocity of axle is 0
Set-point acknowledge **Bit 12**	0	Trajectory generator has not assumed the positioning value (yet)
	1	Trajectory generator has assumed the positioning value
Following error **Bit 13**	0	No following error
	1	Following error

Example: **single set-point**

control bit *change on set-point* = **0**

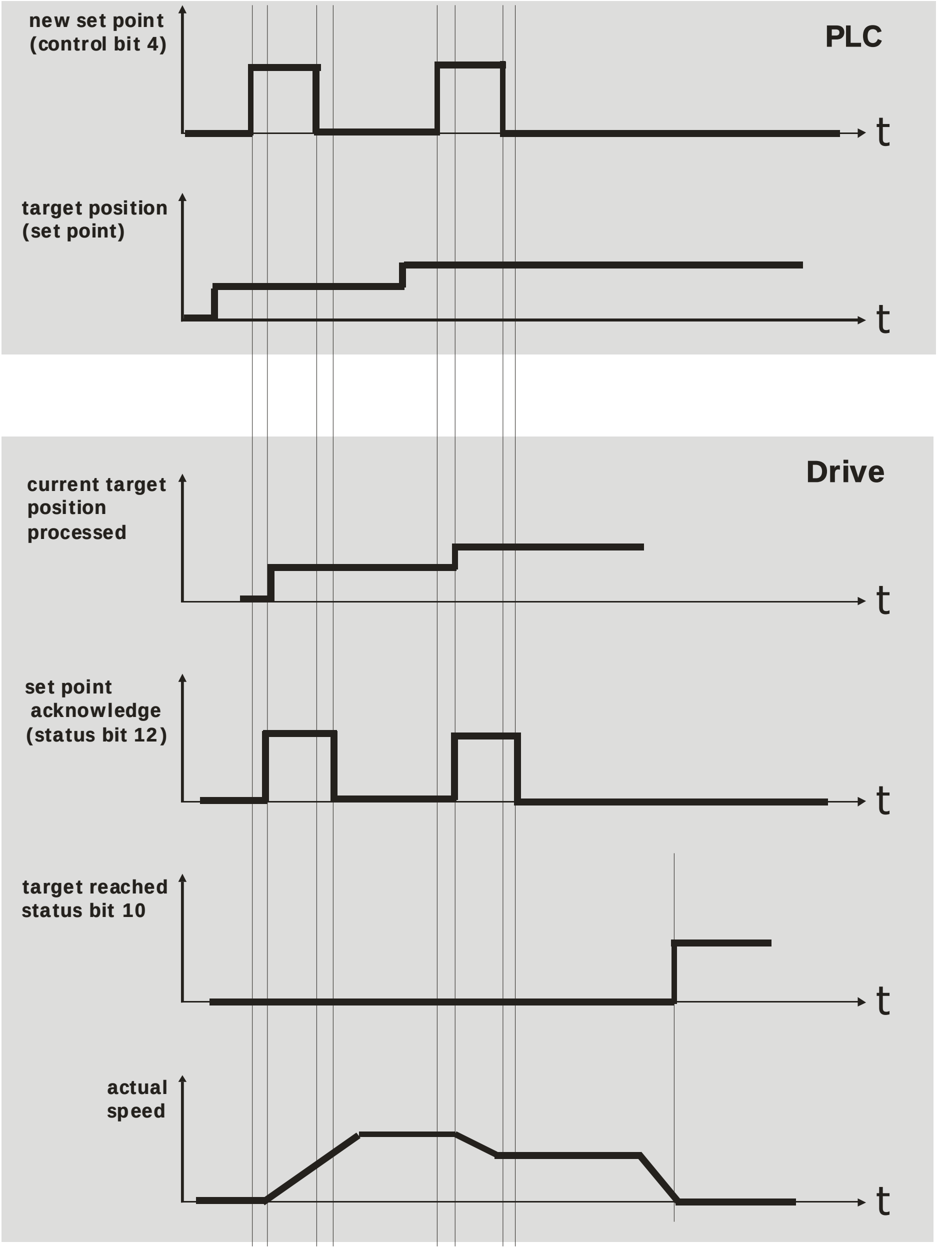
control bit *change set immediately* = **0**

After a set-point is sent to the drive, the control device signals set-point valid by a rising edge on bit *new set-point* in the controlword. The drive answers by setting bit *set-point acknowledge* and starts moving to the new target position. After that, the control device clears the bit *new set-point* and the drive also clears the bit *set-point acknowledge*. After clearing the bit *set-point acknowledge* the drive is able to accept a new target position.


new set point (control bit 4)
PLC
t
target position (set point)
t
current target position processed
Drive
t
set point acknowledge (status bit 12)
t
target reached status bit 10
t
actual speed
t

Example: **single set-point**
control bit *change on set-point* = **0**
control bit *change set immediately* = **1**

When a set-point is in progress and a new set-point is validated by control bit *new set-point* (rising edge), the new set-point is processed immediately.



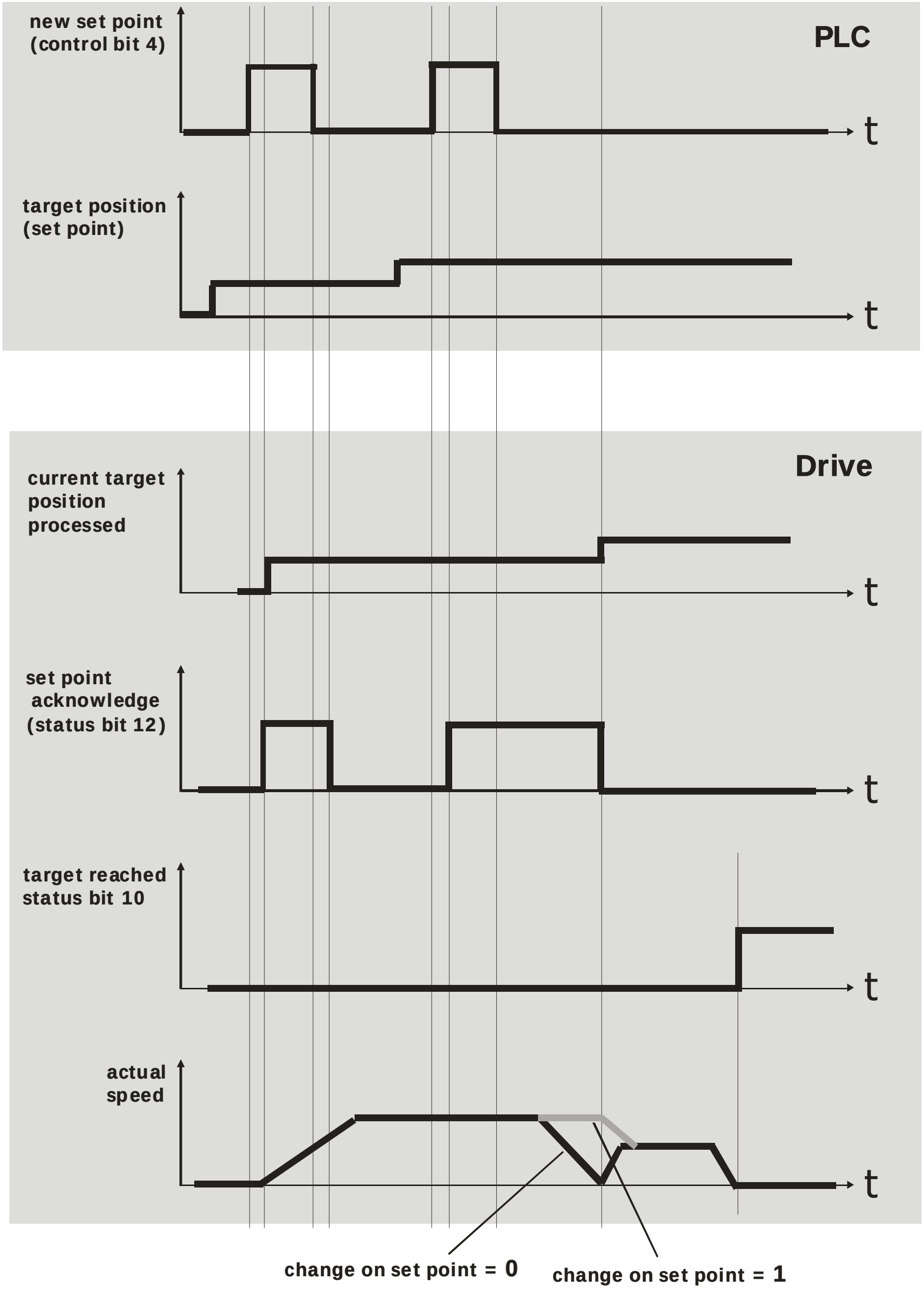
Example: **set of set-points**
control bit *change on set-point* = **0/1**
control bit *change set immediately* = **0**

While a Positioning is in progress, the set point is changed.

