Bonfiglioli
Vectron

ACTIVE CUBE

PROFINET
Communication module CM-PROFINET
Frequency inverter 230 V / 400 V

Bonfiglioli
power, control and green solutions

TABLE OF CONTENTS

1 General Information about the Documentation

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

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

Quick Start Guide

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

User manual

The user manual documents the complete functionality of the frequency inverter. The parameters required for special purposes, for adjustment to the application and the numerous additional functions are described in detail.

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

Application manual

The application manual complements the documentation to ensure goal-directed installation and commissioning of the frequency inverter. Information on various topics in connection with the use of the frequency inverter is described in context with the specific application.

Installation instructions

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

1.1 This document

The present user manual of the CM-PROFINET communication module complements the Operating Instructions and the “Quick Start Guide” for the frequency inverters of the ACU 201 and ACU 401 device series.

The user manual contains important information on the installation and use of the PROFINET communication module CM-PROFINET in its specified application range. Compliance with this user manual contributes to avoiding risks, minimizing repair cost and downtimes and increasing the reliability and service life of the frequency inverter.

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

⚠ WARNING

Compliance with the documentation is required to ensure safe operation of the frequency inverter. BONFIGLIOLI VECTRON GmbH shall not be held liable for any damage caused by any non-compliance with the documentation.

In case any problems occur which are not covered by the documentation sufficiently, please contact the manufacturer.

1.2 Warranty and liability

BONFIGLIOLI VECTRON GmbH would like to point out that the contents of this user manual do not form part of any previous or existing agreement, assurance or legal relationship. Neither are they intended to supplement or replace such agreements, assurances or legal relationships. Any obligations of the manufacturer shall solely be based on the relevant purchase agreement which also includes the complete and solely valid warranty stipulations. These contractual warranty provisions are neither extended nor limited by the specifications contained in this documentation.

The manufacturer reserves the right to correct or amend the specifications, product information and omissions in these operating instructions without notice. The manufacturer shall not be liable for any damage, injuries or costs which may be caused for the aforementioned reasons.

Furthermore, BONFIGLIOLI VECTRON GmbH excludes any warranty/liability claims for any personal and/or material damage if such damage is due to one or more of the following causes:

- inappropriate use of the frequency inverter,
- non-compliance with the instructions, warnings and prohibitions contained in the documentation,
- unauthorized modifications of the frequency inverter,
- insufficient monitoring of parts of the machine/plant which are subject to wear,
- repair work at the machine/plant not carried out properly or in time,
- catastrophes by external impact and force majeure.

1.3 Obligation

This user manual must be read before commissioning and complied with. Anybody entrusted with tasks in connection with the

- transport,
- assembly,
- installation of the frequency inverter and
- operation of the frequency inverter

must have read and understood the user manual and, in particular, the safety instructions in order to prevent personal and material losses.

1.4 Copyright

1.5 Storage

The documentation form an integral part of the frequency inverter. It must be stored such that it is accessible to operating staff at all times. If the frequency inverter is sold on to other users, then this user manual must also be handed over.

2 General safety instructions and information on use

The chapter "General safety instructions and information on use" contains general safety instructions for the Operator and the Operating Staff. At the beginning of certain main chapters, some safety instructions are included which apply to all work described in the relevant chapter. Special work-specific safety instructions are provided before each safety-relevant work step.

2.1 Terminology

According to the documentation, different activities must be performed by certain persons with certain qualifications.

The groups of persons with the required qualification are defined as follows:

Operator

This is the entrepreneur/company who/which operates the frequency inverter and uses it as per the specifications or has it operated by qualified and instructed staff.

Operating staff

The term Operating Staff covers persons instructed by the Operator of the frequency inverter and assigned the task of operating the frequency inverter.

Skilled Personnel

The term Skilled Personnel covers staff that are assigned special tasks by the Operator of the frequency inverter, e.g. installation, maintenance and service/repair and troubleshooting. Based on their qualification and/or know-how, Skilled Personnel must be capable of identifying defects and assessing functions.

Qualified electrician

The term Qualified Electrician covers qualified and trained staff that have special technical know-how and experience with electrical installations. In addition, Qualified Electricians must be familiar with the applicable standards and regulations, they must be able to assess the assigned tasks properly and identify and eliminate potential hazards.

Instructed person

The term Instructed Person covers staff that are instructed and trained about/in the assigned tasks and the potential hazards that might result from inappropriate behavior. In addition, instructed persons must have been instructed in the required protection provisions, protective measures, the applicable directives, accident prevention regulations as well as the operating conditions and have their qualification verified.

Expert

The term Expert covers qualified and trained staff that have special technical know-how and experience relating to the frequency inverter. Experts must be familiar with the applicable government work safety directives, accident prevention regulations, guidelines and generally accepted rules of technology in order to assess the operationally safe condition of the frequency inverter.

2.2 Designated use

The frequency inverter is designed according to the state of the art and recognized safety regulations.

The frequency inverters are electrical drive components intended for installation in industrial plants or machines. Commissioning and start of operation is not allowed until it has been verified that the machine meets the requirements of the EC Machinery Directive 2006/42/EC and DIN EN 60204-1.

The frequency inverters meet the requirements of the low voltage directive 2006/95/EEC and DIN EN 61800-5-1. CE-labeling is based on these standards. Responsibility for compliance with the EMC Directive 2004/108/EC lies with the operator. Frequency inverters are only available at specialized dealers and are exclusively intended for commercial use as per EN 61000-3-2.

No capacitive loads may be connected to the frequency inverter.

The technical data, connection specifications and information on ambient conditions are indicated on the rating plate and in the documentation and must be complied with at all times.

2.3 Misuse

Any use other than that described in "Designated use" shall not be permissible and shall be considered as misuse.

For, example, the machine/plant must not be operated

- by uninstructed staff,
- while it is not in perfect condition,
- without protection enclosure (e.g. covers),
- without safety equipment or with safety equipment deactivated.

The manufacturer shall not be held liable for any damage resulting from such misuse. The plant operator shall bear the sole risk.

2.3.1 Explosion protection

The frequency inverter is an IP 20 protection class device. For this reason, use of the device in explosive atmospheres is not permitted.

2.4 Residual risks

Residual risks are special hazards involved in handling of the frequency inverter which cannot be eliminated despite the safety-compliant design of the device. Remaining hazards are not obvious and can be a source of possible injury or health damage.

Typical residual hazards include:

Electrical hazard

Danger of contact with energized components due to a defect, opened covers or enclosures or improper working on electrical equipment.

Danger of contact with energized components in frequency inverter if no external disconnection device was installed by the operator.

Electrostatic charging

Touching electronic components bears the risk of electrostatic discharges.

Thermal hazards

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

Charged capacitors in DC link

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

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

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

2.5 Safety and warning signs on the frequency inverter

- Comply with all safety instructions and danger information provided on the frequency inverter.
- Safety information and warnings on the frequency inverter must not be removed.

2.6 Warning information and symbols used in the user manual

2.6.1 Hazard classes

The following hazard identifications and symbols are used to mark particularly important information:

⚠ DANGER

Identification of immediate threat holding a **high** risk of death or serious injury if not avoided.

⚠ WARNING

Identification of immediate threat holding a **medium** risk of death or serious injury if not avoided.

⚠ CAUTION

Identification of immediate threat holding a **low** risk of minor or moderate physical injury if not avoided.

NOTE

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

2.6.2 Hazard symbols

Symbol	Meaning	Symbol	Meaning
	General hazard		Suspended load
	Electrical voltage		Hot surfaces

2.6.3 Prohibition signs

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

2.6.4 Personal safety equipment

Symbol	Meaning
	Wear body protection

2.6.5 Recycling

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

2.6.6 Grounding symbol

Symbol	Meaning
	Ground connection

2.6.7 ESD symbol

Symbol	Meaning
	ESD: Electrostatic Discharge (can damage components and assemblies)

2.6.8 Information signs

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

2.7 Directives and guidelines to be adhered to by the operator

The operator must follow the following directives and regulations:

- Ensure that the applicable workplace-related accident prevention regulations as well as other applicable national regulation are accessible to the staff.
- An authorized person must ensure, before using the frequency inverter, that the device is used in compliance with its designated use and that all safety requirements are met.
- Additionally, comply with the applicable laws, regulations and directives of the country in which the frequency inverter is used.

Any additional guidelines and directives that may be required additionally shall be defined by the operator of the machine/plant considering the operating environment.

2.8 Operator's general plant documentation

- In addition to the user manual, the operator should issue separate internal operating instructions for the frequency inverter. The user manual of the frequency inverter must be included in the user manual of the whole plant.

2.9 Operator's/operating staff's responsibilities

2.9.1 Selection and qualification of staff

- Any work on the frequency inverter may only be carried out by qualified technical staff. The staff must not be under the influence of any drugs. Note the minimum age required by law. Define the staff's responsibility in connection with all work on the frequency inverter clearly.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering.
- The operating staff must be trained for the relevant work to be performed.

2.9.2 General work safety

- In addition to the user manual of the machine/plant, any applicable legal or other regulations relating to accident prevention and environmental protection must be complied with. The staff must be instructed accordingly.
  Such regulations and/or requirements may include, for example, handling of hazardous media and materials or provision/use of personal protective equipment.
- In addition to this user manual, issue any additional directives that may be required to meet specific operating requirements, including supervision and reporting requirements, e.g. directives relating to work organization, workflow and employed staff.
- Unless approved of expressly by the manufacturer, do not modify the frequency inverter in any way, including addition of attachments or retrofits.
- Only use the frequency inverter if the rated connection and setup values specified by the manufacturer are met.
- Provide appropriate tools as may be required for performing all work on the frequency inverter properly.

2.10 Organizational measures

2.10.1 General

- Train your staff in the handling and use of the frequency inverter and the machine/plant as well as the risks involved.
- Use of any individual parts or components of the frequency inverter in other parts of the operator's machine/plant is prohibited.
- Optional components for the frequency inverter must be used in accordance with their designated use and in compliance with the relevant documentation.

2.10.2 Use in combination with third-party products

- Please note that BONFIGLIOLI VECTRON GmbH will not accept any responsibility for compatibility with third-party products (e.g. motors, cables or filters).
- In order to enable optimum system compatibility, BONFIGLIOLI VECTRON GmbH offers components facilitating commissioning and providing optimum synchronization of the machine/plant parts in operation.
- If you use the frequency inverter in combination with third-party products, you do this at your own risk.

2.10.3 Transport and storage

- The frequency inverters must be transported and stored in an appropriate way. During transport and storage the devices must remain in their original packaging.
- The units may only be stored in dry rooms which are protected against dust and moisture and are exposed to small temperature deviations only. The requirements of DIN EN 60721-3-1 for storage, DIN EN 60721-3-2 for transport and labeling on the packaging must be met.
- The duration of storage without connection to the permissible nominal voltage may not exceed one year.

2.10.4 Handling and installation

- Do not commission any damaged or destroyed components.
- Prevent any mechanical overloading of the frequency inverter. Do not bend any components and never change the isolation distances.
- Do not touch any electronic construction elements and contacts. The frequency inverter is equipped with components which are sensitive to electrostatic energy and can be damaged if handled improperly. Any use of damaged or destroyed components will endanger the machine/plant safety and shall be considered as a non-compliance with the applicable standards.
- Only install the frequency inverter in a suitable operating environment. The frequency inverter is exclusively designed for installation in industrial environments.
- If seals are removed from the case, this can result in the warranty becoming null and void.

2.10.5 Electrical connections

- The five safety rules must be complied with.
- Never touch live terminals. The DC link may have dangerous voltage levels even up to three minutes after shutdown.
- When performing any work on/with the frequency inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants of the country in which the frequency inverter is used.
- The cables connected to the frequency inverters may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.
- Only connect the frequency inverter to suitable supply mains.

2.10.5.1 The five safety rules

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

1. Isolate
2. Take appropriate measures to prevent re-connection
3. Check isolation
4. Earth and short-circuit
5. Cover or shield neighboring live parts.

2.10.6 Safe operation

- During operation of the frequency inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants.
- Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to the applicable national and international safety directives.
- During operation, never open the machine/plant
- Do not connect/disconnect any components/equipment during operation.
- The machine/plant holds high voltage levels during operation, is equipped with rotating parts (fan) and has hot surfaces. Any unauthorized removal of covers, improper use, wrong installation or operation may result in serious injuries or material damage.
- Some components, e.g. the heat sink or brake resistor, may be hot even some time after the machine/plant was shut down. Don't touch any surfaces directly after shutdown. Wear safety gloves where necessary.
- The frequency inverter may hold dangerous voltage levels until the capacitor in the DC link is discharged. Wait for at least 3 minutes after shutdown before starting electrical or mechanical work on the frequency inverter. Even after this waiting time, make sure that the equipment is deenergized in accordance with the safety rules before starting the work.
- In order to avoid accidents or damage, only qualified staff and electricians may carry out the work such as installation, commissioning or setup.
- In the case of a defect of terminals and/or cables, immediately disconnect the frequency inverter from mains supply.
- Persons not familiar with the operation of frequency inverters must not have access to the frequency inverter. Do not bypass nor decommission any protective facilities.
- The frequency inverter may be connected to power supply every 60 s. This must be considered when operating a mains contactor in jog operation mode. For commissioning or after an emergency stop, a non-recurrent, direct restart is permissible.
- After a failure and restoration of the power supply, the motor may start unexpectedly if the Auto-Start function is activated.
  If staff are endangered, a restart of the motor must be prevented by means of external circuitry.
- Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to EN 60204 and applicable safety directives (e.g. Working Machines Act or Accident Prevention Directives).

2.10.7 Maintenance and service / troubleshooting

- Visually inspect the frequency inverter when carrying out the required maintenance work and inspections at the machine/plant.
- Perform the maintenance work and inspections prescribed for the machine carefully, including the specifications on parts/equipment replacement.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering. Only use original spare parts.
- Unauthorized opening and improper interventions in the machine/plant can lead to personal injury or material damage. Repairs on the frequency inverters may only be carried out by the manufacturer or persons authorized by the manufacturer. Check protective equipment regularly.
- Before performing any maintenance work, the machine/plant must be disconnected from mains supply and secured against restarting. The five safety rules must be complied with.

2.10.8 Final decommissioning

Unless separate return or disposal agreements were made, recycle the disassembled frequency inverter components:

- Scrap metal materials
- Recycle plastic elements
- Sort and dispose of other component materials

Electric scrap, electronic components, lubricants and other utility materials must be treated as special waste and may only be disposed of by specialized companies.

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

3 Introduction

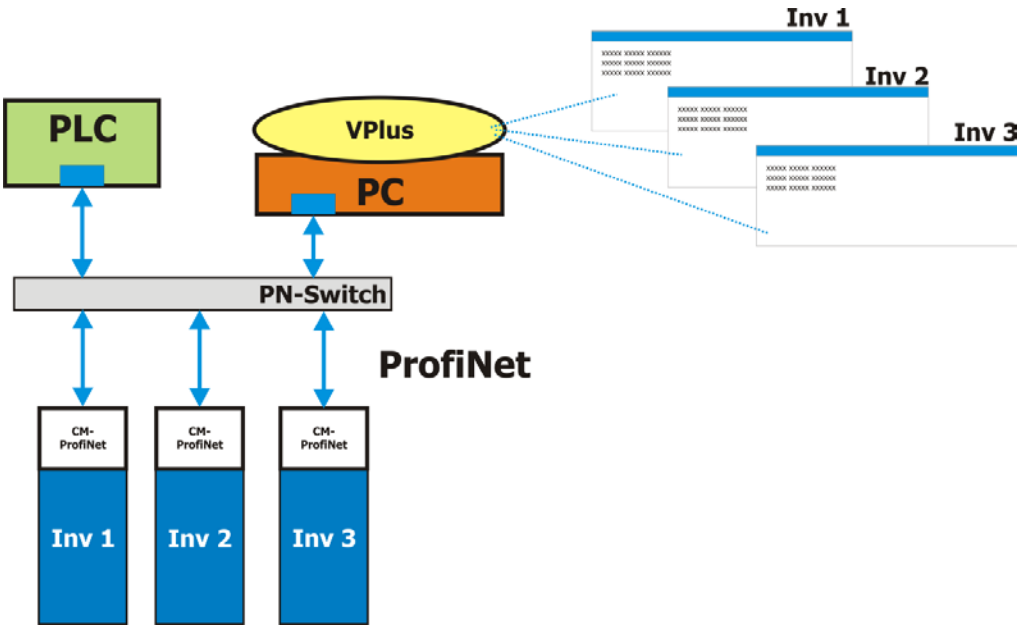
The present document describes the possibilities and properties of the PROFINET communication module CM-PROFINET for the frequency inverters of the *ACU* series of devices.

Specification: PROFINET IO device, real-time class 1, conformance class A.

For a PROFINET connection, the frequency inverter must be equipped with the CM-PROFINET communication module. The CM-PROFINET component is supplied separately and must be installed by the operator. The installation procedure is described in Chapter 5.1 “Assembly”.

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

In some chapters, setting and display options via the PC software VPlus are described as an alternative to the KP500 control unit. If you wish to use the VPlus PC software, you will need an optional serial interface adapter KP232 or direct Ethernet connection to the PROFINET system.



The PROFINET component CM-PROFINET has manufacturer ID 0x020B (hexadecimal).

The latest device description can be downloaded from the Bonfiglioli.com website. The file bears a name like **GSDML-V2.3-BV-CMM-20130604.xml**, where the version number and the date might be updated.

The manufacturer ID is assigned by PROFIBUS Nutzerorganisation e. V. in Karlsruhe.

With the CM-PROFINET communication module, it is possible to access **ALL** frequency inverter parameters from a controller. There is no access control via the control level as in the case of the KP500 manual control unit or the VPlus PC software. Changing parameters, the functions of which are not known to the user, can result in unintended movements and material and/or personal losses as well as inoperativeness of the frequency inverter.

3.1 Supported configurations

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

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

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

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

Standard:
Necessary settings: *Configuration* **30** ≠ x40.
Local/Remote **412** = (Remote) contacts

➔ The control (Start, Stop, Frequency change over, etc.) is carried out typically via:
- Digital contacts
- Remote contacts via Field bus

➔ Reference values result from the selected configuration. Typical are:
- Reference speed / Reference frequency:
  - Analogue input
  - Fixed values from parameters
  - Target velocity
- Percentage reference value for technology controller or Torque control
  - Analogue input
  - Fixed values from parameters

Please refer to chapter 11.3 "Configurations without Motion Control" for the control without Positioning functionality.

Positioning via contacts (or remote contacts):
Necessary settings: *Configuration* **30** = x40.
Local/Remote **412** = (Remote) contacts

➔ The control (Start, Stop, Target position change over, etc.) is carried out typically via:
- Digital contacts
- Remote contacts via Field bus

➔ Reference values result from the selected configuration. Typical are:
- Reference speed / Reference frequency
- Reference target position

Please refer also to the application manual "Positioning".

MCI (Motion Control Interface – Positioning via Field bus):
Necessary settings: *Configuration* **30** = x40.
Local/Remote **412** = 1 - Statemachine

➔ The control (Start, Stop, mode change over, etc.) is carried out via PZD1 *Control word*.
➔ Reference values result from the selected *Modes of Operation*.
Typical are:
- Reference speed via target velocity
- Target position

The usage of the Motion Control Interface is described in this manual in Chapters 10 "Motion Control Interface (MCI)" and 11.4 "Motion control configurations".

3.2 Initialization time

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

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

4 First commissioning

For first commissioning, you should be familiar with the followings steps and the described functions:

- Installation of the module — Chapter 5.1
- Selection of device control *Local/Remote* **412** — Chapter 11
- Commissioning of device functions via PLC
  - Setting the station address — Chapter 6.3
  - Setting the process data — Chapter 7
  - Fault Reaction — Chapter 6.5
    - Resetting errors — Chapter 8.5
  - Parameter access — Chapter 8.1
- Setting reference values:
  - Reference speed in speed-controlled configuration x10, x11, x15, x16, x30, x60 — Chapter 11.3
  - Reference value in position configuration x40 — Chapter 10.2
    - Velocity mode vl — Chapter 10.2.7
    - Profile velocity mode pv — Chapter 10.2.8
    - Profile position mode — Chapter 10.2.6
    - Homing mode — Chapter 10.2.9
    - Table travel record mode — Chapter 10.2.10
    - Move Away from Limit Switch — Chapter 10.3
    - Mode of Operation change — Chapter 10.2.2
- Diagnosis: — Chapter 11, 12

5 Assembly / disassembly of the communication module

5.1 Assembly

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

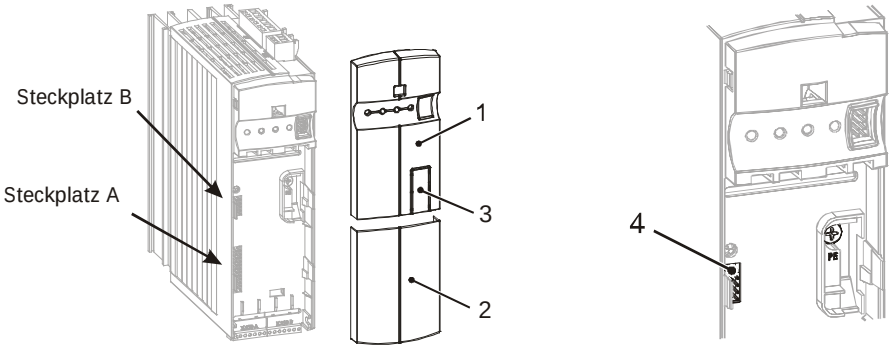
⚠ CAUTION

Danger of destruction of frequency inverter and/or communication module

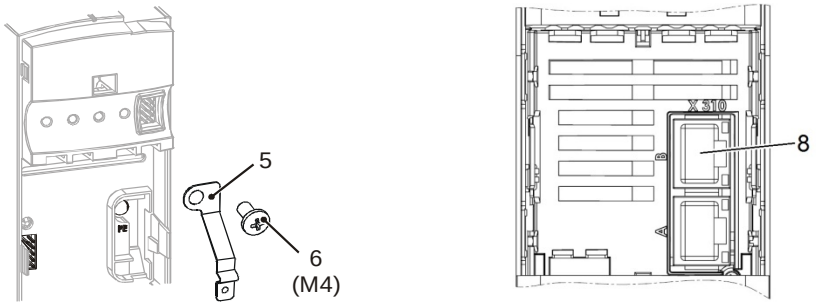
- Before installation of the communication module, the frequency inverter must be disconnected from power supply. Installation is not permissible while the unit is energized.
- Do not touch the PCB visible on the back of the module, otherwise components may be damaged.

Work steps:

- Disconnect the frequency inverter from 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.



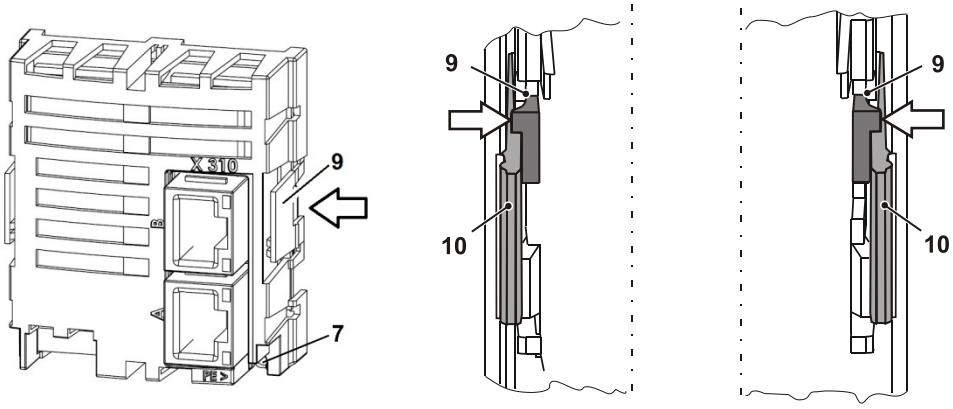
- Mount the supplied PE spring **(5)** using the M4 screw **(6)** in the unit. The spring must be aligned centrally.
- Insert the communication module in slot B **(4)** until it engages audibly.
- Fix the communication module and PE spring **(5)** using the M2-screw provided at the module.



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

5.2 Disassembly

- Disconnect the frequency inverter from power supply and protect it against being energized unintentionally.
- Remove the covers **(1)** and **(2)** of the frequency inverter, see Chapter 5.1 “Assembly”.

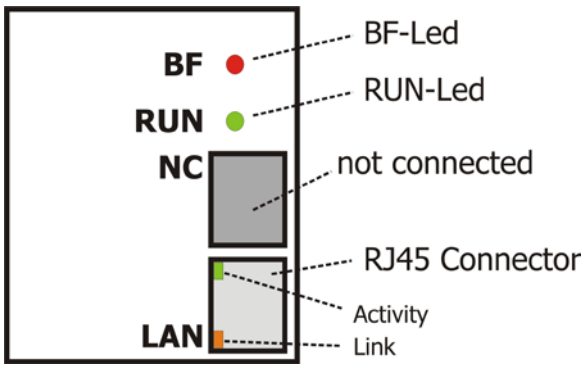


- Loosen the M2 screw (**7**) on the communication module
- Unplug the communication module from Slot B by unlocking the locking hooks **(9)** on the right and left side of the module from the case of the frequency inverter using a small screwdriver.
  The locking hooks **(9)** are located at the place where the locking hooks **(10)** for the upper cover project from the case of the frequency inverter.
  - To do this, insert the screwdriver in the gap between the case of the module and the frequency inverter carefully and push the locking hook inwards in the direction of the arrow **(⇦)**. As soon as the right side is unlocked, pull out the module a bit on the right side and hold it.
  - Hold the module on the right side while unlocking the locking hook on the left side in the same way **(⇨)**.
  - Pull the module out of the slot by gently pulling on the right and left side alternately.
- Disassemble the PE spring **(5),** see Chapter 5.1 “Assembly”.
- Mount the two covers **(1)** and **(2),** see Chapter 5.1 “Assembly”.

6 Description of module and commissioning

6.1 Connector assignment

The CM-PROFINET module is connected to the PLC or switch using RJ45 connectors (LAN).



6.2 LED status indicators

The green RUN LED indicates the current status of the module.

LED Status	Module status
Off	Module is off.
On	Module is on and running.

The red BF-LED indicates the current status of the connection.

LED Status	Module status
On	Module has no Ethernet connection.
Flashing	Module has Ethernet connection, no cyclic exchange of data is taking place.
Off	Exchange of Cyclic data is taking place.

6.3 Setting the station address

A PROFINET IO controller accesses IO devices based on unique device names. The device name is assigned during system configuration using a PROFINET hardware configurator. The PROFINET IO controller can also assign the IP settings. During the hardware configuration, it is set for each IO device if the local IP settings are used or the IP settings of the PROFINET IO controller are applied.

When the IP settings of the PROFINET IO controller are applied, the local IP settings on the frequency inverter are blocked. In this case, the VPlus configuration software shows “Zero” for IP address, Net mask and Gateway. The IP settings cannot be edited via VPlus. If you enter the “Apply” command, the settings entered before are reset to “Zero”.

In the case of replacement of a module, a special function of the CM-PROFINET module enables assignment of a device name without the PROFINET configurator.

The TCP/IP configuration of VPlus shows the IP settings and, as the “Host name”, the device name saved in the module.

If a CM-PROFINET module must be replaced, the device name assigned before **without** PROFINET configurator can be assigned again.

- Start the TCP-IP configuration in VPlus and enter the device name as the “Host name”.

The IP settings must also be made again.

6.4 Alarm messages

In the case of a frequency inverter fault, CM-PROFINET sends an alarm message. This function can be deactivated via parameter *Profibus/PROFINET Diagnostic/Alarm Message* **1444**.

Diagnostic/Alarm Message 1444	Function
0 - Off	No alarm message in the case of a frequency inverter fault.
1 - On	Alarm message in the case of a frequency inverter fault. **Factory setting.**

List of Alarm messages

Error Type	Error Text	Help Text
257	Ixt Overload	F01nn Inverter rated current exceeded
258	Heatsink temperature	F02nn Heatsink temperature too high
259	Inside temperature	F03nn Inside temperature too high
260	Motor connection	F04nn Motor temperature, protection switch, V-belt monitoring, phase failure
261	Output current	F05nn Overload, short circuit, earth fault, asymmetric current, phase monitoring
262	Internal Fault	F06nn Internal Fault
263	DC-Link voltage	F07nn DC-Link voltage too low/high, brake/motor chopper threshold too small
264	Electronic voltage	F08nn Electronic voltage DC 24V too low/high
265	Pre-charging relay	F09nn Pre-charging relay faulted
272	Brake chopper	F10nn Brake chopper faulted
273	Output frequency	F11nn Output frequency exceeded maximum frequency
274	Safety function STO	F12nn Diagnosis error of function STO, STOA/STOB monitoring
275	Motor load	F13nn Earth fault, IDC compensation limit, minimum current monitoring
276	Control connection	F14nn Encoder signals, external error
277	Table travel record	F15nn Table travel record, error in motion blocks
278	Parameter	F16nn Parameter error
279	Encoder	F17nn Encoder error
289	CAN-Systembus slave error	F21nn CAN-Systembus slave node id = nn reports error
290	CAN-System bus	F22nn CAN-Systembus error
292	EM-Module	F24nn Unknown EM-Module
304	Application	F30nn Application error
511	Generic	Fxxxx Generic error

6.5 Operating behavior in the case of bus connection failure

The operating behavior in the case of failure of the PROFINET systems can be parameterized. The required behavior can be set via parameter *Bus Error behavior* **388**.

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

The parameter settings *Bus Error Behaviour* **388** = 2...5 are evaluated depending on parameter *Local/Remote* **412**.

There are numerous options of parameterizing the fault and warning behavior of the frequency inverter. For details about possible faults, refer to Chapter 13.5 "Error messages".

7 Setting the process data

Depending on the application used, different process data objects with various lengths and contents are required for data exchange. The CM-PROFINET module enables a wide range of settings. Using a hardware configurator, the user can design the process data objects required for the relevant application.

Two types of process data objects are available:

The required objects must be created in the hardware configuration of the PROFINET IO controller. On the frequency inverter side it is not possible to set up the required object. The frequency inverter adjusts itself to the created object automatically.

Process data objects		
Object	**Object length / bytes**	**Object length / words**
PKW	8	4
PZD	4	2

For more information on the contents of the objects, refer to Chapter 8 “Handling of objects”.

The PKW object is used for read and write access to frequency inverter parameters. The object will produce additional bus load because it will send its contents with each data exchange cycle, no matter if it is actually needed or not. As an alternative to the PKW object, the CM-PROFINET module supports read and write access to data sets. The function is described in Chapter 8.2 “Parameter access through reading/writing of data sets”.

Each PZD object contains two Word data type input and output objects. For information on how to handle this object, refer to Chapter 8.3.1 “Data types of OUT/IN objects”.

7.1 Configuration process on PROFINET IO controller

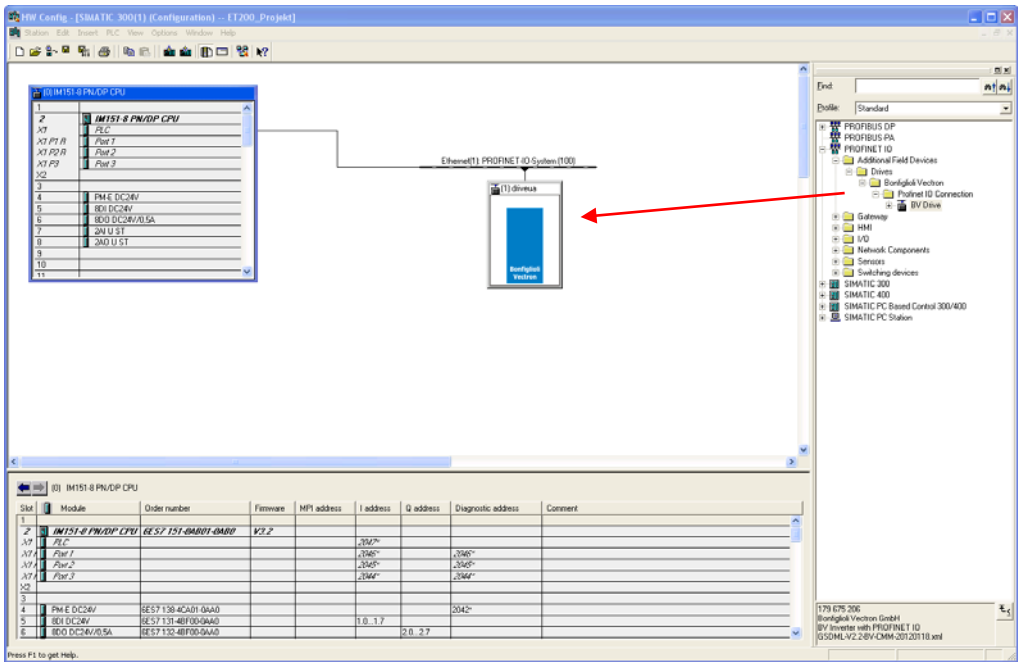
The following chapter describes the configuration procedure of a frequency inverter with the PROFINET communication module CM-PROFINET using the example of the Siemens STEP7 hardware configurator. Generally, the procedure is the same for other configurations.

First, the device description file is installed in the hardware configurator (if not done already). This is done in the menu **Options\Install GSD file**. Here, enter the path and name of the GSD file.

Once the GSD file is installed, the frequency inverter will appear on level:

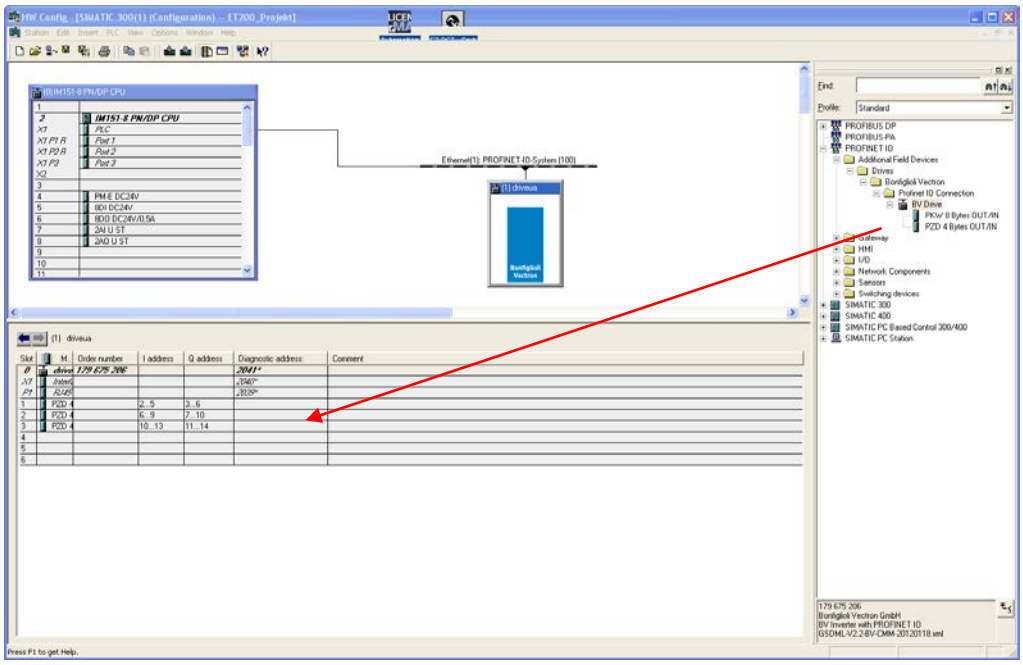
PROFINET IO\ Additional Field Devices \Drives\Bonfiglioli Vectron\ PROFINET IO Connection

From this position, a frequency inverter **BV Drive** can be connected to the PROFINET system (drag & drop).