Change on set point = 0 Current target position will be **stopped** at. After the position is reached, the new set point is taken over.

Change on set point = 1 The current target position will be **driven to in current speed.** As soon as the position is reached, the new set point is taken over.

The grey line in segment "actual speed" shows the actual speed behavior if control bit *change of set- point* is set (= **1**).



12.4.2.1 Example Sequence

To start the Profile position mode, the correct sequence has to be sent from the PLC.

1	Control word = Status word =	0x0000 0x0050	Disable voltage Switch On Disabled
2	Modes of Operation =	1	(Profile Positon mode)
3	Control word = Status word =	0x0006 0x0031	Shutdown Ready to switch on
4	Control word = Status word =	0x0007 0x0033	Switch On Switched On
5	Control word = Status word =	0x0007 ↓ 0x000F 0xnn37	Enable Operation. A positioning is not started Operation enabled
6a	Control word = Status word =	0x0007 or 0x000F ↘ ↙ 0x001F 0xnn37	Enable Operation, start with **absolute** movement Profile[1]. If a motion is already running, that motion is finished, then the new Profile will be used. Operation enabled
6b	Control word = Status word =	0x0007 or 0x000F ↘ ↙ 0x005F 0xnn37	Enable Operation, start with **relative** movement Profile[1]. If a motion is already running, that motion is finished, then the new Profile will be used. Operation enabled
6c	Control word = Status word =	0x0007 or 0x000F ↘ ↙ 0x003F 0xnn37	Enable Operation, start with **absolute** movement Profile[1]. A running motion is changed to the new profile. Operation enabled
6d	Control word = Status word =	0x0007 or 0x000F ↘ ↙ 0x007F 0xnn37	Enable Operation, start with **relative** movement Profile[1]. A running motion is changed to the new profile. Operation enabled
7	Control word = Status word =	0x01nF 0xnn37	HALT: The drive is stopped with ramp 0x6049 *Velocity deceleration*. Operation enabled

1) A profile consists of the following entries. If a value is not changed, the old value will still be active.

- 0x607A *Target Position*
- 0x6081 *Profile velocity*
- 0x6083 *Profile acceleration*
- 0x6084 *Profile deceleration*

Note: 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 Profile 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.
Note: To start a new Positon Profile, it is not necessary to change the Control word to 0x0007 first and switch to 0xnnnF.
After a position profile is finished a new Profile can be started from controlword 0xnnnF by using the "New Setpoint" Bit (Bit 4).
While a position profile is active, using the "Change Setpoint immediately" (Bit 5) and "New Setpoint" (Bit 4) will start a new profile without stopping.
Danger: When 0x6060 *Modes of Operation* is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode. Bonfiglioli Vectron recommends checking the status word before changing 0x6060 *Modes of Operation* (i.e. check state 0xnn33).

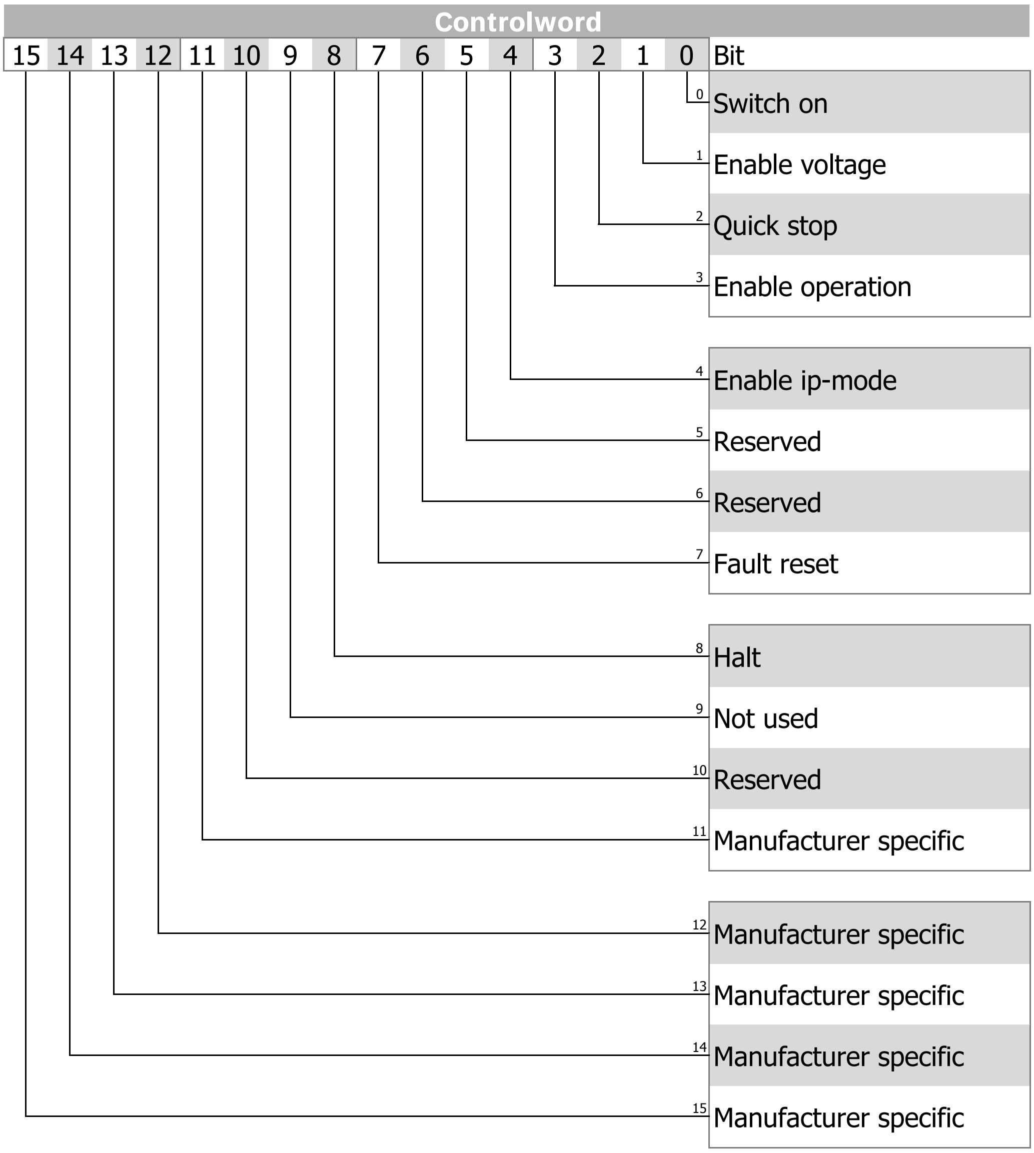
12.4.3 Interpolated position mode

The interpolated position mode is selected via object 0x6060/0 *Modes of operation* = **7.** In interpolated position mode the inverter receives a target position at equidistant time intervals.

Related objects:

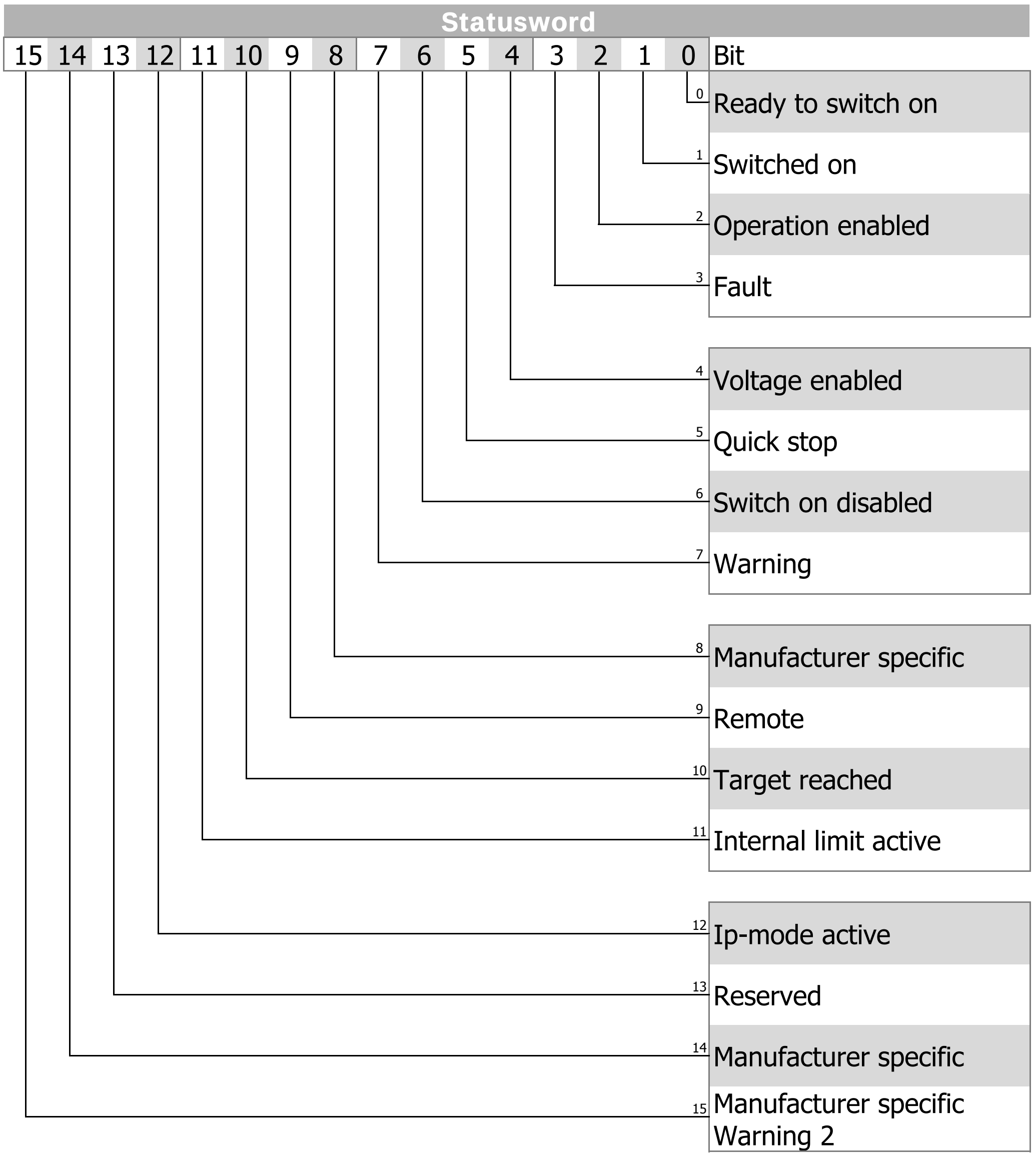
0x6040	Controlword
0x6041	Statusword
0x6046	Velocity min max amount
0x6060	Modes of operation
0x6061	Modes of operation display
0x6083	Profile acceleration
0x6084	Profile deceleration
0x6085	Quick stop deceleration
0x60C1	Interpolation data record

In interpolated position mode the "operation mode specific" bits of *controlword* and *statusword* are used as shown:



Controlword

Bit	
0	Switch on
1	Enable voltage
2	Quick stop
3	Enable operation
4	Enable ip-mode
5	Reserved
6	Reserved
7	Fault reset
8	Halt
9	Not used
10	Reserved
11	Manufacturer specific
12	Manufacturer specific
13	Manufacturer specific
14	Manufacturer specific
15	Manufacturer specific



Statusword

Bit	
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Manufacturer specific
9	Remote
10	Target reached
11	Internal limit active
12	Ip-mode active
13	Reserved
14	Manufacturer specific
15	Manufacturer specific Warning 2

Only linear interpolation is available (for this, object 0x60C0/0 *interpolation submode select* is NOT implemented). For proper operation, object 0x60C1/1 *interpolation data re*cord must be sent by a synchronous RxPDO. The time interval of the SYNC messages MUST be constant. For the evaluation of the SYNC interval, object 0x1006/0 *communication cycle period* must be set or at least eleven SYNC messages are necessary before the interpolated position mode is activated by setting control bit 4 *enable_ip_mode*. For the SYNC interval only multiples of milliseconds are allowed (1, 2, 3, 4, …; refer to chapter 10.2.4 "0x1006/0 Communication Cycle Period").
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 0x60C1/1 *interpolation data record*. The new interpolated reference positions and an additional speed reference are calculated from the last reference position, the *interpolation data record* and the time interval of the SYNC messages. As shown, the target position actually received will be reached at the time of the next SYNC message.

Note:

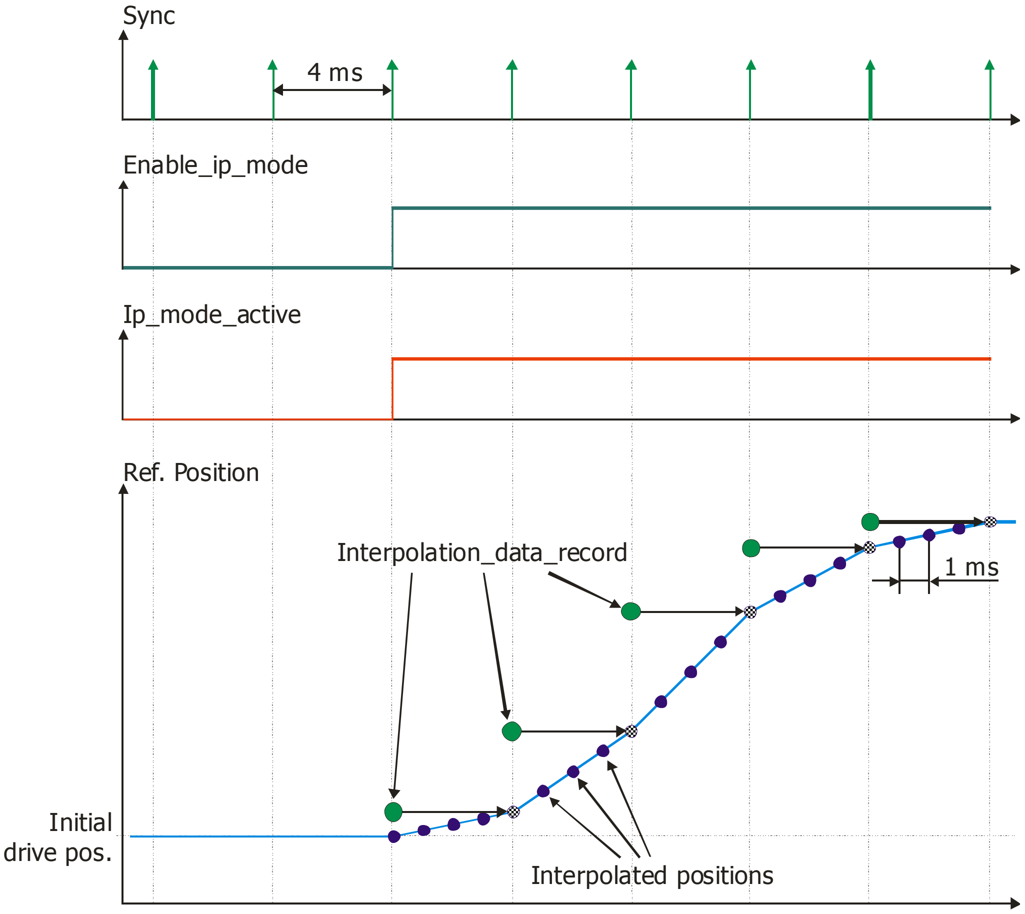
- 0x6083 *Profile acceleration* is only used when the interpolated mode is activated (rising edge of Bit 4 "enable ip-mode").Then this acceleration is used to synchronize from the actual speed to the calculated speed of the interpolated trajectory.
- 0x6084 *Profile deceleration* is used when the interpolated mode is switched off (falling edge of Bit 4 "enable ip-mode") or a HALT signal (Bit 8) is set.
- 0x6085 *Quick stop deceleration* or 0x6084 *Profile deceleration* is used when a fault occurred. This can be changed via Stopping behavior **630** *Operation mode* and Communication fault reaction 0x6007/0 *abort connection option code*.