The two possible objects PKW and PZD are available in the **BV Drive** menu. The required object can be assigned to the frequency inverter (drag & drop).

The screen shot of the STEP7 hardware configurator shows a frequency inverter configured with 3 PZD objects connected to the PROFINET IO system.



- The data flow direction IN/input and OUT/output is given from the PLC's point of view.
- Each configured PZD object comprises two word objects (4 bytes) PZDn and PZDn+1, one for input and one for output.

Restrictions for user-defined configuration settings:

- The PKW object is allowed only once at slot 1.
- At least one PZD object must be configured.
  - The total number of bytes must be less than or equal to 24 bytes (12 words).

If the restrictions are not followed, a configuration error is signaled by the controller (PLC) upon PROFINET startup.

7.2 Available objects

The configured data exchange objects generally have two components which are available either fully, partly or not at all in the different object configurations. These components are the communication channel and the process channel.

The **communication channel** (PKW object) is used for access (write/read) to any parameters in the frequency inverter. The string parameters to which no access is possible form an exception. The communication follows a defined handshake procedure and includes several cyclic data exchange cycles.

The **process data channel** (PZD object) is processed in each cycle. Reference values are taken over and actual values are handed over. Thus, the data is updated with each cyclic data exchange.

Transmission direction IO controller ➔ IO device (OUT)

Communication channel				**Process data channel**					
PKW range				PZD range					
PKE	**IND**	**PWE**	**PWE**	**PZD 1**	**PZD 2**	**PZD x**	**PZD x**	**PZD x**	**PZD x**
		PWEh	PWEl	STW	HSW	Outx	Outx	Outx	Outx

PKW Parameter ID Value
PZD Process data channel STW = Control word HSW = Main reference value
Outx = User defined

Transmission direction IO device ➔ IO controller (IN)

Communication channel				**Process data channel**					
PKW range				PZD range					
PKE	**IND**	**PWE**	**PWE**	**PZD 1**	**PZD 2**	**PZD x**	**PZD x**	**PZD x**	**PZD x**
		PWEh	PWEl	ZSW	HIW	Inx	Inx	Inx	Inx

PKW Parameter ID Value
PZD Process data channel ZSW = Status word HIW = Main actual value
Inx = User defined

Process data channel objects PZD1/PZD2 are fixed and cannot be edited. This definition also applies to user-defined configurations.

The contents of process data channels PZD3 through PZD12 (maximum, without communication channel PKW) are user-defined.

In the data transmission, it is assumed that the **Motorola format** is used as supported by a PLC type Siemens S7.

8 Handling of objects

8.1 Parameter access via communication channel PKW

The communication channel (PKW range) has the following structure:

Designation	PKW range							
	PKE		IND		PWE-high		PWE-low	
Contents	Parameter ID		Index		Parameter value high word		Parameter value low word	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
			Data set	System-bus				
Byte no.	0	1	2	3	4	5	6	7

The data is transmitted in the **Motorola format** as used by the S7 PLC from Siemens, for example. Thus, the high byte is on the lower byte of the message, and the low byte is on the higher byte.

The data set is always on the high byte of “Index” (data set/byte no. 2). If system bus is used, a system bus address is set on the low byte of “Index” (System-bus/byte no. 3). With this parameter, access to a Systembus client is possible. See Systembus instructions.

Structure of parameter ID (PKE):

PKE	High byte								Low byte							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	AK				**0**	PNU										

AK: Order / response ID (value range 0 ... 15)
PNU: Parameter number (value range 1 ... 1599)

The order and response IDs are stored in the AK range. If no parameter processing is to be performed, the function type **"No Order"** must be selected.

The PNU range transmits the number of the parameter to be edited.

Parameter values (= data) of type Integer/Unsigned Integer (16 Bit) and Long (32 Bit) can be written and read. The data type is specified in the order ID. In the case of data set switchable parameters (array), the required data set is given under the index byte (byte 2).

An Excel file containing the required information about the parameters as regards the data type and data set switchability can be made available upon request.

8.1.1 Order ID

Structure of order ID AK (in output data set, Master → Slave)		
Order ID AK	**Data type**	**Function**
0	-	**no order**
1	int/uint , long	read parameter value
2	int/uint	write int/uint parameter value
3	long	write long parameter value
6	int/uint , long array	read array parameter value
7	int/uint array	write int/uint array parameter value
8	long array	write long array parameter value

Array: Applies to data set switchable parameters. In Data set/INDEX, you will have to specify the required data set, otherwise Data set/INDEX = 0.

8.1.2 Response ID

Structure of response ID AK (in input data set, Slave→ Master)		
Response ID	**Data type**	**Function**
0	-	**no order**
1	int/uint	transmit int/uint parameter value
2	long	transmit long parameter value
4	int/uint array	transmit int/uint array parameter value
5	long array	transmit long array parameter value
7	-	Order cannot be executed
8	-	no control rights for PKW interface

- If the order ID = 7 (order not executable), an error message is shown in PWE-low (byte 6/7).
- If response code = 8 (no control rights), the master is not entitled to write to the slave.

8.1.3 Error message

Encoding of error messages in response data set PWE-Low/Low-Byte in byte 7 (Slave ➔ Master):

Error no. (decimal) according to PROFIDRIVE	Meaning
0	non-permissible parameter number PNU
1	Parameter value cannot be edited
2	lower or upper parameter value limit exceeded
3	faulty data set
4	no data set switchable parameter
5	wrong data type
18	other error
20	system bus does not respond

Extension	Meaning
101	Parameter cannot be read:
103	Error when reading EEPROM
104	Error when writing EEPROM
105	EEPROM checksum error occurred
106	Parameter must not be written in operation
107	Values of data sets are different
108	Unknown order

Error number “20” may have different causes.

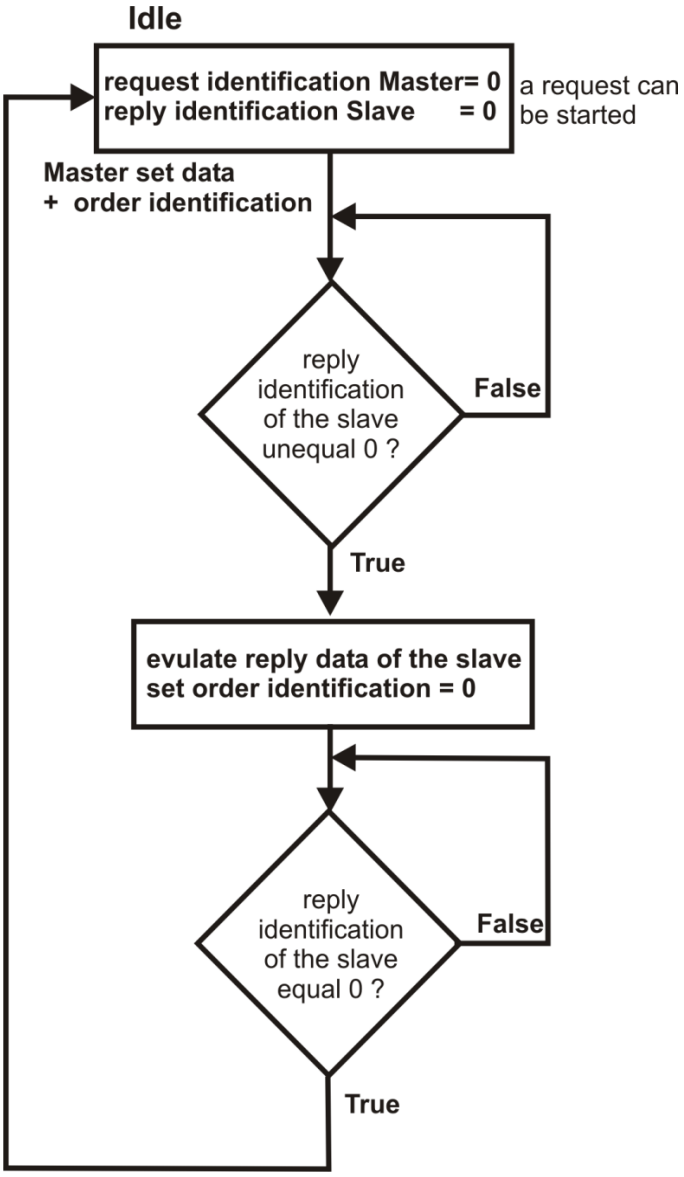
- If you do not use System Bus: Check if the low byte is “0” (zero). With values greater than zero, an attempt is made to address a System Bus client instead of the PROFINET client.
- If you use System Bus (e.g. via an EM-SYS module), the addressed device is not responding. Check if the addressed device is connected to power supply and the System Bus node addresses in the index low byte and in the parameter settings of the device to be addressed correspond to one another.

8.1.4 Communication procedure

An order from the master will **always** be answered by a slave response. Each parameter request or response can only accept one order/response at a time. For this reason, a defined handshake procedure must be followed between the master and slave.

In the initial situation, the order **and** response ID must be = 0. The master sets its order ID and waits until the slave changes the response ID from 0 to ≠ 0. Now, the slave's response is available and can be evaluated. Then, the master sets its order ID = 0 and waits until the slave changes the response ID from ≠ 0 to 0. This completes the communication cycle and a new cycle can start.

The slave will only respond to new orders once it has reacted to order ID = 0 with response ID = 0.



8.1.5 Parameters, data set selection and cyclic writing

For the parameters to be set, refer to the Operating Instructions according to the chosen configuration. The parameter list specifies if a parameter is switchable (Data set/INDEX = 1 through 4) or is available once only (Data set/INDEX = 0).

The parameter list also provides information about the display format of a parameter and its type (int/uint/long). String parameters cannot be transmitted due to the possible number of bytes.

The transmitted values are always integer numbers. In the case of decimal values, the decimal point is not transmitted.

The IND word hands over the required data set of the parameter. In the present application, the existing parameters are assigned data set number 0; to enable switching among multiple parameters (switchable), a number from 1 through 4 is assigned.

The actual parameter value is transmitted in the PWE range; as 16-bit value (int/uint), it occupies PWEl, as 32-bit value (long) PWE-high and PWE-low, with the high-word being in PWE-high.

If parameters are set to data set = 0, each of the four data sets is set to the same 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. Otherwise, an error message will be displayed.

NOTE

The values are entered automatically in the EEPROM of the controller. However, only a limited number of write cycles is permissible for the EEPROM (approx. 1 million cycles). When this number is exceeded, the EEPROM will be destroyed.

- Values which are written cyclically at a high repetition rate should be written to the RAM and not the EEPROM.

In the RAM, the data is not protected against loss of power. Once power supply is disrupted, the data must be written again.
This procedure is activated when the target data set is increased by five when specifying the data set (IND).

Enter in RAM only

EEPROM	RAM
Entry in data set = 0	Data set (IND)= 5:
Entry in data set = 1	Data set (IND)= 6:
Entry in data set = 2	Data set (IND)= 7:
Entry in data set = 3	Data set (IND)= 8:
Entry in data set = 4	Data set (IND)= 9:

When writing to data set switchable parameters, note:

Via data set (IND) = 0, data set switchable parameters can be set to the same value in all data sets.

8.1.5.1 Communication examples

Parameters					Settings		
No.	**Description**	**Type**	**Write / read**	**Format**	**Min.**	**Max.**	**Factory settings**
400	Switching frequency	P-W	S/L	x	1	8	2
480	Fixed frequency 1	P[I]-D	S/L	xxxx.xx Hz	-999.00	999.00	5.00

Example 1
Parameter **400** is a type int word (P-W), is not data set switchable and is to be read.

Order from master:

AK = 1 (order code = read parameter value)
PNU = 400 (= 0x190)
IND = 0
PWEh = 0
PWEl = 0

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter ID**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x11	0x90	0	0	0	0	0	0
Byte no.	0	1	2	3	4	5	6	7

Response from slave:

AK = 1 (response code = transmit int/uint parameter value)
PNU = 400 (= 0x190)
IND = 0
PWEh = 0
PWEl = value

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter ID**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x11	0x90	0	0	0	0	0	Value
Byte no.	0	1	2	3	4	5	6	7

Example 2

Parameter 480 is a type long double word (P[I]-D), is data set switchable and is to be written. The target data set is Data set 3.

Reference value = -300.00 Hz (-30000 is transmitted)

According to integer arithmetics, the negative value is represented as follows: 0xFFFF8AD0

Order from master:

AK = 8 (order code = write long array parameter value)
PNU = 480 (= 0x1E0)
IND = 3
PWEh = 0xFFFF
PWEl = 0x8AD0

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter ID**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x81	0xE0	3	0	0xFF	0xFF	0x8A	0xD0
Byte no.	0	1	2	3	4	5	6	7

Response from slave:

AK = 5 (order code = transmit long array parameter value)
PNU = 480 (= 0x1E0)
IND = 3
PWEh = 0xFFFF
PWEl = 0x8AD0

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter code**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x51	0xE0	3	0	0xFF	0xFF	0x8A	0xD0
Byte no.	0	1	2	3	4	5	6	7

8.1.6 Handling of index parameters / cyclic writing

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

Function	Parameters	Index range		Indexing parameter
		Write EEPROM and read	Write RAM	
Positioning	**1202** *Target position / distance* **1203** *Speed* **1204** *Acceleration* **1205** *Ramp Rise time* **1206** *Deceleration* **1207** *Ramp Fall time* **1208** *Motion mode* **1209** *Touch-Probe Window* **1210** *Touch-Probe-Error: Next Motion Block* **1211** *No. of Repetitions* **1212** *Delay* **1213** *Delay: Next Motion Block* **1214** *Event 1* **1215** *Event 1: Next Motion Block* **1216** *Event 2* **1217** *Event 2: Next motion block* **1218** *Digital signal 1* **1219** *Digital signal 2* **1247** *Digital signal 3* **1248** *Digital signal 4* **1260** *Interrupt-Event 1* **1261** *Int.-Event 1: Eval.-Mode* **1262** *Int. event 1: Next motion block* **1263** *Interrupt-Event 2* **1264** *Int.-Event 2: Eval.-Mode* **1265** *Int. event 2: Next motion block*	0[1]; 1...32	33[1]; 34...65	**1200** Write **1201** Read
PLC function (Function Table)	**1343** *FT-Instruction* **1344** *FT-Input 1* **1345** *FT-Input 2* **1346** *FT-Input 3* **1347** *FT-Input 4* **1348** *FT-Parameter 1* **1349** *FT-Parameter 2* **1350** *FT-Target Output 1* **1351** *FT-Target Output 2* **1352** *FT-Commentary*	0[1]; 1...32	33[1]; 34...65	**1341** Write **1342** Read
Multiplexer	**1252** *Mux Input*	0[1]; 1...16	17[1]; 18...33	**1250** Write **1251** Read
CANopen multiplexer	**1422** *CANopen Mux Input*	0[1]; 1...16	17[1]; 18...33	**1420** Write **1421** Read

1) When the indexing parameter = 0, all indexes will be written upon parameter access in EEPROM. 17 (for 16 indexes) or 33 (for 32 indexes) will write all indexes in RAM.

The values are entered automatically in the EEPROM of the controller. However, only a limited number of write cycles is permissible for the EEPROM (approx. 1 million cycles). When this number is exceeded, the EEPROM will be destroyed.

- Values which are written cyclically at a high repetition rate should be written to the RAM and not the EEPROM.

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

8.1.6.1 Example: Writing of index parameters

Typically, index parameters are written regularly during commissioning or in simple positioning applications.

Writing of Parameter **1202** *Target position/distance* (Type double word), in Index 1 in RAM (→ Index 34 for write access) with parameter value 30000.

First step: Set index parameter
Order from master:

AK = 2 (Order code = write int/uint parameter value)
PNU = 1200 (=0x4B0)
IND = 0
PWEh = 0x0000
PWEI = 0x0022 (=34)

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter code**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x24	0xB0	0	0	0x00	0x00	0x00	0x22
Byte no.	0	1	2	3	4	5	6	7

Response from slave:

AK = 1 (response code = transmit int/uint parameter value)
PNU = 1200 (=0x4B0)
IND = 0
PWEh = 0x0000
PWEI = 0x0022 (=34)

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter code**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x14	0xB0	0	0	0x00	0x00	0x00	0x22
Byte no.	0	1	2	3	4	5	6	7

Second step: Set value of target position

Order from master:

AK = 3 (order code = write long parameter value)
PNU = 1202 (=0x4B2)
IND = 0
PWEh = 0x0000
PWEI = 0x7530 (=30000)

PKW range								
Designa-tion	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter code**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x34	0xB2	0	0	0x00	0x00	0x75	0x30
Byte no.	0	1	2	3	4	5	6	7

Response from slave:

AK = 2 (order code = transmit long parameter value)
PNU = 1202 (=0x4B2)
IND = 0
PWEh = 0x0000
PWEI = 0x7530 (=30000)

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter code**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x24	0xB2	0	0	0x00	0x00	0x75	0x30
Byte no.	0	1	2	3	4	5	6	7

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

8.1.6.2 Example: Reading of index parameters

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

Reading of Parameter **1202** *Target position/distance* (type long), in Index 1 with parameter value 123000.
123000 = 0x0001 E078

First step: Set index parameter

Order from master:

AK = 2 (Order code = write int/uint parameter value)
PNU = 1201 (=0x4B1)
IND = 0
PWEh = 0x0000
PWEI = 0x0022 (=34)

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter code**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x24	0xB1	0	0	0x00	0x00	0x00	0x22
Byte no.	0	1	2	3	4	5	6	7

Response from slave:

AK = 1 (response code = transmit int/uint parameter value)
PNU = 1201 (=0x4B1)
IND = 0
PWEh = 0x0000
PWEI = 0x0022 (=34)

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter code**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x14	0xB1	0	0	0x00	0x00	0x00	0x22
Byte no.	0	1	2	3	4	5	6	7

Second step: Read value of target position

Order from master:

AK = 1 (order code = read long parameter value)
PNU = 1202 (=0x4B2)
IND = 0
PWEh = 0x0000
PWEI = 0x0000

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter code**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x34	0xB2	0	0	0x00	0x00	0x00	0x00
Byte no.	0	1	2	3	4	5	6	7

Response from slave:

AK = 2 (order code = transmit long parameter value)
PNU = 1202 (=0x4B2)
IND = 0
PWEh = 0x0001
PWEI = 0xE078

PKW range								
Designation	**PKE**		**IND**		**PWE-high**		**PWE-low**	
Contents	**Parameter code**		**Index**		**Parameter value high word**		**Parameter value low word**	
	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
	0x24	0xB2	0	0	0x00	0x01	0xE0	0x78
Byte no.	0	1	2	3	4	5	6	7

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

8.2 Parameter access through reading / writing of data sets

The PROFINET communication module CM-PROFINET features the PROFINET data set access function. This feature can be used as an alternative to the PKW communication object in the data exchange object. The PKW object is always sent to the bus, regardless of whether it is currently being used or not. Thus, it produces unnecessary bus load.

Data set access messages for parameter access are special PROFINET messages which are sent only if a parameter is required. Unlike in the case of PKW objects, data access messages can access all parameter types, including string type parameters.

The S7 PLC uses two special functions, **SFC58 WR_REC** and **SFC59 RD_REC**, for data set access. Addressing is carried out based on the diagnosis address of the device to be accessed (Slot 0 / Sub-slot 1 / Index). “Index” addresses the accessed parameters using the following code:

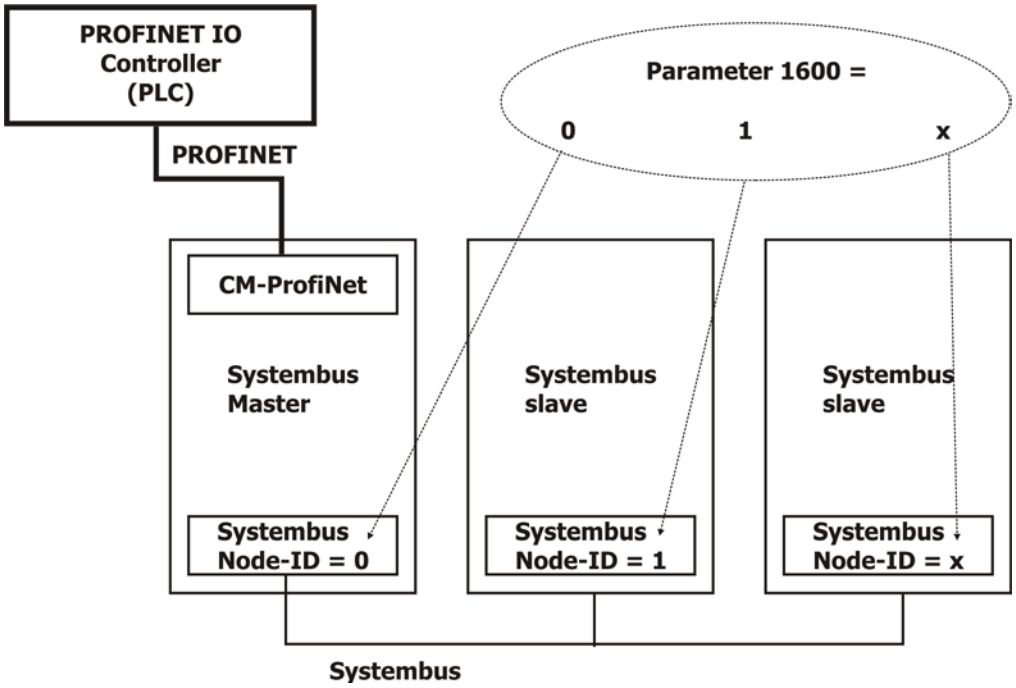
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	Data set				Parameter number										

Permissible index range = 0 ... 0x7FFF

Data types and byte arrangement

Byte	0	1	2	3	4	5	...	....	max. 98
Data type	uint/int								
Contents	high byte	low byte							
Data type	long								
Contents	high byte			low byte					
Data type	string								
Contents	first char.								

uint/int = 2 bytes
long = 4 bytes
string = 1 ... 99 bytes



In order to access the parameters of the individual frequency inverters through System Bus, Parameter **1600** is set to the ID of the relevant Systembus node.

The data type of **1600** is an unsigned integer, value range 0...63.

Parameter **1600** can be read and written.

8.3 Process data channel

This chapter describes how to handle the PZD objects. For a description of the required process data objects PZD1/2, refer to Chapters 11.1 “Control via contacts/remote contacts”, 11.2 “Control via state machine” and 11.3.3 “Reference value/actual value”.

Objects PZD 3 ... 12 can be used application-specifically. In the frequency inverter, these objects are represented as sources for PZD Out objects (data received from PROFINET controller) and as input parameters for sources (data to be sent to the master).

Inputs and outputs are as seen from the point of view of the PROFINET controller.

8.3.1 Data types of OUT/IN objects

Data type “Boolean”

Permissible values of “Boolean” are FALSE/0x0000 and TRUE/0xFFFF.

Data type – Boolean		
	Boolean value	**Data contents Hexadecimal**
OUT/IN-PZDn Boolean	FALSE	0x0000
OUT/IN-PZDn Boolean	TRUE	0xFFFF

n = 3 ... 12

Data type “Word”

The “Word” data type can be used for percentage, current and torque variables. Current and torque variables are possible in applications with field-oriented control. The standardization is as described below.

Word data type “Percentage”

The range for percentage values is -300.00% ... +300.00%. The values in OUT/IN-PZDn are shown with a factor of 100.

Word data type – Percentage			
	Data contents Hexadecimal	**Data contents Decimal**	**Logical interpretation**
OUT/IN-PZDn word	0x8AD0	- 30000	- 300.00%
OUT/IN-PZDn word	0x0000	0	0.00%
OUT/IN-PZDn word	0x7530	+ 30000	+ 300.00%

n = 3 ... 12

Word data type “Current”

A device-internal standardization conversion is performed for the current.
The standardization is as follows:

$$\textbf{Reference value} = (\textbf{Reference current [A]} / \textbf{Standard current [A]}) \cdot 2^{13}$$

2^{13} = 8192 (decimal) = 0x2000 (hexadecimal)

Word data type “Torque”

A device-internal standardization conversion is performed for the torque. The standardization of a reference torque corresponds to that of a reference current (see “Word data type: Current”). If the machine is operated with a rated flux value, a reference torque corresponds to a reference current.

The specified equation for reference current and reference torque applies to operation with the rated flux value. This must be considered when a machine is operated in the field weakening range.

The device-internal standard must be considered when current or torque variables are used.

Data type “Long”

The “Long” data type can be used for frequency and position variables.

Frequencies use the internal representation of the frequency inverter (xxx Hz / 4000 Hz) * 2^{31}.

Examples:

50.00 Hz ➔ (50.00 / 4000.00) * 2^{31} = 0x01999999

-80.00 Hz ➔ (-80.00 / 4000.00) * 2^{31} = 0xFD70A3D8

The position information depends on the settings of the Motion Control Systems (see “Positioning” application manual).

Data type – Long			
	Data contents Hexadecimal	**Data contents Decimal**	**Logic reproduction**
OUT/IN-PZDx/y Long	0xnnnnmmmm	Application specific	Application specific

x/y = 3/4, 5/6, ... 11/12

8.3.2 PROFINET output sources (OUT-PZD x)

In the table below, the available output sources of the PZD-Out objects are listed. The content of the sources depends on the application. For the different data types, the relevant sources must be linked to the input parameters of the frequency inverter.

- Availability of output sources depends on the number of configured PZD objects.
- Each configured PZD object comprises either two Boolean, two Word or one Long output object(s).
- A PZD output object can only be used for one data type (depending on the requirements of the application).
- The first PZD object configured (obligatory) represents PZD1/2 with fixed contents and functions.

Number of configured PZD objects	Boolean sources		Word sources		Long sources	
	Identification	Source no.	Identification	Source no.	Identification	Source no.
2	Out-PZD3 Boolean	640	Out-PZD3 Word	656	Out-PZD3/4 Long	672
	Out-PZD4 Boolean	641	Out-PZD4 Word	657		
3	Out-PZD5 Boolean	642	Out-PZD5 Word	658	Out-PZD5/6 Long	673
	Out-PZD6 Boolean	643	Out-PZD6 Word	659		
4	Out-PZD7 Boolean	644	Out-PZD7 Word	660	Out-PZD7/8 Long	674
	Out-PZD8 Boolean	645	Out-PZD8 Word	661		
5	Out-PZD9 Boolean	646	Out-PZD9 Word	662	Out-PZD9/10 Long	675
	Out-PZD10 Boolean	647	Out-PZD10 Word	663		
6	Out-PZD11 Boolean	648	Out-PZD11 Word	664	Out-PZD11/12 Long	676
	Out-PZD12 Boolean	649	Out-PZD12 Word	665		

- Each source can be linked to an input parameter of the frequency inverter of the same data type. The method is the same as the method used for the System Bus receive objects.
- Boolean sources represent Boolean objects.
- Word sources represent percentage, current or torque objects.
- Long sources represent frequency or position objects.

The sources are typically linked to the sources using the linking function of the Motion Control interface. For an example, refer to Chapter 10.4 “Motion Control Mapping for PROFINET”.

8.3.3 PROFINET input parameters (IN-PZD x)

In the table below, the available input parameters of the PZD In objects are listed. The content of the sources depends on the application. For the different data types, the relevant input parameters must be linked to the sources of the frequency inverter.

- Availability of input sources depends on the number of configured PZD objects.
- Each configured PZD object comprises either two Boolean, two Word or one Long input parameter(s).
- A PZD input object can only be used for one data type (depending on the requirements of the application).
- The first PZD object configured (obligatory) represents PZD1/2 with fixed contents and functions.

Number of configured PZD objects	Boolean parameter		Word parameter		Long parameter	
	Identification	Parameter no.	Identification	Parameter no.	Identification	Parameter no.
2	In-PZD 3 Boolean	1300	In-PZD 3 Word	1302	In-PZD 3/4 Long	1304
	In-PZD 4 Boolean	1301	In-PZD 4 Word	1303		
3	In-PZD 5 Boolean	1305	In-PZD 5 Word	1307	In-PZD 5/6 Long	1309
	In-PZD 6 Boolean	1306	In-PZD 6 Word	1308		
4	In-PZD 7 Boolean	1310	In-PZD 7 Word	1312	In-PZD 7/8 Long	1314
	In-PZD 8 Boolean	1311	In-PZD 8 Word	1313		
5	In-PZD 9 Boolean	1315	In-PZD 9 Word	1317	In-PZD 9/10 Long	1319
	In-PZD 10 Boolean	1316	In-PZD 10 Word	1318		
6	In-PZD 11 Boolean	1320	In-PZD 11 Word	1322	In-PZD 11/12 Long	1324
	In-PZD 12 Boolean	1321	In-PZD 12 Word	1323		

By default, the input parameters are set to Off or Zero, except Parameters **1302**, **1303**, **1307** and **1308**.

The default settings of input parameters **1302**, **1303**, **1307** and **1308** is compatible with the CM-PDP module:

In-PZD 3 Word **1302** = 770 PDP Effective Current
In-PZD 4 Word **1303** = 771 PDP Active Current
In-PZD 5 Word **1307** = 772 Warning Status
In-PZD 6 Word **1308** = 773 Error Status

- When an object is set to a certain source number, it must be ensured that the relevant objects have the preset values at the same place. This method is the same as is the one used in the case of objects for Systembus transmission (transmit objects).
- Boolean inputs represent Boolean objects.
- Word inputs represent percentage, current or torque objects.
- Long inputs represent frequency or position objects.

The displayed PDP active current depends on the type of control. In the case of field-oriented controls, the torque-forming current is displayed. In applications with U/f characteristic control, the active current also measured for the torque will be displayed.
The PDP effective current will always be positive. The torque-forming current and the active current are signed.
A positive current sign corresponds to motor operation mode.
A negative current sign corresponds to generator operation mode.

Current standardization

Standardization			
Reference Value	**Binary**	**Decimal**	**Hexadecimal**
+ 100%	+ 2^{14}	16384	0x4000

Possible range = ±200% = +32768 to -32768 = 0x8000 through 0x7FFF

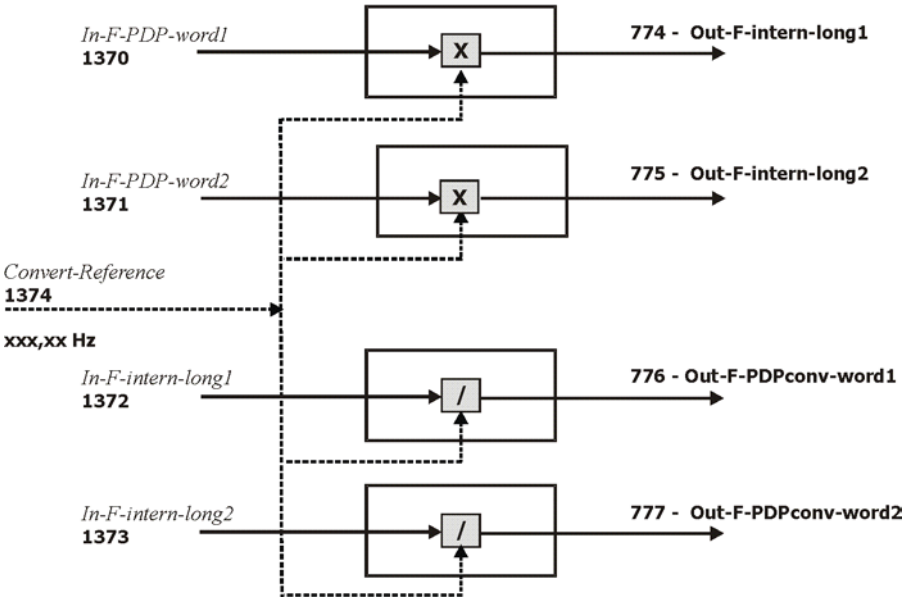
For internal standardization, the data set switchable parameter *Rated Current* **371** is used as the reference value.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
371	Rated current	0.01 · I_{FUN}	10 · I_{FUN}	I_{FUN}

8.4 Frequency conversion PDP-Word to internal representation

If the frequency inverter is equipped with a PROFINET module CM-PROFINET or an extension module with Systembus, the *Convert PDP/internal* function will be available. It converts frequency values with Profibus representation to frequency values with device-internal representation and vice versa, see Chapter 11.3.3 “Reference value/actual value”.

Frequency conversion Profibus representation/ Internal representation



The standardization for In-F-PDP-word1/2 and Out-F-PDPconv-word1/2 is:

Standardization			
Reference Value	**Binary**	**Decimal**	**Hexadecimal**
+ 100%	+ 2^{14}	16384	0x4000
- 100%	- 2^{14}	49152	0xC000

Possible range = ±200% = +32768 to -32768 = 0x7FFF through 0x8000

The function uses its own reference value *Convert Reference* **1374** for data conversion. The advantage of this function is the fact that the “Word” data type is used for frequency values instead of the “Long” data type.

8.5 Resetting errors

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

- When using control via parameter *Local/Remote* **412** = Statemachine:
  Set bit 7 of control word PZD1 = 0x8000.
- By pressing the stop button of the control panel.
  Resetting by pressing the STOP button is only possible if Parameter *Local/Remote* **412** permits control via the control panel.
- Via parameter *Error acknowledgment* **103** which is assigned a logic signal or a digital input
  A reset via a digital signal can only be carried out when parameter *Local/Remote* **412** permits this or when an input with the addition (hardware) is selected in the case of physical inputs.

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

9 Operation without Motion Control

In speed-controlled configurations (including Technology Controller, Electronic Gear and Torque Control → all configurations, except for "x40"), various control modes are available. The control mode is set via Parameter *Local/Remote* **412**. For details, refer to Chapter 11 "Control of frequency inverter".

In speed-controlled configurations, the reference speed is set via PZD2.

10 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 by field bus systems such as PROFINET. With the Motion Control Interface, the user can carry out a positioning operation via a field bus using a positioning profile typically including the target position, speed, acceleration, deceleration, quick stop and mode-specific information.

The Motion Control Interface uses *modes of operation* for switching between the different modes. The supported modes as per CANopen® Standard DS402 are:

- 1 – Profile Position mode
- 2 – Velocity mode [rpm]
- 3 – Profile Velocity mode [u/s]
- 6 – Homing
- 7 – Interpolated mode (not for PROFINET as field bus)
- 8 – Cyclic sync position mode (not for PROFINET as field bus)
- 9 – Cyclic sync velocity mode (not for PROFINET as field bus)
-

Bonfiglioli Vectron specific mode

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

The current mode is shown in *modes of operation display*.

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

It is recommended that a currently active movement be stopped by the PLC first, then to switch the mode of operation and restart in the new mode.

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

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

10.1 Object and parameter relationships

Depending on the selected mode of operation, various objects and parameters are used. The various objects and parameters must be set specifically for the different modes of operation.
Use of “Deceleration” and “Quick Stop” depends on the modes of operation, control commands and behavior in the case of communication errors (see *Bus Error Behaviour* **388**).

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

Parameters **1292** *Modes of Operation* and following *(***1293**, **1294**, **1295**, **1296** & **1297***)* and **1285** *S.Target velocity pv [u/s]* are used for linking the internal functions to CANopen® objects. Usually, these need not to be changed when using CANopen®. For PROFINET, they will have to be changed. Please check chapter 10.4 “Motion Control Mapping for PROFINET” for a setup proposal.