Controlword

Name	Value	Description
Enable ip-mode **Bit 4**	0	Interpolated position mode inactive
	1	Interpolated position mode active
Halt **Bit 8**	0	Execute the instruction of bit 4 "enable ip-mode"
	1	Stop axle , inverter remains in state "operation enabled" 0x6084 *Profile deceleration* is used for deceleration.

Statusword

Name	Value	Description
Target reached **Bit 10**	0	Halt = 0: position not (yet) reached
		Halt = 1: axle decelerates
	1	Halt = 0: position reached
		Halt = 1: axle has velocity 0
Ip-mode active **Bit 12**	0	Interpolated position mode inactive
	1	Interpolated position mode active


Sync
4 ms
Enable_ip_mode
Ip_mode_active
Ref. Position
Interpolation_data_record
1 ms
Initial
drive pos.
Interpolated positions

12.4.3.1 Example Sequence

To start the Interpolated position mode, the correct sequence has to be sent from the PLC.

1	Control word = Status word =	0x0000 0x0050	Disable voltage Switch On Disabled
2	Modes of Operation =	7	(Interpolated Positon mode)
3	Control word = Status word =	0x0006 0x0031	Shutdown Ready to switch on
4	Control word = Status word =	0x0007 0x0033	Switch On Switched On
5a	Control word = Status word =	0x000F 0xnn37	Enable Operation. Operation enabled
5b	Control word = Status word =	0x001F 0x1n37	Enable Operation and start Interpolated Mode (IP). Operation enabled

Note: 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 Interpolated position mode is stopped. After that it is possible to start again with 0x001F.
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.
Note: Always ensure that a valid position is stored in the Interpolated Data Record. Bonfiglioli Vectron recommends copying the actual position to the Data Record before starting the Interpolated mode.
Danger: When 0x6060 *Modes of Operation* is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode. Bonfiglioli Vectron recommends checking the status word before changing 0x6060 *Modes of Operation* (i.e. check state 0xnn33).

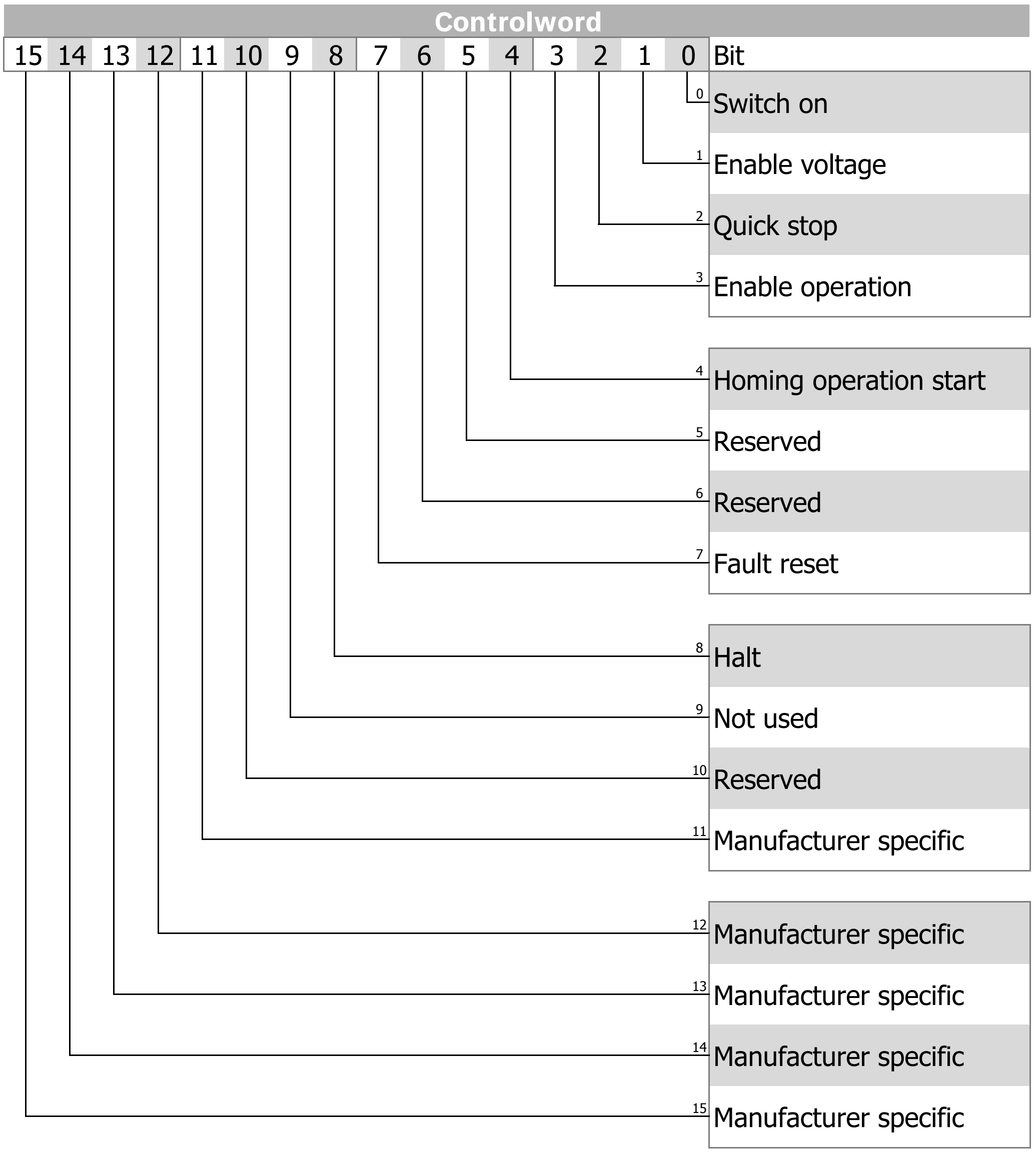
12.4.4 Homing mode

The homing mode is selected via object 0x6060/0 *Modes of operation* = **6.** In homing mode the inverter moves the drive to a reference position. The method used for this movement is defined by object 0x6098 *homing method*.

Related objects:

0x6040	Controlword
0x6041	Statusword
0x6046	Velocity min max amount
0x6060	Modes of operation
0x6061	Modes of operation display
0x6098	Homing method
0x6099	Homing speeds
0x609A	Homing acceleration

In homing mode the "operation mode specific" bits of *controlword* and *statusword* are used as shown:



Controlword

Bit	
0	Switch on
1	Enable voltage
2	Quick stop
3	Enable operation
4	Homing operation start
5	Reserved
6	Reserved
7	Fault reset
8	Halt
9	Not used
10	Reserved
11	Manufacturer specific
12	Manufacturer specific
13	Manufacturer specific
14	Manufacturer specific
15	Manufacturer specific

Statusword

Bit	
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Manufacturer specific
9	Remote
10	Target reached
11	Internal limit active
12	Homing attained
13	Homing error
14	Manufacturer specific
15	Manufacturer specific Warning 2

Controlword

Name	Value	Description
Homing operation start **Bit 4**	0	Homing mode inactive
	0 → 1	Start homing mode
	1	Homing mode active
	1 → 0	Interrupt homing mode
Halt **Bit 8**	0	Execute instruction of bit 4 “homing operation start”
	1	Stop axle with homing acceleration, , inverter remains in state “operation enabled”

Statusword

Name	Value	Description
Target reached **Bit 10**	0	Halt = 0: home position not reached
		Halt = 1: axle decelerates
	1	Halt = 0: home position reached
		Halt = 1: axle has velocity 0
Homing attained **Bit 12**	0	Homing not yet completed
	1	Homing mode carried out successfully
Homing error **Bit 13**	0	No homing error
	1	Homing error occurred Homing mode carried out unsuccessfully

For an exact description of the various homing modes refer to the application manual "Positioning".