Mode	Homing	Velocity Mode	Profile Velocity Mode
Modes of Operation 1)2)	**6**	**2**	**3**
Target position			
Speed	**1132** & **1133** *Fast speed / Creep speed*	**1297** *S.reference speed vl [rpm]*2)	**1285** *S.reference speed pv [u/s]*2)
Limitation3)	**418** *Minimum frequency* **419** *Maximum Frequency*	**418** *Minimum frequency* **419** *Maximum Frequency*	**418** *Minimum frequency* **419** *Maximum Frequency*
Acceleration	**1134** *Acceleration*	**420** *Acceleration (clockwise)* **422** *Acceleration anticlockwise*	**1295** S.*Acceleration* 2)
Deceleration	**1134** *Acceleration*	**421** *Deceleration (clockwise)* **423** *Deceleration anticlockwise*	**1296** *S.Deceleration* 2)
Emergency stop 4) Quick Stop	**1179** *Emergency stop ramp*	**424** *Emergency stop clockwise* **425** *Emergency stop anticlockwise*	**1179** *Emergency stop ramp*
Homing Method	**1130** *Homing type*		

1) The mode of operation is set via **1292** *S. Modes of Operation*.
Factory setting: 801 - Obj. 0x6060 modes of 2 – Velocity mode.
2) Parameters **1285**, **1292**, **1293**, **1294**, **1295**, **1296** & **1297** are used for linking the CANopen® objects and internal functions. For CANopen®, they don't have to be changed. For PROFINET, refer to Chapter 10.4 “Motion Control Mapping for PROFINET”.
3) The limitation results from *Minimum frequency* **418** and *Maximum Frequency* **419**. Through *Limitation* **1118** of the position controller in Configuration x40, an increase above the Maximum Frequency can occur, because the output of the position controller is added to the Maximum Frequency.
4) Emergency stop or Deceleration is used depending on the stopping behavior *Mode of operation* **630** or the behavior in the case of communication errors *Bus Error Behaviour* **388**.

Mode	Profile Positioning mode
Modes of Operation [1)2)]	1
Target position	**1293** *S. target position*[2)]
Speed	**1294** *S. Pos.speed.* [2)]
Limitation[3)]	**418** *Minimum frequency* **419** *Maximum Frequency*
Acceleration	**1295** *S. Acceleration*[2)]
Deceleration	**1296** *S. Deceleration* [2)]
Emergency stop [4)] Quick Stop	**1179** *Emergency stop ramp*

1) The mode of operation is set via **1292** *S. Modes of Operation*.
Factory setting: 801 - Obj. 0x6060 modes of 2 – Velocity mode.
2) Parameters **1285**, **1292**, **1293**, **1294**, **1295**, **1296** & **1297** are used for linking the CANopen® objects and internal functions. For CANopen®, they don't have to be changed. For PROFINET, refer to Chapter 10.4 “Motion Control Mapping for PROFINET”.
3) The limitation results from *Minimum frequency* **418** and *Maximum Frequency* **419**. Through *Limitation* **1118** of the position controller in Configuration x40, an increase above the Maximum Frequency can occur, because the output of the position controller is added to the Maximum Frequency.
4) Emergency stop or Deceleration is used depending on the stopping behavior *Mode of operation* **630** or the behavior in the case of communication errors *Bus Error Behaviour* **388**.

Mode	Table travel record mode	Move away from limit switch	Electronic gear - Slave
Modes of Operation [1)2)]	**-1**	**-2**	**-3**
Target position	**1202** *Target position*		
Speed	**1203** *Speed*	**1132** *Fast speed* **1133** *Creep speed*	**1285** *S.reference speed pv [u/s]*[2)]
Limitation[3)]	**418** *Minimum frequency* **419** *Maximum Frequency*	**418** *Minimum frequency* **419** *Maximum Frequency*	**418** *Minimum frequency* **419** *Maximum Frequency*
Acceleration	**1204** *Acceleration*	**1134** *Acceleration*	**1295** *S.Acceleration* [2)]
Deceleration	**1205** *Deceleration*	**1134** *Acceleration*	**1296** *S.Deceleration* [2)]
Emergency stop [4)] Quick Stop	**1179** *Emergency stop ramp*	**1179** *Emergency stop ramp*	**1179** *Emergency stop ramp*
Motion block	Selected via control word		
Gear factor			**1123** *Gear factor Numerator* **1124** *Gear factor denominator*
Phasing [5)]			**1125** *Phasing: Offset* **1126** *Phasing: Speed* **1127** *Phasing: Acceleration*

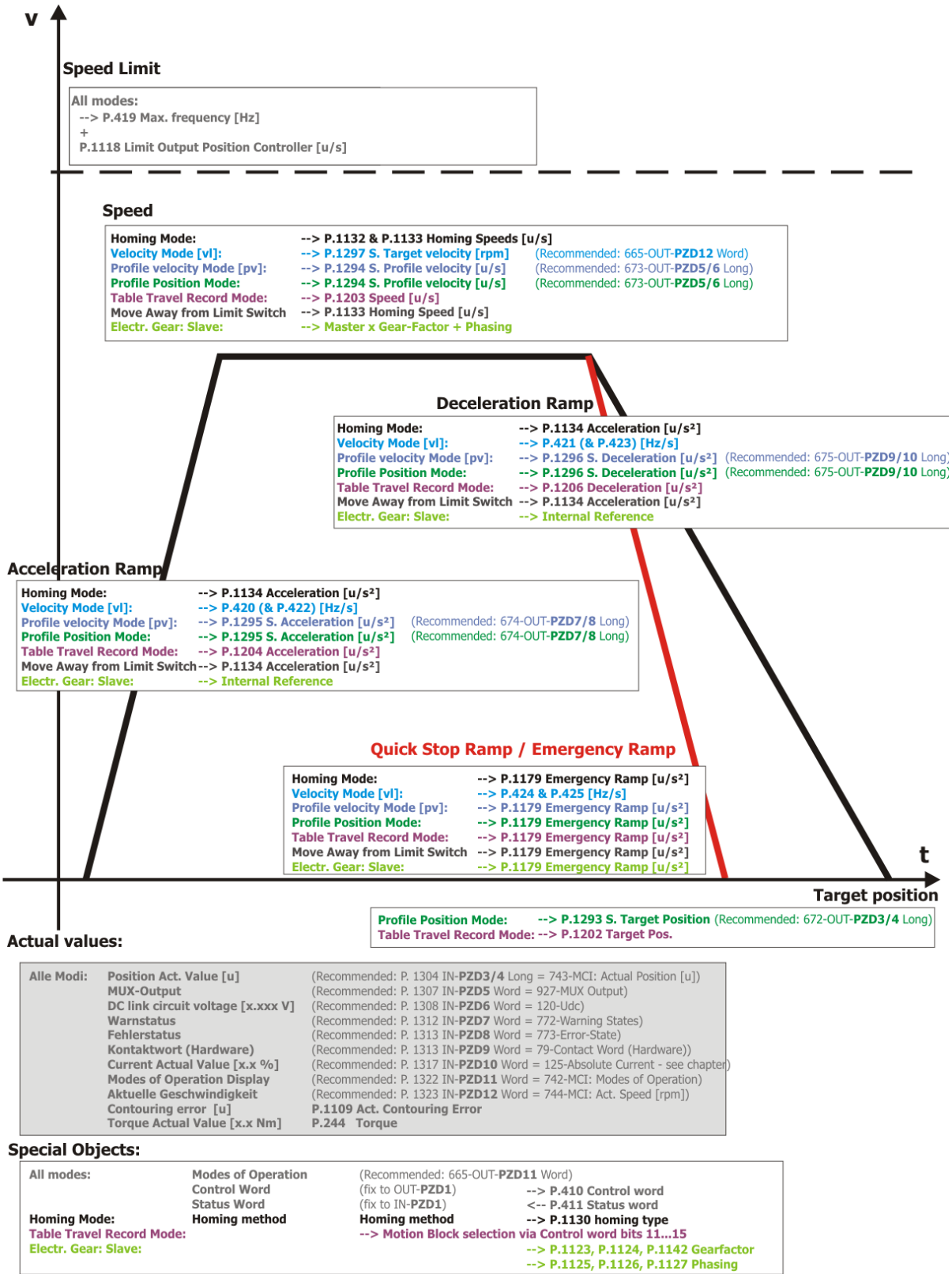
1) The mode of operation is set via **1292** *S. Modes of Operation*.
Factory setting: 801 - Obj. 0x6060 modes of 2 - Velocity mode.

2) Parameters **1285**, **1292**, **1293**, **1294**, **1295**, **1296** & **1297** are used for linking the CANopen® objects and internal functions. For CANopen®, they don't have to be changed. For PROFINET, refer to Chapter 10.4 “Motion Control Mapping for PROFINET”.

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

4) Emergency stop or Delay is used depending on the stopping behavior *Mode of operation* **630** or the behavior in the case of communication errors *Bus Error Behaviour* **388**.

Relationships between objects, parameters and conversions



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

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

The Motion Control Interface is a defined interface of the ACU devices for position control. This interface is typically used in combination with a field bus such as PROFINET.

The source “125-Abs. current value” uses the device-internal standardization, see Chapter 8.3.1 “Data types of OUT/IN objects”.

10.2 Functions of the Motion Control Interface (MCI)

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

10.2.1 Reference system

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

Conversion between “user units” [u] and frequencies [Hz]

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

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

The same formulas can be used for converting acceleration values from a[Hz/s] to a[u/s²] and vice versa. In the formulas, replace speeds f[Hz] and v[u/s] by accelerations a[Hz/s] and a[u/s²].

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

10.2.2 Modes of operation

In *Modes of operation*, you can define the operation mode of the frequency inverter. The available options depend on the set frequency inverter configuration.

PZD

Modes of operation must be assigned, via Parameter *S.Modes of Operation* **1292**, to an OUT-PZD. The mode of operation is switched via the assigned OUT-PZD.

Available values for *Modes of operation* in frequency inverter configurations with Motion control (Parameter *Configuration* **30** = x40):

Modes of operation
1 – Profile position mode
2 – Velocity mode [rpm] **(factory setting)**
3 – Profile velocity mode [u/s]
6 – Homing mode
-1 – Table travel record mode (manufacturer-specific mode of operation)
-2 – Move away from limit switch (manufacturer-specific mode of operation)
-3 – Electronic Gear: Slave (manufacturer-specific mode of operation)

Available values for *Modes of operation* in frequency inverter configurations without Motion control (Parameter *Configuration* **30** ≠ x40):

Modes of operation
2 – Velocity mode [rpm]

In configurations without Motion Control, any settings other than value 2 will be ignored by the frequency inverter.

10.2.3 Modes of operation display

PZD

Modes of operation display confirms the mode of operation set before by displaying the value of *Modes of operation*.

Modes of operation must be assigned to an IN-PZD.
Example: *IN-PZD 11 Word* **1322** = 742 – MCI: Modes of operation

After setting *Modes of operation*, the PLC will have to wait for this confirmation before another command can be transmitted to the frequency inverter.

10.2.4 Current position and contouring errors

Parameter *Act. position value* **1108** returns the actual position in user units.

Using an IN-PZD, the actual position can be transmitted to the PLC cyclically.
Example: *IN-PZD 3/4 Long* **1304** = 743 – Act. position value [user units]

Parameter *Act. contouring error* **1109** returns the actual contouring error.

Using an IN-PZD, the actual contouring error can be transmitted to the PLC cyclically.
Example: *IN-PZD 3/4 Long* 1304 = 747 – Act. contouring error [user units]

The contouring error can be monitored internally in order to trigger a device error once a threshold is reached. For details on parameters *Fault reaction* **1120**, *Warning threshold* **1105**, *Error threshold* **1106** and *Contouring error time* **1119**, refer to the "Positioning" application manual.

10.2.5 Position Controller

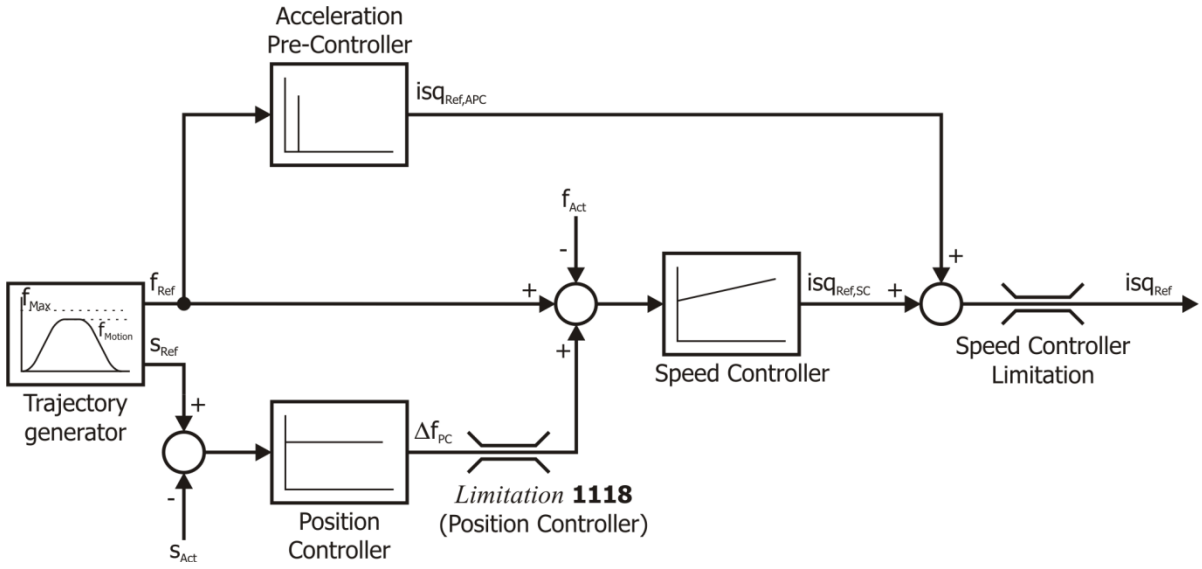
The position controller evaluates the positioning operation (target/actual position) and tries to control the drive such that it comes as close as possible to the specifications. For this purpose, an additional frequency is calculated for compensation of position deviations. By setting the corresponding parameter, this frequency can be limited. The parameter settings of the position controller determine how quick and to what extent position deviations are to be compensated.
Via *Time Constant* **1104**, you can define the maximum time in which the position deviation is to be compensated.
Via parameter *Limitation* **1118**, you can define to which value the speed is limited for compensation of the position deviation.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1104	Time constant	0.00 ms	300.00 ms	10.00 ms [1)] 100.00 ms [2)]
1118	Limit	0 u/s	2^{31}-1 u/s	327 680 u/s

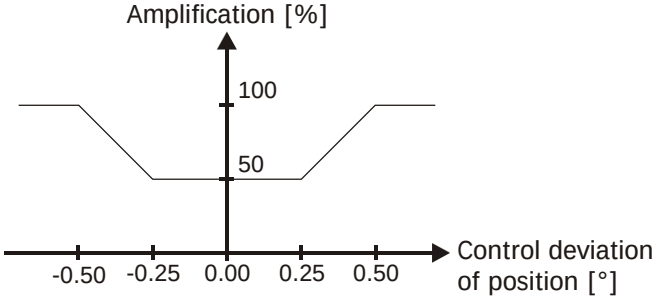
[1)] Factory parameter setting *Configuration* **30** = 240 or 540
[2)] Factory parameter setting *Configuration* **30** = 440

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

Controller block diagram



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



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

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

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

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

10.2.6 Profile position mode

PZD **Target position:**
The target position [u] is evaluated in positioning mode and must be set via a PZD object.
Example: *S. Target position* **1293** = 672 – OUT-PZD3/4 Long.

PZD **Positioning speed:**
The positioning speed [u/s] for positioning mode is typically set via a PZD object.
Example: *S. Positioning speed* **1294** = 674 – OUT-PZD5/6 Long.

If *S. Positioning speed* **1294** is set to “9-Zero”, the value from *Fixed speed 1* **1170** is used.

PZD **Acceleration:**
The acceleration [u/s²] for positioning mode is typically set via a PZD object.
Example: *S. Acceleration* **1295** = 675 – OUT-PZD7/8 Long.

If *S. Acceleration* **1295** is set to “9-Zero, the value from *Acceleration* **1175** is used.

PZD **Deceleration:**
The deceleration [u/s²] for positioning mode is typically set via a PZD object.
Example: *S. Deceleration* **1296** = 676 – OUT-PZD9/10 Long.

If *S. Deceleration* **1296** is set to “9-Zero”, the value from *Deceleration* **1177** is used.

Parameters **Ramp times - acceleration and deceleration:**
The ramp times of the acceleration and deceleration ramps [ms] in positioning mode are set via parameters *Ramp Rise Time* **1176** and *Ramp Fall Time*. **1178**.

Parameters **Emergency stop ramp:**
The emergency stop ramp [u/s²] for positioning mode is set via parameter *Emergency ramp* **1179** .

10.2.7 Velocity mode vl

PZD **Speed:**
The reference speed vl is evaluated in velocity mode vl and must be set via a PZD object.
Example: *S. Target Velocity vl [rpm]* **1297** = 665 – OUT-PZD12 Word.

Parameters **Acceleration**:
The acceleration [Hz/s] for velocity mode vl is set via parameters *Acceleration (clockwise)* **420** and *Acceleration anticlockwise* **422** .

Parameters **Deceleration**:
The deceleration [Hz/s] for velocity mode vl is set via parameters *Deceleration (clockwise)* **421** and *Deceleration anticlockwise* **423** .

Parameters **Ramp times - acceleration and deceleration:**
The ramp times for the acceleration and deceleration ramps [ms] are set, for velocity mode vl, via parameters *Ramp rise time clockwise* **430**, *Ramp fall time clockwise* **431**, *Ramp rise time anticlockwise* **432** and *Ramp fall time anticlockwise* **433** .

Parameters **Emergency stop ramp:**
The emergency stop ramp [Hz/s] for velocity mode vl is set via parameters *Emergency stop clockwise* **424** and *Emergency stop clockwise* **425** .

10.2.8 Profile velocity mode pv

PZD **Speed:**
The reference speed vl is evaluated in velocity mode vl and must be set via a PZD object.
Example: *S.Reference speed pv [u/s]* **1285** = 665 – OUT-PZD12 Word.

Parameters **Acceleration**:
The acceleration [Hz/s] for velocity mode vl is set via parameter *S. Acceleration* **1295**.

Parameters **Deceleration**:
The deceleration [Hz/s] for velocity mode vl is set via parameter *S.Deceleration* **1296.**

Parameters **Ramp times - acceleration and deceleration:**
The ramp times of the acceleration and deceleration ramps [ms] in positioning mode are set via parameters *Ramp Rise time* **1176** and *Ramp Fall time* **1178**.

Parameters **Emergency stop ramp:**
The emergency stop ramp [u/s²] for positioning mode is set via parameter *Emergency ramp* **1179**.

10.2.9 Homing mode

Parameters **Homing mode:**
The homing mode is set via parameter *Homing mode* **1130**. For a description of the homing modes, refer to Chapter 13.6 “Homing modes”.

Parameters **Home offset:**
Via parameter *Home offset* **1131**, you can define a home offset.

Parameters **Speed:**
The speeds during homing are set via parameters *Fast speed* **1132** and *Creep speed* **1133**.

Parameters **Acceleration and Deceleration:**
The acceleration and deceleration during homing are set via parameter *Acceleration* **1134**.

Parameters **Ramp times - acceleration and deceleration:**
The ramp times of the acceleration and deceleration ramps for homing are set via parameter *Ramp Rise time* **1135**.

Parameters **Start position after homing:**
After homing:
P. 1185 = -1 → Drive remains in “coast to stop” position
P. 1185 ≠ -1 → Drive is moved actively to set position.

Parameters **Flying Homing:**
The Flying homing can be used to update the reference position during a running motion. This function is described in the application manual “Positioning”.

10.2.10 Table travel record mode

PZD **Motion block:**
The motion blocks are controlled via control word PZD1:

- Select start motion block with bits 11...15
- Select sequence mode with bit 4
- Start motion block with bit 9
- Continue motion block with bit 6.

For details on the functions of the motion blocks in table travel record mode, refer to the “Positioning” application manual.

10.3 Move away from Hardware limit switches

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

After an error reset, it is possible to move in the direction that is still enabled. Generally, any mode of operation can be used for clearing, as long as the travel command has the enabled direction.
As long as the limit switch is triggered, the limit switch warning in the status word and actual value parameters *Warnings* **269**, *Warnings Application* **273** and *Controller status* **275** will remain. Once the limit switch is cleared, the warning will be deleted in the status word and actual value parameters.

For simple clearing of the limit switches, you can use mode “-2 Move away from limit switch” (see Chapter 11.4.6 “Move away from limit switch mode”).

10.4 Motion Control Mapping for PROFINET

With the Motion Control Interface, the user can edit the sources which the Motion Control Interface accesses. By default, the sources are set to CANopen®. For PROFINET, they will have to be changed. The following table shows recommended settings for transmission direction PLC→ACU.

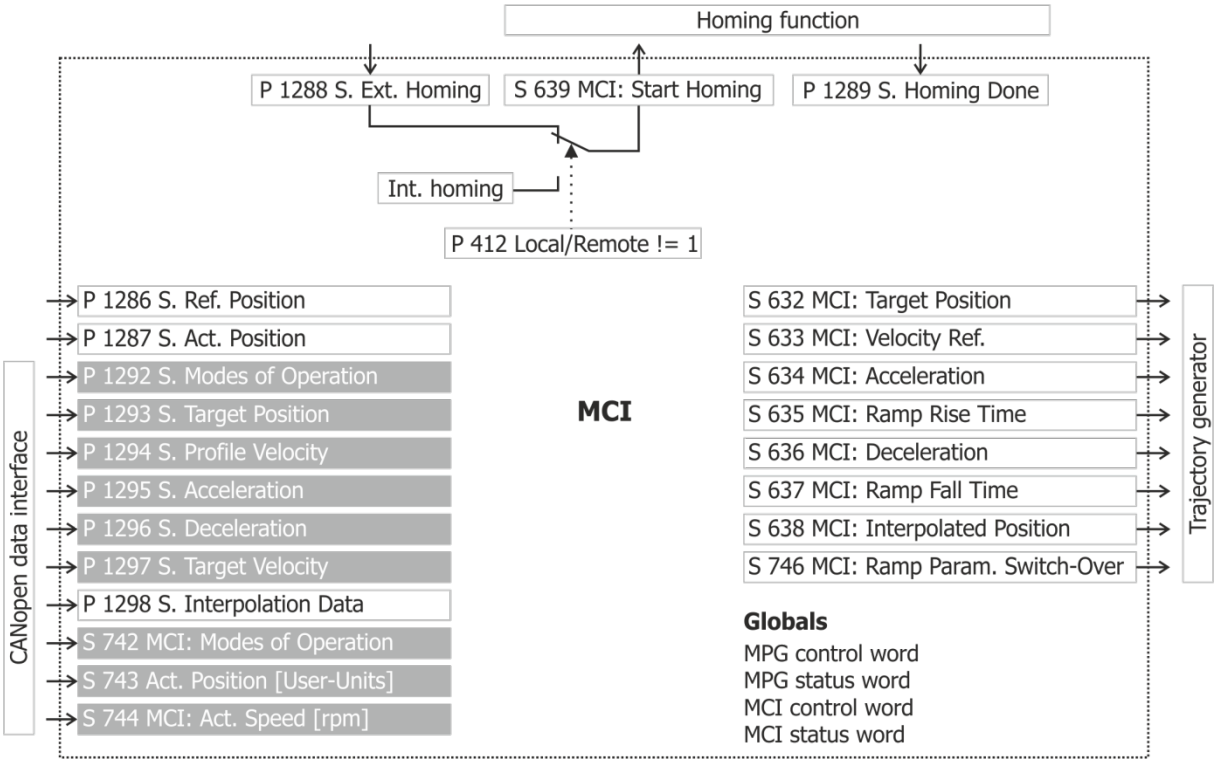
Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Recommended settings for PROFINET mode**
1292	S. Modes of Operation	Selection		664 – OUT-PZD11 Word
1293	S. Target position	Selection		672 – OUT-PZD3/4 Long
1294	S. Profile Velocity	Selection		673 – OUT-PZD5/6 Long
1295	S. Acceleration	Selection		674 – OUT-PZD7/8 Long
1296	S. Deceleration	Selection		675 – OUT-PZD9/10 Long
1297	S. Target Velocity vl [rpm]	Selection		665 – OUT-PZD12 Word
1299	S. Special Function Generator	Selection		9-Zero
1285	S. Target Velocity pv [u/s]	Selection		673 – OUT-PZD5/6 Long

1) If *S. Profile Velocity* **1294** is set to "9-Zero", the value from *Fixed speed 1* **1170** is used.
2) If *S.Acceleration* **1295** is set to "9-Zero", the value from *Acceleration* **1175** is used.
3) If *S.Deceleration* **1296** is set to "9-Zero", the value from *Deceleration* **1177** is used.

The following table shows recommended settings for transmission direction PLC←ACU.

Parameters	Recommended setting
1300 In-PZD 3 Boolean	= 7-Off
1301 In-PZD 4 Boolean	= 7-Off
1302 In-PZD 3 Word	= 9-Zero
1303 In-PZD 4 Word	= 9-Zero
1304 In-PZD 3/4 Long	**= 743 – Actual position value [user units]**
1305 In-PZD 5 Boolean	= 7-Off
1306 In-PZD 6 Boolean	= 7-Off
1307 In-PZD 5 Word	**= 927 – Output MUX**
1308 In-PZD 6 Word	**= 120 – Udc**
1309 In-PZD 5/6 Long	= 9 – Zero
1310 In-PZD 7 Boolean	= 7-Off
1311 In-PZD 8 Boolean	= 7-Off
1312 In-PZD 7 Word	**= 772 – Warning status**
1313 In-PZD 8 Word	**= 773 – Error status**
1314 In-PZD 7/8 Long	= 9 – Zero
1315 In-PZD 9 Boolean	= 7-Off
1316 In-PZD 10 Boolean	= 7-Off
1317 In-PZD 9 Word	**= 79 – Contact assignment word (hardware)**
1318 In-PZD 10 Word	**= 125 – Absolute current value**
1319 In-PZD 9/10 Long	= 9 – Zero
1320 In-PZD 11 Boolean	= 7-Off
1321 In-PZD 12 Boolean	= 7-Off
1322 In-PZD 11 Word	**= 742 – MCI: Modes of operation**
1323 In-PZD 12 Word	**= 744 – MCI: Speed [rpm]**
1324 In-PZD 11/12 Long	= 9 – Zero

The following graph shows the parameters (P) and sources (S) which are used for defining the Motion Control Interface.



10.5 Motion Control Override

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

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

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

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1454	Override Modes Of Operation	Selection		0
1455	Override Target Position	-2^{31}-1...2^{31}-1 u		-1 u
1456	Override Profile Velocity	-1...2^{31}-1 u/s		-1 u/s
1457	Override Profile Acceleration	-1...2^{31}-1 u/s²		-1 u/s²
1458	Override Profile Deceleration	-1...2^{31}-1 u/s²		-1 u/s²
1459	Override Target Velocity vl [rpm]	-32768...32767 rpm		-1 rpm
1460	Override Target Velocity pv [u/s]	-2^{31}-1...2^{31}-1 u/s		-1 u/s

Based on the recommended settings of the Motion Control Interface (parameters **1292**...**1297**) as described in Chapter 10.4 “Motion Control Mapping for PROFINET” the override parameters and PZD objects are used as follows:

1454 *Override Modes Of Operation*	**or**	PZD11 Modes of Operation
1455 *Override Target Position*	**or**	PZD3/4 Target Position
1456 *Override Profile Velocity*	**or**	PZD5/6 Profile Velocity
1457 *Override Profile Acceleration*	**or**	PZD7/8 Profile Acceleration
1458 *Override Profile Deceleration*	**or**	PZD9/10 Profile Deceleration
1459 *Override Target Velocity vl [rpm]*	**or**	PZD12 Target Velocity
1460 *Override Target Velocity pv [u/s]*	**or**	PZD5/6 Profile Velocity

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

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

11 Control of frequency inverter

The master sends its control commands (control word) via the output object PZD1 to the frequency inverter and receives feedback about its status via a status word (status word).

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

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
412	Local/Remote	0	44	44

For operation with PROFINET, only operation modes 0, 1 and 2 are relevant. The other settings refer to the control option via the KP500 control unit.

Operation mode	Function
0 - Control via contacts (Chapter 11.1)	The Start and Stop commands as well as the direction of rotation are controlled via digital signals.
1 - Control via state machine (Chapters 11.2, 11.4)	The frequency inverter is controlled via the control word. **Only this setup supports positioning functions via the control word and modes of operation.**
2 - Control via remote contacts (Chapter 11.1)	The Start and Stop commands as well as the direction of rotation are controlled via virtual digital signals of the control word.

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

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

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
414	Data set selection	0	5	0

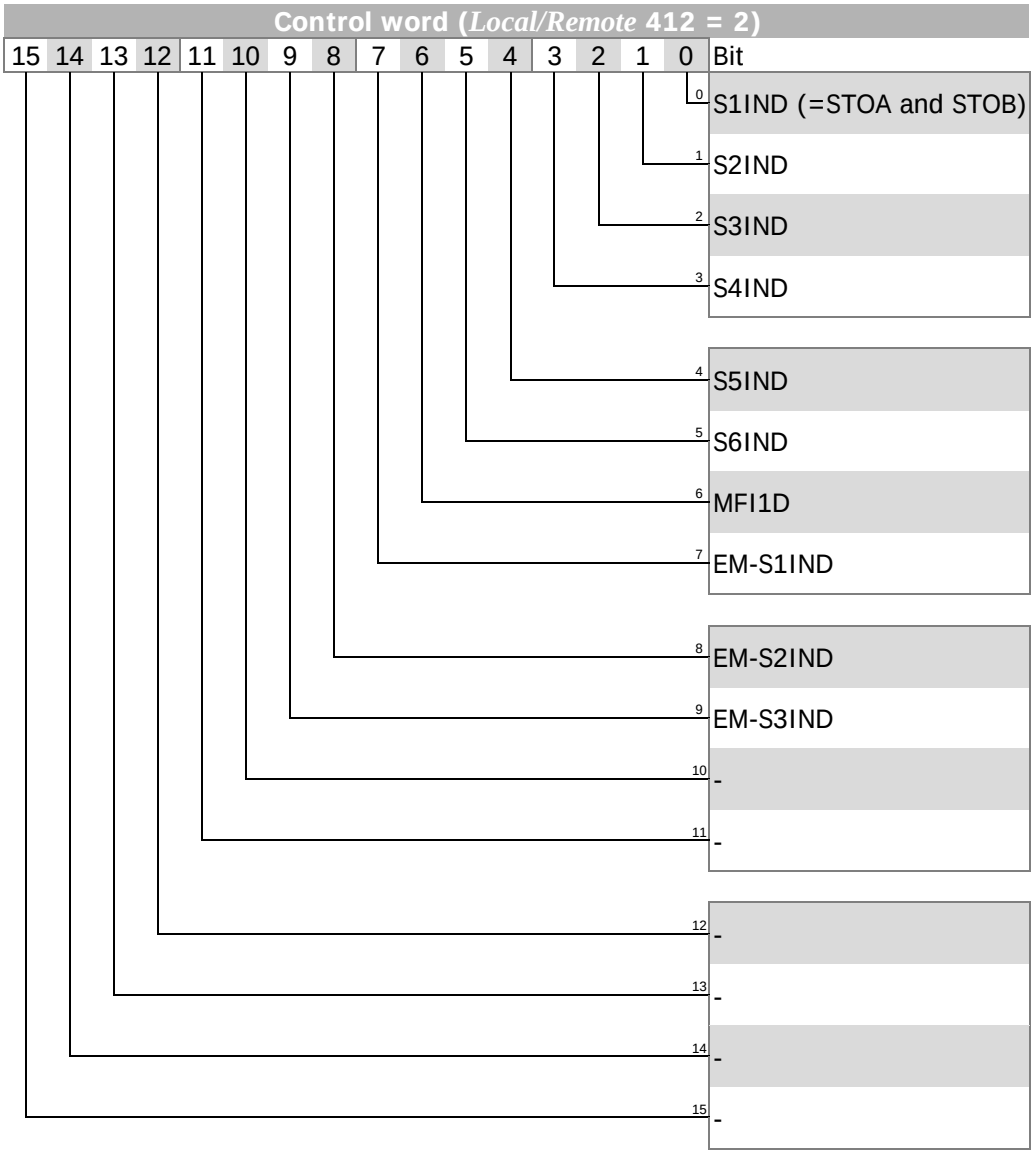
With *Data set selection* **414** = 0, data set switching via contact inputs will be active. If *Data set selection* **414** is set to 1, 2, 3 or 4, the selected data set is activated and data set switching via the contact inputs is deactivated.
If *Data set selection* **414** is set to 5, data set switching via contact inputs will be active if the frequency inverter is not enabled.

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

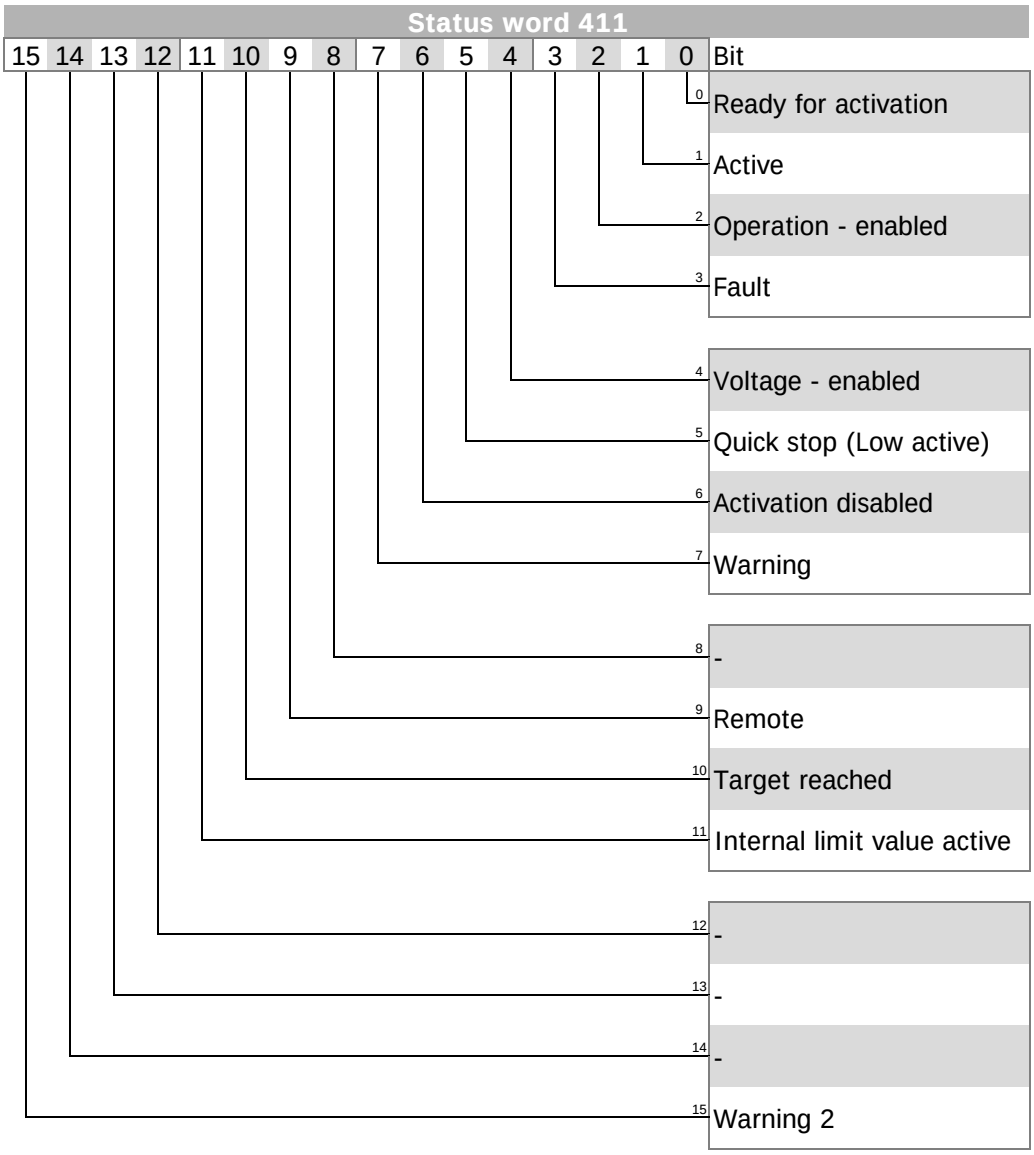
11.1 Control via contacts / remote contacts

In PZD1, the master sends its control words, via the output data set, to the frequency inverter and receives information about the frequency inverter (status words) via the input data set.