12.4.4.1 Example Sequence

To start the Homing mode, the correct sequence has to be sent from the PLC.

1	Control word = Status word =	0x0000	0x0050	Disable voltage Switch On Disabled
2	Modes of Operation =	6		(Homing)
3	Control word = Status word =	0x0006	0x0031	Shutdown Ready to switch on
4	Control word = Status word =	0x0007	0x0033	Switch On Switched On
5a	Control word = Status word =	0x000F	0xnn37	Enable Operation. Operation enabled
5b	Control word = Status word =	0x001F	0x1n37	Enable Operation and start Homing. Operation enabled and homing attained.

Note: 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 0x0007 (or 0x000F) to 0x001F the Homing is started. The "homing attained" is set in Bit 12 of the status word.
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.
Danger: When 0x6060 *Modes of Operation* is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode. Bonfiglioli Vectron recommends checking the status word before changing 0x6060 *Modes of Operation* (i.e. check state 0xnn33).

12.4.5 Table travel record

The table travel record mode is selected via object 0x6060/0 *Modes of operation* = **0xFF** =**-1**. In table travel record mode the inverter moves the drive autonomous to consecutive positions.
The table travel record mode uses predefined sets of positions. Every target position is defined by one motion block. Several sets of motion blocks may be defined.

For an exact description of table travel record mode options refer to the application manual "Positioning".

Related objects:

0x6040	Controlword
0x6041	Statusword
0x6046	Velocity min max amount
0x6060	Modes of operation
0x6061	Modes of operation display
0x5FF0	Active motion block
0x5FF1	Motion block to resume
0x6064	Position actual value
0x6065	Following error window
0x6066	Following error time
0x6067	Position window
0x6068	Position window time
0x6085	Quick stop deceleration

In table travel mode the "operation mode specific" and "manufacturer specific" bits of *controlword* and *statusword* are used as shown:

Controlword

Bit	
0	Switch on
1	Enable voltage
2	Quick stop
3	Enable operation
4	Sequence mode
5	Not used
6	Resume
7	Fault reset
8	Halt
9	Start motion block
10	Reserved
11	Motion block select 0
12	Motion block select 1
13	Motion block select 2
14	Motion block select 3
15	Motion block select 4

Statusword

Bit	
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Motion block in progress
9	Remote
10	Target reached
11	Internal limit active
12	In gear
13	Following error
14	Manufacturer specific
15	Manufacturer specific Warning 2

Controlword

Name	Value	Description
Sequence mode **Bit 4**	0	Single motion block
	1	Sequence of motion blocks
Resume **Bit 6**	0	Start motion block = motion block select
	1	Start motion block = last active motion block
Halt **Bit 8**	0	Execute instruction of bit 4 "sequence mode"
	1	Stop axle with ramp of actual motion block, inverter remains in state "operation enabled"
Start motion block **Bit 9**	0	Stop axle with ramp of actual motion block
	0 → 1	Start execution of motion block(s)
Motion block select 0…4 **Bit 11…15**	n	Start motion block = n + 1

Motion block select:

Controlword															
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Motion block select															
4	**3**	**2**	**1**	**0**											

Start motion block = motion block select + 1:

Motion block select					**resulting start motion block**
4	3	2	1	0	
0	0	0	0	0	1
0	0	0	1	1	4
1	0	0	0	0	17
1	1	1	1	1	32

Statusword

Name	Value	Description
Motion block in progress **Bit 8**	0	Single motion block: motion block completed Sequence of motion blocks: sequence completed
	1	Single motion block/sequence of motion blocks active
Target reached **Bit 10**	0	Halt = 0: target position not reached yet (motion blocks with positioning only)
		Halt = 1: axle decelerates
	1	Halt = 0: target position reached (motion blocks with positioning only)
		Halt = 1: axle has velocity 0
In gear **Bit 12**	0	Electronic gear not coupled
	1	Electronic gear coupled
Following error **Bit 13**	0	No following error
	1	Following error

Basic functions

The control bit *sequence mode* decides between execution of one single motion block (*sequence mode = 0*) and execution of a sequence of motion blocks (*sequence mode = 1*).

In both cases the selection of the desired motion block (motion block number of single motion block or start motion block number of motion block sequence) is done by calculating the motion block number from *motion block select* with the rising edge of *start motion block*

While the selected motion block or motion block sequence is processed *motion block in progress* is set to 1. *Motion block in progress* remains 1 until the motion block processing is finished. When using a single motion block *motion block in progress* is set to 0 with completion of the single motion block. Otherwise when using a motion block sequence *motion block in progress* is set to 0 when reaching a next motion block setting of 0 (end of motion block) or -1 (error) -2 (stop and error) or -3 (quick stop and error).

While processing a motion block sequence the actual processed motion block is displayed by object 0x5FF0 *active motion block*.

If motion block processing is interrupted by setting *start motion block* to 0 the axle stops with the ramp defined by the actual motion block. The interrupted motion block/motion block sequence can be restarted again by setting *resume* and a rising edge of *start motion block*.

If *resume* is set to 1 and there is no valid motion block available the motion block defined by *motion block select* will be used. A valid motion block is displayed by object 0x5FF1 *motion block to resume*. *Motion block to resume* displays -1 in case there is no valid motion block or the last motion block/motion block sequence was not interrupted.

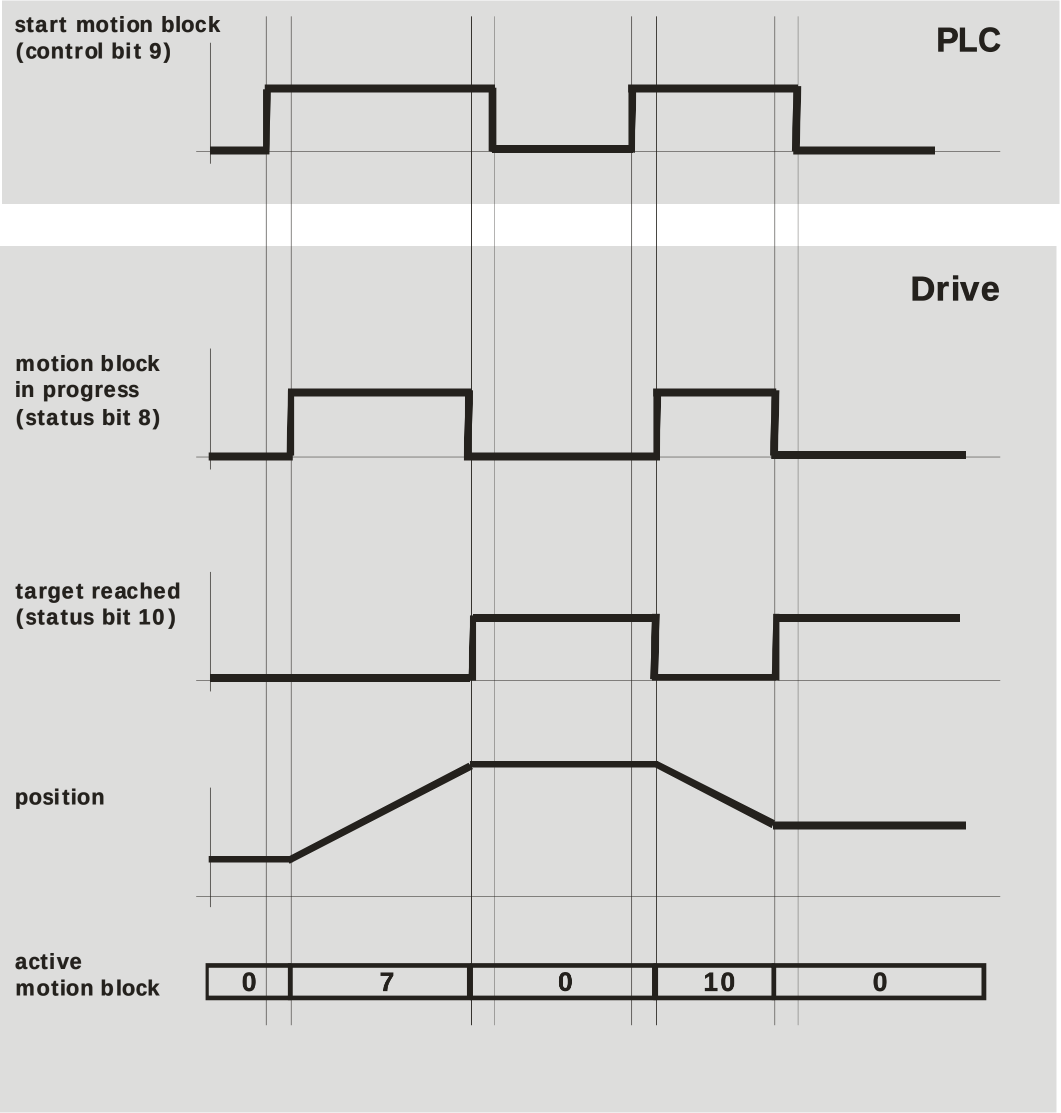
Target reached is set by motion blocks with absolute or relative positioning when the actual position reaches the *position window*.