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



The digital inputs set via the control word can be monitored using parameter *Digital inputs* **250**. Digital input S1IND will only be displayed if controller release is switched on at STOA and STOB **and** the control word (Bit 0) was set. If the data set switching function is used, please ensure that Parameter *Local/Remote* **412** is set to “2 – Control via remote contacts” is set in all data sets used.



If operation mode “Control via remote contacts” is used, controller release must be turned on at STOA (Terminal X210A.3) and STOB (Terminal X210B.2) **and** Bit 0 of the control word must be set in order to be able to start the drive.
Operation modes “Control via contracts” and “Control via remote contacts” support operation mode “Speed vl” (*modes of operation* = “velocity mode”).

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

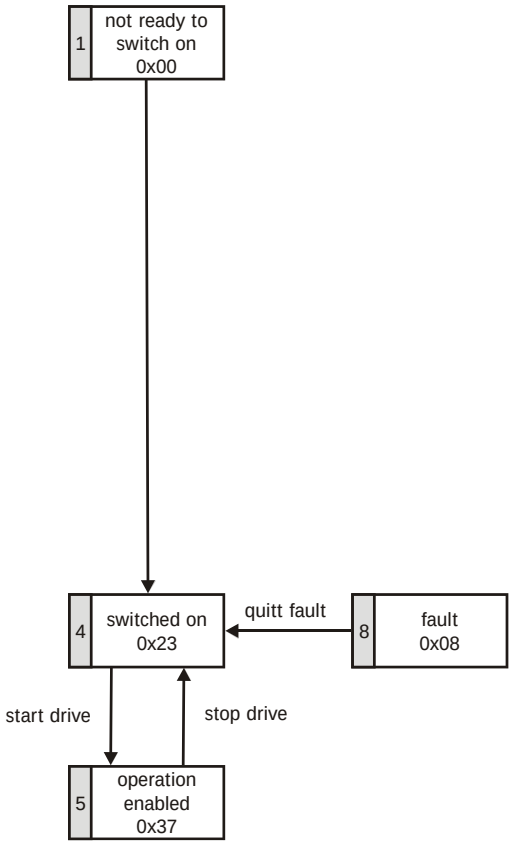
Bit 4 “Power supply – enabled” of the status word shows the current mains power supply status:

Bit 4 “Power supply – enabled” = 0 signals “No mains voltage”, starting of drive not possible.

Bit 4 “Power supply – enabled” = 1 signals “Mains voltage on”, drive ready for starting.

11.1.1 Device state machine

State machine:



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

"x" means any value.

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

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

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

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

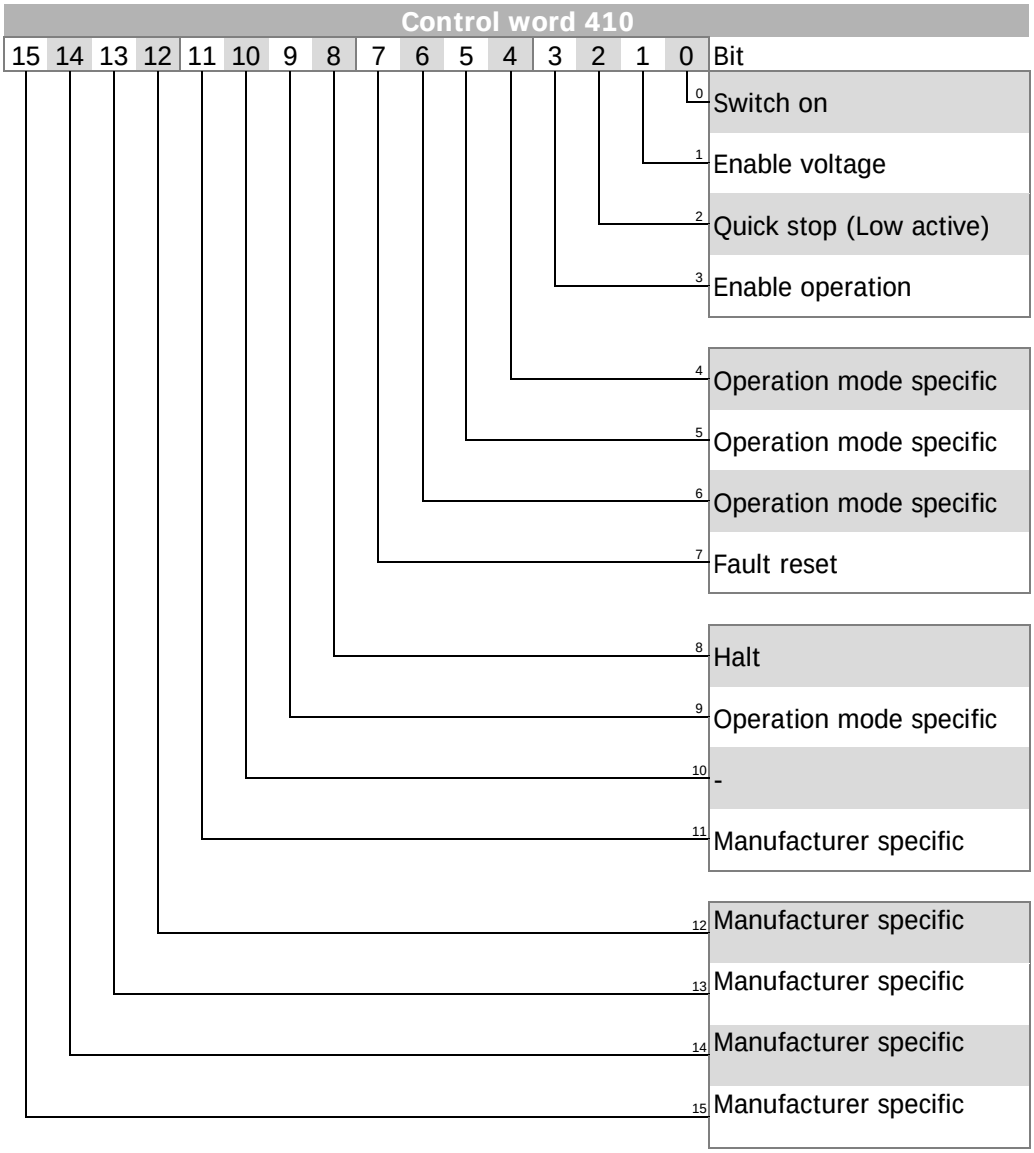
11.2 Control via state machine

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

Transition 4 to status “Operation enabled” is only possible:

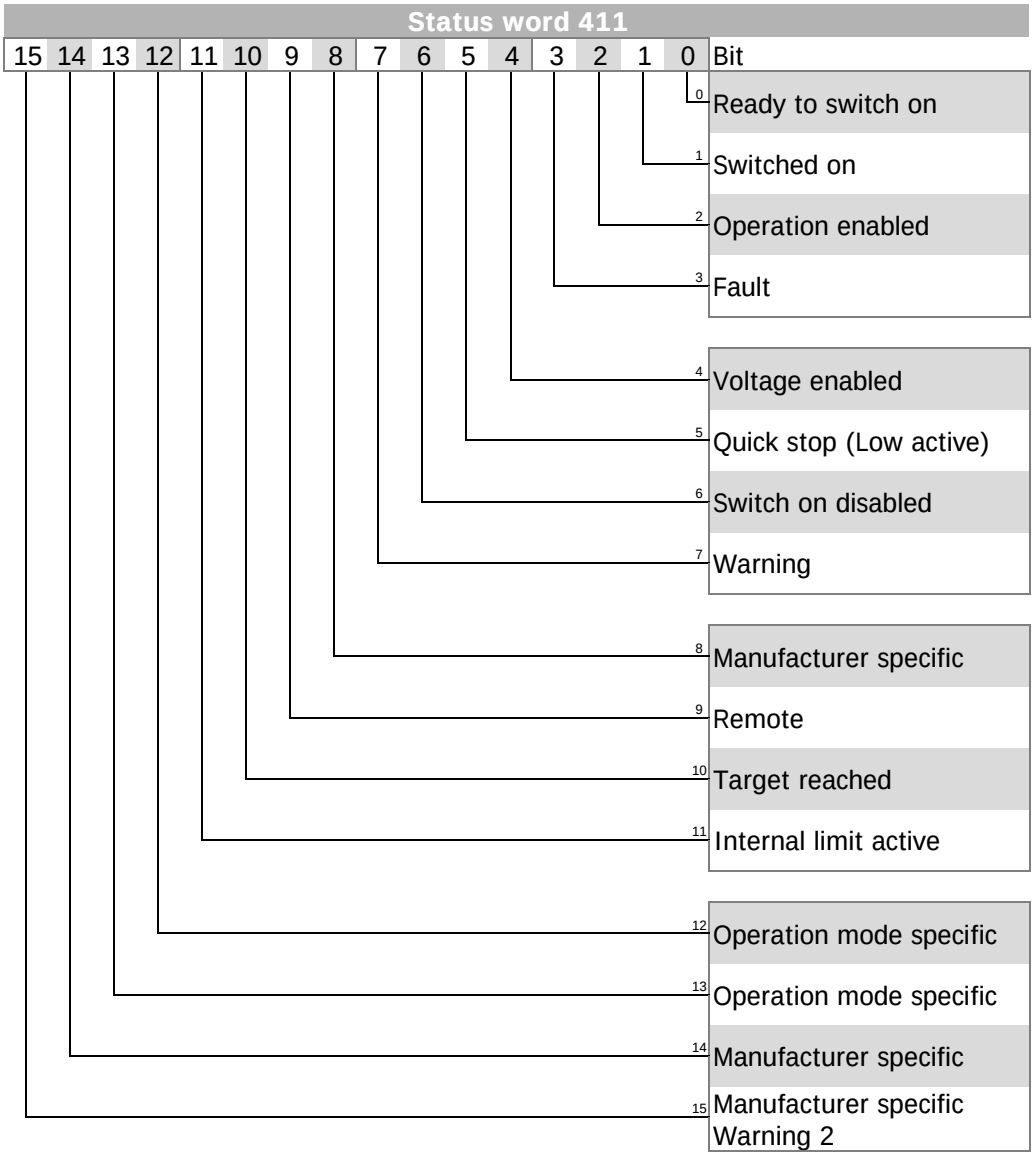
- if, in a configuration for Motion Control (parameter *Configuration* **30** = x40), the controller release is set via STOA and STOB,
- if, in other configurations (parameter *Configuration* **30** ≠ x40) the controller release is set via STOA and STOB and if one of the digital inputs S2IND or S3IND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

PZD1 / Parameter *Control word* **410** is applicable to the frequency inverter if parameter *Local/Remote* **412** is set to “1 – Control via state machine”.



Bits 9 ... 15 are used depending on the configuration and on *Mode of Operation.*

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



Bit 14 is not used.

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

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

Bit 4 “Power supply – enabled” of the status word shows the current mains power supply status:

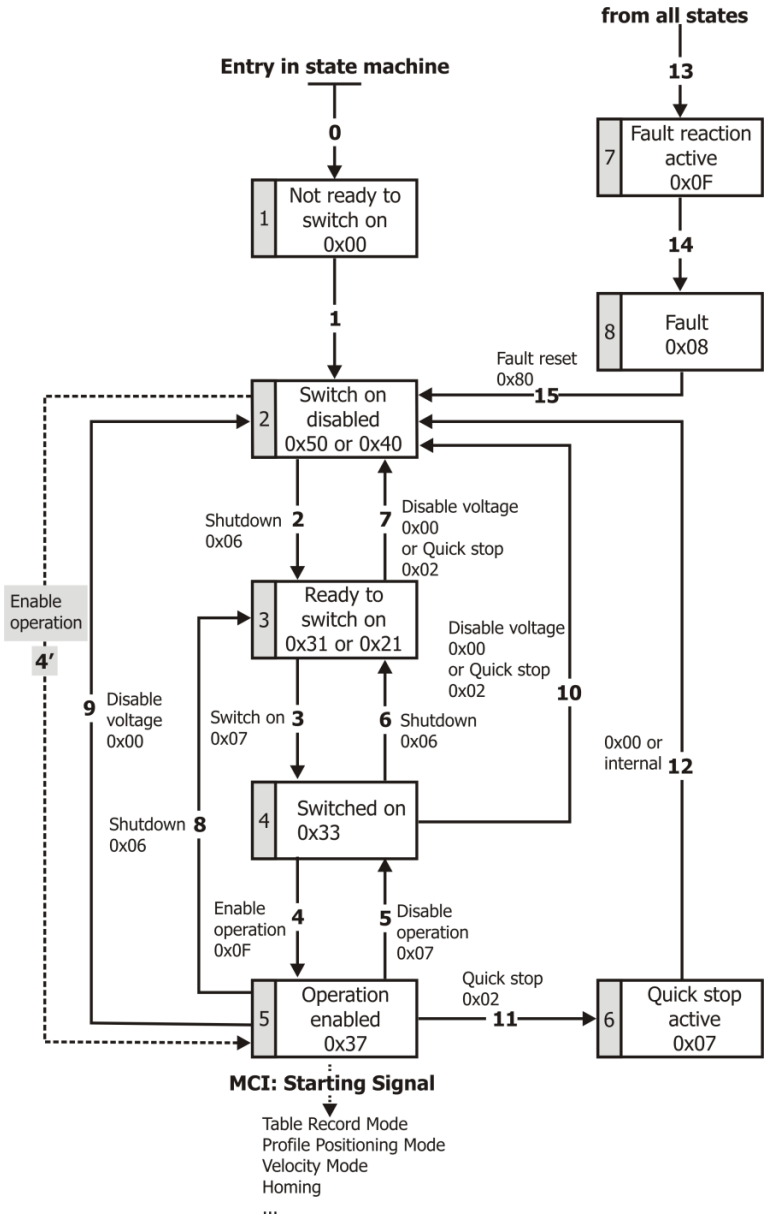
Bit 4 “Power supply – enabled” = **0** signals “No mains voltage”, starting of drive not possible.

Bit 4 “Power supply – enabled” = **1** signals “Mains voltage on”, drive ready for start.

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

11.2.1 State machine diagram

State machine:



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

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

"X" means any value.

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

Transition 4 (Command "Enable operation" [0xF]) will only be processed if the release is set via the hardware contacts STO.
If the hardware release via STO is not set, the frequency inverter will remain in status "Switched On" [0x33] until the hardware release via STO is present.
In status "Operation enabled" [0x37], the device will switch to status "Switched On" [0x33] internally once the hardware release via STO is reset.

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

- Transition **4'** is **not** available.
- In status "5-Operation enabled [0x37]" an additional start signal must be provided via bits from the "High Byte" of the control word in order to start a movement of the motor. For a description of the start signal for this "Motion Control Interface" (MCI), refer to Chapter 11.4. The *Modes of operation* function is available for switching to other MCI modes.
- Digital inputs (STOA and STOB) must be set. Start clockwise and Start anticlockwise have no function in these configurations.

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

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

Status word:
The status word indicates the current operating state.

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

"X" means any value.

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

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

Bit 10 "**Target reached**" is set when the specified reference value is reached.
In configurations without Motion Control (parameter *Configuration* **30** ≠ x40) "Target reached" refers to the reference speed from OUT-PZD2. In the special case of power failure regulation, the bit is also set when the power failure regulation reaches the frequency 0 Hz (see frequency inverter operating instructions).
For "Target reached", there is a hysteresis (tolerance range) which can be set via the parameter *Max. control deviation* **549** see frequency inverter Operating Instructions).

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

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

11.3 Configurations without Motion Control

In configurations without Motion Control (*Configuration* **30** ≠ x40) *Modes of operation* is set permanently to "2 - *velocity mode*" (velocity mode vl). *Modes of operation display* will also be "2 - *velocity mode*" (velocity mode vl). These settings cannot be changed.

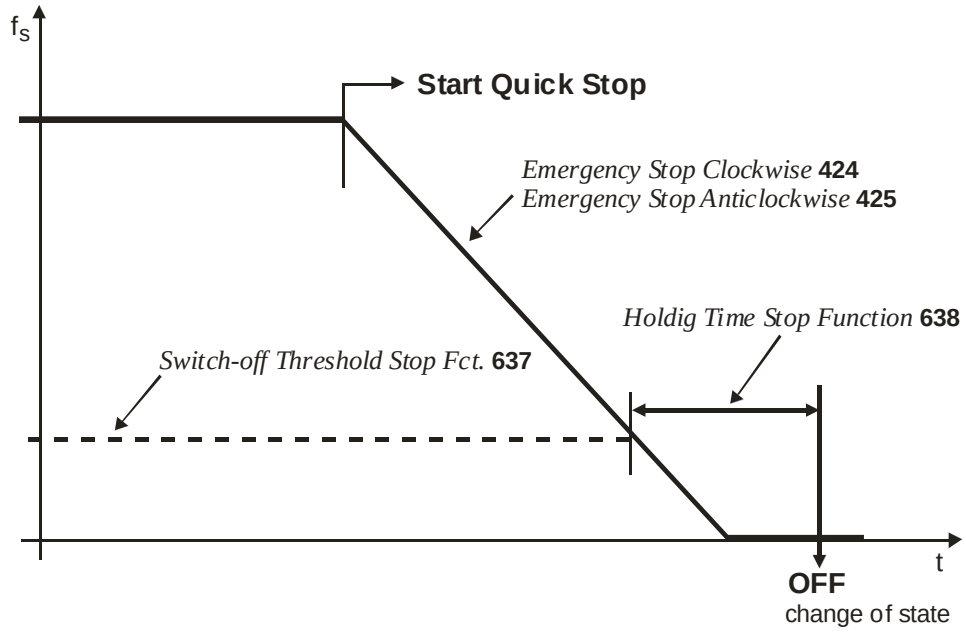
Relevant objects:

OUT-PZD1	Control word	IN-PZD1	Status word
OUT-PZD2	Target velocity	IN-PZD2	Control effort
P. 418	Minimum frequency	P. 420 (& P.422)	Acceleration
P. 419	Maximum Frequency	P. 421 (& P.423)	Deceleration
		P. 424 (& P.425)	Emergency stop

The ramp times are specified via parameters **430**...**433**.

11.3.1 Behavior in the case of a quick stop

In quick stop, the parameters *Switch-off threshold* **637** (percent of parameter *Maximum Frequency* **419**) and *Holding time* **638** (holding time after falling short of the switch-off threshold) are relevant. *Maximum Frequency*. In the case of a quick stop, the drive is stopped via emergency stop ramps.
The emergency stop ramps are set via parameters *Emergency Stop Clockwise* **424** and *Emergency Stop Anticlockwise* **425** .



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

The quick stop behavior is only relevant for configurations without Motion Control (parameter *Configuration* **30** ≠ x40).

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

The behavior in transition 5 from “Operation enabled” to “Switched On” can be configured via parameter *State transition 5* **392**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
392	State transition 5	0	2	2

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

Setting 1 “Direct current brake” is only possible with applications with U/f characteristic control (e.g. configuration 110). Other configurations do not support this operation mode.
If the frequency inverter is operated with a configuration which does not support the operation mode Direct Current Brake (e.g. configuration 210, field-oriented control), value "1" cannot be used.
In this case, the operation mode is not offered in the selection menus of the control unit KP500 and the control software VPlus.

By default, *State-transition 5* **392** is set to operation mode “2 - Ramp” For configurations with torque control, the default value is “0 - coasting”.
If the configuration is changed, the value set for *State-transition 5* **392** is also changed, if necessary.

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

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

If parameter *State-transition 5* **392** = “2 - Ramp” is set, the control word can be set to “Operation enabled” again, while the drive is decelerating. In this way, the drive accelerates to its set reference value again and remains in the state “operation enabled”.

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

11.3.3 Reference value / actual value

In PZD2, the master sends its reference value to the frequency inverter in its output data set and receives information about the actual value in its input data set.

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

The reference value and actual value refer to parameter *Rated frequency* **375 OR** *Profibus/PROFINET Reference* **390**.

The distinction is made based on the setting of parameter *Profibus/PROFINET reference* **390**. If *Profibus/PROFINET reference* **390** = 0, the values are obtained from *Rated frequency* **375**. If *Profibus/PROFINET reference* **390** ≠ 0, *Profibus/PROFINET reference* **390** is used. Both parameters are data set switchable.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
375	Rated frequency	10.00 Hz	1000.00 Hz	50.00 Hz
390	Profibus/PROFINET reference	0.00 Hz	999.99 Hz	0.00 Hz

The reference and actual value are transmitted in standardized form. Standardization is effected through the variable used as the reference variable (*Rated frequency* **375 OR** *Profibus/PROFINET reference* **390**).

Standardization			
Reference value	**Binary**	**Decimal**	**Hexadecimal**
+ 100 %	+ 2^{14}	16384	0x4000
- 100 %	- 2^{14}	49152	0xC000

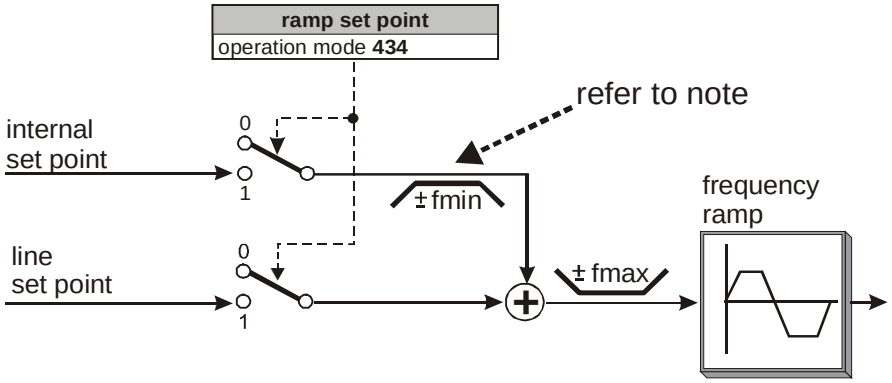
Value range = ±200 % = +32768 through -32768 = 0x7FFF through 0x8000

Example: In Parameter *Profibus/PROFINET reference* **390**, the rated frequency of 60.00 Hz is set. The required reference frequency is 30.00 Hz. Since this is 50 % of the reference value, 8192 (0x2000) must be transmitted as the reference value.

With the reference variable *Profibus/PROFINET reference* **390**, a machine can be operated in the field weakening range above its reference frequency.

Example: Parameter *Rated frequency* **375** is set to 50.00 Hz. With the setting of parameter *Profibus/PROFINET reference* **390** to 100.00 Hz, the value range ±200 Hz is possible.

The reference value for the frequency inverter from PZD2 is supplied via the reference line value. This reference value is combined in the input of the ramp function with the internal reference frequency from the reference frequency channel. For information on the reference frequency channel, refer to the frequency inverter Operating Instructions.



The internal reference value from the reference frequency channel and the reference line value can be fed to the ramp individually or as an added variable. The operation mode of the ramp function is set via the data set switchable parameter *Ramp setpoint* **434**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
434	Ramp setpoint	1	3	3

Operation mode	Function
1 - Internal reference frequency	The internal reference frequency is determined from the percentage reference value source or the reference frequency channel.
2 - Reference line value	The reference value is supplied externally via the communication interface.
3 - internal + reference line value	Addition (considering the sign) of internal reference frequency and reference line value

The Internal reference frequency can be controlled via the frequency inverter with the control unit KP500 or the control software VPlus, the reference line value is supplied via PZD2.

If *Ramp setpoint* **434** = 2 (reference line value only), this reference line value is limited to fmin.
The sign in front of fmin with reference value = 0 is derived from the sign in front of the last reference line value which was not 0.
After Mains On, the reference line value is limited to +fmin.

For *Ramp setpoint* **434** = 3, the sign of the total reference value results from the total of internal reference frequency and reference line value.

Actual values		
Parameters	**Contents**	**Format**
Internal reference frequency **228**	Internal reference value from the reference frequency channel	xxx.xx Hz
Reference bus frequency **282**	PROFINET reference line value	xxx.xx Hz
Reference ramp frequency **283**	= sum of internal reference frequency + reference line value	xxx.xx Hz

11.3.4 Sequence example

In configurations without Motion Control (*Configuration* **30** ≠ x40), the PLC must send the correct sequence:

1	Control word =	0x0000	Disable voltage
2	Control word =	0x0006	Shut down
3	Control word =	0x0007	Switch On
4	Control word =	0x000F	Enable operation

OR

1	Control word =	0x0000	Disable voltage
2	Control word =	0x000F	Enable operation

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

11.4 Motion control configurations

⚠ WARNING

Dangerous state due to new mode!

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

- BONFIGLIOLI VECTRON recommends checking the status word before changing the mode of operation (e.g. for status 0xnn33).

Motion Control Definition

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

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

The function of the state machine describes the basic operating behavior of the frequency inverter in configurations with position control (*Configuration* **30** = x40). The objects *control word* and *status word* described above support the bits marked as operation mode specific.
These bits and bit "Target reached" have different meanings in the different position control operation modes – defined by modes of operation. The following chapters describe the application of the operation mode specific bits in the *control word* and *status word*, depending on the different position control operation modes. The preset mode is *Modes of operation* = 2 – velocity mode.

Basic functions:

The state machine must be set to "operation enabled", before the position command can be issued via the operation mode specific bits of the *control word*.

Once a *mode of operation* has been set by the PLC, no commands will be accepted for this operation mode until this operation mode is displayed in the *modes of operation display* object.

The bits in the *control word* and *status word* marked as operation mode specific are only supported in configurations with position control (*Configuration* **30** = x40).

11.4.1 Velocity mode [rpm]

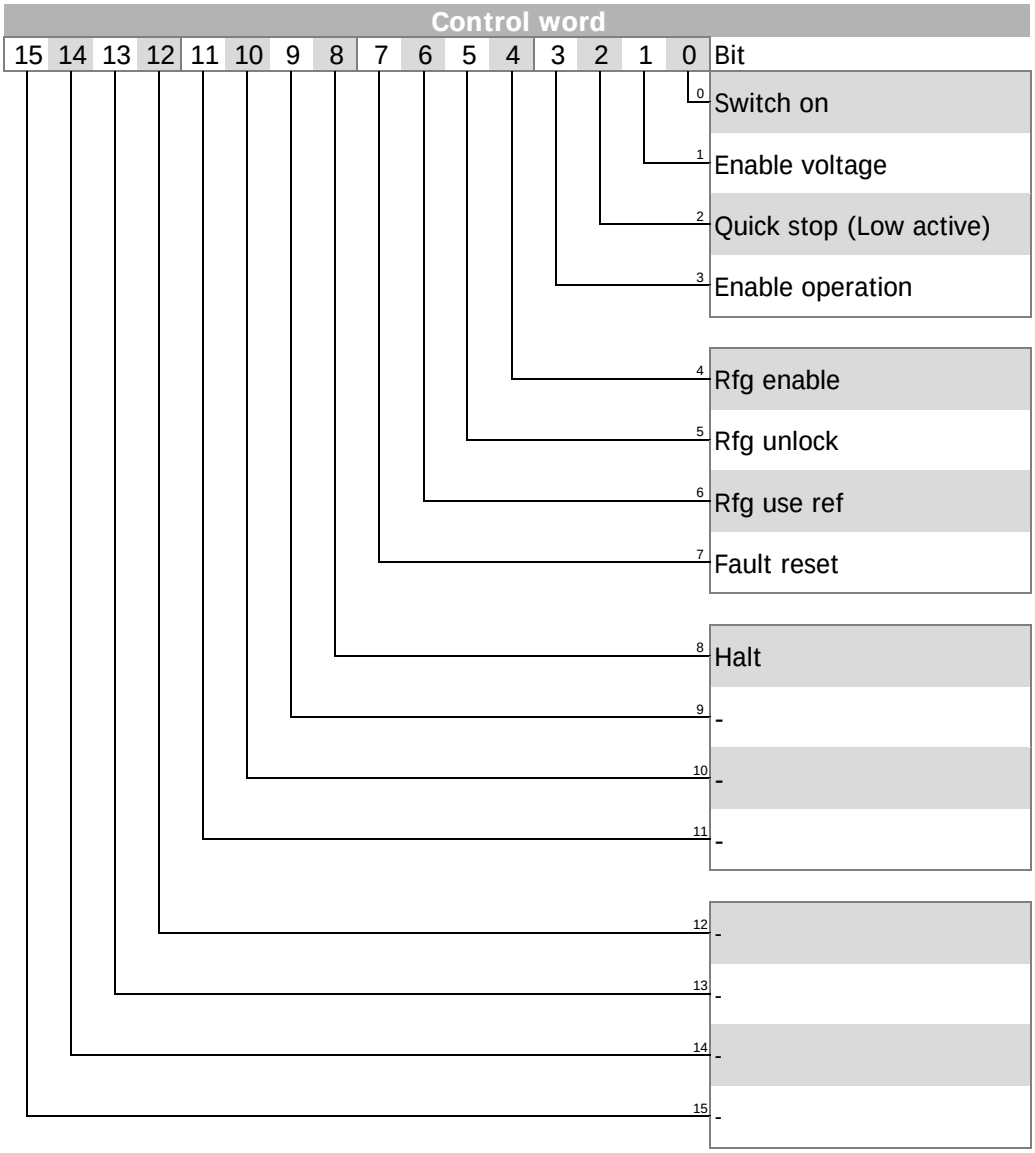
Velocity mode [rpm] can be selected via *modes of operation* = **2**.
In velocity mode, the operation mode specific of the control word control the ramp generator (RFG – Ramp Function Generator). The block diagram illustrates the function.

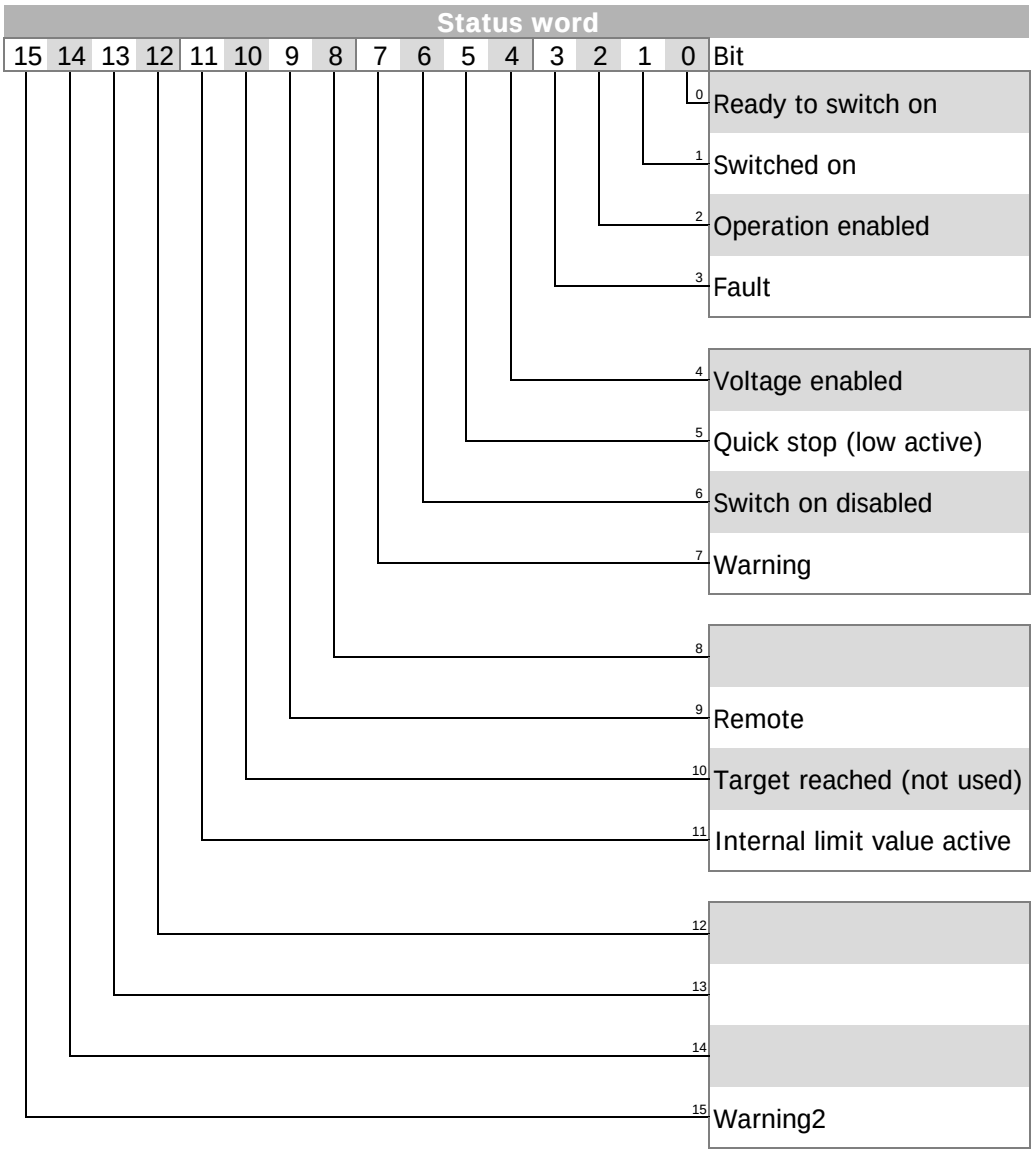
Relevant objects:

OUT-PZD1	Control word	IN-PZD1	Status word
OUT-PZD12[r)]	Target velocity [rpm]	IN-PZD12[r)]	Actual Speed [rpm]
OUT-PZD11[r)]	Modes of operation	IN-PZD11[r)]	Modes of operation display
P. 418	Minimum frequency	P. 420 (& P.422)	Acceleration
P. 419	Maximum Frequency	P. 421 (& P.423)	Deceleration
		P. 424 (& P.425)	Emergency stop

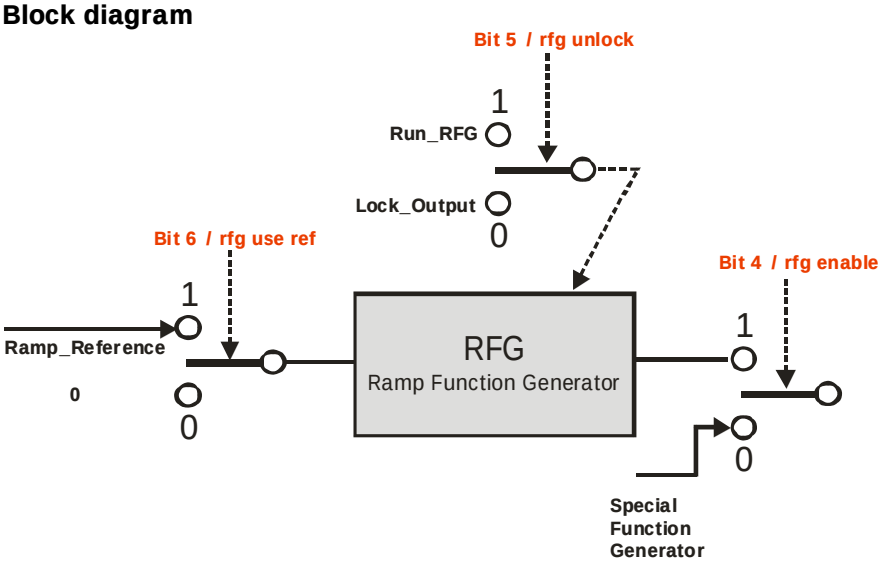
r) permissible only when the recommended settings from 10.4 “Motion Control Mapping for PROFINET” have been made.

The ramp times are specified via parameters **430**...**433**.





Block diagram



Bit 4 / rfg enable
Rfg enable = 0 the reference speed comes from a manufacturer-specific special function.
Rfg enable = 1 The reference speed corresponds to the ramp output.

The special function is evaluated only if **1299** *S. Special Function Generator* ≠ "9-Zero".
If **1299** *S. Special Function Generator* = "9-Zero", the value of the ramp output will always be used.

Bit 5 / rfg unlock
Rfg unlock = 0 The last speed will be maintained and used.
Rfg unlock = 1 The ramp function is active and changes according to the reference value and the ramp.

Bit 6 / rfg use ref
Rfg use ref = 0 Reference value "0" is used.
Rfg use ref = 1 The reference value from *Target Velocity* is used.

Bit 8 Halt
STOP = 0 → **Execute positioning.**
STOP = 1 → **Stop axis.** (The frequency inverter remains enabled in "Operation enabled" state.)

If special function generator **1299** *S. Special Function Generator* ≠ "9-Zero", the reference value from the ramp output will also be used if bit 4 "rfg enable" = 1, and if bit 4 "rfg enable" = 0, the reference value from the source specified in **1299** *S. Special Function Generator* will be used.

Reference value source		
	1299 *Q. Special Function Generator* ≠ "9-Zero"	**1299** *Q. Special Function Generator* = "9-Zero"
Bit 4 rfg enable = 0	Reference value from special function	Reference value from ramp output
Bit 4 rfg enable = 1	Reference value from ramp output	

11.4.1.1 Sequence example

In order to start “velocity mode”, the correct sequence must be sent by the PLC.

Preparation:
Set *Acceleration (clockwise)* **420** to the required value
(factory setting: 5 Hz/s)
Set *Deceleration (clockwise)* **421** to the required value
(factory setting: -0.01 Hz/s)
→ -0.01 means that the value set for the acceleration will also be used for deceleration.

	OUT IN	PZD1 Control word Status word	PZD11 r) Modes of operation Mod. Of. Op. Displ.	PZD12 r) Reference actual speed	Remark
1		0x0000 0x0050		arbitrary any	Disable voltage Switch On Disabled
2			0x0002 0x0002	any any	(Velocity mode)
3		0x0006 0x0031	0x0002 0x0002	any any	Shutdown Ready to switch on
4		0x0007 0x0033	0x0002 0x0002	any any	Switch On Switched On
5		0x000F 0xnn37	0x0002 0x0002	0xABCD	Enable operation, no change of previous status if already enabled. Operation enabled
6a		0x007F 0xnn37	0x0002 0x0002	0xABCD	Starts “Velocity mode” with reference value from OUT-PZD12r) 0xABCD. Operation enabled
6b		0x006F 0xnn37	0x0002 0x0002	0xABCD	**1299** *S. Special Function Generator*: = “9-Zero” ➔ Starts “Velocity mode” with reference value from OUT-PZD12r) 0xABCD. **1299** *S. Special Function Generator*: ≠ “9-Zero” ➔ Starts with reference value with source from **1299** *S. Special Function Generator.* Operation enabled
6c		0x003F 0xnn37	0x0002 0x0002	0xABCD	Starts “Velocity mode” with reference value “0” Operation enabled
6d		0x002F 0xnn37	0x0002 0x0002	0xABCD	**1299** *S. Special Function Generator*: = “9-Zero” ➔ Starts “Velocity mode” with reference value “0” **1299** *S. Special Function Generator*: ≠ “9-Zero” ➔ Starts with reference value with source from **1299** *S. Special Function Generator* Operation enabled
6e		0x005F 0xnn37	0x0002 0x0002	0xABCD	Starts “Velocity mode” at current speed – current ramps will be canceled. Operation enabled

6f		0x004F 0xnn37	0x0002 0x0002	0xABCD	**1299** *S. Special Function Generator*: = "9-Zero" ➔ Starts "Velocity mode" at current speed – current ramps will be canceled. **1299** *S. Special Function Generator*: ≠ "9-Zero" ➔ Starts with reference value from source from **1299** *S. Special Function Generator* Operation enabled
7		0x01xx 0xnn37	0x0002 0x0002	0xABCD	HALT: Drive is decelerated at ramp *Velocity deceleration*. Operation enabled

r) permissible only when the recommended settings from 10.4 "Motion Control Mapping for PROFINET" have been made.

⚠ WARNING

Dangerous state due to new mode!

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

- BONFIGLIOLI VECTRON recommends checking the status word before changing the mode of operation (e.g. for status 0xnn33).

Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).
In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).
With control word transition from 0xnnnF to 0x0007, "Velocity mode" will be stopped. Then, the mode can be restarted via 0xnnnF.
As long as 0x0007 is active, the mode of operation can be edited safely. Once *modes of operation* has been set to another value, operation can be started with a corresponding sequence.

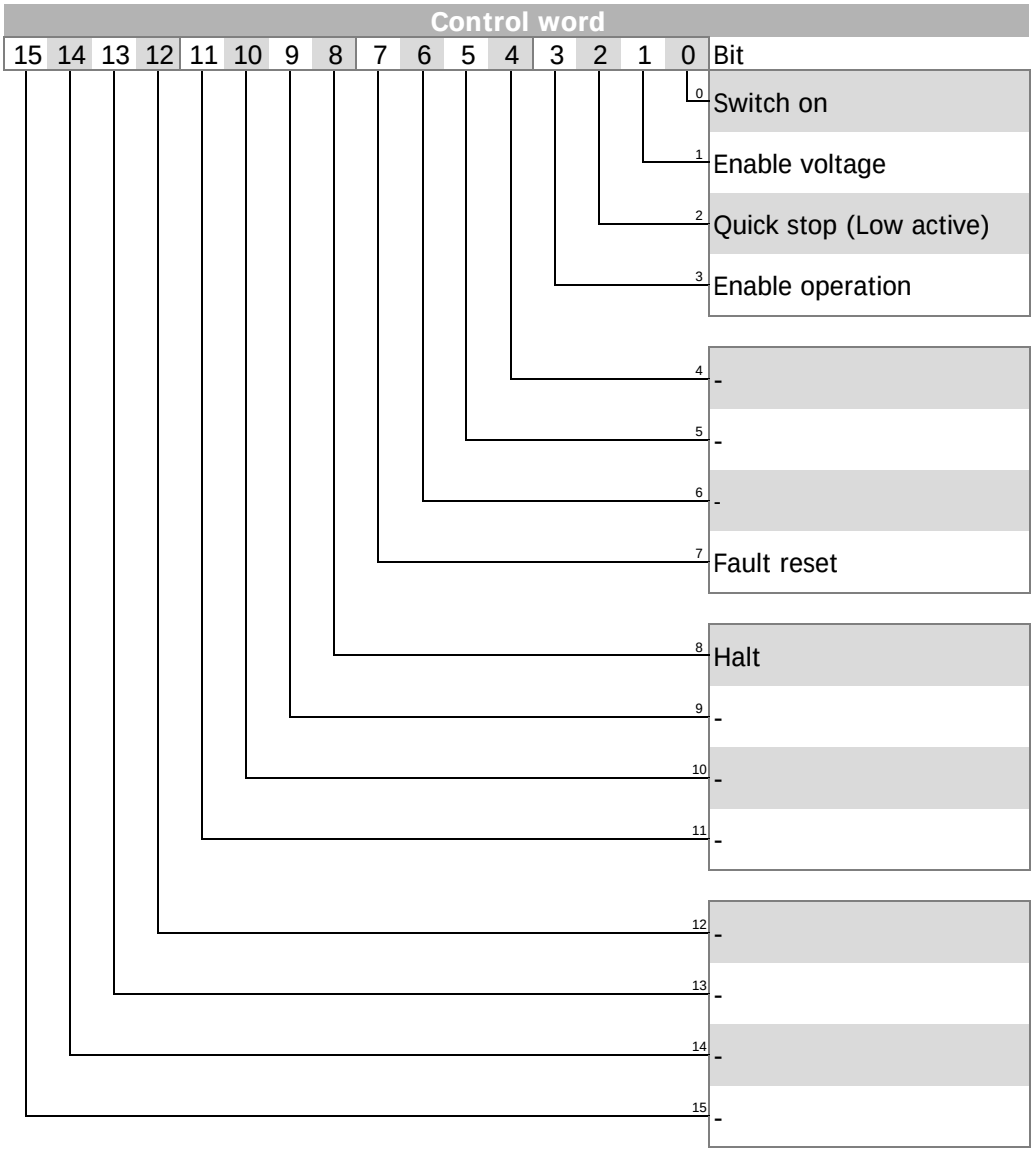
11.4.2 Profile Velocity mode [u/s]

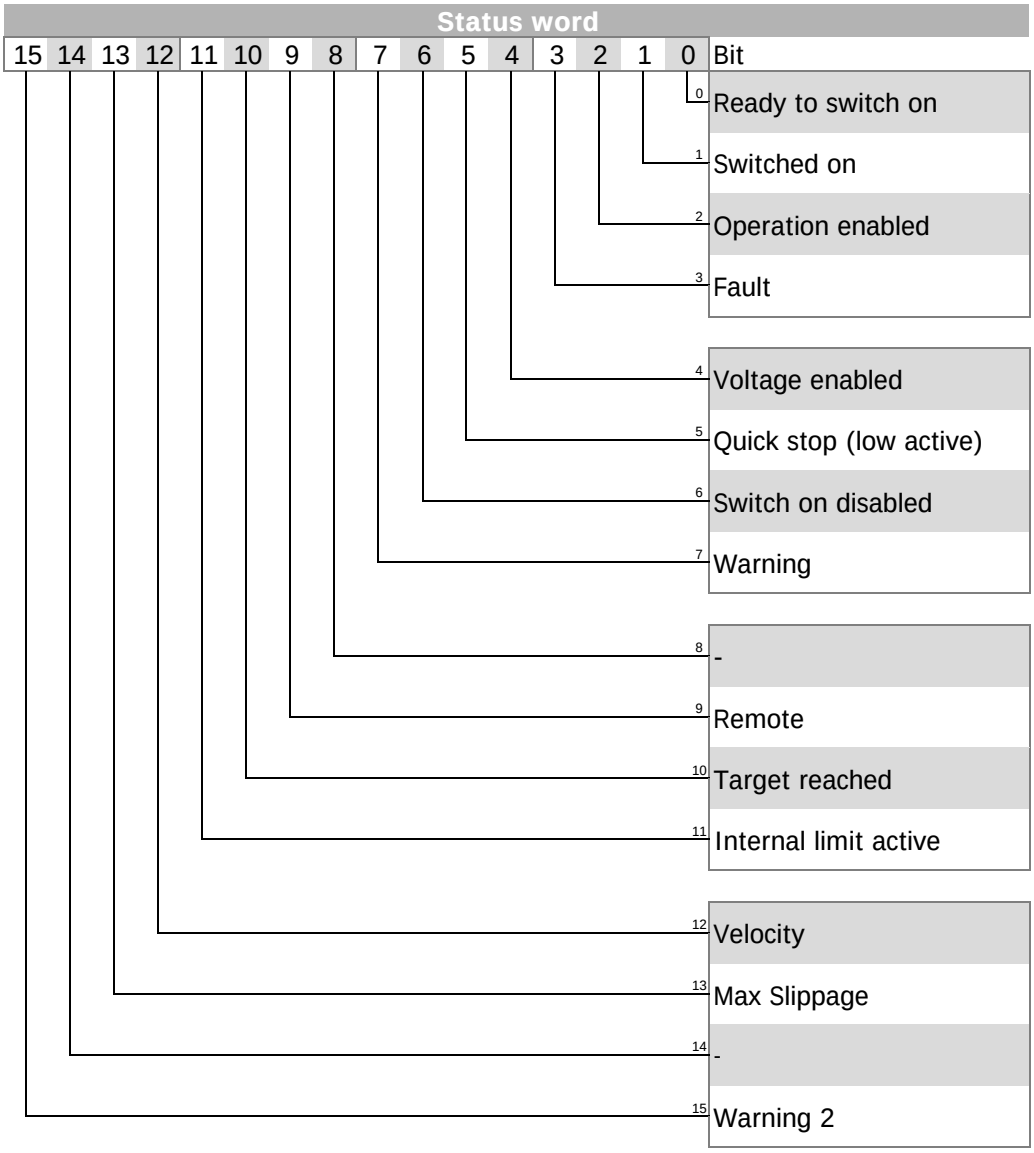
The profile velocity mode is selected via object *Modes of operation* =**3**.
In profile velocity mode the inverter receives a reference speed in [u/s].

OUT-PZD1	Control word	IN-PZD1	Status word
OUT-PZD11 r)	Modes of operation	IN-PZD11 r)	Modes of operation display
OUT-PZD5/6 r)	Profile velocity	P. 418	Minimum frequency
OUT-PZD7/8 r)	Profile acceleration	P. 419	Maximum Frequency
OUT-PZD9/10 r)	Profile deceleration	P. 1179	Emergency stop ramp

The Ramp Rise/Fall times are set up via parameters **1176** and **1178**.

In profile velocity mode, the operation mode specific bits of the control word and the status word are used as follows:





The Profile Velocity Mode is used to set the reference speed in user units [u/s]. The reference speed PZD5/6[r)] *Profile Velocity* is taken over in mode "operation enabled" immediately (0xnn37). The acceleration and deceleration ramp are specified by PZD7/8[r)] *Profile acceleration* and PZD9/10[r)] *Profile deceleration*.
Setting Bit 8 "Halt" of the control word delays the drive with ramp PZD9/10[r)] *Profile deceleration* and holds the drive at standstill. Resetting Bit 8 results in an acceleration with ramp PZD7/8[r)] *Profile acceleration* to the actual reference velocity.

Control word Bit 8: Halt
HALT = 0 → Execute Profile Velocity Mode.
HALT = 1 → Halt Axis. (The Frequency inverter remains in state "Operation enabled".)

Via parameter **1276** *Velocity Window* and **1277** *Velocity Window Time* Bit 10 “Target reached” of the status word is set.
Via parameter **1278** *Threshold Window* and **1279** *Threshold Window Time* Bit 12 “Velocity” of the status word is set.
Via parameter **1275** *Max Slippage* a slip monitoring via Bit 13 “Max Slippage” of the status word can be set up.

Status word Bit 10: Target reached

Target reached = 0 → The actual velocity doesn’t match the reference velocity.

Target reached = 1 → **The actual velocity matches the reference velocity.** The actual velocity differs at least from the defined time period in **1277** *Velocity Window Time* up to the defined amount [us] in **1276** *Velocity Window*.

Status word Bit 12: Velocity

Velocity = 0 → **The Actual Velocity matches the comparison speed.** The Actual Velocity has exceeded for a defined time (**1279** *Threshold Window Time*) a defined Velocity in user units per seconds [u/s] (**1278** *Threshold Window*).

Velocity = 1 → The Actual Velocity doesn’t match the Comparison Velocity.

Status word Bit 13: Maximum Slippage

Maximum Slippage = 0 → **The actual Slippage speed is smaller than defined.** The comparison value of the slippage speed is defined Object **1275** *Max Slippage*.

Maximum Slippage = 1 → **The actual Slippage speed is bigger than defined.** The comparison value of the slippage speed is defined **1275** *Max Slippage*.

11.4.2.1 Example Sequence

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

	OUT IN	PZD1 Control word Status word	PZD11 r) Modes of Op. M. Of. Op. Displ.	PZD5/6 r) *) Profile velocity	Remark
1		0x0000 0x0050	any any	any	Disable voltage Switch On Disabled
2		0x0000 0x0050	0x0003 0x0003	any	Profile Velocity mode
3		0x0006 0x0031	0x0003 0x0003	any	Shutdown Ready to switch on
4		0x0007 0x0033	0x0003 0x0003	0x1234 0x5678*)	Switch On Switched On
5		0x0007 ↓ 0x000F 0xnn37	0x0003 0x0003	0x1234 0x5678*)	Enable Operation, no change to previous state if already enabled. The Profile Velocity mode is started with reference PZD5/6r) Profile velocity and Ramp profile PZD7/8r) *Profile acceleration* and PZD9/10r) *Profile deceleration*. Changes to Target Velocity and Ramps are taken over immediately. Operation enabled

*) In addition to the Profile speed PZD5/6, Acceleration PZD7/8 and Deceleration 9/10 must be assigned appropriate values > 0. These PZDs are not shown in the table for reasons of clarity. Generally, it is recommended that all specified PZDs be changed at the same time.

⚠ WARNING

Dangerous state due to new mode!

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

- BONFIGLIOLI VECTRON recommends checking the status word before changing the mode of operation (e.g. for status 0xnn33).

Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).
In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).
With control word transition from 0xnnnF to 0x0007, "Profile position mode" will be stopped. Then, the mode can be restarted via 0xnnnF.
As long as 0x0007 is active, the mode of operation can also be changed safely. Once *modes of operation* has been set to another value, operation can be started with a corresponding sequence.

11.4.3 Profile position mode

Profile position mode can be selected via *modes of operation* = **1**.
In profile position mode, the frequency inverter receives a target position, followed by the command to travel to this target.

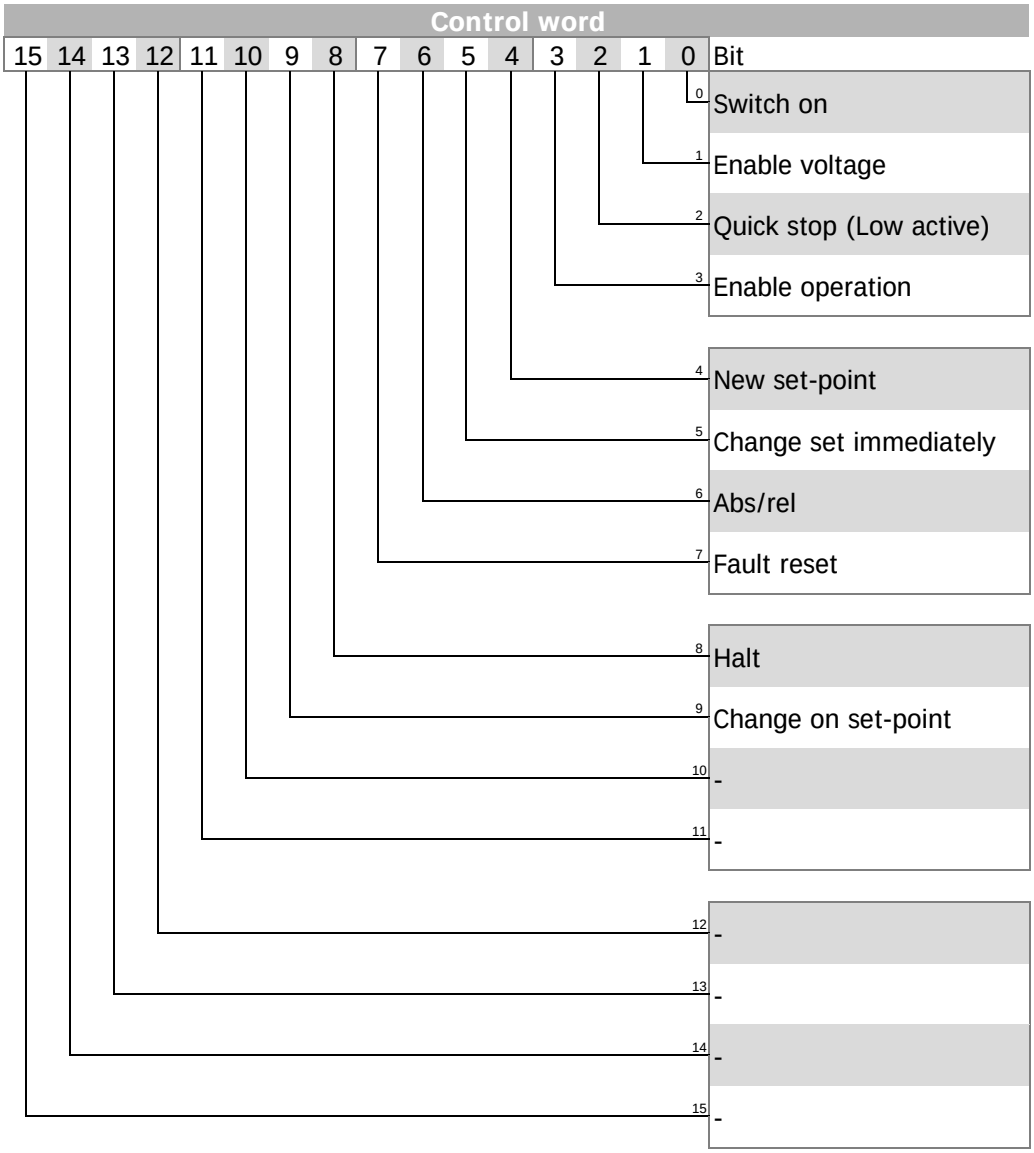
Relevant objects:

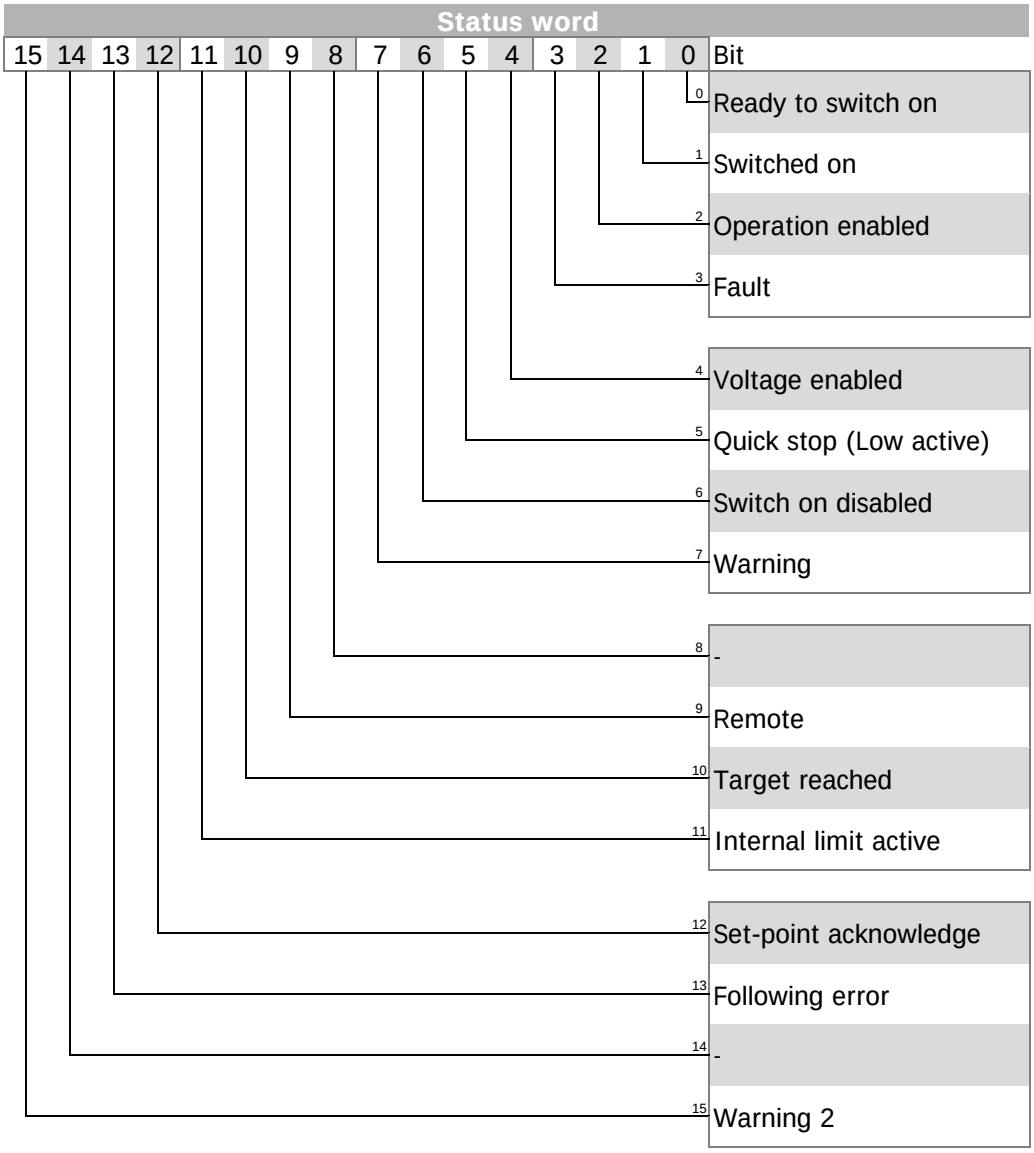
OUT-PZD1	Control word	IN-PZD1	Status word
OUT-PZD11 r)	Modes of operation	IN-PZD11 r)	Modes of operation display
OUT-PZD3/4 r)	Target position		
OUT-PZD5/6 r)	Profile velocity	P. 418	Minimum frequency
OUT-PZD7/8 r)	Profile acceleration	P. 419	Maximum Frequency
OUT-PZD9/10 r)	Profile deceleration	P. 1179	Emergency stop ramp

r) permissible only when the recommended settings from 10.4 “Motion Control Mapping for PROFINET” have been made.

The ramp times are specified via parameters **1176**...**1178**.

In profile position mode, the mode-specific bits of the control word and the status word are used as follows:




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

Control word

Change on set-point Bit 9	Change set-point immediately Bit 5	New set-point Bit 4	Description
0	0	0 → 1	Positioning operation to be completed (target reached) before the next one is started.
X	1	0 → 1	Next positioning operation to be started immediately.
1	0	0 → 1	Positioning operation to be started with the current speed profile until the current reference value is reached, then, the next positioning operation is to be processed.

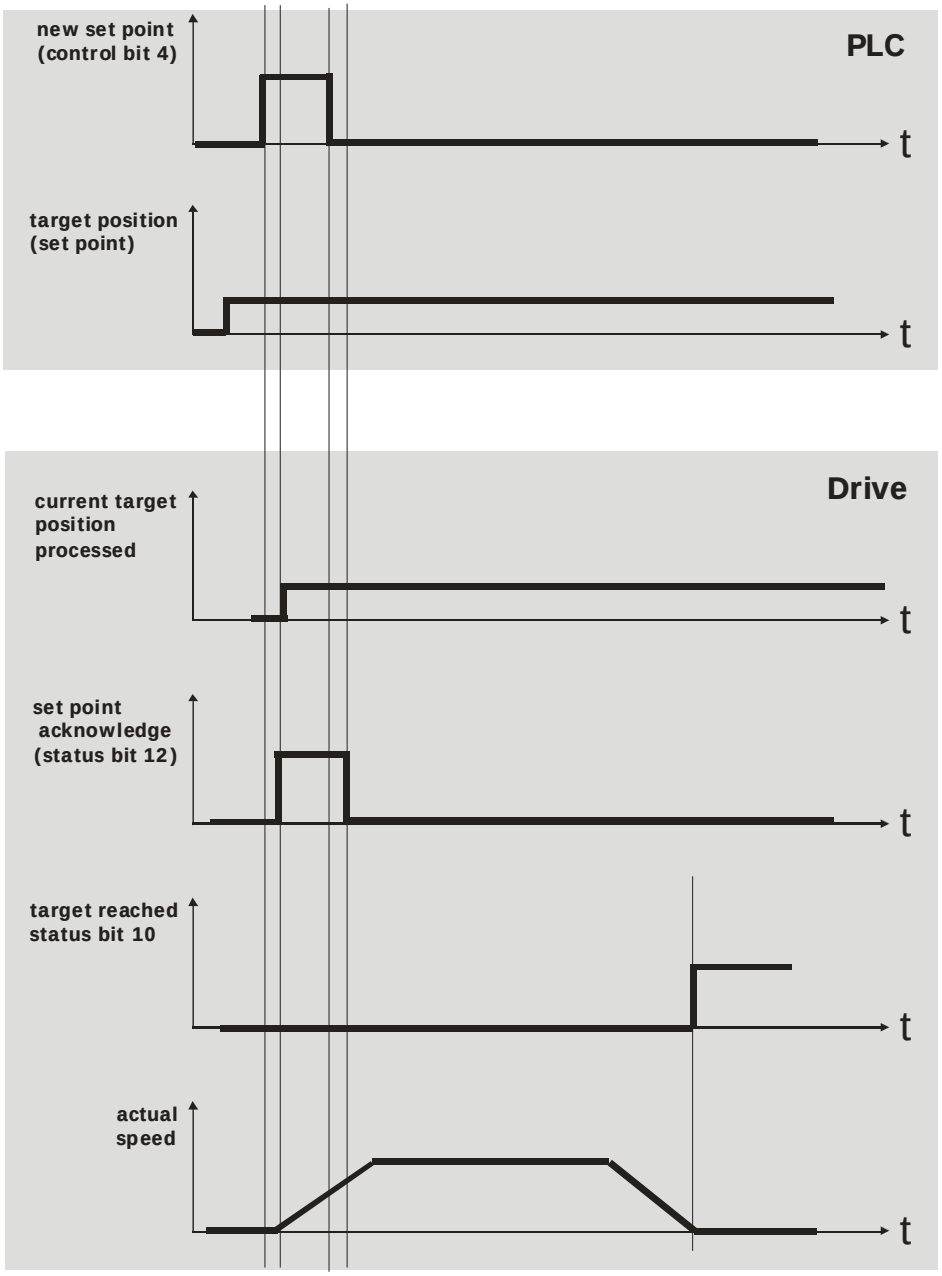
Identification	Value	Description
Abs/rel Bit 6	0	The target position is an absolute value.
	1	The target position is a relative value.
Halt Bit 8	0	Execute positioning operation.
	1	Stop axle with *profile deceleration* (if not supported by *profile acceleration*), the frequency inverter will remain in status “Operation enabled”.

Status word

Identification	Value	Description
Target reached Bit 10	0	Stop = 0: *Target position* (still) not reached.
		Stop = 1: Axle decelerated.
	1	Stop = 0: *Target position* reached.
		Stop = 1: Speed of axis is 0.
Set-point acknowledge Bit 12	0	The travel profile calculation has not applied the position value (yet).
	1	The travel profile calculation has applied the position value.
Following error Bit 13	0	No following error.
	1	Following error.

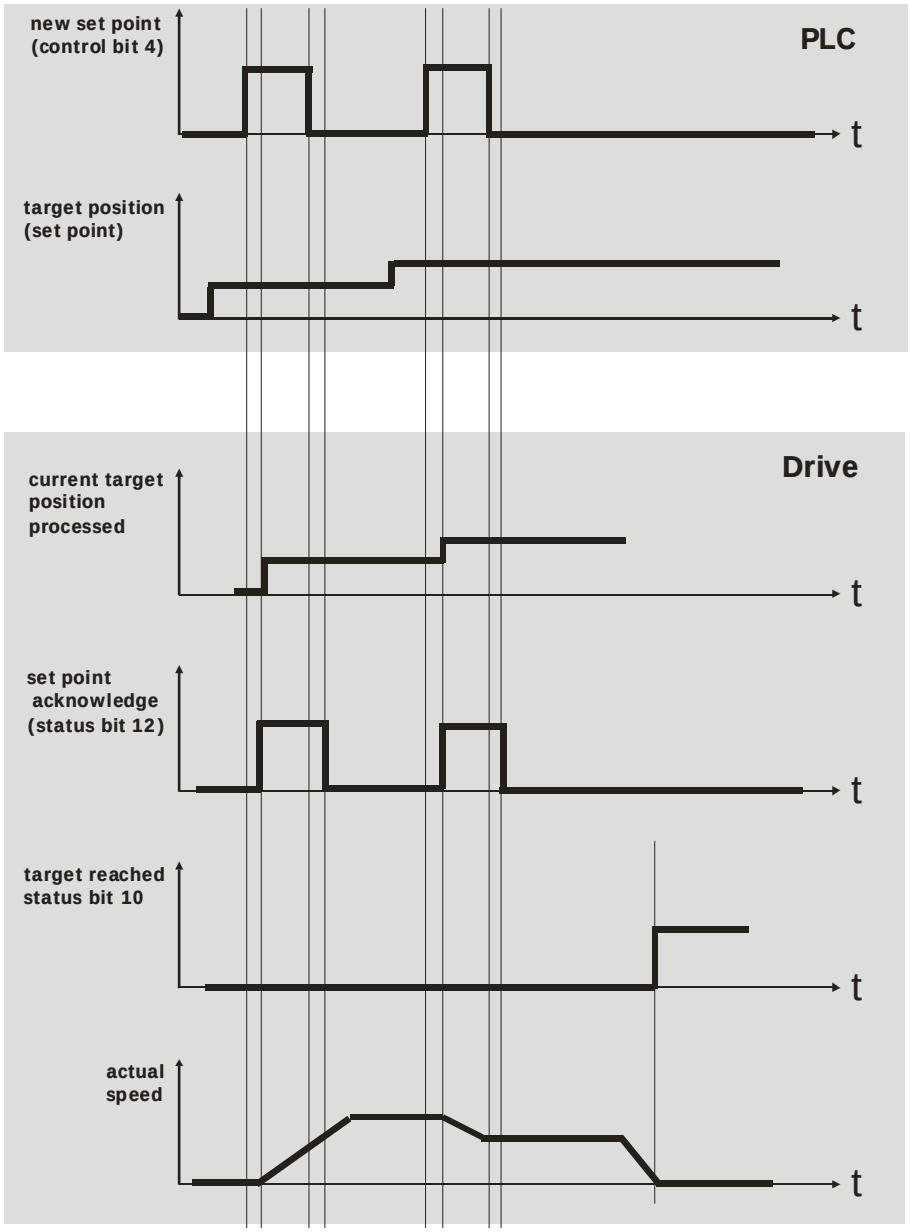
Example: **single set-point**
control bit *change on set-point* = **0**
control bit *change set immediately* = **0**

Once a reference value has been transmitted to the drive, the controller signals a permissible value in the control word by a rising signal edge for the bit “New reference value”. The drive responds by setting the bit “Reference value confirmed” and starts moving to the new target position. After that, the controller resets the bit “New reference value”, and the drive resets the bit “Reference value confirmed”. Once the bit “Reference value confirmed” has been reset, the drive is ready for receiving a new target position.



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

A new reference value is confirmed by the control bit “New reference value” (rising edge) while a reference value is being processed. The new reference value is processed immediately.