In gear is set when the function electronic gear is used and the gear is coupled.

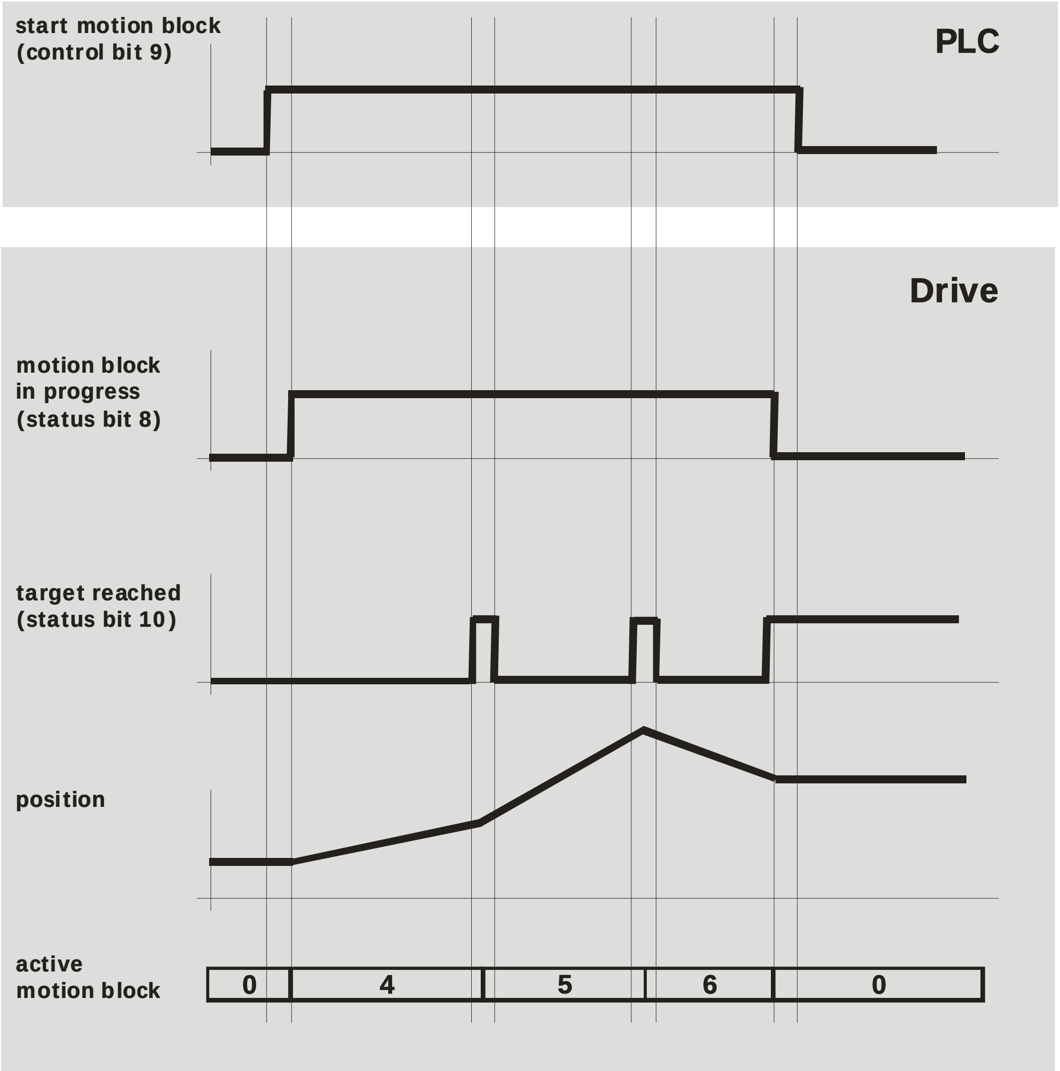
Setting *Halt* to 1 interrupts an actual processed motion block. The axle is stopped with the ramp defined by the actual motion block. When reaching velocity 0 *target reached* is set to 1. The drive remains in state *operation enabled*. Resetting *Halt* to 0 restarts processing of the interrupted motion block.

Examples:

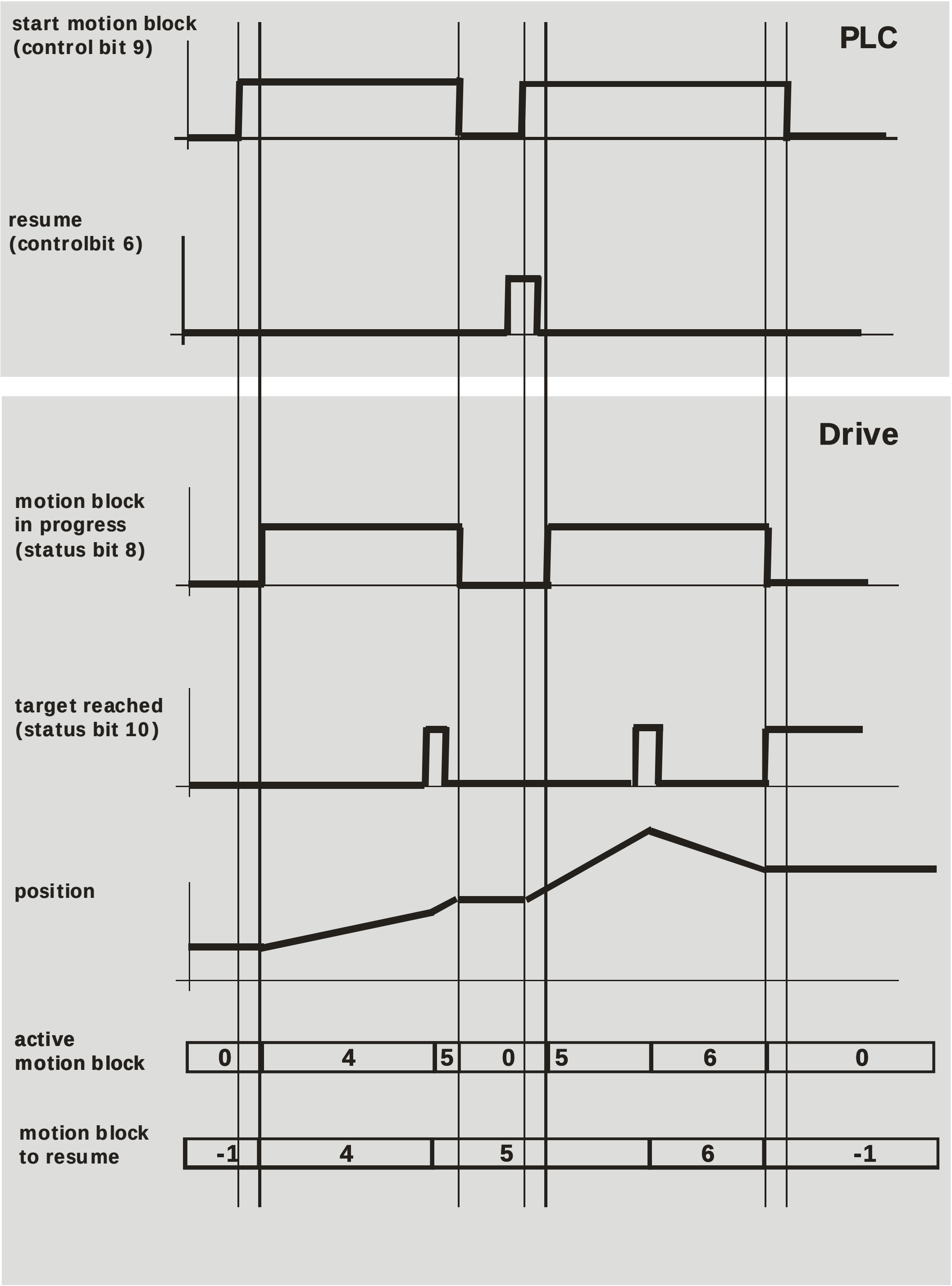
"single motion block" **sequence mode (control bit 4) = 0**
2 motion blocks 7 + 10



“ motion block sequence” 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



12.4.5.1 Example Sequence

To start the Table travel record mode, the correct sequence has to be sent from the PLC.

1	Control word =	0x0000		Disable voltage
	Status word =		0x0050	Switch On Disabled
2	Modes of Operation =	-1		(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 =		0xn337	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 =		0xn337	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 =		0xn337	Operation enabled and Positioning active.
	Status word =		0xn637	Operation enabled and Target reached.
5e	Control word =	0x021F		Start Motion Block 1 in Sequence Mode
	Status word =		0xn337	Operation enabled and Positioning active.
	Status word =		0xn637	Operation enabled and Target reached.
5f	Control word =	0x004F		Resume last Motion Block as Single Motion Block
	Status word =		0xn337	Operation enabled and Positioning active.
	Status word =		0xn637	Operation enabled and Target reached.
5g	Control word =	0x005F		Resume last Motion Block in Sequence Mode
	Status word =		0xn337	Operation enabled and Positioning active.
	Status word =		0xn637	Operation enabled and Target reached.

Note: 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).
Bit 9 "Start motion block" has to stay active during the positioning. If bit 9 is reset to "0", the positioning is interrupted.
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.
Danger: When 0x6060 M*odes of Operation* is changed during operation (Control word = 0xnnnF), a dangerous state can occur in the new mode. Bonfiglioli Vectron recommends checking the status word before changing 0x6060 *Modes of Operation* (i.e. check state 0xnn33).

13 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.
- ⊗ This parameter cannot be written when the frequency inverter is in operation.

13.1 Actual values

No.	Description	Unit	Display range	Chapter
	Actual values of the frequency inverter			
228	Internal Reference Frequency	Hz	-1000.00 ... 1000.00	11.3.3
249	Active Data Set	-	1 ... 4	11
260	Current error	-	0 ... 0xFFFF	10.5.2
270	Warnings	-	0 ... 0xFFFF	13.3
282	Reference Bus Frequency	Hz	-1000.00 ... 1000.00	11.3.3
283	Reference Ramp Frequency	Hz	-1000.00 ... 1000.00	11.3.3
1290	Node State (NMT)	-	0 … 127	9.7
1291	CAN State (physical layer)	-	0 … 4	4
1453	OS SyncSource Act	-	Selection	9.10

Note:
The parameters *Current error* **260** and *Warnings* **270** are only accessible via the manufacturer objects 0x2nnn. They cannot be accessed via the VPlus program or the KP500 control unit.

13.2 Parameters

	No.	Description	Unit	Display range	Factory setting	Chapter
		CAN bus				
	276	CAN Interface	-	Selection	1 - CM-CAN	7
	385	CAN Baud Rate	-	Selection	6 - 250 kBit/s	5
	387	CAN Node Number	-	-1 … 127	-1	6
	388	CAN Error Behavior	-	Selection	1 - Error	8, 10.5.1
		Rated motor parameters				
▤	373	No. of Pole Pairs	-	1 ... 24	2	10.5
		Bus control				
	392	State-transition 5	-	Selection	2 - Ramp	11.3.2
▤	412	Local/Remote	-	Selection	44 - Ctrl. Cont.+KP, Dir. Cont.+KP	11
		Data set change-over				
	414	Data set selection	-	0 ... 4	0	11
		Frequency ramps				
▤	420	Acceleration (Clockwise)	Hz/s	0.01 ... 9999.99	5.00	10.5.9
▤	421	Deceleration (Clockwise)	Hz/s	0.01 ... 9999.99	5.00	10.5.10, 10.5.11
▤	422	Acceleration (Anticlockwise)	Hz/s	-0.01 ... 9999.99	-0.01	10.5.9
▤	423	Deceleration (Anticlockwise)	Hz/s	-0.01 ... 9999.99	-0.01	10.5.10, 10.5.11
▤	424	Emergency stop (Clockwise)	Hz/s	0.01 ... 9999.99	5.00	10.5.11, 11.3.1

No.	Description	Unit	Display range	Factory setting	Chapter
425	Emergency stop (Anticlockwise)	Hz/s	0.01 ... 9999.99	5.00	10.5.11, 11.3.1
434	Ramp Setpoint	-	Selection	3 - Internal + Line Setpoint	11.3.3
Digital outputs					
549	Max. Control Deviation	%	0.01 ... 20.00	5.00	11.1, 11.2
Stopping behavior					
637	Switch-Off Threshold	%	0.0 ... 100.0	1.0	11.3.1, 11.3.2
638	Holding Time	s	0.0 ... 200.0	1.0	11.3.1, 11.3.2
Motion Control Interface					
1292	S. Modes of Operation	-	Selection	801 – 0x6060	11.2
1293	S. Target Position	-	Selection	802 – 0x607A	11.2
1294	S. Profile Velocity	-	Selection	803 – 0x6081	11.2
1295	S. Acceleration	-	Selection	804 – 0x6083	11.2
1296	S. Deceleration	-	Selection	805 – 0x6084	11.2
1297	S. Target Velocity	-	Selection	806 – 0x6042	11.2
CANopen® Mux/DeMux					
1420	CANopen Mux Input Index (write)[1)]	-	EEPROM 0…16 RAM 17… 33	1	10.4.5
1421	CANopen Mux Input Index (read) [1)]	-	EEPROM 0…16 RAM 17… 33	1	10.4.5
1422	CANopen Mux Input	-	Selection	7 - Off	10.4.5
1423	CANopen Percentage Actual Value Source	-	Selection	52 - Analog Input MFI1A	10.4.8
1451	CANopen OS Synctime	-	700…900 us	800 us	9.10
1452	OS_SyncSource	-	Selection	52 - Analog Input MFI1A	9.10

[1)]

Non volatile (fixed Parameterization)		Volatile	
0:	All indexes in EEPROM	17:	Alle indexes in RAM
1…16:	One Index in EEPROM	18…33:	One Index 1…16 in RAM

Note:
The setting "0" for *CANopen Mux Input Index (write)* **1420** changes all Data in EEPROM and. RAM.

Note:
The parameter *Data set selection 414* is only accessible via the manufacturer objects 0x2nnn. It cannot be accessed via the VPlus program or the KP500 control unit.

14 Annex

14.1 Control Word overview

The tables on this page list in an overview the funcionality of the **Control Word** bits.