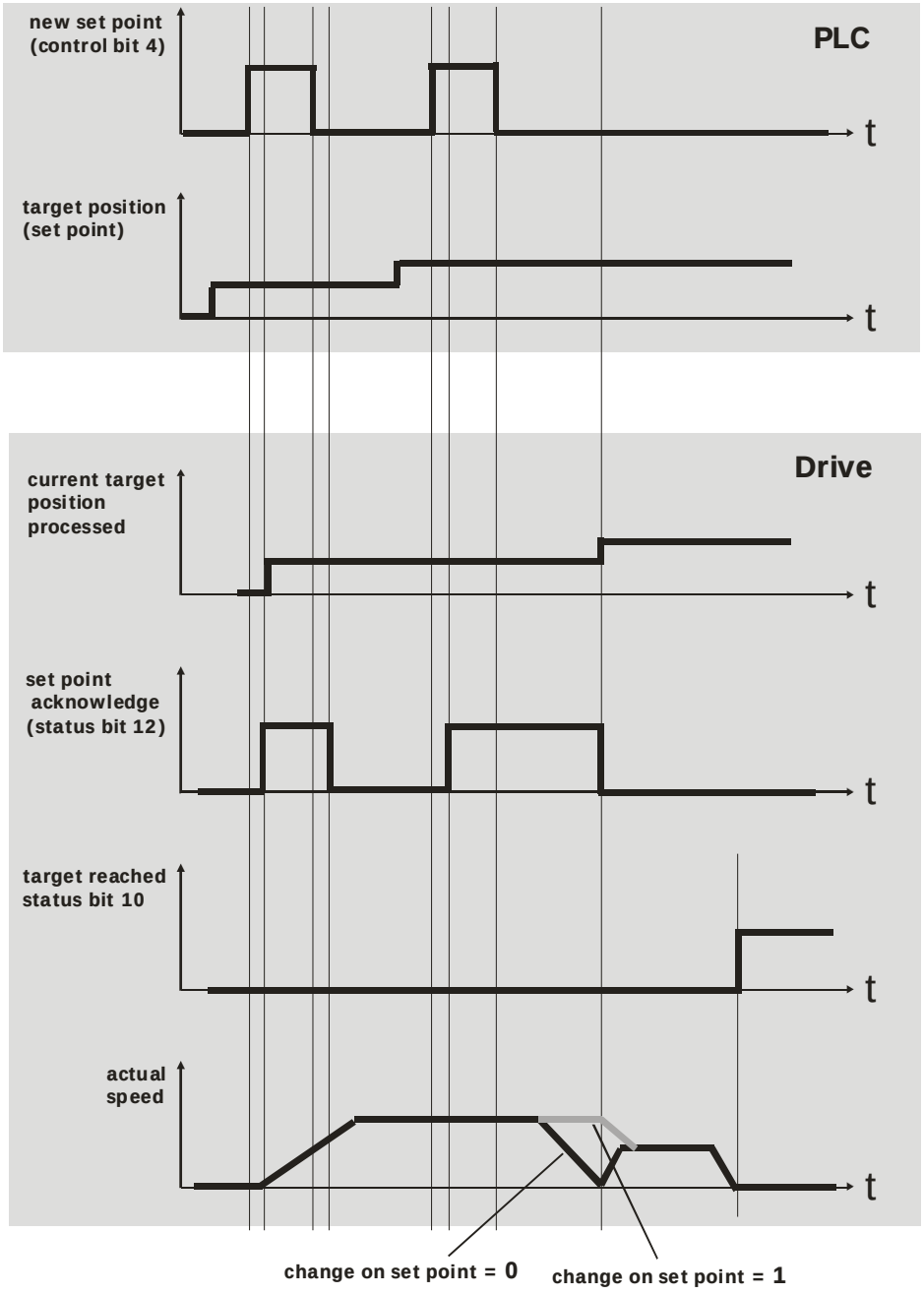
Example: **set of set-points**
control bit *change on set-point* = **0 / 1**
control bit *change set immediately* = **0**

The travel profile is changed during an active positioning operation.

Change on set point = 0 The current target position is approached with a **Stop**. Once the position has been reached, the new reference value is set.

Change on set point = 1 The current target position is approached at the active speed. Once the current target position has been reached, the new reference value is applied without reducing the speed to zero.

The gray line in the segment “Actual speed” shows the speed behaviors when the control bit “Switch at reference value” is set to 1.



11.4.3.1 Sequence example

In order to start “Profile position mode”, the correct sequence must be sent by the PLC.

	OUT IN	PZD1 Control word Status word	PZD11 r) Modes of Op. M. Of. Op. Displ.	PZD3/4 r) *) Target position	Remark
1		0x0000 0x0050	any any	any	Disable voltage Activation disabled
2		0x0000 0x0050	0x0001 0x0001	any	Profile position mode
3		0x0006 0x0031	0x0001 0x0001	any	Stop Ready for activation
4		0x0007 0x0033	0x0001 0x0001	0x1234 0x5678*)	Start Active
5		0x0007 ↓ 0x000F 0xnn37	0x0001 0x0001	0x1234 0x5678*)	Enable operation. Positioning operation is not started. Operation enabled
6a		0x0007 or 0x000F ↘ ↙ 0x001F 0xnn37	0x0001 0x0001	0x1234 0x5678*)	Operation enabled, start **absolute** positioning with profile1). If a positioning operation is already in process, this operation will be completed. Then, the new profile will be used. Operation enabled
6b		0x0007 or 0x000F ↘ ↙ 0x005F 0xnn37	0x0001 0x0001	0x1234 0x5678*)	Operation enabled, start **relative** positioning with profile1). If a positioning operation is already in process, this operation will be completed. Then, the new profile will be used. Operation enabled
6C		0x0007 or 0x000F ↘ ↙ 0x003F 0xnn37	0x0001 0x0001	0x1234 0x5678*)	Operation enabled, start **absolute** positioning with profile1). Running positioning operations will change and apply the new profile Operation enabled
6d		0x0007 or 0x000F ↘ ↙ 0x007F 0xnn37	0x0001 0x0001	0x1234 0x5678*)	Operation enabled, start **relative** positioning with profile1). Running positioning operations will change and apply the new profile Operation enabled
7		0x01nF 0xnn37	any 0x0001	any	HALT: Drive is decelerated with ramp *Velocity deceleration*. Operation enabled

r) permissible only when the recommended settings from10.4 Motion Control Mapping for PROFINET have been made.

*) In addition to the Target position in PZD3/4, Profile speed PZD5/6, Acceleration PZD7/8 and Deceleration 9/10 must be assigned appropriate values > 0. These PZDs are not shown in the table for reasons of clarity. Generally, it is recommended that all specified PZDs be changed at the same time.

⚠ WARNING

Dangerous state due to new mode!

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

- BONFIGLIOLI VECTRON recommends checking the status word before changing the mode of operation (e.g. for status 0xnn33).

Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).
In state "operation enabled" (0xnnnF), the state of the Motion Control can be changed (white table area).
With control word transition from 0xnnnF to 0x0007, "Profile position mode" will be stopped. Then, the mode can be restarted via 0xnnnF.
As long as 0x0007 is active, the mode of operation can also be changed safely. Once *modes of operation* has been set to another value, operation can be started with a corresponding sequence.

In order to start a profile, you don't have to set the control word to 0x0007 first before switching to 0xnnnF.
Once a profile has been processed, a new profile can be started with the bit "New Setpoint" (bit 4) in control word 0xnnnF.
While a profile is being processed, you can start a new profile without stopping by using the bits "Change Setpoint immediately" (bit 5) and "New Setpoint" (bit 4).

11.4.4 Homing mode

Homing mode can be selected via *modes of operation* = **6**.
In homing mode, the frequency inverter moves the drive to a reference position. The method used for this movement is defined by parameter *Homing mode* **1130**.

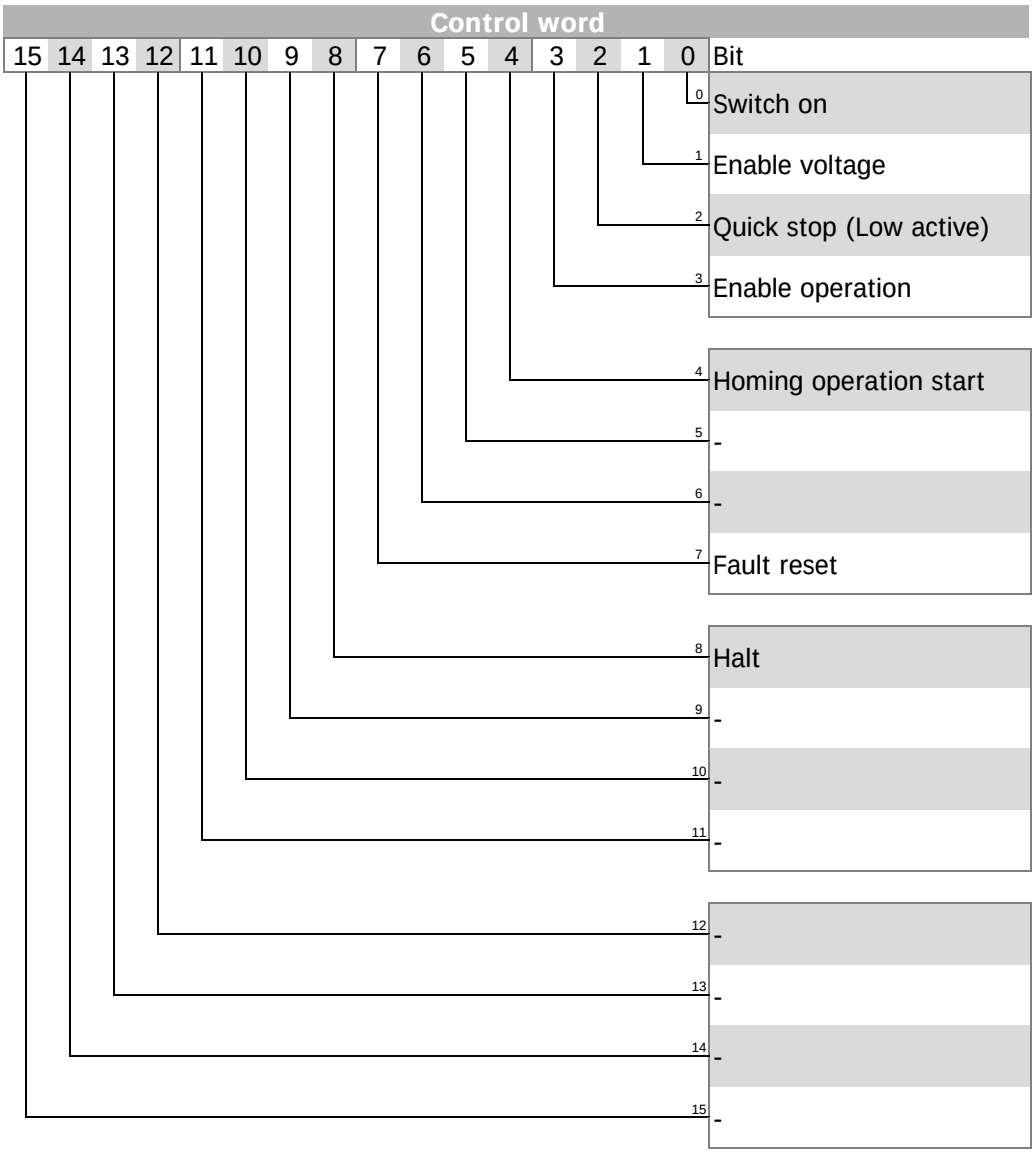
Relevant objects:

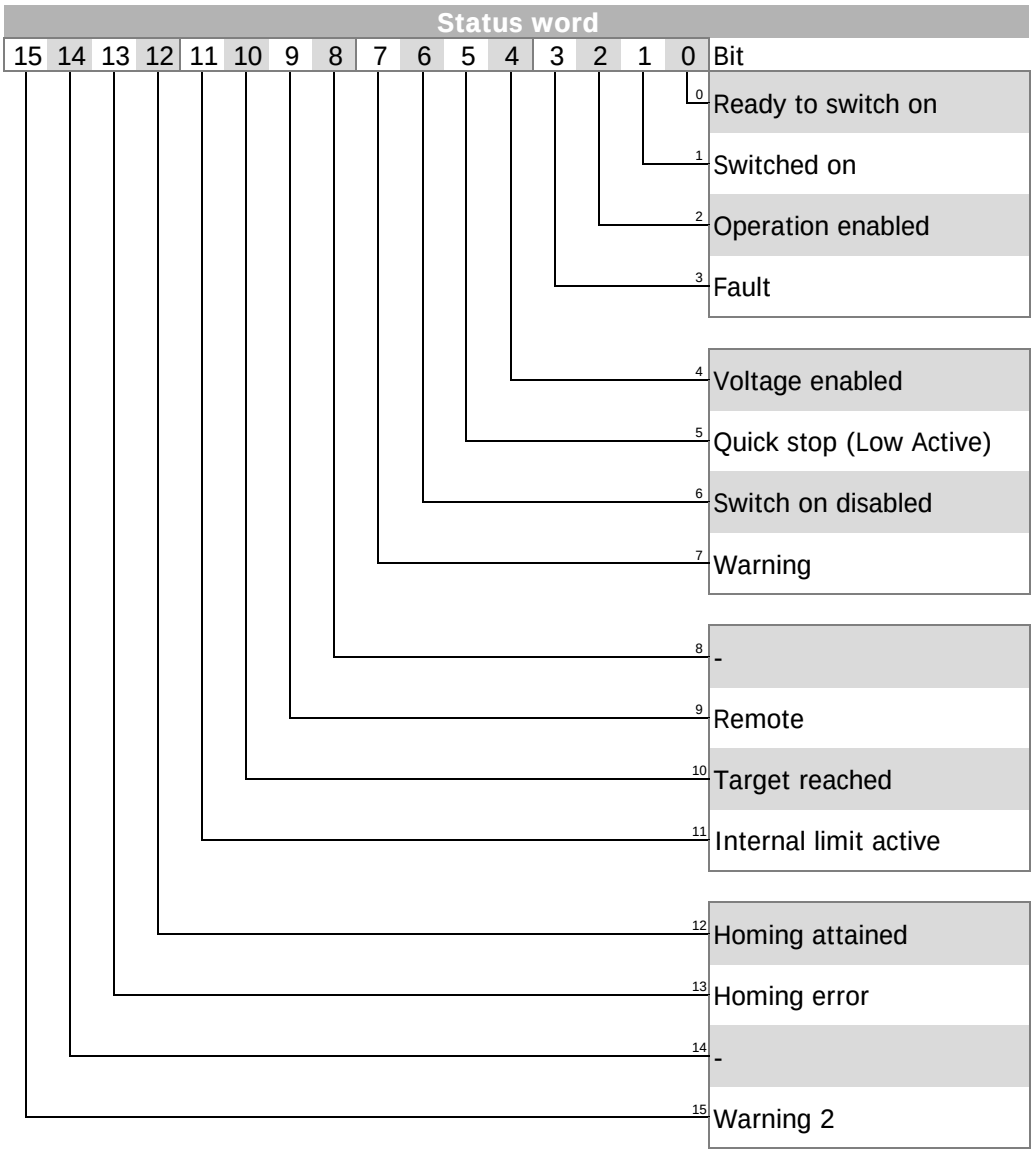
OUT-PZD1	Control word	IN-PZD1	Status word
OUT-PZD11[r)]	Modes of operation	IN-PZD11[r)]	Modes of operation display
P. 1130	Homing mode	P. 418	Minimum frequency
P. 1132 & P. 1133	Fast speed / creep speed	P. 419	Maximum Frequency
P. 1134	Acceleration	P. 1179	Emergency stop ramp

r) permissible only when the recommended settings from 10.4 Motion Control Mapping for PROFINET have been made.

The ramp times are specified via parameter **1135**.

In homing, the mode-specific bits of the control word and the status word are used as follows:





Control word

Identification	Value	Description
Homing operation start **Bit 4**	0	Homing not active.
	0 → 1	Start homing.
	1	Homing active.
	1 → 0	Stop homing.
Halt **Bit 8**	0	Execute command from bit 4 “Start homing”.
	1	Stop axis with acceleration value (as deceleration) for homing. (The frequency inverter remains enabled in “Operation enabled” status.)

Status word

Identification	Value	Description
Target reached **Bit 10**	0	Stop = 0: Home position (still) not reached.
		Stop = 1: Axle decelerated.
	1	Stop = 0: Home position reached.
		Stop = 1: Axle has speed 0.
Homing attained **Bit 12**	0	Homing not completed yet.
	1	Homing completed successfully.
Homing error **Bit 13**	0	No homing error.
	1	Homing error occurred, homing not completed successfully.

For a description of homing operations, refer to Chapter 13.6 “Homing modes”.

11.4.4.1 Sequence example

In order to start “homing mode”, the correct sequence must be sent by the PLC.

Preparation:
Set *Homing mode* **1130** (factory setting: “0 – no homing”).
Set *Home Offset* **1131** if available (factory setting: 0).
Set *Fast speed* **1132** (factory setting: 327680 u).
Set *Creep speed* **1133** (factory setting: 163840 u).
Set *Acceleration* **1134** (factory setting: 327680 u/s²).
Set *Ramp time* **1135**, if available (factory setting = 0 ms).

	OUT IN	PZD1 Control word Status word	PZD11 r) Modes of operation Mod. Of. Op. Displ.	Remark
1		0x0000 0x0050		Disable voltage Switch On Disabled
2			0x0006 0x0006	(Homing)
3		0x0006 0x0031	0x0006 0x0006	Shutdown Ready to switch on
4		0x0007 0x0033	0x0006 0x0006	Switch On Switched On
5a		0x000F 0xnn37	0x0006 0x0006	Enable Operation.
5b		0x001F 0x1n37	0x0006 0x0006	Enable Operation and start Homing. homing attained

r) permissible only when the recommended settings from 10.4 “Motion Control Mapping for PROFINET” have been made.

⚠ WARNING

Dangerous state due to new mode!

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

- BONFIGLIOLI VECTRON recommends checking the status word before changing the mode of operation (e.g. for status 0xnn33).

Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).
In state “operation enabled” (0xnnnF), the state of the Motion Control can be changed (white table area).
With control word transition from 0x0007 (or 0x000F) to 0x001F the homing operation is started. Bit “Homing attained” (Bit 12) returns the status in the status word.
As long as 0x0007 is active, the mode of operation can also be changed safely. Once *modes of operation* has been set to another value, operation can be started with a corresponding sequence.

11.4.5 Table travel record mode

Table travel record mode can be selected via *modes of operation* **= 0xFF = -1**. Table travel record mode used pre-defined positions. Each target position is defined by a motion block. Several motion blocks can be defined.

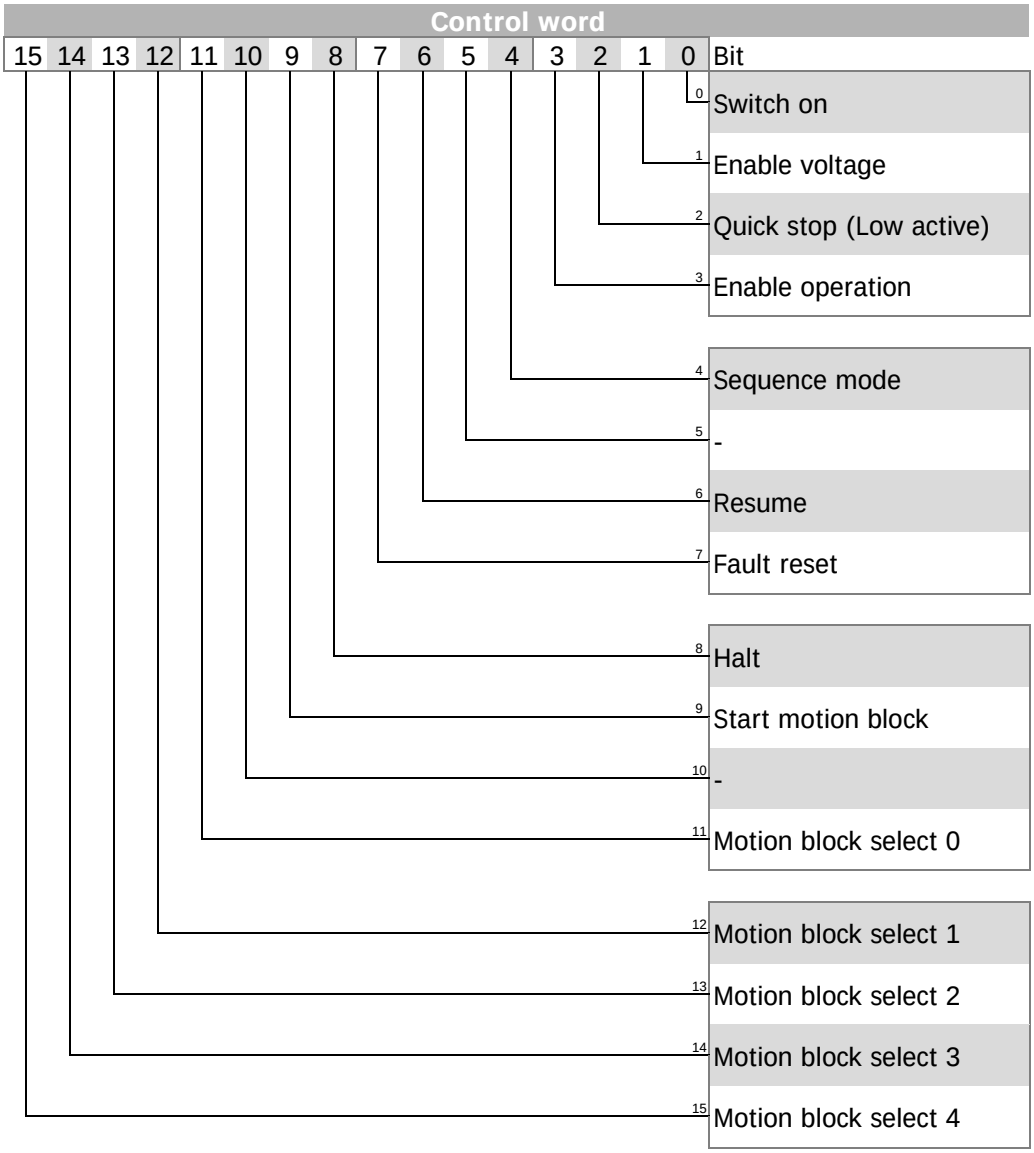
For a description of motion blocks, refer to the “Positioning” application manual.

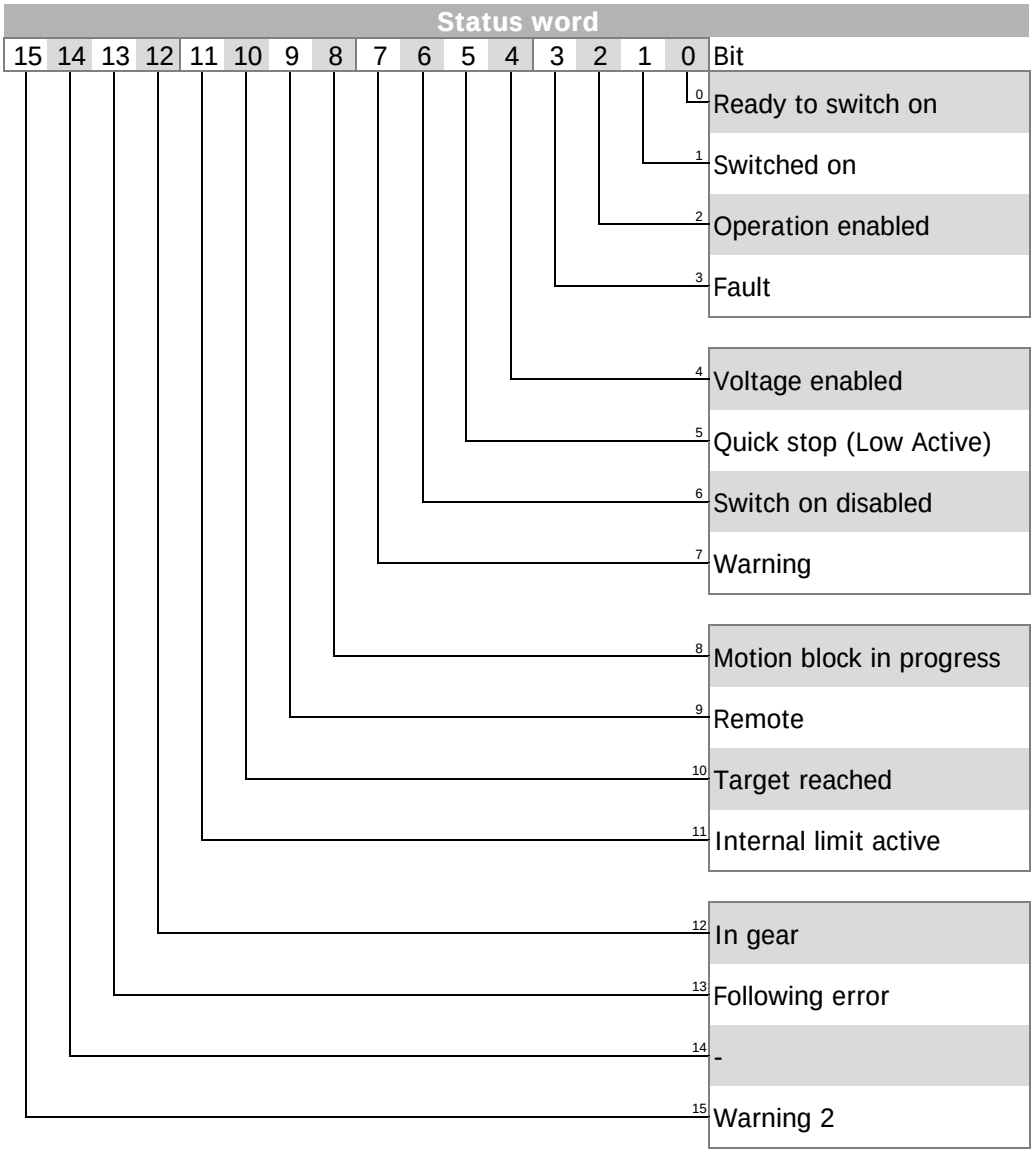
Relevant objects:

OUT-PZD1	Control word	IN-PZD1	Status word
		IN-PZD5[r)]	Actual position
OUT-PZD11[r)]	Modes of operation	IN-PZD11[r)]	Modes of operation display
P. 1106	Error threshold	P. 418	Minimum frequency
P. 1119	Contouring error time	P. 419	Maximum Frequency
P. 1109	Act. contouring error	P. 1179	Emergency ramp
P. 1165	Target window	P. 1246	Actual Motion Block
P. 1166	Target window time	P. 1249	Motion block to resume

r) permissible only when the recommended settings from 10.4 “Motion Control Mapping for PROFINET” have been made.

In table travel record mode, the mode-specific bits of the control word and the status word are used as follows:




Status word
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Bit
0 Ready to switch on
1 Switched on
2 Operation enabled
3 Fault
4 Voltage enabled
5 Quick stop (Low Active)
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 -
15 Warning 2

Control word

Identification	Value	Description
Sequence mode **Bit 4**	0	Single motion
	1	Automatic sequence
Resume **Bit 6**	0	Start motion block = motion block switching
	1	Start motion block = last active motion block
Halt **Bit 8**	0	Execute command from bit 4 “Sequence mode”
	1	Stop axis with ramp of current motion block The frequency inverter remains in “Operation – enabled” status.
Start motion block **Bit 9**	0	Stop axis with ramp of current motion block
	0 → 1	Execute motion block(s)
Motion block select 0...4 **Bit 11...15**	n	Start motion block = n + 1

Motion block select

Control word															
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Motion block select						Sta	Stop		Res		Seq				
4	**3**	**2**	**1**	**0**											

Start motion block = motion block switching +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

Status word

Identification	Value	Description	
Motion block in progress **Bit 8**	0	Single motion:	Motion block complete
		Automatic sequence:	Sequence complete
	1	Single motion/automatic sequence active	
Target reached **Bit 10**	0	Halt = 0:	Target position not reached yet (only motion blocks with positioning)
		Halt = 1:	Axle decelerated
	1	Halt = 0:	Target position reached (only motion blocks with positioning)
		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 “Automatic sequence” defines if a single motion (*Automatic sequence* = 0) or and automatic motion block sequence (*Automatic sequence* = 1) is to be executed.

In both cases, the selection of the required motion block (motion block number of single motion or start motion block number of automatic sequence) is calculated by the motion block switching feature with the rising edge of "*Start motion block"*.

"Motion block is being processed" is set to "1" while a selected motion block or an automatic sequence is being executed. "Motion block is being processed" will remain set to "1" until the motion block sequence is complete. When a single motion block is executed, "Motion block is being processed" will be set to "0" once the single motion block is complete. When an automatic sequence is executed, "Motion block is being processed" will be set to "0" once a motion block with setting 0 for Next motion block (end of motion block), -1 (error stop), -2 (Stop, error) or -3 (emergency stop, error) is reached.

During the automatic processing of motion blocks, the currently processed motion block is indicated by parameter *Actual motion block* **1246**.

If the execution of motion blocks is interrupted by setting "Start motion block" to "0", the drive will stop with the ramp set in the current motion block. The interrupted motion block or automatic motion block sequence can be continued by setting "Resume" and a rising signal edge for "Start motion block". If "Resume" is set to "1" and no valid motion block is available, the motion block selected by the motion block switching function will be used. A valid motion block is indicated by parameter *Motion block to Resume* **1249**. *Motion block to Resume* **1249** reads -1, if no valid motion block is present or if the last motion block or motion block sequence was not interrupted.

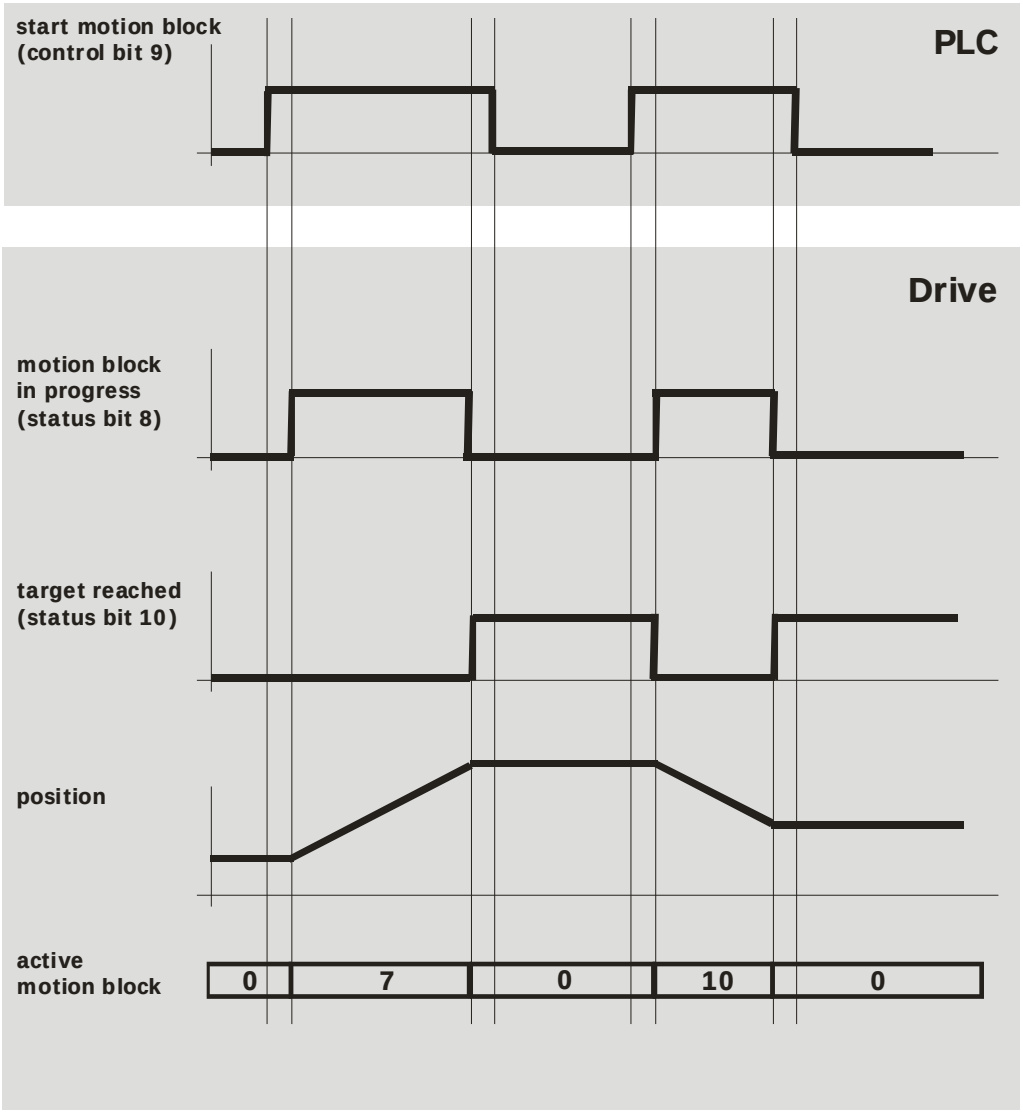
"Target reached" is set if the actual position of motion blocks with absolute or relative positioning reaches the *position window*.

"In Gear" is set when the electronic gear function is used and the electronic gear is coupled (synchronous running).

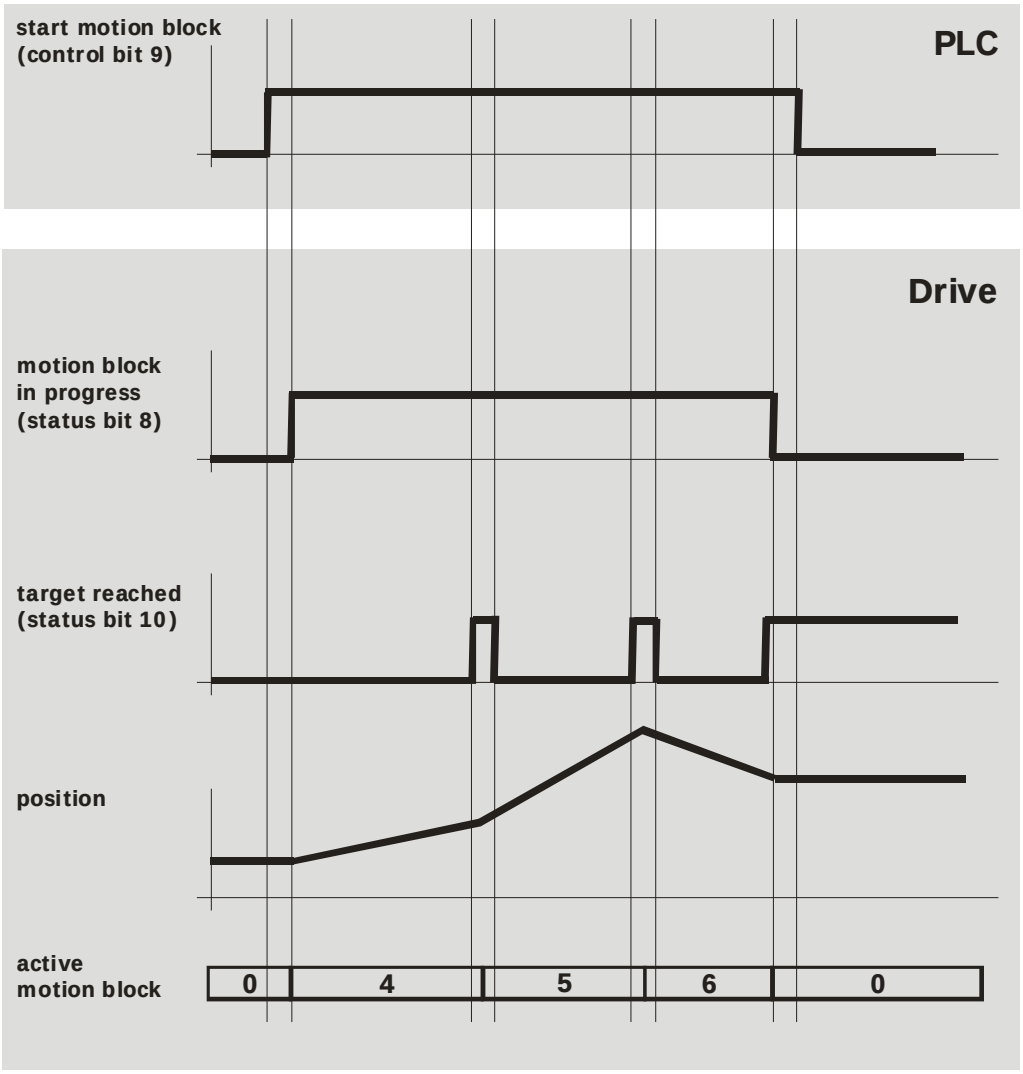
Setting *Halt* to *"*1" will stop a currently executed motion block. The axle is stopped th the ramp set in the current motion block. "Target reached" is set to "1" when the speed reaches value 0. The drive remains in "Operation – enabled" status. To continue the interrupted motion block, reset *Halt* to "0".

Examples:

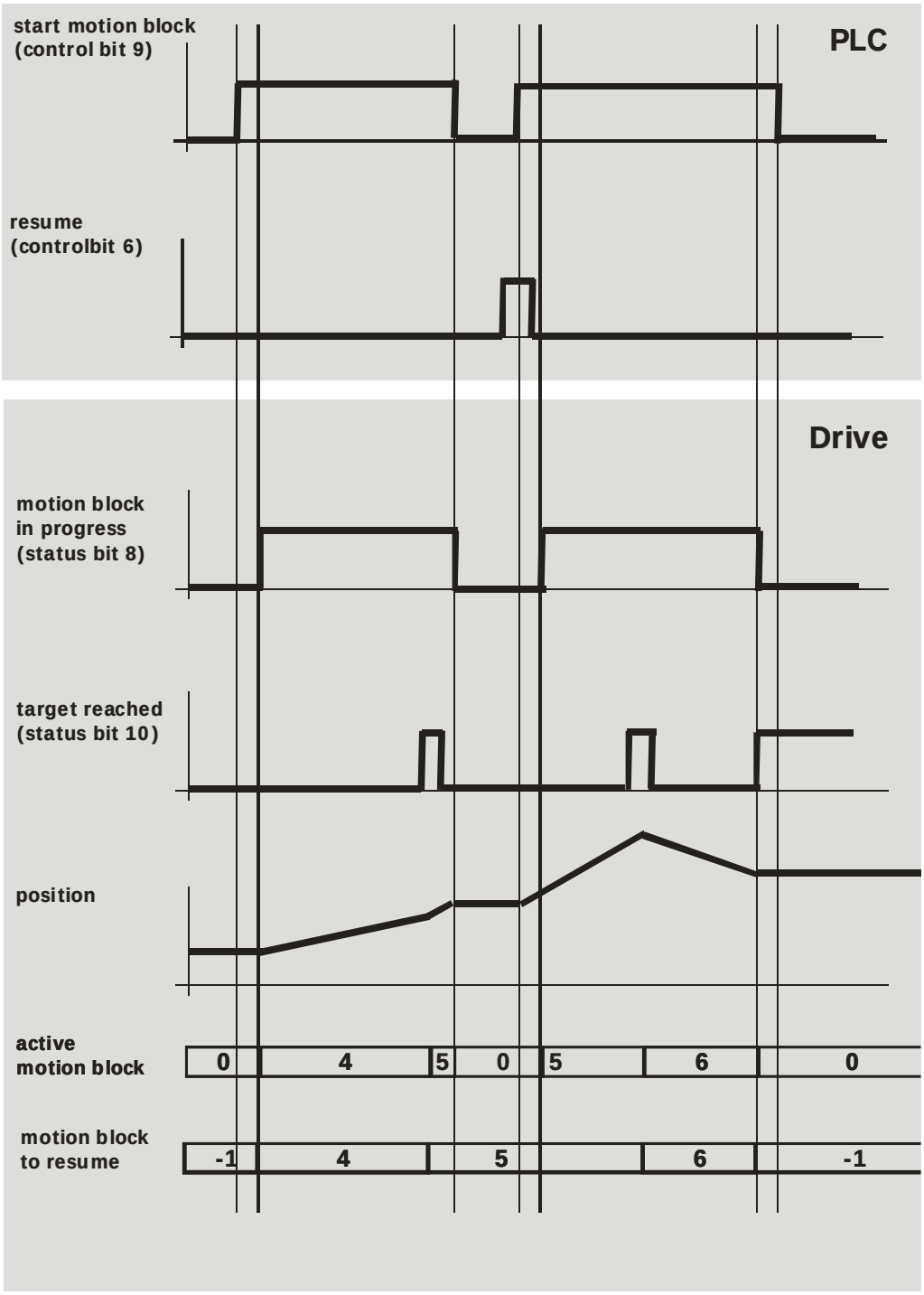
“single motion block” **sequence mode (control bit 4) = 0**
2 motion blocks 7 + 10



“ motion block sequence” **sequence mode (control bit 4) = 1**
sequence = motion block 4, 5, 6



Interrupted motion blocks sequence
Automatic sequence (control bit 4) = 1,
Sequence = Motion block 4, 5, 6
Motion block 5 interrupted



11.4.5.1 Sequence example

In order to start “Table travel record mode”, the correct sequence must be sent by the PLC.

	OUT IN	PZD1 Control word Status word	PZD11 r) Modes of operation Mod. Of. Op. Displ.	Remark
1		0x0000 0x0050	any any	Disable voltage Switch On Disabled
2			0xFFFF (=-1) 0xFFFF (=-1)	(Table travel record mode)
3		0x0006 0x0031	0xFFFF (=-1) 0xFFFF (=-1)	Shutdown Ready to switch on
4		0x0007 0x0033	0xFFFF (=-1) 0xFFFF (=-1)	Switch On Switched On
5a		0x000F 0xnn37	0xFFFF (=-1) 0xFFFF (=-1)	Enable operation Operation enabled
5b		0x020F 0xn337 0xn637	0xFFFF (=-1) 0xFFFF (=-1) 0xFFFF (=-1)	Start motion block 1 as single motion block Operation enabled and Positioning active. Operation enabled and Target reached.
5c		0x0A0F 0xn337 0xn637	0xFFFF (=-1) 0xFFFF (=-1) 0xFFFF (=-1)	Start motion block 2 as single motion block Operation enabled and Positioning active. Operation enabled and Target reached.
5d		0x120F 0xn337 0xn637	0xFFFF (=-1) 0xFFFF (=-1) 0xFFFF (=-1)	Start motion block 3 as single motion block Operation enabled and Positioning active. Operation enabled and Target reached.
5e		0x021F 0xn337 0xn637	0xFFFF (=-1) 0xFFFF (=-1) 0xFFFF (=-1)	Start motion block 1 as sequence motion block Operation enabled and Positioning active. Operation enabled and Target reached.
5f		0x004F 0xn337 0xn637	0xFFFF (=-1) 0xFFFF (=-1) 0xFFFF (=-1)	Resume previous motion block as single motion block Operation enabled and positioning active. Operation enabled and target reached.
5g		0x005F 0xn337 0xn637	0xFFFF (=-1) 0xFFFF (=-1) 0xFFFF (=-1)	Resume previous motion block as sequence motion block Operation enabled and positioning active. Operation enabled and target reached.

r) permissible only when the recommended settings from 10.4 “Motion Control Mapping for PROFINET” have been made.

⚠ WARNING

Dangerous state due to new mode!

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

- BONFIGLIOLI VECTRON recommends checking the status word before changing the mode of operation (e.g. for status 0xnn33).

Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).
In state “operation enabled” (0xnnnF), the state of the Motion Control can be changed (white table area).
Bit 9 “Start motion block” must be active during positioning. If bit 9 is reset to “0”, the positioning operation is interrupted.
As long as 0x0007 is active, the mode of operation can also be changed safely. Once *modes of operation* has been set to another value, operation can be started with a corresponding sequence.

11.4.6 Move away from limit switch mode

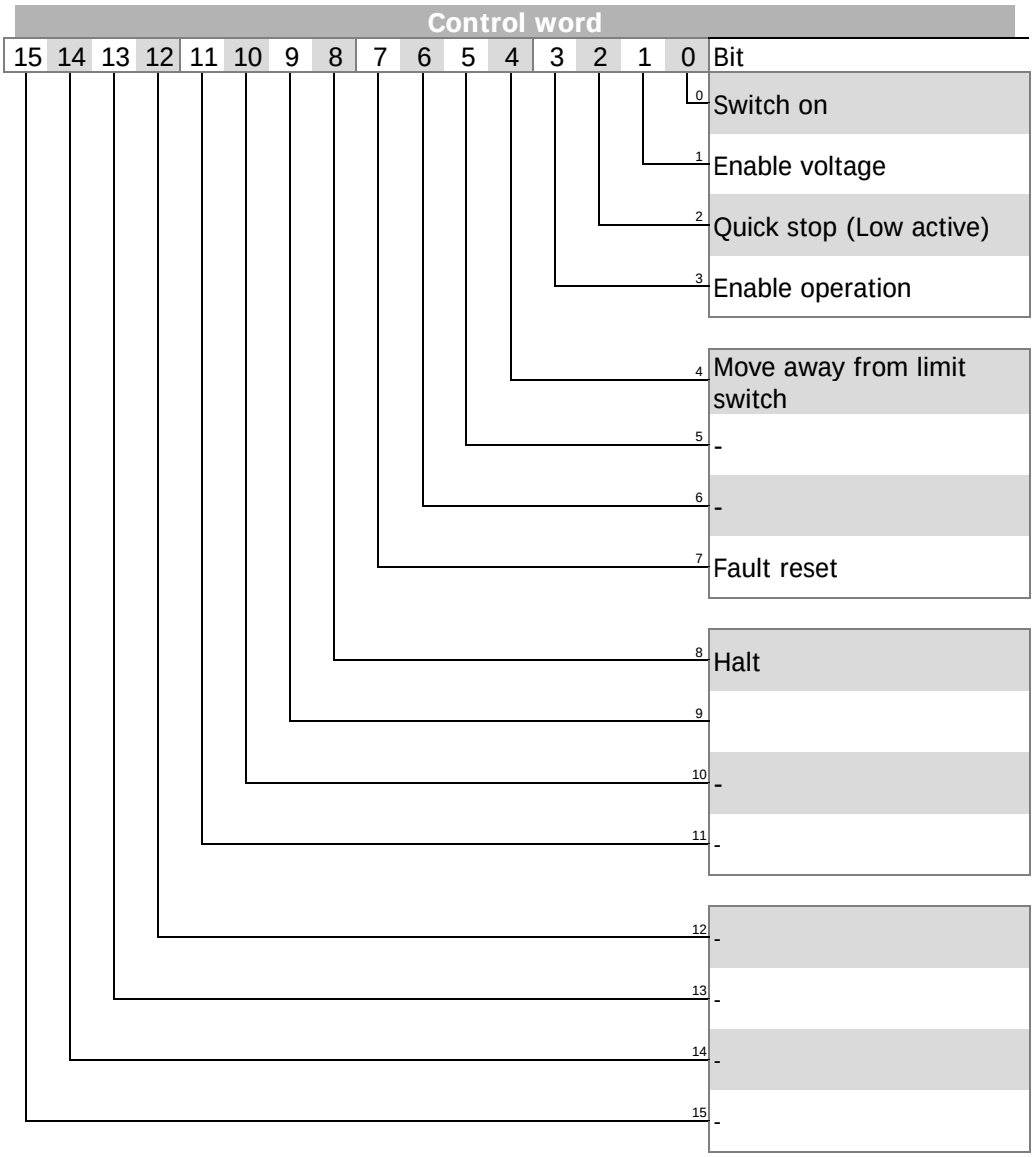
Move away from limit switch mode can be selected via *modes of operation* = **0xFE** = **-2**.
In *Move away from limit switch mode*, the drive moves back from a triggered limit switch to the permissible travel range.

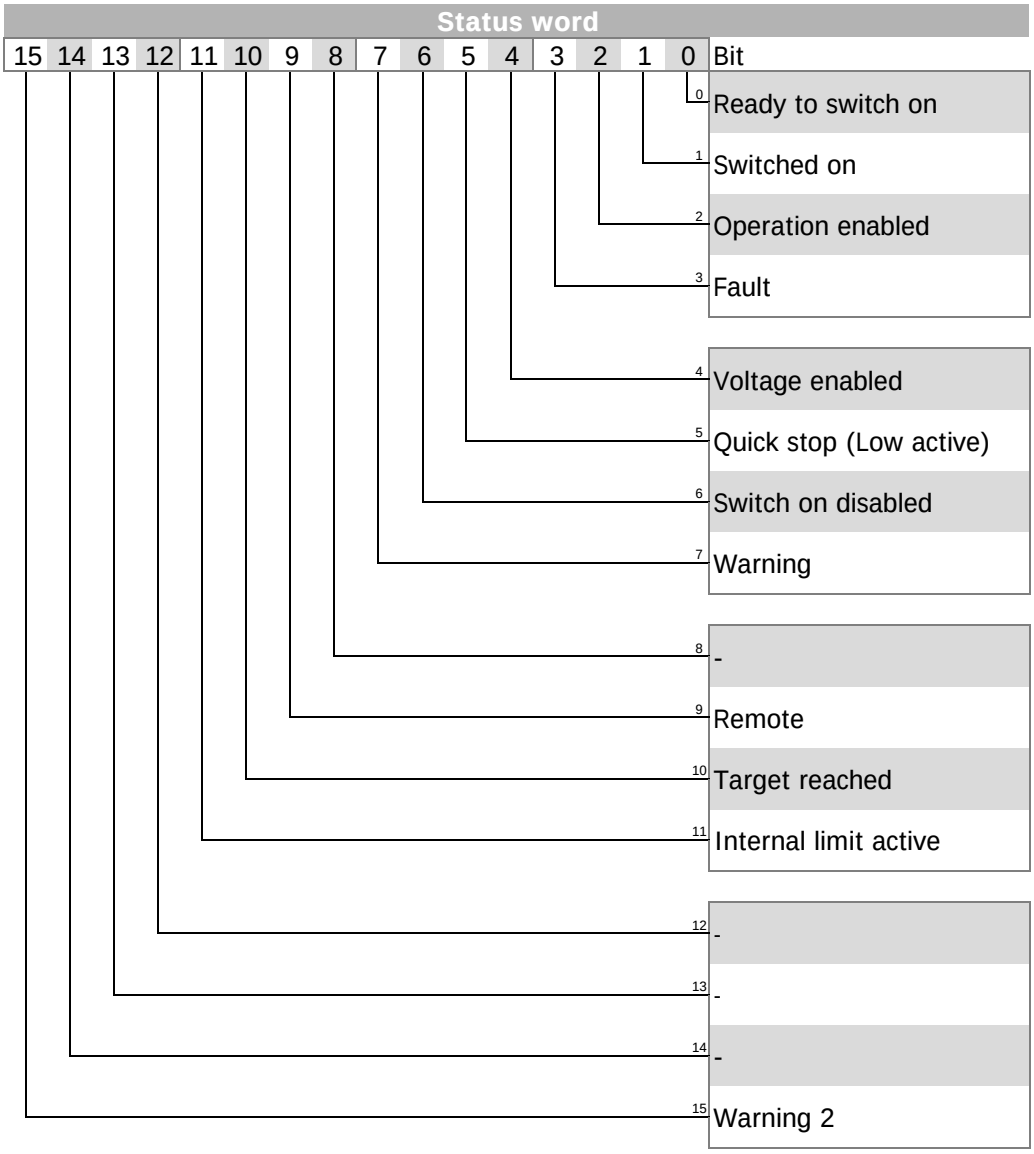
Relevant objects:

OUT-PZD1	Control word	IN-PZD1	Status word
OUT-PZD11[r)]	Modes of operation	IN-PZD11[r)]	Modes of operation display
P. 419	Maximum Frequency	P. 1133	Creep Speed
P. 1179	Emergency Ramp	P. 1134	Acceleration

r) permissible only when the recommended settings from 10.4 “Motion Control Mapping for PROFINET” have been made.

In “Move away from limit switch mode”, the mode-specific bits of the control word and the status word are used as follows:





NOTE

"Move away from limit switch mode" will always work with hardware limit switches. In the case of software limit switches, the mode will only work if a software limit switch *Fault reaction* **1144** with error stop was selected. If a setting with warning (e.g. "10-Warning") was selected, the software limit switch will not trigger an error, thus "Move away from limit switch mode" will not clear the software limit switch.

NOTE

"Move away from limit switch mode" must not be used when one of the following error messages occurs:

- F1444 Pos. limit switch < Neg. limit switch
- F1445 Both limit switches at the same time
- F1446 Wrong limit switch wiring

If one of these errors has occurred, the wiring and parameter settings must be checked first before resuming operation.

Control word

Identification	Value	Description
Move away from limit switch mode **Bit 4**	0	Do not start or stop movement.
	1	Start (or resume) movement from limit switch to travel range.
Halt **Bit 8**	0	Execute command from bit 4 “Move away from limit switch”.
	1	Stop axis with ramp of current motion block (The frequency inverter remains enabled in “Operation enabled” status).

Status word

Identification	Value	Description	
Target reached **Bit 10**	0	Halt = 0:	Limit switch still active
		Halt = 1:	Axle decelerated
	1	Halt = 0:	Limit switch cleared
		Halt = 1:	Axle has speed 0

Basic functions

In mode -2 “Move away from limit switch”, the drive is cleared from a triggered hardware limit switch or software limit switch. The direction of rotation depends on the active limit switch: If the positive limit switch is active, the drive moves to negative direction and vice versa.

“Move away from limit switch” mode is started in status “Operation enabled” by control word bit 4 “Move away from limit switch”. The drive is accelerated with the ramp from parameter *Acceleration* **1134** to the speed set in parameter *Creep speed* **1133**. Once the active limit switch has been cleared, the drive is stopped. Once speed 0 has been reached, status word bit 10 “Target reached” will be set.

When both directions of rotation are blocked, e.g. due to simultaneous triggering of positive and negative limit switch, error message “F1449 Both directions locked”. In this case, the function “Move away from limit switch” cannot be used.

NOTE

In the clearing phase of a hardware limit switch, the hysteresis defined in parameter *Hysteresis* **1149** will be active. After detection of the limit switch edge, the axis will be moved on, at least by the defined hysteresis distance.

Setting *Halt* to *“*1” will stop the started clearing operation. The axis will be stopped. Status bit “Target reached” is set to “1” when the speed reaches value 0. The drive remains in “Operation enabled” status. By resetting *Halt* to “0”, the interrupted clearing operation will be continued, and “Target reached” will be reset to “0”.

11.4.6.1 Sequence example

In order to clear the limit switches, the correct sequence must be sent by the PLC.

	OUT IN	PZD1 Control word Status word	PZD11 r) Modes of operation Mod. Of. Op. Displ.	Remark
1		0x0000 0x0050	any any	Disable voltage Switch On Disabled
2			0xFFFE (=-2) 0xFFFE (=-2)	(Move away from limit switch)
3		0x0006 0x0031	0xFFFE (=-2) 0xFFFE (=-2)	Shutdown Ready to switch on
4		0x0007 0x0033	0xFFFE (=-2) 0xFFFE (=-2)	Switch On Switched On
5		0x000F 0xnn37	0xFFFE (=-2) 0xFFFE (=-2)	Enable Operation. Operation enabled
6a		0x001F 0xn2B7 0xn637	0xFFFE (=-2) 0xFFFE (=-2) 0xFFFE (=-2)	Move away from limit switch mode Operation enabled, limit switch active, clearing active Operation enabled and limit switch cleared (target reached).

r) permissible only when the recommended settings from 10.4 “Motion Control Mapping for PROFINET” have been made.

⚠ WARNING

Dangerous state due to new mode!

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

- BONFIGLIOLI VECTRON recommends checking the status word before changing the mode of operation (e.g. for status 0xnn33).

Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).
In state “operation enabled” (0xnnnF), the state of the Motion Control can be changed (white table area).
Bit 4 “Move away from limit switch” must be active in the clearing phase. If bit 4 is reset to “0”, the clearing operation is interrupted.
As long as 0x0007 is active, the mode of operation can also be changed safely. Once *modes of operation* has been set to another value, operation can be started with a corresponding sequence.

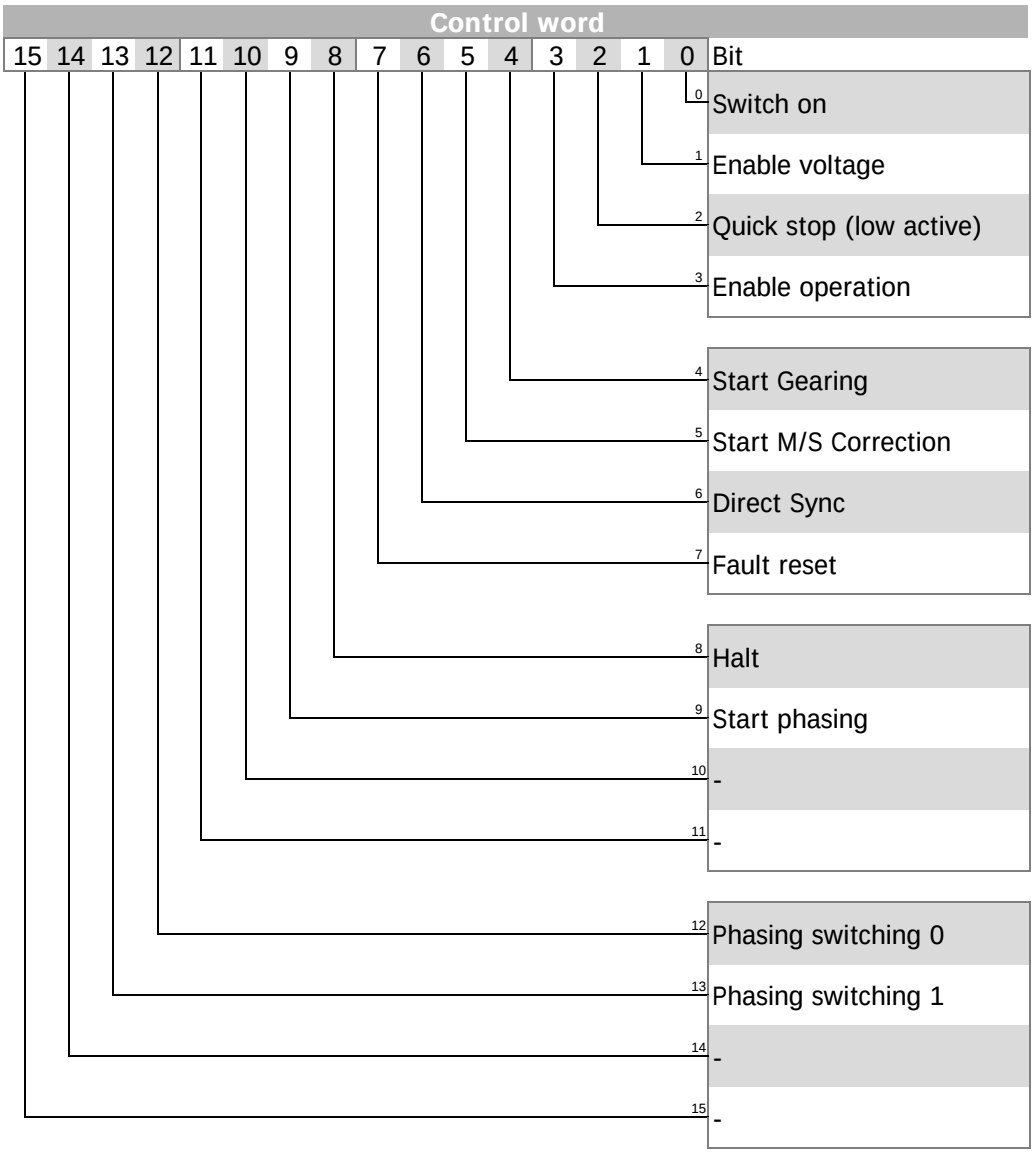
11.4.7 Electronic gear: Slave

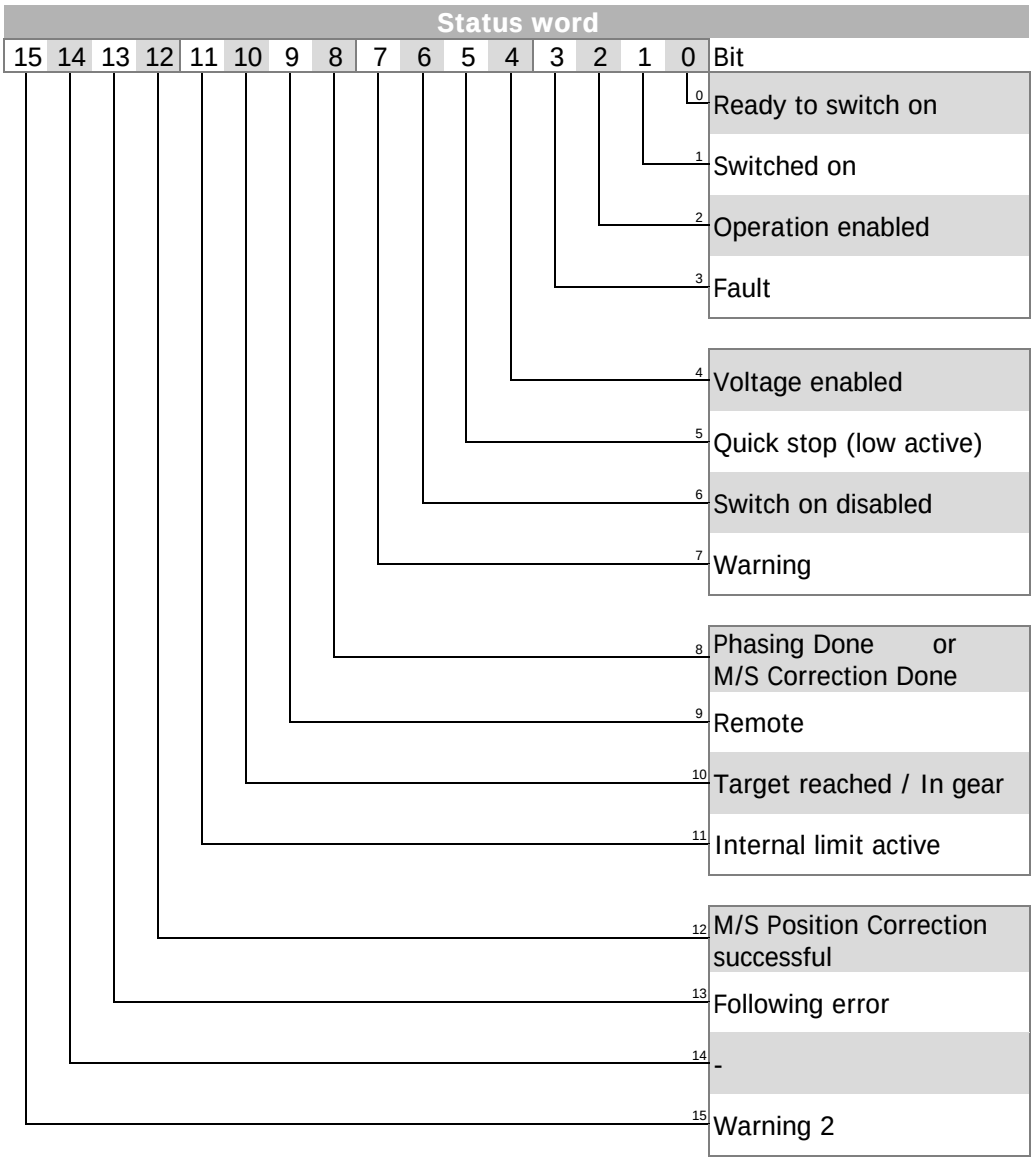
The mode *Electronic gear: Slave* can be selected via *modes of operation* = **0xFD** = **-3**.
In *Electronic gear slave mode* the drive follows a master drive as a slave drive.

Relevant objects:

OUT-PZD1	Control word	IN-PZD1	Status word
		IN-PZD5[r)]	Actual position
OUT-PZD11[r)]	Modes of operation	IN-PZD11[r)]	Modes of operation display
419	Maximum Frequency	**1179**	Emergency stop ramp
1106	Following error window	**1119**	Following error time
1165	Position window	**1166**	Target window time
1123 & **1124**	Electronic Gear: Gear factor	**1125**, **1126**, **1127**, **1142**	Electronic Gear: Phasing 1 ... Electronic Gear: Phasing 4

In *Electronic gear: Slave* mode, the operation mode specific bits of the control word and the status word are used as follows:





⚠ WARNING

Dangerous state due to faulty parameterization

- The function Master/Slave Position Correction is only allowed to be used after complete setup of this function. Check for parameter setup chapter 11.4.7.1 “Master/Slave Position Correction”.

Control word

Identification	Value	Description
Start electronic gear **Bit 4**	0	Stop drive with ramp **1296** *S.Deceleration*.
	1	Start electronic gear with master speed reference value with ramp **1295** *S.Acceleration*.
Start M/S Correction **Bit 5**	0	M/S Correction not started.
	1	Start Master/Slave Position correction. See chapter 11.4.7.1 “Master/Slave Position Correction”.
Direct Sync **Bit 6**	0	Direct Synchronisation enabled.
	1	Direct Synchronisation disabled.
Halt **Bit 8**	0	Execute command from bit 4 “Start el. gear”.
	1	Stop axis with ramp of current motion block The frequency inverter remains in “Operation enabled” status.
Start Phasing **Bit 9**	0	Phasing disabled / aborted.
	1	Start Phasing with profile defined by Bits 12 & 13.
Phasing select 0...1 **Bit 12...13**	n	Phasing Profile = n + 1

Phasing select

Control word															
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
		Ph. sw.				Pha	Stop		DS	MS	SG				
		1	**0**												

Phasing profile = Phasing switch over +1

Phasing select		Phasing profile
Bit 13	Bit 12	
0	0	1
0	1	2
1	0	3
1	1	4

Status word

Identification	Value	Description
Phasing done (or M/S Correction done) **Bit 8**	0	Phasing (or M/S Correction) in process or not started yet.
		Phasing (or M/S Correction) done.
	1	Single motion/automatic sequence active.
Target reached/ gear in **Bit 10**	0	Halt = 0: Electronic gear (still) not in gear
		Halt = 1: Axis decelerated.
	1	Halt = 0: Electronic gear in gear.
		Halt = 1 Axis has speed 0.
M/S Position Correction successful **Bit 12**	0	M/S Correction is running or wasn’t started yet.
	1	M/S Correction finished. See chapter 11.4.7.1 “Master/Slave Position Correction”.
Following error **Bit 13**	0	No following error.
	1	Following error.

Basic functions

Mode "-3 Electronic gear: Slave" implements a mode for a slave drive in the electronic gear to a master drive. The master of the electronic gear must be connected to the slave via signal cables or System Bus (recommended). The master input is selected in the Slave via parameter *Master position source* **1122**.

Master Position Source 1122	Function
0 - Off	No source selected.
1 - Encoder 1	The current speed and position of the master drive is taken over from encoder input 1.
2 - Encoder 2 / Resolver	The current speed and position of the master drive is taken over from encoder input 2 or resolver.
11 - RxPDO1.Long1 extrapolated	The current position of the master drive is taken over by the process data channel RxPDO1.Long1 of the system bus. Additionally, the data received are extrapolated, even for slow settings of TxPDO Time of the master. Depending on the application, select a setting of the corresponding TxPDO.Long of the master: "606 – Internal act. Position (16/16)", mechanical position of master drive. Value **will not change abruptly** when a homing operation of the master drive is completed. "607 – Act. Position (16/16)", mechanical position of master drive. Value will jump when the master drive carries out a homing operation. "620 – motion profile gen.: internal reference position", reference position of master drive; advantage: Improved controller properties. Value **will not change abruptly** when a homing operation of the master drive is completed. "627 - Motion profile gen.: reference position", reference position of master drive; advantage: Improved controller properties. Value will jump when the master drive carries out a homing operation. Settings 607 and 627 are only to be used in exceptional situations. In most applications, source 606 or 620 is the better setting.

In setting "11 - RxPDO1.Long1 extrapolated" of parameter *Master position source* **1122**, the *Operation mode* **1180** of the system bus synchronization must be set to 1 or 10 to ensure reliable functional operation.

Operation mode 1180
0 - Off [1]
1 - RxPDO1 [2]
2 - RxPDO2 [3]
3 - RxPDO3 [3]
10 - SYNC

[1] If the error message "F1453 Systembus-Synchronization not activated" is displayed when the slave drive is started, operation mode 1, 2, 3 or 10 must be selected.

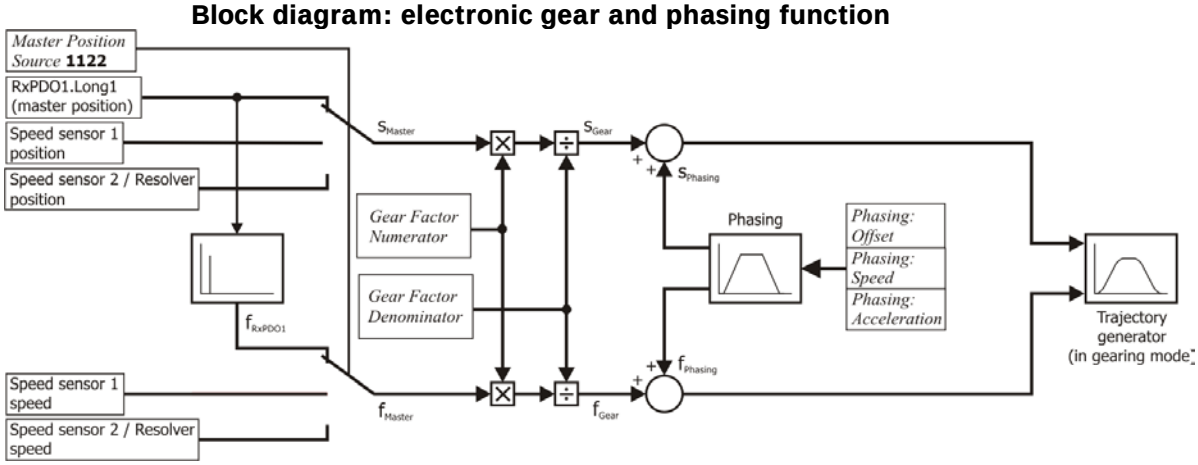
[2] Synchronization of processing with data message or cyclic sending of SYNC message.

[3] Not recommended for el. gear because no extrapolation carried out.

Synchronization between several drives must be performed at high updating rates in order to guarantee optimum results. In the transmitter of the TxPDO object, set a low value for the time (e.g. *TxPDO1 Time* **931**). If you use the SYNC function of Systembus, set parameter *SYNC time* **919** to a lower value.
Note that, due to these settings, the bus load of the Systembus must provide for sufficient reserves for proper operation.