Bit	*Standard (No Positioning)*	*Velocity Mode*	*Profile Position Mode*
0	Switch On	Switch On	Switch On
1	Enable Voltage	Enable Voltage	Enable Voltage
2	Quick Stop	Quick Stop	Quick Stop
3	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
8	Halt	Halt	Halt
9			Change on setpoint
10			
11			
12			
13			
14			
15			

Bit	*Interpolated Position Mode*	*Homing Mode*	*Table travel record Mode*
0	Switch On	Switch On	Switch On
1	Enable Voltage	Enable Voltage	Enable Voltage
2	Quick Stop	Quick Stop	Quick Stop
3	Enable Operation	Enable Operation	Enable Operation
4	Enable ip-mode	Homing operation start	Sequence mode
5			
6			Resume
7	Fault reset	Fault reset	Fault reset
8	Halt	Halt	Halt
9			Start motion block
10			
11			Motion Block Select 0
12			Motion Block Select 1
13			Motion Block Select 2
14			Motion Block Select 3
15			Motion Block Select 4

14.2 Status Word overview

The tables on this page list in an overview the funcionality of the **Status Word** bits.

Bit	*Standard (No Positioning)*	*Velocity Mode*	*Profile Position Mode*
0	Ready to Switch On	Ready to Switch On	Ready to Switch On
1	Switched On	Switched On	Switched On
2	Operation enabled	Operation enabled	Operation enabled
3	Fault	Fault	Fault
4	Voltage enabled	Voltage enabled	Voltage enabled
5	Quick Stop	Quick Stop	Quick Stop
6	Switch On Disabled	Switch On Disabled	Switch On Disabled
7	Warning	Warning	Warning
8			
9	Remote	Remote	Remote
10	Target reached	Target reached	Target reached
11	Internal limit active	Internal limit active	Internal limit active
12			Set-point acknowledge
13			Following error
14			
15	Warning 2	Warning 2	Warning 2

Bit	*Interpolated Position Mode*	*Homing Mode*	*Table travel record Mode*
0	Ready to Switch On	Ready to Switch On	Ready to Switch On
1	Switched On	Switched On	Switched On
2	Operation enabled	Operation enabled	Operation enabled
3	Fault	Fault	Fault
4	Voltage enabled	Voltage enabled	Voltage enabled
5	Quick Stop	Quick Stop	Quick Stop
6	Switch On Disabled	Switch On Disabled	Switch On Disabled
7	Warning	Warning	Warning
8			Motion Block in Progress
9	Remote	Remote	Remote
10	Target reached	Target reached	Target reached
11	Internal limit active	Internal limit active	Internal limit active
12	IP-mode active	Homing attained	In gear
13		Homing error	Following error
14			
15	Warning 2	Warning 2	Warning 2

14.3 Warning messages

The various control functions and methods as well as the hardware of the frequency inverter contain functions that continuously monitor the application. In addition to the messages documented in the manual, the following warning messages are activated by the CANopen® communication module CM-CAN.
The warning messages are given via parameter *Warnings* **270**, bit-coded according to the following scheme. The parameter *Warnings* **270** is menat to be read out by PLCs, parameter *Warnings* **269** shows the same information with a short text description in VPlus 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 *Warning status application* **367**

Note:
The meaning of the individual warnings is described in detail in the operating instructions.

14.4 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).

Communication error		
Code		Meaning
F20	21	Bus OFF
	22	Guarding failure
	23	Error state
	24	SYNC error (SYNC timing)
	25	NMT state change (operational → xxx)
	26	RxPDO1 length error (number of received bytes different to mapping)
	27	RxPDO2 length error (number of received bytes different to mapping)
	28	RxPDO3 length error (number of received bytes different to mapping)
F23	nn	Heartbeat failure – nn = node address of the failed subscriber (hex)

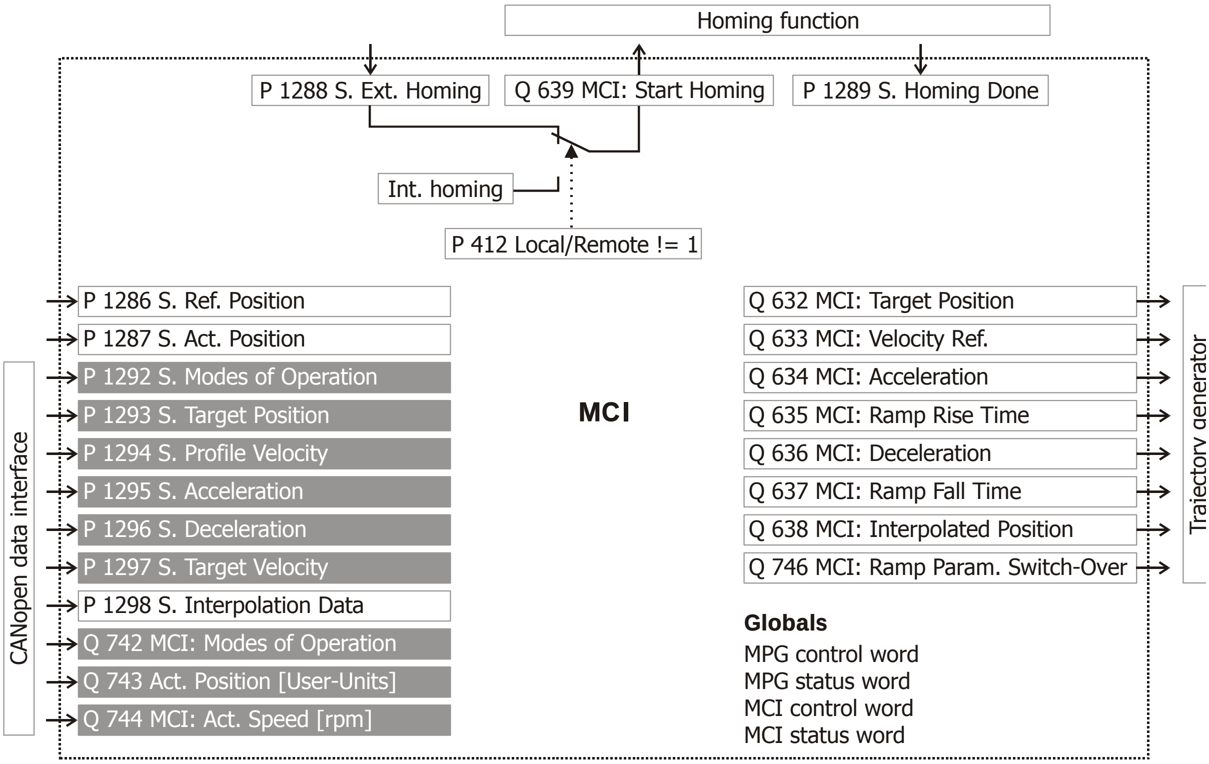
In addition to the fault messages stated, there are further fault messages used for internal purposes only and which are not listed here. If you receive any fault messages which are not listed, please contact us by phone.

15 Motion-control-interface for Profibus connection

The motion control interface is the interface between the communication system and the motion control system. With factory setting the motion control interface is connected to the CANopen® system. This connection can be changed to the Profibus system.

As with CANopen® parameter *Local/Remote* **412** MUST be set to "1" = "control via state machine".
The motion control functions are available in configuration x**40** only.
This setting is necessary to control the inverter and motion control functions with the help of controlword (located in PZD1-OUT) and statusword (located in PZD1-IN). The functions and bit definitions are identical to the descriptions of CANopen®.

Note:
With Profibus the mode of operation "interpolated position mode" can **NOT** be used.
In motion control configurations Profibus objects PZD2-OUT (reference speed) and PZD2-IN (actual speed) have no function.



MCI: motion control interface,
MPG: motion profile generator (trajectory generator),
P: parameter,
S: source,
rpm: revolution per minute

Only the grey marked parameters are necessary for controlling the motion control system by Profibus.

Input parameters **P xxxx** must be connected to Profibus OUT sources. These input parameters are direct accessible with parameter *Control Level* **28** set to **4.**

Output sources Q **xxx** must be connected to Profibus IN parameters (PZD-IN objects).

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