Systembus is described in the manuals of the extension modules with Systembus interface.

Block diagram: electronic gear and phasing function



The master position and speed are multiplied by the *gear factor*. When phasing is started, the phasing profile is added to the master speed until the phasing offset is reached.

Start electronic gear and phasing function

The electronic gear is started by control word bit 4 “Start electronic gear”. The drive accelerates as specified in *Acceleration* **1295**. Once the slave speed is coupled into the master, status word bit 10 “Target reached/In Gear” is set. The conditions for “In Gear” status are set via parameters *In Gear'-Threshold* **1168** and *In Gear'-Time* **1169**.

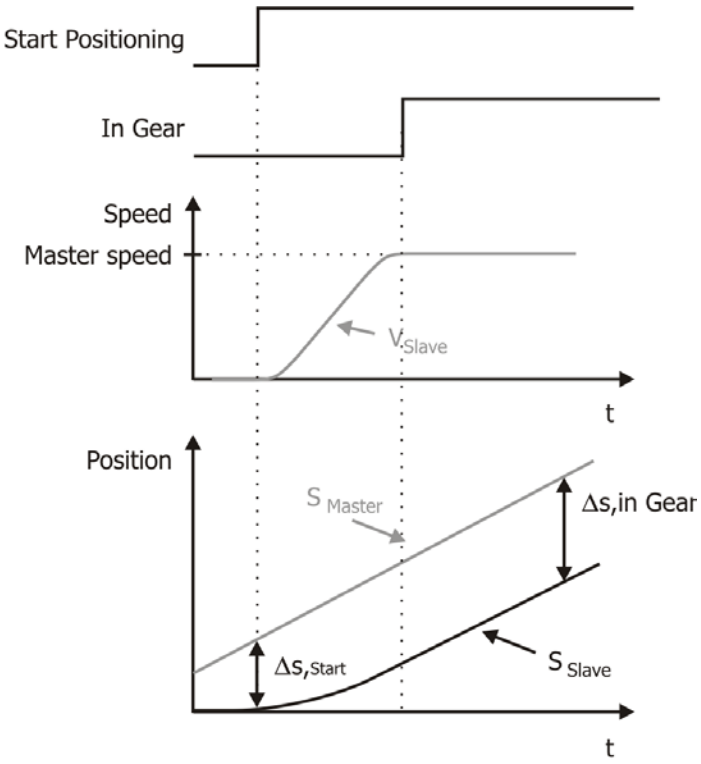
“Target reached/In Gear” is set when the electronic gear function is used and electronic gear synchronous running is reached.

Setting *Halt* “1” will stop a currently executed movement. The axle is stopped with the ramp **1296** *S.Deceleration*. “Target reached” is set to “0” to start the deceleration and to “1” when the speed reaches value 0. The drive remains in “Operation – enabled” status. To continue the interrupted movement, reset *Halt* to “0”. Bit “Target reached” is set to “0” to start the acceleration and to “1” when the conditions for “Gear in” of parameters *In Gear'-Threshold* **1168** and *In Gear’-Time* **1169** are reached.

Phasing
With the phasing function, the slave position is offset from the master position received by the value of *Phasing: Offset* **1125**.

Function without direct synchronization
("Standard Synchronization")

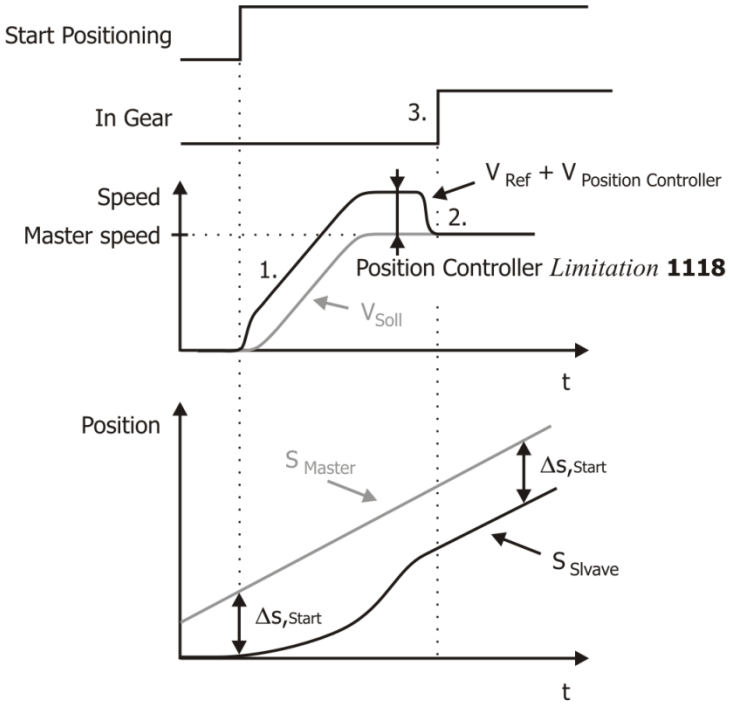
The drive accelerates the master speed with the ramps parameterized in the motion block. As soon as the master speed is reached for the first time, the drive is synchronized with the master drive. The slave is engaged at the current position and operates at a synchronous angle to the master. In the case of a relative positioning operation, this engaging position is used as the start position.
The acceleration and deceleration for synchronizations follow an S-curve.
The relative position change due to acceleration is not compensated.



Function with direct synchronization

The drive accelerates the master speed with the ramps parameterized in the motion block. When the motion block is started, the drive is synchronized with the master drive directly. The master position is processed directly by the position controller.
The acceleration and deceleration for synchronizations follow an S-curve.

The relative position change due to acceleration is compensated by the position controller.



11.4.7.1 Master/Slave Position Correction

NOTE

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

The Master/Slave Position Correction offers as part of the Electronic Gear the possibility to synchronize the absolute Position of the Slave to the absolute Position of the master.
This function is helpful in example in applications, in which drives often work independently from each other and have to work together for certain activities. In example this could be the case in crane applications, where normal loads are operated intently from each other and which are switched together for heavy loads. To speed up the switching together process, the Master/Slave Position correction can be used to synchronize the absolute position of the Slave with the absolute position of the Master.
Additionally by using an Offset a relative reference can be set up in the target position.

Preparations Master drive
The Master drive must be set up as follows:
TxPDO2 Identifier **927 =** 640 (or a different not used Identifier)
TxPDO2 Function **932** = 1 – controlled by time or 2 – controlled by SYNC
TxPDO2.Long1 **964** = 743 – Act. Position [User Units]

Additionally the following parameters must be set according to the electronic gear:
TxPDO1.Long1 **954** corresponding to the description of *Master Position Source* **1122**
TxPDO1 Identifier **925 =** 384 (or a different not used Identifier)
TxPDO1 Function **930** = 1 – controlled by time or 2 – controlled by SYNC

Preparations Slave drive
The Slave drive must be set up as follows:
RxPDO2 Function **926 =** 640 (or the Identifier defined in the Master drive)

Additionally the following parameters must be set according to the electronic gear:
RxPDO1 Function **924 =** 384 (or the Identifier defined in the Master drive)
Source Master position **1122** = 11 – RxPDO1.Long

The function Master/Slave Position Correction expects the Target Position [u] always in RxPD2.Long. When using this function RxPDO2.Long1 and also RxPDO2.Word1, RxPDO2.Word2, RxPDO2.Boolean1 and RxPDO2.Boolean2 are not allowed to be used for any other purpose.

Starting of Master/Slave Position Correction in Slave drive

To start the Master/Slave Position correction at first Bit 4 and then Bit 5 have to be set in the Control word. Bit 5 is only allowed to be set when Bit 10 In Gear is shown in the Status word.

By setting Bit 5 in the Control word the Slave drive is started to position to the Master position + Offset.

The acceleration is done with Parameter *Acceleration* **1134**. The used velocity can be set up via Parameter *Fast Speed* **1132**.

As long as the Master/Slave Position correction is executed, Bit 12 is deactivated in the Status word. When the Master/Slave Position correction is finished successfully Bit 12 is set.

During the Correction sequence the Status word bit 8 “Master/Slave Position correction” is set to “Low”. As soon as the Master/Slave Position correction is finished or cancelled, the Bit is set to “High”. After first switch-on (or after a device reset) the “Phasing Done” bit is also “Low”.

Since Bit 8 is also used for Phasing, always the last started function is signaled by this bit.

Offset Reference

The Offset for the M/S Synchronization can be set via *M/S Synchronization offset* **1284**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1284	M/S Synchronisation-soffset	-2147483647 u	2147483647 u	0 u

Application limitations

The function can be used in most of all applications without any limitations. In applications with very long travelling distances the following must be checked:

- The position difference to be compensated must not be greater than 2^{15}-1 motor revolutions.
- The position difference to be compensated must not be greater than 2^{31}-1 user units.

Depending on the used reference system it can vary, which limit is decisive. Always the smaller limit must be complied with.

A motor with a reference speed of 6000 rpm would have to travel for around 5.5 minutes into one direction to exceed this limit.

11.4.7.2 Sequence example

In order to start “Electronic Gear: Slave mode”, the correct sequence must be sent by the PLC.

	OUT IN	PZD1 Control word Status word	PZD11 r) Modes of operation Mod. Of. Op. Displ.	Remark
1		0x0000 0x0050	any any	Disable voltage Switch On Disabled
2			0xFFFD (=-3) 0xFFFD (=-3)	(Electronic Gear: Slave mode)
3		0x0006 0x0031	0xFFFD (=-3) 0xFFFE (=-3)	Shutdown Ready to switch on
4		0x0007 0x0033	0xFFFD (=-3) 0xFFFE (=-3)	Switch On Switched On
5		0x000F 0xnn37	0xFFFD (=-3) 0xFFFE (=-3)	Operation enabled, reference speed “0” Operation enabled
6a		0x001F 0xn327 0xn337 0xn727 0xn737	0xFFFD (=-3) 0xFFFD (=-3) 0xFFFD (=-3) 0xFFFD (=-3) 0xFFFD (=-3)	Start electronic gear without direct synchronization Operation enabled, Slave not coupled (yet), Phasing not finished. Operation enabled, Slave not coupled (yet), Phasing finished. Operation enabled, Slave coupled, Phasing not (yet) finished. Operation enabled, Slave coupled, Phasing finished.
6b		0x005F See 6a	0xFFFD (=-3) 0xFFFD (=-3)	Start Electronic Gear with Direct Synchronisation See 6a
7a		0x021F See 6a	0xFFFD (=-3) 0xFFFD (=-3)	Start Electronic Gear **without** Direct Synchronisation and Phasing Profile 1 See 6a
7b		0x121F See 6a	0xFFFD (=-3) 0xFFFD (=-3)	Start Electronic Gear without Direct Synchronisation and Phasing Profile 2 See 6a
7C		0x221F See 6a	0xFFFD (=-3) 0xFFFD (=-3)	Start Electronic Gear without Direct Synchronisation and Phasing Profile 3 See 6a
7d		0x321F See 6a	0xFFFD (=-3) 0xFFFD (=-3)	Start Electronic Gear without Direct Synchronisation and Phasing Profile 4 See 6a
8a		0x025F See 6a	0xFFFD (=-3) 0xFFFD (=-3)	Start Electronic Gear **with** Direct Synchronisation and Phasing Profile 1 See 6a
8b		0x125F See 6a	0xFFFD (=-3) 0xFFFD (=-3)	Start Electronic Gear **with** Direct Synchronisation and Phasing Profile 2 See 6a

8c		0x225F See 6a	0xFFFD (=-3) 0xFFFD (=-3)	Start Electronic Gear **with** Direct Synchronisation and Phasing Profile 3 See 6a
8d		0x225F See 6a	0xFFFD (=-3) 0xFFFD (=-3)	Start Electronic Gear **with** Direct Synchronisation and Phasing Profile 4 Disable voltage
9		0x001F 0x003F 0xnn37 0x1n37	0xFFFD (=-3) 0xFFFD (=-3)	Enable Operation, the Slave drive synchronizes to the Master position. Operation enabled M/S Position Correction finished.

r) permissible only when the recommended settings from 10.4 “Motion Control Mapping for PROFINET” have been made.

⚠ WARNING

Dangerous state due to new mode!

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

- BONFIGLIOLI VECTRON recommends checking the status word before changing the mode of operation (e.g. for status 0xnn33).

Once the sequence of the first four status words has been processed correctly, the ACU is ready for operation (dark table area).
In state “operation enabled” (0xnnnF), the state of the Motion Control can be changed (white table area).
Bit 4 “Start electronic gear” must be active during the movement. If bit 4 is reset to “0”, the movement is interrupted.
As long as 0x0007 is active, the mode of operation can also be changed safely. Once *modes of operation* has been set to another value, operation can be started with a corresponding sequence.

Bit 5 “Start Position Correction” is only allowed to be used when the Slave is in gear (Status word Bit 10).
Bit 5 “Start Position Correction” should be used for optimum results when the master drive doesn’t move.
When Bit 5 of the Control word is reset to “0” the movement is interrupted.

11.4.8 Motion Control configurations

For certain functions (e.g. “Technology Controller” or “Torque Reference value”) the reference percentage channel is required.

Reference percentages are transmitted by PROFINET via OUT-PZD3. The following sources can be set for parameter *Reference percentage source* **476**, for example:

96 -	Absolute value Profibus OUT-PZD 3	PROFINET OUT-PZD3 is the reference value source as an absolute value.
196 -	+/- Profibus OUT-PZD3	PROFINET OUT-PZD3 is the reference value source as a value with sigh.

12 Parameter List

The parameter list is structured according to the menu branches of the control unit. For better overview, the parameters are marked with pictograms:

The parameter is available in the four data sets.

☑ The parameter value is set by the SETUP routine.

⊗ This parameter cannot be written when the frequency inverter is in operation.

12.1 Actual values

No.	Description	Unit	Indication range	Chapter
Actual values of frequency inverter				
228	Internal reference frequency	Hz	-1000.00 ... 1000.00	11.3.3
249	Active dataset	-	1 ... 4	11
250	Digital inputs	-	0 ... 255	11.1
260	Current error	-	0 ... 0xFFFF	13.5
270	Warnings	-	0 ... 0xFFFF	13.3
274	Warning application	-	0 ... 0xFFFF	13.4
282	Reference bus frequency	Hz	-1000.00 ... 1000.00	11.3.3
283	Reference ramp frequency	Hz	-1000.00 ... 1000.00	11.3.3
Actual values of Motion Control Interface (MCI)				
1108	Actual Position	u	-2147483647 ... 2147483647	10.2.4
1109	Act. Contouring Error	u	-2147483647 ... 2147483647	10.2.4

Parameters *Current error* **260,** *Warnings* **270** and *Application warnings* **274** are only accessible via the communication channel of objects PPO1 and PPO2. They cannot be addressed via the VPlus control software or the KP500 control unit.

12.2 Parameters

PROFINET				
No.	**Description**	**Unit**	**Setting range**	**Chapter**
Rated motor values				
371	Rated current	Hz		8.3.3
373	No. of pole pairs	-	1 ... 24	10.2.1
375	Rated frequency	Hz	10.00 ... 1000.00	11.3.3
PROFIBUS/PROFINET				
388	Bus Error Behaviour	-	0 ... 5	6.5
390	Profibus/PROFINET reference	Hz	0.00 ... 999.99	11.3.3
Bus control				
392	Transition 5	-	0 ... 5	11.3.2
412	Local/Remote	-	0 ... 44	11
Data set switching				
414	Data set selection	-	0 ... 4	11
Frequency ramps				
420	Acceleration (Clockwise)	Hz/s	0.00 ... 9999.99	10.1, 10.2.8, 11.3, 11.4.1
421	Deceleration (Clockwise)	Hz/s	0.01 ... 9999.99	
422	Acceleration Anticlockwise	Hz/s	-0.01 ... 9999.99	
423	Deceleration Anticlockwise	Hz/s	-0.01 ... 9999.99	
424	Emergency Stop Clockwise	Hz/s	0.01 ... 9999.99	
425	Emergency Stop Anticlockwise	Hz/s	0.01 ... 9999.99	
430	Ramp Rise Time Clockwise	ms	0 ... 2000	10.2.8, 11.3, 11.4.1
431	Ramp Fall Time Clockwise	ms	0 ... 2000	
432	Ramp Rise Time Anticlockwise	ms	0 ... 2000	
433	Ramp Fall Time Anticlockwise	ms	0 ... 2000	
434	Reference Ramp	-	1 ... 3	11.3.3
Digital outputs				
549	Max. Control deviation	%	0.01 ... 20.00	11.1.1, 11.2.1
Stopping behavior				
637	Switch-off threshold	%	0.0 ... 100.0	11.3.1, 11.3.2
638	Holding time	s	0.0 ... 200.0	
Motion Control Interface: Reference system				
1115	Feed constant		1 ... 2147483647	10.2.1
1116	Gear: Shaft revolutions		1 ... 65535	
1117	Gear: Motor revolutions		1 ... 65535	
Electronic gear				
1122	Master position source	-	Selection	11.4.7
Motion Control Interface: Homing				
1130	Homing mode		0 ... 35	10.1, 10.2.9, 11.4.4
1131	Home offset		-2147483647 ... 2147483647	
1132	Fast speed		1 ... 2147483647	
1133	Creep speed		1 ... 2147483647	
1134	Acceleration		1 ... 2147483647	
1135	Ramp time		0 ... 2000	
Motion Control Interface: Limit switch fault reaction				
1143	Fault Reaction		0 ... 3, 10	10.3
Motion Control Interface: Fixed speed values				
1170	Fixed speed 1	u/s	-2147483647 ... 2147483647	10.2.6, 10.4

Motion Control Interface: Profile position mode				
No.	**Description**	**Unit**	**Setting range**	**Chapter**
1175	Acceleration	u/s^2	1 ... 2147483647	10.2.6, 10.4
1176	Ramp time Accel.	ms	0 ... 2000	
1177	Deceleration	u/s^2	1 ... 2147483647	
1178	Ramp time Decel.	ms	0 ... 2000	
1179	Emergency stop ramp	u/s^2	1 ... 2147483647	
Systembus				
1180	Operation mode	-	Selection	11.4.7
Motion Control Interface: Velocity Mode				
1275	Max Slippage	u/s	0 ... 2147483647	11.4.2
1276	Velocity Window	u/s	0 ... 65535	
1277	Velocity Window Time	ms	0 ... 65535	
1277	Threshold Window	u/s	0 ... 65535	
1279	Threshold Window Time	ms	0 ... 65535	
Master/Slave Position Correction				
1284	M/S Synchronisation offset	u	-2147483647 ... 2147483647	11.4.7.1
Motion Control Interface: Mapping				
1285	S. Target velocity pv [u/s]	-	Selection	10.1
1292	S. Modes of Operation	-	Selection	10.1, 10.2.2, 10.4, 10.5
1293	S. Target Position	-	Selection	10.1, 10.2.6, 10.4, 10.5
1294	S. Profile Velocity	-	Selection	
1295	S. Acceleration	-	Selection	
1296	S. Deceleration	-	Selection	
1297	S. Target Velocity vl [rpm]	-	Selection	
1299	S. Special Function Generator	-	Selection	11.4.1
PROFIBUS/PROFINET				
1300 . . . 1324	In-PZD 3 Boolean all In-PZD parameters In-PZD 11/12 Long	- -		8.3.3, 10.4
Motion Control Override				
1454	Override Modes Of Operation	-	Selection	10.5
1455	Override Target Position	-	-2^{31}-1...2^{31}-1 u	
1456	Override Profile Velocity	-	-1...2^{31}-1 u/s	
1457	Override Profile Acceleration	-	-1...2^{31}-1 u/s²	
1458	Override Profile Deceleration	-	-1...2^{31}-1 u/s²	
1459	Override Target velocity vl [rpm]	-	-32768...32767 rpm	
1460	Override Target velocity pv [u/s]	-	-2^{31}-1...2^{31}-1 u/s	

Parameter *Data set selection***414** is only accessible via the communication channel of objects PPO1 and PPO2. It cannot be addressed via the VPlus control software or the KP500 control unit.

For information about positioning and use of the Motion Control Interface, refer to the application manual “Positioning”.

13 Appendix

13.1 Control Word overview

The tables on this page provide an overview of the functions of the **control word** bits.

Bit	*Standard (No Positioning)*	*Positioning without MCI*	*MCI: Velocity Mode*	*MCI: Profile Velocity Mode*	*MCI: Profile Position Mode*
0	Switch On	Switch On	Switch On	Switch On	Switch On
1	Enable Voltage	Enable Voltage	Enable Voltage	Enable Voltage	Enable Voltage
2	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)
3	Enable Operation	Enable Operation	Enable Operation	Enable Operation	Enable Operation
4			Rfg enable		New setpoint
5			Rfg unlock		Change set immediately
6			Rfg use ref		Abs/rel
7	Fault reset	Fault reset	Fault reset	Fault reset	Fault reset
8	Halt	Halt	Halt	Halt	Halt
9					Change on setpoint
10					
11					
12					
13					
14					
15					

Bit	*MCI: Homing Mode*	*MCI: Table travel record Mode*	*MCI: Move away from Limit Sw.*	*MCI: Electronic Gear: Slave*
0	Switch On	Switch On	Switch On	Switch On
1	Enable Voltage	Enable Voltage	Enable Voltage	Enable Voltage
2	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)
3	Enable Operation	Enable Operation	Enable Operation	Enable Operation
4	Homing operat.start	Sequence mode	Move away from LS	Start Gearing
5				
6		Resume		Direct Sync
7	Fault reset	Fault reset	Fault reset	Fault reset
8	Halt	Halt	Halt	Halt
9		Start motion block		Start Phasing
10				
11		Motion Block Select 0		
12		Motion Block Select 1		Phasing Profile Sel. 1
13		Motion Block Select 2		Phasing Profile Sel. 2
14		Motion Block Select 3		
15		Motion Block Select 4		

13.2 Status Word overview

The tables on this page list in an overview the functionality of the **Status Word** bits.

Bit	*Standard (No Positioning)*	*Positioning without MCI*	*MCI: Velocity Mode*	*MCI: Profile Velocity Mode*	*MCI: Profile Position Mode*
0	Ready to Switch On	Ready to Switch On	Ready to Switch On	Ready to Switch On	Ready to Switch On
1	Switched On	Switched On	Switched On	Switched On	Switched On
2	Operation enabled	Operation enabled	Operation enabled	Operation enabled	Operation enabled
3	Fault	Fault	Fault	Fault	Fault
4	Voltage enabled	Voltage enabled	Voltage enabled	Voltage enabled	Voltage enabled
5	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)
6	Switch On Disabled	Switch On Disabled	Switch On Disabled	Switch On Disabled	Switch On Disabled
7	Warning	Warning	Warning	Warning	Warning
8		Homing done			
9	Remote	Remote	Remote	Remote	Remote
10	Target reached	Target reached	Target reached	Target reached	Target reached
11	Internal limit active	Internal limit active	Internal limit active	Internal limit active	Internal limit active
12				Speed	Set-point acknowl.
13				Max slippage error	Following error
14		Target Pos. reached			
15	Warning 2	Warning 2	Warning 2	Warning 2	Warning 2

Bit	*MCI: Homing Mode*	*MCI: Table travel record Mode*	*MCI: Move away from Limit Sw.*	*MCI: Electronic Gear: Slave*
0	Ready to Switch On	Ready to Switch On	Ready to Switch On	Ready to Switch On
1	Switched On	Switched On	Switched On	Switched On
2	Operation enabled	Operation enabled	Operation enabled	Operation enabled
3	Fault	Fault	Fault	Fault
4	Voltage enabled	Voltage enabled	Voltage enabled	Voltage enabled
5	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)	Quick Stop (low active)
6	Switch On Disabled	Switch On Disabled	Switch On Disabled	Switch On Disabled
7	Warning	Warning	Warning	Warning
8		Motion Block in Progress		Phasing Done
9	Remote	Remote	Remote	Remote
10	Target reached	Target reached	Target reached	Target reached
11	Internal limit active	Internal limit active	Internal limit active	Internal limit active
12	Homing attained	In gear		
13	Homing error	Following error		Following error
14				
15	Warning 2	Warning 2	Warning 2	Warning 2

13.3 Warning messages

The different control methods and the hardware of the frequency inverter include functions for continuous monitoring of the application. In addition to the messages documented in the frequency inverter Operating Instructions, further warning messages are activated by the PROFINET communication module CM-PROFINET. The bit-coded warning reports are issued via parameter *Warnings* **270** according to the following pattern: Parameter *Warnings* **270** is provided for read-out via a PLC, Parameter *Warnings* **269** provides the information, including a brief description in VPlus and the KP500 control unit.

Warning messages		
Bit no.	**Warning code**	**Description**
0	0x0001	Warning Ixt
1	0x0002	Warning short-time Ixt
2	0x0004	Warning long-time Ixt
3	0x0008	Warning heat sink temperature Tk
4	0x0010	Warning inside temperature Ti
5	0x0020	Warning Limit
6	0x0040	Warning Init
7	0x0080	Motor temperature warning
8	0x0100	Warning mains failure
9	0x0200	Warning motor circuit breaker
10	0x0400	Warning Fmax
11	0x0800	Warning analog input MFI1A
12	0x1000	Warning analog input A2
13	0x2000	Warning Systembus
14	0x4000	Warning Udc
15	0x8000	Warning *Application warning status* **367**

The meanings of the individual warnings are described in detail in the frequency inverter Operating Instructions.

13.4 Application warning messages

When the highest bit of the warning message is set, an “Application warning message” is present. The application warning messages are bit-encoded as per the following pattern via parameter *Application warnings* **274.** Parameter *Application warnings* **273** indicates the warnings as plain text in the control panel and the VPLus PC control software.
Use parameter *Application warnings* **274** in order to read the warning messages via Field Bus.

Application warning messages			
Bit no.	**Warning code**	**Description**	
0	0x0001	BELT	- V-belt
1	0x0002	SW-LIM CW	– SW limit switch clockwise
2	0x0004	SW-LIM CCW	– SW limit switch anticlockwise
3	0x0008	HW-LIM CW	– HW limit switch clockwise
4	0x0010	HW-LIM CCW	– HW limit switch anticlockwise
5	0x0020	CONT	– contouring error
6	0x0040	ENC	– Warning Absolute encoder
7	0x0080	User 1	– User Warning 1
8	0x0100	User 2	– User Warning 2
9	0x0200	(reserved)	
10	0x0400	(reserved)	
11	0x0800	(reserved)	
12	0x1000	(reserved)	
13	0x2000	(reserved)	
14	0x4000	(reserved)	
15	0x8000	(reserved)	

For details on the warnings, refer to the frequency inverter Operating Instructions and the “Positioning” application manual.
The Warning Bit 6 “Absolute encoder” can be read out via Parameter **1274** in VPlus or **1273** via field bus. The Absolute encoder warnings are described in detail in the Extension manual EM-ABS-01.

13.5 Error messages

The error code stored following a fault comprises the error group FXX (high-byte, hexadecimal) and the code YY (low-byte, hexadecimal).

Communication error

	Key		Meaning
Motion Control Interface	F04	04	Control Deviation Position Controller
	F14	42	Pos. SW Limit Switch
		43	Neg. SW Limit Switch
		44	Pos. SW Limit Sw. < Neg. SW Limit Sw.
		45	Pos. and Neg. HW-Lim Switch Simultaneously
		46	Limit Switch Incorrect Wired
		47	Pos. HW Limit Switch
		48	Neg. HW Limit Switch
		51	Switch: Pos. Dir. Blocked
		52	Switch: Neg. Dir. Blocked
		53	System bus-Synchronization not activated
		60	Pos. HW Limit Sw.: Non-permissible signal source
		61	Pos. HW Limit Sw.: Input deactivated by PWM /FF input
		62	Pos. HW Limit Sw.: Input deactivated of index controller
		63	Pos. HW Limit Sw.: wrong mode for MFI1
		64	Pos. HW Limit Sw.: Input deactivated by encoder 1
		65	Pos. HW Limit Sw.: Input deactivated by encoder 2
		66	Pos. HW Limit Sw.: wrong mode for EM-S1IOD
		70	Neg. HW Limit Sw.: Non-permissible signal source
		71	Neg. HW Limit Sw.: Input deactivated by PWM /FF input
		72	Neg. HW Limit Sw.: Input deactivated of index controller
		73	Neg. HW Limit Sw.: wrong mode for MFI1
		74	Neg. HW Limit Sw.: Input deactivated by encoder 1
		75	Neg. HW Limit Sw.: Input deactivated by encoder 2
		76	Neg. HW Limit Sw.: wrong mode for EM-S1IOD
	F15	xx	User-Defined Error in Motion Block xx ($1 \leq xx \leq 32$)
		70	No Homing Done
		71	Homing Encoder-Mode without Z-Impulse
		72	Both Directions Locked
		73	No Touch Probe Signal Detected
		74	M/S Position Correction: Master Position source not set. Check chapter 11.4.7.1 “Master/Slave Position Correction”.
PROFINET	F27	14	Communication loss to PLC*
		50	PNIO Configuration Error (wrong configuration of cyclic data objects PZD)

* This message is only displayed if *Bus Error Behaviour* **388** ≠ 0.

The current error can be read via parameter *Current error* **260**.
Parameter *Current error* **259** indicates the current error as plain text in the control panel and the VPlus PC control software.
In addition to the error messages mentioned, there are other error messages specified in the Operating Instructions. The errors of the Motion Control Interface (F14xx, F15xx) are described in detail in the “Positioning” application manual.

13.6 Homing modes

For parameter *Homing Mode* **1130** the following settings are available:

Homing Mode 1130		Function
0 -	No Homing Done	**Factory setting.** No homing; the current position value is not changed. The current position value is the value saved upon last disconnection of power supply.
1 -	Neg. Limit switch & zero impulse	Homing to negative HW limit switch with detection of encoder ref. signal
2 -	Pos. limit switch & zero impulse	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 Ref. 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 Ref. 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 Ref. 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 Ref. position is the first encoder ref. signal to the left of the edge of the home switch signal.
7 -	Pos. Limit Sw., zero pulse to the left of left home switch edge	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. Ref. 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. Limit Sw., zero pulse to the right of left home switch edge	
9 -	Pos. Limit Sw., zero pulse to the left of right home switch edge	
10 -	Pos. Limit Sw., zero pulse to the right of right home switch edge	
11 -	Neg. Limit Sw., zero pulse to the right of right home switch edge	Homing to home switch with detection of encoder ref. signal Homing direction negative (anticlock-wise). Reversal of direction of rotation when nega-tive HW limit switch is reached. Ref. 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. Limit Sw., zero pulse to the left of right home switch edge	
13 -	Neg. Limit Sw., zero pulse to the right of left home switch edge	
14 -	Neg. Limit Sw., zero pulse to the left of left home switch edge	
17...30: like 1 ... 14, but without encoder ref. signal		
17 -	Neg. Limit Switch	Moving to negative HW limit switch.
18 -	Pos. Limit Switch	Moving to positive HW limit switch.
19 -	Pos. Home-Sw., to the left of edge	Moving to positive home switch. Home position is to the left of the edge of the home switch signal.
20 -	Pos. Home-Sw., to the right of edge	Moving to positive home switch. Home position is to the right of the edge of the home switch signal.
21 -	Neg. Home-Sw., to the right of edge	Moving to negative home switch. Home position is to the right of the edge of the home switch signal.
22 -	Neg. Home-Sw., to the left of edge	Moving to negative home switch. Home position is to the left of the edge of the home switch signal.

Homing Mode 1130		Function
23 -	Pos. Limit Sw., to the left of left home switch edge	Moving to home switch. Homing direction positive (clockwise). Reversal of direction of rotation when positive HW limit switch is reached. Ref. position is to the left or right of the left or right edge of the home switch signal.
24 -	Pos. Limit Sw., to the right of left home switch edge	
25 -	Pos. Limit Sw., to the left of right home switch edge	
26 -	Pos. Limit Sw., to the right of right home switch edge	
27 -	Neg. Limit Sw., to the right of right home switch edge	Moving to home switch. Homing direction negative (anticlockwise). Reversal of direction of rotation when negative HW limit switch is reached. Ref. position is to the left or right of the left or right edge of the home switch signal.
28 -	Neg. Limit Sw., to the left of right home switch edge	
29 -	Neg. Limit Sw., to the right of left home switch edge	
30 -	Neg. Limit Sw., to the left of left home switch edge	

33 -	zero impulse to the left of act. pos.	Ref. position is the first encoder ref. signal in negative (operation mode 33) or positive (operation mode 34) direction.
34 -	zero impulse to the right of act. pos.	
35 -	Current position	Current position is ref. position. Home offset (Parameter *Home offset* **1131**) is taken over as actual position value.

For detailed descriptions of the homing modes, refer to the “Positioning” application manual.

13.7 Conversions

The speeds/frequencies can be converted to other speed formats using the formulas in this chapter:

Frequency [Hz] into	speed [1/min]	See Chapter 13.7.2
	Speed into user units per second [u/s]	See Chapter 13.7.4
Speed [1/min] in	Frequency [Hz]	See Chapter 13.7.1
	Speed into user units per second [u/s]	See Chapter 13.7.6
Speed into user units per second [u/s] into	Speed [1/min]	See Chapter 13.7.5
	Frequency [Hz]	See Chapter 13.7.3

13.7.1 Speed [1/min] into frequency [Hz]

$$f\ [\mathrm{Hz}] = \frac{n[\mathrm{min}^{-1}] \times No.\,of\ pole\ pairs\ \ (P.373)}{60}$$

13.7.2 Frequency [Hz] into speed [1/min]

$$n[rpm] = \frac{f\ [\mathrm{Hz}] \times 60}{No.\,of\ pole\ pairs\ (P.373)}$$

13.7.3 Speed in user units per second [u/s] into frequency [Hz]

$$f\ [\mathrm{Hz}] = v\ [\tfrac{\mathrm{u}}{\mathrm{s}}] \times \frac{No.\,of\ pole\ pairs\ (P.373)}{Feed\ Constant\ (P.1115)} \times \frac{Gear\ Box{:}\ Motor\ Shaft\ Revolutions\ (P.1117)}{Gear\ Box{:}\ Driving\ Shaft\ Revolutions (P.1116)}$$

13.7.4 Frequency [Hz] into speed in user units per second [u/s]

$$v\ [\tfrac{\mathrm{u}}{\mathrm{s}}] = f\ [\mathrm{Hz}] \times \frac{Feed\ Constant\ (P.1115)}{No.\,of\ pole\ pairs\ (P.373)} \times \frac{Gear\ Box{:}\ Driving\ Shaft\ Revolutions (P.1116)}{Gear\ Box{:}\ Motor\ Shaft\ Revolutions\ (P.1117)}$$

13.7.5 Speed in user units pro second [u/s] into speed [1/min]

$$n\ [rpm] = v\ [\tfrac{\mathrm{u}}{\mathrm{s}}] \times \frac{60}{Feed\ Constant\ (P.1115)} \times \frac{Gear\ Box{:}\ Motor\ Shaft\ Revolutions\ (P.1117)}{Gear\ Box{:}\ Driving\ Shaft\ Revolutions\ (P.1116)}$$

13.7.6 Speed [1/min] into speed in user units per second [u/s]

$$v\ [\tfrac{\mathrm{u}}{\mathrm{s}}] = n\ [rpm] \times \frac{Feed\ constant\ (P.1115)}{60} \times \frac{Gear\ Box{:}\ Driving\ Shaft\ Revolutions\ (P.1116)}{Gear\ Box{:}\ Motor\ Shaft\ Revolutions\ (P.1117)}$$

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